

CENTRE FOR DISCRETE MATHEMATICS AND THEORETICAL COMPUTER SCIENCE

Annual Report 2006

The Centre for Discrete Mathematics and Theoretical Computer Science was founded in 1995 in order to a) support basic research on the interface between mathematics and computing, b) increase local knowledge in these areas, and c) broaden research skills in New Zealand. The Centre is supported financially by the Departments of Computer Science and Mathematics.

Director

Professor C.S. Calude

Deputy Director

Dr. Michael J. Dinneen

Management Committee

The activities of the Centre are overseen by a Management Committee consisting of

- Professor Douglas Bridges (External Researchers Representative, Canterbury University),
- Professor Cristian Calude (Director),
- Dr. Michael J. Dinneen (Deputy Director),
- A/Professor B. Barton (HOD Mathematics Department),
- Professor Robert Amor (HOD, Computer Science).

Research Reports Coordinator

Dr. Michael J. Dinneen

Seminar Coordinator

Dr. Andre Nies

International Advisory Board

The Centre has a International Advisory Board consisting of the following members:

M.A. Arslanov (Kazan State University, Russia), R.C. Backhouse (Eindhoven University of Technology, Netherlands), J. Casti (Santa F'e Institute, New Mexico, US), G.J. Chaitin (IBM, New York, US), C.J. Colbourn (University of Vermont, US), E.W. Dijkstra (1995–2002), J.H. Dinitz (University of Vermont, US), J.A. Goguen (University of California at San Diego, US), E. Goles (CONICYT, Santiago, Chile), R.L. Graham (University of California at San Diego, US), J. Hartmanis (Cornell University, US), H. Jurgensen (University of Western Ontario, Canada and Potsdam University, Germany), C.C. Lindner (Auburn University, Alabama, US), R. Mathon (University of Toronto, Canada), B.D. Mackay (Australian National University, Australia), A. Nerode (Cornell University, US), I. Prigogine (1995–2003), G. Rozenberg (Leiden University, Netherlands), A. Salomaa (University of Turku, Finland), J. Seberry (University of Wollongong, Australia), D. van Dalen (University of Utrecht, Netherlands).

International Affiliations

- Logic Group at JAIST,
- Mindship International,
- Turku Centre for Computer Science (TUCS),
- Valparaiso Institute of Complex Systems.

Departments of Participating Members

Computer Science, Mathematics, Philosophy.

Introduction

The aim of the Management Committee to build one of the world's best centres for research in Discrete Mathematics and Theoretical Computer Science is coming true. The Centre has become a major force in fostering research and development in those areas within the South Pacific Region and creating productive links between that region's researchers and their counterparts in the rest of the world.

Plans, Objectives, Areas

Although the Centre encourages and supports a wide range of research activity, its primary research foci are the following:

- Combinatorial Optimisation
- Computability and Complexity
- Bioinformatics
- Unconventional Computation

The main objectives of the CDMTCS are:

- to stimulate and encourage the interest of undergraduate students in theoretical computer science and discrete mathematics (including ACM and regional programming contests),
- to foster research, development and cooperation in theoretical computer science and discrete mathematics (participating members, graduate students),
- to fund short and long term visitors, postdoctoral researchers, and doctoral students,
- to organize conferences, summer schools, workshops and seminars,
- to publish, in cooperation with Graz University of Technology and Turku University, the Journal of Universal Computer Science (Springer).

Participating Members

The Centre includes the following faculty members:

C. P. Bonnington (Mathematics, Auckland), D. S. Bridges (Mathematics, Canterbury),
C. Calude (Computer Science, Auckland), M. D. E. Conder (Mathematics, Auckland),
M. J. Dinneen (Computer Science, Auckland), R. W. Doran (Computer Science, Auckland),
A. Drummond (Computer Science, Auckland), H. Guesgen (Computer Science, Auckland),
P. R. Hafner (Mathematics, Auckland), F. Kroon (Philosophy, Auckland), B. Khossainov
(Computer Science, Auckland), R. Nicolescu (Computer Science, Tamaki),
A. Nies (Computer Science, Auckland), E. O'Brien (Mathematics, Auckland), B. Pavlov
(Mathematics, Auckland), J. Seligman (Philosophy, Auckland), U. Speidel (Computer
Science, Tamaki), M. Titchener (Computer Science, Tamaki), C. Thomborson (Computer
Science, Auckland), M.C. Wilson (Computer Science, Auckland).

External Researchers

The *External Researchers* had a great contribution to the Centre's activities by refereeing papers, assisting with conference and workshop organisation, and by other means. The current External Researchers are

I. Antoniou (Solvay Institute, Belgium), E. Calude (Massey University at Albany, New Zealand),
R. Downey (Victoria University of Wellington, New Zealand), B. Everitt (University of Aberdeen, Scotland),
R. Goldblatt (Victoria University of Wellington, New Zealand), P. Hertling (FernUniversität Hagen, Germany),
D. Holton (University of Otago, New Zealand), K.W. Lih (Institute of Mathematics, Academia Sinica, Taiwan),
C. Little (Massey University, New Zealand), M. Lipponen (Turku University, Finland), J. McKay (Concordia University, Canada),
Gh. Paun (Institute of Mathematics, Romanian Academy, Romania), C.E. Praeger (University of Western Australia),
L. Staiger (MartinLuther-Universität Halle-Wittenberg, Germany), K. Svozil (Technische Universität, Vienna),
D. Stefanescu (Bucharest University, Romania), S. Yu (University of Western Ontario, Canada),
I. Tomescu (Bucharest University, Ontario).

Graduate Students

The following graduate students are working in close connection with the research program of the Centre:

1. Hannes Diener, Constructive theory of differential manifolds [PhD]
2. Cynthia Fok, Games Played on Finite Graphs [MSc]
3. Matthew Goode, Computational Aspects of Phylogenetics [PhD]
4. Raimund Eimann, Entropy Based Detection of DDoS Attacks [PhD]
5. Robert Kieran, Optical switch [MSc]
6. Nicholas J. Hay. Optimal Agents [MSc]
7. ByungDoo Lee, A Heuristic Lifeand Death Problem Solver for the Game of Go [PhD]
8. Daniel Bertinshaw, Weighted Update Games [MSc]
9. Jamie Sneddon, Minors and Embeddings of Digraphs [PhD]
10. Anna Torstenson, Maximal Symmetry Groups of Hyperbolic 3manifolds [PhD]
11. Sibon Li. Comparative Genomic Approach to Detecting Selection in Genome Non-coding Regions [PhD]
12. Jiamou Liu. Automatic Structures [PhD]
13. Sidney Markowitz. Simulation Models of Prebiotic Evolution of Genetic Coding [PhD]
14. Pavel Semukhin. Computable structures [PhD]
15. David Carl Uthus. Reinforcement Learning in Dynamic Environments [PhD]
16. Damir Azhar. High Performance Traffic Flow Metering [MSc]
17. Xuensong He. AI Command System In Real-Time Tactical Games [MSc]
18. Kai Shang. XML Based Distributed Programming Contest Control [MSc]
19. Daniel Bertinshaw. Weighted Update Games [MSc]

Visitors

The Centre hosted the following visitors:

- Prof. L. Staiger, Martin Luther Universitat Halle-Wittenberg, Germany
- Prof. G. J. Chaitin, IBM Research, New York, USA
- Prof. J. Casti, Technical University Vienna, Austria
- Prof. K. Svozil, Technical University Vienna, Austria
- Prof. R. Lupacchini, Bologna University, Italy
- Dr. J. Stecher, NHH, Norway
- Dr. J. Reimann, Mathematisches Institut, Heidelberg University, Germany
- Dr. L. Vata, Canterbury University, Christchurch
- Dr. P. Moscato, University of Newcastle, Australia

Major Developments

The major activity of the Centre in 2006 have been the organisation of the 5th *International Conference Unconventional Computation*, <https://www.cs.auckland.ac.nz/uc06> and the Workshop [Infinite Aspects of Topological Graph Theory](#).

The proceedings of UC'06 have appeared as

C. S. Calude, M. J. Dinneen, G. Paun, G. Rozenberg, S. Stepney (eds.). *Proc. 5th International Conference Unconventional Computation*, Lecture Notes Comput. Sci. 4135, Springer, Heidelberg, 2006, 270 pp.

Starting with 2005, International Conference Unconventional Computation has become an annual event, organised by the following Steering Committee (see <https://www.cs.auckland.ac.nz/uc>):

C. Calude, co-chair, Auckland, L.K. Grover, Murray Hill, NJ, USA, J. van Leeuwen, Utrecht, Holland, S. Lloyd, Cambridge, MA, USA, Gh. Paun, Seville, Spain, T. Toffoli, Boston, MA, USA, C. Torras, Barcelona, Spain G. Rozenberg, Leiden, co-chair, Holland, A. Salomaa, Turku, Finland.

A workshop on *Computability, Randomness and Model Theory* was organised at the University of

Auckland on 8-9 November 2006, <http://www.cs.auckland.ac.nz/~nies/workshop.pdf>.

In 2008 the NZIMA programme on **Algorithms: New Directions and Applications** will be organised in cooperation with the CDMTCS: Michael Dinneen and Mark Wilson are on the programme committee, as well as Rod Downey (external researcher for CDMTCS), see <http://www.nzima.org/>.

Publications and Technical Reports

The CDMTCS cooperates with Graz University of Technology and Turku University in editing Springer *Journal of Universal Computer Science*. Members of the CDMTCS are members of the editorial boards of the following journals: *N.Z. Journal of Mathematics*, *International Journal of Applied Intelligence*, *Math. Logic Quarterly*, *Pattern Analysis and Applications Journal*, *Australasian Journal of Combinatorics*, *Philosophia Mathematica*, *Journal of Computing and Information*, *Fundamenta Informaticae*, *Romanian Journal of Information Science and Technology*, *Natural Computing Journal*, *Contributions to Discrete Mathematics*.

Special Issues of the *Fundamenta Informaticae*, *International Journal of Foundations of Computer Science*, *International Journal on Applied Intelligence*, *Natural Computing*, *Journal of Universal Computer Science* have been edited.

Research Papers

More than 170 research papers have been published by faculty members and graduate students.

CDMTCS Research Reports

The following reports were published in 2005 (see (<http://www.cs.auckland.ac.nz/staffcgibin/mjd/secondcgi.pl>):

276. A. Juarna and V. Vajnovski. *Combinatorial Isomorphisms Beyond a Simion-Schmidt's Bijection*. 01/2006
277. C.S. Calude, E. Calude and M.J. Dinneen. *A New Measure of the Difficulty of Problems*. 02/2006
278. S. Schwarz. *Lukasiewicz Logics and Weighted Logics over MV-Semirings*. 05/2006
279. L. Staiger. *The Kolmogorov Complexity of Infinite Words*. 05/2006
280. L. Staiger. *On Maximal Prefix Codes*. 05/2006
281. G.J. Chaitin. *Is Incompleteness A Serious Problem*. 07/2006
282. G.J. Chaitin. *Speculations on Biology, Information and Complexity*. 07/2006
283. C.S. Calude and G.J. Chaitin. *A Dialogue on Mathematics and Physics*. 07/2006
284. C.S. Calude and M.A. Stay. *Most Short Programs Halt Quickly or Never Halt*. 08/2006
285. C.S. Calude. *De-Quantising the Solution of Deutsch's Prolem*. 08/2006
286. U. Speidel. *T-Complexity and T-Information Theory--an Executive Summary, 2nd revised version*. 10/2006
287. G. Pritchard and M.C. Wilson. *Probability Calculations Under the IAC Hypothesis*. 10/2006
288. M.E. Lladser, P. Potocnik, J. Siran, J. Siagiova and M.C. Wilson. *The Diameter of Random Cayley Digraphs of Given Degree*. 10/2006
289. G. Firror, T. Mansour and M.C. Wilson. *Longest Alternating Subsequences in Pattern-Restricted Permutations*. 10/2006
290. T.A. Gulliver and U. Speidel. *On T-Codes and Necklaces*. 10/2006
291. C.S. Calude and K. Svozil. *Quantum Randomness and Value Indefiniteness*. 11/2006
292. C.S. Calude. *Information: The Algorithmic Paradigm*. 12/2006
293. C.S. Calude and M.J. Dinneen. *Exact Approximations of Omega Numbers*. 12/2006

Educational Activities

The CDMTCS supports the following activities:

- The group of courses "Logic and computation" leading to BA, BSc, MA, MSc degrees organized in cooperation with the departments of computer science, mathematics, philosophy and linguistics. See <http://www.cs.auckland.ac.nz/~bmk/lc/>.
- The CDMTCS is the major contributor to the undergraduate core courses CompSci 220 (Algorithms and Data Structures), CompSci 225 (Discrete Structures), CompSci 320 (Algorithmics), and CompSci 350 (Mathematical Foundations of Computer Science).

- Two theoretical graduate courses CompSci 720 (Advanced Design and Analysis of Algorithms), CompSci 750 (Computational Complexity) were taught by CDMTCS staff. CDMTCS members spend time organizing, judging NZ and ACM programming contests.
- Michael Dinneen coached the advancing NZ team (Stephen Merriman, Robert Bowmaker, Andrew Olsen) at the ACM World Finals in San Antonio, Texas, April, 2006.
- One-day Graduate Workshop [CS Graduate Student Workshop](#), 8 September 2006.
- Awards the “J.C. Butcher Award in Theoretical Computer Science”; Stephen David Charles Merriman is the fourth recipient of this award.

CDMTCS Seminars

1. Ludwig Staiger, The Kolmogorov complexity of infinite words
2. B. Khoussainov. Structures, computability and logic
3. R. Gray. Quantization, compression and classification
4. U. Spiedel. Necklaces as a byproduct of T-code construction
5. G. Chaitin. Speculations on biology, information and complexity
6. C. Thomborson. Trusted computing: open, closed, or both?
7. K. Svozil. Staging quantum cryptography with chocolate balls

Professor Cristian S. Calude

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