

Icelandic Centre of Excellence  
in Theoretical Computer Science  
(ICE-TCS)  
Annual Report, June 2007–May 2008

Luca Aceto      Magnús Már Halldórsson      Anna Ingólfssdóttir

## 1 Introduction

The Icelandic Centre of Excellence in Theoretical Computer Science (ICE-TCS) celebrated its third birthday on 29 April 2007. This third 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 during the third year of its existence. 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. In order to facilitate the evaluation of the Centre’s research activities by the aforementioned parties, this installment of our annual report includes, for the first time, a list of the publications by the members of the Centre since its inception. (See Appendix A.)

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 was started as a collaboration between the Department of Computer Science, Faculty of Engineering, University of Iceland, and the School of Computer Science, Reykjavík University, and is presently still based at both institutions. We remark, however, that the director of the centre, Magnús Már Halldórsson, took up a professorship at the School of Computer Science at Reykjavík University in August 2007. This means that most of the activities and the research carried out within the centre are presently taking place at Reykjavík University. We think that a healthy development of research and education in Theoretical Computer Science in Iceland will benefit from an increased level of activity at the University of Iceland; we are therefore pleased to point out that Mark Dukes, who is a researcher at the Department of Mathematics at the University of Iceland, joined the list of members of ICE-TCS in December 2007.

As highlighted in the mission statement for the Centre, ICE-TCS aims at conducting high-quality research in the areas of Theoretical Computer Science it covers and at making Theoretical Computer Science visible in Iceland. We believe that our research and its dissemination within the Icelandic (scientific) society will have a positive effect on the awareness of society at large that Computer Science has a deep scientific foundation, and that computing is not just a technology. The spreading of this message amongst high-school students may, for instance, entice more mathematically-inclined students to pursue a degree in Computer Science or to consider a minor degree in this subject. This may help combat the gradual decrease in the enrollments for Computer Science degrees at a time when our society is increasingly reliant on the ideas and artifacts arising from that field. Our efforts in this direction at Reykjavík University will be made easier by a recent move leading to the creation of a School of Computer Science that will soon also incorporate all the mathematicians based at Reykjavík University who are active within ICE-TCS. Having both computer scientists and mathematicians located within the School of Computer Science at Reykjavík University should create an excellent environment for the development of university degrees focussing on the mathematical foundations of Computer Science and on Discrete Mathematics. Preliminary enrollment figures in Computer Science and Mathematics at Reykjavík University for the academic year 2008–2009 seem to indicate that, hopefully also because of our outreach activities reported below, student interest in pursuing university education in Computer Science and Mathematics in Iceland is increasing. This bodes well for the future.

## 2 Executive Summary and Highlights for the Third Year

The third year of activities of the Centre has been by far the busiest so far. On the one hand, the members of the Centre have been doing the groundwork for the organization of **ICALP 2008**, the largest and most visible event in Computer Science ever organized in Iceland. On the other, we have striven to maintain a suitable level of activity in all of the core areas of business for the Centre.

### Events

**ICALP 2008** and its affiliated events will be held at Reykjavik University in the period 4–13 July 2008, with the main conference scheduled for 7–11 July. It seems that this edition of the conference will break all previous records. In response to the call for papers, the program committees received 472 submissions, the highest ever: 269 for track A, 122 for track B and 86 for track C. Out of these, 126 papers were selected for inclusion in the scientific program: 70 papers for track A, 32 for track B and 24 for track C. The selection was made by the program committees based on originality, quality, and relevance to Theoretical Computer Science. The quality of the manuscripts was very high indeed, and many deserving papers could not be selected. In addition, we received 16 workshop proposals, another record number, out of which 13 were selected. At the time of writing, it looks like 12 events will be co-located with the main conference.

Apart from the contributed papers, ICALP 2008 will feature five invited lectures and the presentation of two prestigious awards. The invited speakers for the conference will be Ran Canetti (IBM T. J. Watson Research Center and MIT, USA), Bruno Courcelle (Labri, Université Bordeaux, France), Javier Esparza (Technische Universität München, Germany), S. Muthukrishnan (Google, USA) and Peter Winkler (Dartmouth, USA). The EATCS Award 2008 and the Gödel Prize 2008 will also be awarded at the conference in a special ceremony that will take place in the afternoon of July 10. The EATCS Award is given in recognition of a distinguished career in Theoretical Computer Science. The recipient of the 2008 EATCS Award is Leslie G. Valiant (Harvard, USA). The 2008 Gödel Prize for outstanding journal articles in the area of Theoretical Computer Science, co-sponsored by the EATCS and ACM SIGACT, will be awarded to the paper *Smoothed analysis of algorithms: Why the simplex algorithm usually takes polynomial time* by Daniel A. Spielman and Shang-Hua Teng, *Journal of the ACM (JACM)*, 51(3), May 2004, 385–463. All the recipients of the above-mentioned awards will attend the conference and will deliver talks during the award session.

The list of special events at ICALP 2008 is completed by a special session devoted to a masterclass on mathematical puzzles for “kids of all ages”. The mas-

terclass will be given by Peter Winkler (Dartmouth, USA), who is the author of two famous books on mathematical puzzles and a noted expositor. We trust that this session will bring ICALP closer to the Icelandic general public and will generate further visibility for Theoretical Computer Science and Discrete Mathematics in the media.

Apart from being busy with the organization of ICALP 2008, ICE-TCS has continued holding and sponsoring a good number of events. The aim of these events is to help to create a stimulating research environment in Computer Science in Iceland. Apart from the immediate positive effect that these activities have on the local research community, we believe that they also play a major role in making ICE-TCS an attractive research centre for foreign visitors and research students from Iceland and abroad.

The organization of international conferences and workshops in Iceland plays a major role in the Centre's strategy to achieve a high level of international visibility. In the reporting period, Magnús M. Halldórsson and Anna Ingólfssdóttir helped co-organize NordSec 2007, the [12th Nordic Workshop on Secure IT Systems](#) (held in the period 11–12 October 2007 at Reykjavik University). The workshop was attended by about 45–50 researchers from all over Europe, and featured two high-quality invited talks by Cédric Fournet (Microsoft Research, Cambridge, UK) and Greg Morrisett (Harvard University, USA).

In addition to NordSec, we organized two installments of our yearly Theory Day. The Theory Day for 2007 was held at Reykjavik University on Friday, 10 August 2007. The programme for the event, which was attended by about 20 participants, included Magnús M. Halldórsson's inaugural professorial address at Reykjavik University as well as an invited talk by Thomas Erlebach (University of Leicester, UK) entitled *Network Discovery Problems*. The full programme of talks is available at <http://www.ru.is/ICETCS/theoryday2007/>. The Theory Day for 2008 was instead held on Friday, 30 May 2008, at Reykjavik University. The fourth edition of this event was the first ever without an invited speaker from outside Iceland. However, we were able to offer a varied programme of talks connecting Theoretical Computer Science and Discrete Mathematics to areas ranging from Artificial Intelligence to Wireless Sensor Networks. The full programme of talks for the Theory Day 2008 is available at <http://www.icetcs.ru.is/theory-day2008.txt>.

The existence of ICE-TCS and the support it offers to colleagues from the international research community in the organization of events in Iceland is beginning to help make Iceland a possible venue for Computer Science events. For instance, ICE-TCS helped organize the 2007 meeting of IFIP Working Group 2.8 on Functional Programming in Iceland in the period 16–20 July 2007. The event was attended by about 40 members of that working group. As part of ICALP 2008,

Magnús M. Halldórsson will co-organize the workshop *MATCH-UP: Matching Under Preferences - Algorithms and Complexity*.

Members of the Centre have also been active in the organization of events that were held outside Iceland. By way of example, we mention that Luca Aceto and Anna Ingólfssdóttir helped co-organize the workshop Applying Concurrency Research in Industry (IFIP WG 1.8), co-located with CONCUR 2007, Lisbon, Portugal. The workshop has given rise to a healthy debate within the concurrency-theory community on the possible interplay between its research and industrial concerns.

Not surprisingly, however, the main organizational efforts during the reporting period were devoted to the organization of **ICALP 2008**. We trust that the organization of a conference of the size and tradition of ICALP will consolidate the status of ICE-TCS within the international research community in theoretical computer science. At the time of writing, we estimate that ICALP and its affiliated events will attract over 380 colleagues to Reykjavik University.

Despite the substantial effort that ICE-TCS is putting into the organization of ICALP 2008, we still intend to continue organizing highly-visible events in Computer Science and Discrete Mathematics in the near future. In particular, the combinatorics group within ICE-TCS will organize the 10th Nordic Combinatorial Conference at Reykjavik University in 2010. (Sergey Kitaev (Reykjavik University) will act as the chair of the organizing committee for the event. Einar Steingrimsón (Reykjavik University) is a member of the newly formed permanent steering committee for this series of workshops.) The same group has also been accepted as the hosts of the 2011 edition of FPSAC (Formal Power Series and Algebraic Combinatorics). This annual conference is the largest and most prestigious event in algebraic combinatorics. ICE-TCS is also considering making a bid for the organization of one of the forthcoming editions of the CONCUR conference, the premiere yearly event devoted to concurrency theory.

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, while events 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 is 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 27 seminars, not counting the talks delivered during the Theory Days.

## Networking and Outreach

As part of our efforts to make Theoretical Computer Science visible within the Icelandic (Computer) Science community, ICE-TCS organized its second public lecture on Friday, 25 April, 2008. The lecture, entitled *Computers are not Omnipotent*, was delivered to a good audience by David Harel (Weizmann Institute of Science, Israel) at Reykjavik University. In addition to this public lecture, which was aimed at a general public, David Harel gave a more technical talk entitled *In Silico Biology, or On Comprehensive and Realistic Modeling*. This talk, which was very well attended, generated a lot of interest from the many attendees working in the life sciences and biomedical engineering, amongst others, and helped raise the profile of computer science research in Icelandic academia.

As already mentioned previously, one of the special events held as part of ICALP 2008 will be a masterclass on mathematical puzzles for “kids of all ages”. The masterclass will be given by Peter Winkler (Dartmouth, USA), who is a noted expositor. Our aim in organizing this event is to generate further interest in Theoretical Computer Science and Discrete Mathematics in the general public within Iceland. The Icelandic Math Olympiad team will attend the event. We remark that, via the combinatorics group and the participation of Bjarni V. Halldórsson, during 2007 and 2008 ICE-TCS has been heavily involved in training the Icelandic Math Olympiad team (for the annual international competition of high school students).

An outreach event specifically aimed at children was the six-session course *An introduction to combinatorics* held by Sergey Kitaev in February and March 2008 as part of the *ad Astra* programme. (See <http://www.adastra.is/adastra/?id=133> for details.) The course was aimed at children between 12 and 16 years of age, and was attended by about eight kids every Saturday morning for six weeks. We plan to offer more courses like this one in the future.

Other educational initiatives that we started during the reporting period were aimed at BSc. and MSc. students. In order to arise interest in Theoretical Computer Science amongst our BSc. and beginning MSc. students, Luca Aceto, Magnús M. Halldórsson and Anna Ingólfssdóttir gave a series of introductory lectures on topics ranging from bisimulation games, model checking, structural operational semantics, temporal logics and characteristic formulae to Ramsey theory. These lectures were well attended, and saw the participation of colleagues from research areas other than Theoretical Computer Science. More recently we began two weekly reading groups on graphs and algorithms, and structural operational semantics. Both reading groups see the active participation of several MSc. 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 host 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. Of particular note here is the fruitful interplay between ICE-TCS and the **Mathematics Institute** at Reykjavík University. The members of the combinatorics group are, by any measure, amongst the most active contributors to ICE-TCS activities.

Despite the remote location of Iceland, ICE-TCS continues to be fairly successful in attracting visitors to the Centre. As we detail in Table 1, visits by short-term visitors have been spread relatively evenly over the course of the year. However, we should like to increase the number of medium-term visitors and to begin a long-term visitor programme. This will require specific funding that is at the moment unavailable. (We remark, however, that ICE-TCS has been instrumental in a recently-submitted pre-proposal for centre-of-excellence funding to the Icelandic Fund for Research (Rannis). See also Section 4.)

During the reporting period, ICE-TCS joined the network *COST295 - DYNAMO: Foundations and Algorithms for Dynamic Networks*. Magnús M. Halldórsson and his research associates will represent the centre in this network. As part of the activities within the aforementioned network, ICE-TCS will host *DYNAMO 2008: Second Training School on Algorithmic Aspects of Dynamic Networks*. This training school for PhD. students and young researchers will be held as an affiliated event of ICALP 2008 in the period 4–6 July 2008 at Reykjavik University. More details about this summer school, which will be attended by more than 70 participants, are available at [http://www.liafa.jussieu.fr/~pierref/COST/Training\\_School\\_2008.html](http://www.liafa.jussieu.fr/~pierref/COST/Training_School_2008.html).

ICE-TCS research has from the start involved students and other young researchers, but this still happens in modest amounts. During the second year, members of ICE-TCS have supervised 3 MSc students in computer science, 3 MSc students in mathematics, and two PhD students. For these numbers to increase, the two main ingredients are student interest and funding. The consistent and increasing student attendance at events speak to the former, while the latter is largely determined by grant funding. Fortunately, ICE-TCS researchers have continued to be successful in the competitive awards for basic research given in 2008 by the Icelandic Fund for Research (Rannis). (See Section 4 for details.) In addition, members of the Centre continue to be active in setting up Erasmus exchange agreements, which are opening up new possibilities for both marketing the Centre's expertise around the European continent as well as enhancing the research education of the Centre's students. ICE-TCS has also been involved in two Erasmus Mundus proposals, but neither of those was funded. We are, however, working on establishing at least one joint master's degree programme with an Italian university. The core competences within ICE-TCS will play a major role in formulating

the educational objectives for the proposed MSc. degree.

## Research Highlights

The reporting period has been a rather successful one for the Centre as a whole. Below, we limit ourselves to pointing out a few of highlights of the work carried out within the third year of activity of the Centre.

- Yngvi Björnsson co-authored the paper *Checkers is Solved*. This paper was published in *Science* and was later named as one of the ten breakthroughs of the year by that journal. Yngvi Björnsson is also a member of the Center for Analysis and Design of Intelligent Agents (CADIA).
- Silvio Capobianco settled a long-standing open problem in the theory of one-dimensional cellular automata in collaboration with Patrizia Mentrasti and Tommaso Toffoli. The result is presented in the paper *When—and how—can a cellular automaton be rewritten as a lattice gas?*, which has been accepted for publication in *Theoretical Computer Science*.
- Sergey Kitaev’s paper *Introduction to partially ordered patterns* was named among the top 25 hottest articles in the journal *Discrete Applied Mathematics* in April–June 2007.
- During a sabbatical year spent at deCODE Genetics, Bjarni V. Halldórsson developed algorithms for detecting genetic copy number variations, and found genetic variants associating to osteoporosis and other traits. The results of this research were published in *Nature Genetics*, the *New England Journal of Medicine* and the *Proceedings of the National Academy of Sciences*.
- Magnús M. Halldórsson co-authored the paper *Robust Cost Colorings*. This paper was published in the *Proceedings of the ACM-SIAM Symposium on Discrete Algorithms 2008 (SODA 2008)*. SODA is widely considered the premiere conference devoted specifically to algorithmic research.
- Einar Steingrímsson’s paper *Permutation tableaux and permutation patterns*, co-authored with Lauren Williams, was amongst the Top 25 Hottest in *J. Combinatorial Theory Series A* during most of 2007 (all quarters except the third one).

In addition, it might be worth mentioning that Luca Aceto and Anna Ingólfssdóttir were amongst the authors of the book *Reactive Systems: Modelling, Specification and Verification* published by Cambridge University Press in August 2007.



The book is already used for courses in about ten universities throughout Europe. Moreover, Luca Aceto, Magnús M. Halldórsson and Anna Ingólfssdóttir co-edited the two-volume proceedings of ICALP 2008, which will be published by Springer-Verlag in July 2008 as volumes 5125 and 5126 of Lecture Notes in Computer Science.

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. Luca Aceto was one of the invited speakers at CONCUR 2007, which was held in Lisbon in September 2007. Luca Aceto and Anna Ingólfssdóttir delivered invited talks at *10 Years of Verification in Cachan*, 26–27 November 2007, ENS Cachan, France. (The event was organized by the Laboratoire Specification et Verification (LSV) to celebrate its 10th anniversary.) Sergey Kitaev was Visiting Scholar, University of St. Andrews, October 2007.

### **3 Current Members and Their Research Areas**

ICE-TCS has now ten permanent members (six at Reykjavík University, three at the University of Iceland and one having a joint appointment at deCODE Genetics and at Reykjavík University). The present members of the Centre are: Luca Aceto (Reykjavík University, Scientific Co-director), Yngvi Björnsson (Reykjavík University), Anders Claesson (Reykjavík University), Mark Dukes (University of Iceland), Hjálmtýr Hafsteinsson (University of Iceland), Bjarni V. Halldórsson (Reykjavík University and deCODE Genetics), Magnús M. Halldórsson (Reykjavík University, Scientific Director), Anna Ingólfssdóttir (Reykjavík University, Scientific Co-director), Sergey Kitaev (Reykjavík University), Sven Sigurdsson (University of Iceland) and Einar Steingrímsson (Reykjavík University). Marjan Sirjani (presently at the University of Tehran, Iran) will join Reykjavík University by the end of the year, and she will become a member of ICE-TCS upon her arrival in Iceland. She will bring to the Centre her expertise in Formal Methods in Software Engineering and other fields. In addition, Luca Q. Zamboni (Professor, University of North Texas, USA) is expected to join the Mathematics Institute and ICE-TCS in 2009.

In addition, the Centre hosts one postdoctoral researcher, Silvio Capobianco (Reykjavík University), whose main field of research is in the theory of cellular automata. During the reporting period, the Centre lost MohammadReza Mousavi, one its previous postdoctoral researchers, who has taken up an assistant professor position at the Department of Mathematics and Computer Science at the Technical University Eindhoven, The Netherlands. However, MohammadReza Mousavi continues to have a research connection with the Centre. For instance, he is one

of the principal investigators in one of the Centre's newly-awarded research grants, and he is one of the workshop organizers for ICALP 2008.

From the autumn 2008, the centre will hire two postdoctoral researchers within the combinatorics group, namely **Amy Glen** (presently a CRM-ISM Postdoctoral Research Fellow at the University of Quebec at Montreal, Canada) and **Robert Parviainen** (currently AMSI MASCOS research fellow, University of Melbourne, Australia). Moreover, Luca Aceto and Anna Ingólfssdóttir have just advertised a postdoctoral position, which they intend to fill by the end of the year.

With the current level of staffing and the upcoming hires, ICE-TCS has become 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, Cellular Automata, Combinatorics, Computational Science, Concurrency Theory, Machine Learning, Search Methods in Artificial Intelligence and Structural Operational Semantics.

Research efforts in the algorithms group in the past year include minimizing interference in sensor networks, fixed-parameter algorithms for non-crossing spanning trees, minimum parsimony haplotyping on tractable sub-instances, approximation algorithms for scheduling variants of graph coloring problems, and analysis of greedy algorithms for independent sets in hypergraphs.

The combinatorics group was involved in research related to pattern avoidance in permutations and to so-called two stack sortable permutations (arising in theoretical computer science). In particular, several connections between restricted permutations, certain types of trees, non-separable planar maps, and two stack sortable permutations were discovered.

The research efforts within the concurrency theory group have focussed on negative and positive results in the equational logic of process algebras, with emphasis on features like parallel composition, priority and real-time, on the meta-theory of structural operational semantics, on computer-aided verification and on the study of cellular automata.

## 4 Funding

ICE-TCS continues to operate on what is a shoestring budget by international standards. In the light of the restructuring that took place last year in the then School of Science and Engineering at Reykjavík University, the Centre was not able to use the seed money that had initially been made available to it for three years. This means that the activities of the Centre during the third year have been supported by a variety of sources in what can only be defined as an ad-hoc way. As in previous years, several research visits to the Centre have been supported by our rather extensive, and growing, 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. David Harel's very influential guest lectures have been sponsored by funding stemming from conservative financial planning for the Nordic Workshop on Programming Theory 2006. The combinatorics group has instead been able to secure funding for guests from various sources both within Reykjavík University and from the Icelandic Ministry for Education.

Fortunately, ICE-TCS researchers continue to be fairly successful in obtaining grants from Rannis (the Icelandic Fund for Research). In the latest round of applications for projects starting in January 2008, members of ICE-TCS have obtained three out of the 12 grants awarded for projects in Engineering, Science and Technology. The grants involved are:

- Project grant awarded to Luca Aceto and Anna Ingólfssdóttir for a three-year project on *New Developments in Operational Semantics*;
- Project grant awarded to Yngvi Björnsson for a three-year project on *General Game Playing*; and
- PhD. grant awarded to Einar Steingrímsson for work in algebraic combinatorics.

The resulting funding amounts to 12 million ISK (roughly 100,500 euros) for 2008. Since the inception of the Centre in 2005, ICE-TCS researchers have obtained funding for 87.5 million ISK (roughly 733,000 euros) from Rannis. This money has been topped up by some successful applications to the Development Fund of Reykjavík University.

In addition, the following grants awarded to ICE-TCS researchers in 2006 are still running:

- Excellence grant to work on “Algebraic combinatorics and permutation patterns” (Einar Steingrímsson, Anders Claesson and Sergey Kitaev);

- Project grant awarded to Magnús M. Halldórsson to collaborate with Fedor Fomin (University of Bergen, Norway) and Jaikumar Radhakrishnan (Tata Institute for Fundamental Research, India);
- Project grant on “The equational logic of processes” (Luca Aceto and Anna Ingólfssdóttir);
- Project grant on “Scheduling split intervals” (Magnús M. Halldórsson).

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 enormously if ICE-TCS had more funding.

ICE-TCS researchers have been lobbying for the development of specific funding sources for Centres of Excellence for some time. In a recent move, Rannis made some funding for this purpose available and issued a call for “pre-proposals” for such centres. ICE-TCS was instrumental in the organization of a consortium building on its strength and in the submission of a pre-proposal. We are now awaiting eagerly the results of the selection process. Rannis intends to invite about 10 pre-proposals to submit a full proposal in October. Out of these 10 proposals, between two and four will received funding for a period of up to seven years.

## **5 Activities for the Period June 2006–May 2007**

### **5.1 Guests**

During the second year of activities, we have received 15 guests from foreign institutions for short stays. These are listed in Table 1 in reverse chronological order. All of 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.

- Structural Operational Semantics 2007 (an affiliated workshop of LICS 2007 and ICALP 2007), July 9, 2007, Wroclaw, Poland. (Luca Aceto and MohammadReza Mousavi PC members)

David Harel, Department of Computer Science and Applied Mathematics, The Weizmann Institute of Science, Israel. Period: 21–27 April, 2008.

Marjan Sirjani (School of Electrical and Computer Engineering, University of Teheran, Iran). Period: 25–29 March 2008.

Bas Luttik, Department of Mathematics and Computer Science, Eindhoven University of Technology, and CWI, Amsterdam, The Netherlands. Period: 10–14 March 2008.

Luca Zamboni (Department of Mathematics, University of North Texas, USA). Period: 8–12 March, 2008.

Pall Melsted (Carnegie-Mellon University, USA). Period: 6–23 March, 2008.

Petter Brändén (Department of Mathematics, Royal Institute of Technology, Sweden). Period: 2–9 March, 2008.

Antti Rasila (Institute of Mathematics, Helsinki University of Technology, Finland). Period: 18–22 February, 2008.

Brian Nielsen, BRICS, CISS and Department of Computer Science, Aalborg University, Denmark. Period: 26 November–18 December, 2007.

Cédric Fournet (Microsoft Research, Cambridge, UK). Period: 11–12 October, 2007.

Greg Morrisett (Harvard University, USA). Period: 11–12 October, 2007.

Luca Tesei, Department of Mathematics and Computer Science, University of Camerino, Italy. Period: 17–21 September, 2007.

Emanuela Merelli, Department of Mathematics and Computer Science, University of Camerino, Italy. Period: 16–19 September, 2007.

Thomas Erlebach, Department of Computer Science, University of Leicester, UK. Period: 10 August, 2007.

Joseph S.B. Mitchell, Department of Applied Mathematics and Statistics, State University of New York at Stony Brook. Period: 18 July, 2007.

Jotun Hein, Department of Statistics, University of Oxford. Period: 4 June, 2007.

Table 1: ICE-TCS Guests in the Period June 2007–May 2007

- 33rd International Workshop on Graph-Theoretic Concepts in Computer Science (WG 2007), Dornburg near Jena, Germany, June 21–23, 2007. (Magnus Halldorsson PC member)
- ISAAC 2007. (Magnus Halldorsson PC member)
- IFIP WG 1.8 Workshop on Applying Concurrency Research in Industry at CONCUR 2007 in Lisbon on 7 September 2007. (This event was co-organized by Luca Aceto and Anna Ingolfsson with Jos Baeten, Wan Fokkink, and Uwe Nestmann (on behalf of IFIP WG1.8).)
- From Biology To Concurrency and back (FBTC) at CONCUR 2007 in Lisbon on 8 September 2007. (PC member: Anna Ingolfsson)
- 19th Nordic Workshop on Programming Theory (NWPT'07), Oslo, Norway, 10–12 October, 2007. (PC members: Luca Aceto and Anna Ingolfsson)
- NordSec 2007: The 12th Nordic Workshop on Secure IT Systems, 11-12 October 2007, Reykjavik, Iceland. (Co-organizers: Magnus M. Halldorsson and Anna Ingolfsson)
- FoSSaCS 2008, Budapest, Hungary. (Luca Aceto PC member)
- Thirtyfifth International Conference on Automata, Languages and Programming (ICALP 2008), Reykjavik, Iceland, 7–11 July, 2008. (Co-organizers: Luca Aceto, Magnus M. Halldorsson and Anna Ingolfsson)
- Matching Under Preferences - Algorithms and Complexity at ICALP 2008 in Reykjavik, Iceland, on 6 July 2008. (Co-organizer: Magnus M. Halldorsson)
- ALGOSENSORS 2008 - International Workshop on Algorithmic Aspects of Wireless Sensor Networks at ICALP 2008 in Reykjavik, Iceland, on 12 July 2008. (PC member: Magnus M. Halldorsson)
- From Biology To Concurrency and back (FBTC) 2008 at ICALP 2008 in Reykjavik, Iceland, on 12 July 2008. (PC member: Anna Ingolfsson)
- CONCUR 2008, Toronto, Canada, August 19–22, 2008. (PC member: Anna Ingolfsson)

See

<http://www.icetcs.ru.is/?node=16>

for further details.

### 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.

### 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 Icelandic research environment in Computer Science at large. To this end, during its third year of existence, 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 27 seminars in this series during the reporting period. (See <http://www.icetcs.ru.is/?node=17> 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 series of meetings on *Graphs and Algorithms* and on *Structural Operational Semantics*. Both reading groups involve MSc. students in order to get them interested in the topics covered and to provide them with some of the necessary background for working on an MSc. thesis in those areas.

### 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 is 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

### **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 Scientific Advisory Board of BICI (Bertinoro International Center for Informatics).
- Luca Aceto is a member of the EATCS council.
- Magnús M. Halldórsson is a member of the steering committee for the Scandinavian Workshop on Algorithm Theory series.
- Anna Ingólfssdóttir served as a member of the steering committee for ETAPS (March 2006-December 2007).
- Einar Steingrímsson is a member of the newly formed permanent steering committee for the Nordic Combinatorial Conference.

### **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)
- Discrete Mathematics and Theoretical Computer Science. (Magnús M. Halldórsson managing editor)
- Annals of Combinatorics. (Einar Steingrímsson guest editor)

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



on *Algorithmics* and *Theory of Computation*, at various levels, and new courses on *Bioinformatics*, on *Modelling and Verification* and on *Semantics of Programming Languages* at Reykjavík University. A new course on *Graph Theory* is being planned for the autumn semester 2008.

Members of the Centre have supervised the following MSc and PhD students.

- Unnar Thor Bachmann (Reykjavík University), MSc student working on his thesis supervised by Magnús M. Halldórsson. (The student was previously tutored by Anna Ingólfssdóttir.)
- Pawel Bartoszek (Reykjavík University), PhD student supervised by Einar Steingrímsson.
- Arnar Birgisson (Reykjavík University), MSc student working on his thesis supervised by Luca Aceto.
- Bergsteinn Einarsson (Reykjavík University), MSc student (Algebraic Combinatorics) working on his thesis supervised by Anders Claesson and Einar Steingrímsson.
- Vigdis Gudjonsdóttir (Reykjavík University), MSc student working on his thesis supervised by Anna Ingólfssdóttir.
- Hilmar Haukur Guðmundsson (Reykjavík University), MSc student (Algebraic Combinatorics) supervised by Sergey Kitaev and Einar Steingrímsson.
- Marteinn Hardarson (Reykjavík University), MSc student (Algebraic Combinatorics) supervised by Anders Claesson and Einar Steingrímsson.
- Elena Losievskaja (University of Iceland), PhD student supervised by Magnús M. Halldórsson.

As an important contribution to our educational effort, Luca Aceto and Anna Ingólfssdóttir have written a textbook on concurrency theory in cooperation with Kim G. Larsen and Jiri Srba. The book was published by Cambridge University Press in August 2007, and is already used for courses in ten universities throughout Europe.

## **6 Publications by Members of the Centre**

In the period covered by this report, ICE-TCS researchers have authored or edited the following six volumes:

- L. Aceto, M. Bravetti, W. Fokkink and A.D. Gordon. *Special Issue: Algebraic Process Calculi (The First Twenty Five Years and Beyond): Volume 3*. Journal of Logic and Algebraic Programming 75(1):1–166 (February-March 2008).
- L. Aceto, I. Damgård, L.A. Goldberg, M.M. Halldórsson, A. Ingólfssdóttir and I. Walukiewicz. *Automata, Languages and Programming, 35th International Colloquium, ICALP 2008, Reykjavik, Iceland, July 7–11, 2008, Proceedings, Parts I and II*. Lecture Notes in Computer Science volumes 5125 and 5126, Springer-Verlag, July 2008. To appear.
- L. Aceto and A. Ingólfssdóttir. Special issue of the Journal of Logic and Algebraic Programming devoted to selected papers presented at the Eighteenth Nordic Workshop on Programming Theory 2006, 18–20 October 2006, Reykjavík, Iceland. To appear in 2008.
- L. Aceto and A. Ingólfssdóttir. *Foundations of Software Science and Computation Structures: 9th International Conference, FOSSACS 2006: Special Issue*. Journal of Logic and Algebraic Programming 73(1–2): 1–146, September-October 2007.
- L. Aceto, A. Ingólfssdóttir, Kim G. Larsen and J. Srba. *Reactive Systems: Modelling, Specification and Verification*, Cambridge University Press, August 2007. ISBN-13: 9780521875462.
- Einar Steingrímsson. *Annals of Combinatorics*, special issue devoted to Permutation Patterns 2006. December 2007.

Other special issues of journals edited by ICE-TCS members are in preparation.

During the reporting period, ICE-TCS researchers published about 30 papers. 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 SODA, SWAT and FPSAC. Yngvi Björnsson’s work on search-methods in artificial intelligence is having 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. It suffices here to mention his work on solving checkers. Finally, ICE-TCS was well represented at CALCO 2007 (two papers) and will present two papers at TCS 2008.

Overall, the members of ICE-TCS have so far published one book, 12 edited volumes, four chapters in books and collections, 70 journal papers and 46 confer-

ence papers. Full details on the publications by members of the Centre since its inception may be found in Appendix A.

## 7 Forthcoming Activities

During the next twelve months, we plan to continue our work with the aim of achieving the objectives stated in Section 1.

We intend to continue expanding our visitors programme. In particular, we hope to be in a position to offer a small number of medium- to long-term visiting positions to selected researchers. The list of guests visiting ICE-TCS during the summer of this year is boosted by the large number of colleagues that will visit the centre during the ICALP 2008 conference. Moreover, as a warm-up for the scientific feast during ICALP, we will offer several talks by distinguished visiting researchers during June and very early July. More specifically, the following guests will be in residence at ICE-TCS over the next three weeks:

- 30 June–3 July 2008: Clifford Stein (IEOR and Department of Computer Science, Columbia University, USA);
- 30 June–31 July 2008: Bridget Eileen Tenner (Department of Mathematical Sciences, DePaul University, USA);
- 16–23 June 2008: Jeff Remmel (Department of Mathematics, University of California at San Diego, USA); and
- 15–20 June 2008: Tommaso Toffoli (Electrical and Computer Engineering Department, Boston University, USA).

The organization of ICALP 2008 and its 12 affiliated events will, we hope, be a watershed event for the visibility of the Centre both nationally and internationally. The scientific programme for the conference is of very high quality, and the event will feature an impressive list of invited talks delivered by top-class scientists. We also expect the EATCS Award and the Gödel Prize to give ICE-TCS a fair amount of visibility. We intend to use these awards as further advertising material for theoretical computer science by announcing them in the popular press and organizing media exposure for the prize winners as well as for the invited speakers at the conference.

We plan to increase our outreach activities by increasing the number of public lectures for a general audience, revive the *Pearls of Theory* seminar series and organize activities to make the young generations and the general public interested in

(theoretical) computer science. We have already contacted some high-profile scientists (including Avi Wigderson from the Institute of Advanced Studies in Princeton) inviting them to come to Iceland to deliver invited public talks, and we are confident to be in a position to offer a couple of very exciting “Heroes in Science” talks before the four birthday of ICE-TCS.

Finally, we think that it will soon be useful for the Centre to undergo an evaluation by a top-class panel of experienced researchers. This evaluation will 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 past year has seen the Centre expand its membership, efforts and activities, increase its research output, and achieve some level of recognition in the local research environment and beyond. The forthcoming ICALP 2008 conference and its 12 affiliated events will hopefully make ICE-TCS a known research centre in the TCS community at large, and the planned future events in combinatorial mathematics organized by the members of the Centre in 2010 and 2011 will further increase the visibility of our already very active combinatorics group.

During the reporting period, the Centre has also increased and diversified its outreach activities. The visit by David Harel helped make the Centre visible among researchers from other sciences and the general public. Moreover, the combinatorics group within ICE-TCS is becoming known for offering high-quality education in (discrete) mathematics from students from age 12 till 18, and for training the Icelandic Math Olympiad team. We feel that these activities are important for the future of TCS and Discrete Mathematics in Iceland, as well as for the visibility of the Centre within Iceland.

We are, by and large, satisfied with the number of short-term visitors we have had during the reporting period. All the visitors contributed seminars to the lively ICE-TCS seminar series during their stays, and some of the visits led to joint research and publications. However, we would like to increase the number of medium- and long-term visitors to the Centre. In particular, we believe that ICE-TCS and the overall Icelandic research environment in (theoretical) computer science and mathematics would benefit if we were able to offer even a small number of visiting positions ranging from one to six months, say, to researchers at different stages of their career. An increase in the number of postdoctoral and PhD positions would also be highly beneficial for creating a research environment in TCS and discrete mathematics that would put Iceland firmly on the map as a centre for high-

quality research in (some of) the areas covered by ICE-TCS. The award of some centre-building funding from Rannis (the Icelandic Fund for Research) would go a long way towards making this possible and helping the Centre increase its level of activity further. We await eagerly the result of our pre-proposal for a Rannis Centre of Excellence.

Overall, we feel that the Centre is on track to achieve the level of impact, recognition, and interest in theory and computer science that was envisioned in its founding. We look forward to the arrival of two new members (Marjan Sirjani and Luca Q. Zamboni), who will further broaden the research scope of the Centre, and to what the future will bring.

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

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

## A List of ICE-TCS Publications 2005–to date

### Books

1. L. Aceto, A. Ingólfssdóttir, Kim G. Larsen and J. Srba. *Reactive Systems: Modelling, Specification and Verification*, Cambridge University Press, August 2007. ISBN-13: 9780521875462.

### Edited Volumes

1. L. Aceto and A. Ingólfssdóttir. Special issue of the Journal of Logic and Algebraic Programming devoted to selected papers presented at the Eighteenth Nordic Workshop on Programming Theory 2006, 18–20 October 2006, Reykjavík, Iceland. To appear.
2. L. Aceto, M. Bravetti, W. Fokkink and A.D. Gordon. *Special Issue: Algebraic Process Calculi (The First Twenty Five Years and Beyond): Volume 3*. Journal of Logic and Algebraic Programming 75(1):1–166 (February-March 2008).
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12. Einar Steingrímsson. *Annals of Combinatorics*, special issue devoted to selected papers from *Permutation Patterns 2006*, December 2007.

## Chapters in Books and Collections

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## Submitted Papers

1. L. Aceto, S. Capobianco, and A. Ingolfssdottir. On the Existence of a Finite Base for Complete Trace Equivalence over BPA with Interrupt. Submitted

to the *Bulletin of the EATCS*.

2. L. Aceto, W. J. Fokkink and A. Ingólfssdóttir. A Cancellation Theorem for BCCSP. Submitted to *Fundamenta Informaticae*. (Irene Guessarian ed.)
3. S. Capobianco. Multidimensional cellular automata and generalization of Fekete's lemma. Submitted for publication to *Discrete Mathematics and Theoretical Computer Science*.
4. A. Claesson, S. Kitaev and E. Steingrímsson: Two-stack sortable permutations,  $\beta(1, 0)$ -trees, planar maps and generalized permutation patterns, submitted.

## Technical Reports and Preprints

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1. A. Claesson, S. Kitaev and E. Steingrímsson: Involutions on Catalan structures, in preparation.