

CENTRE FOR DISCRETE MATHEMATICS AND THEORETICAL COMPUTER SCIENCE

Annual Report 2007

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

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. Matthew Goode, Computational Aspects of Phylogenetics [PhD]
3. Raimund Eimann, Entropy Based Detection of DDoS Attacks [PhD]
4. Nicholas J. Hay. Optimal Agents [MSc]
5. ByungDoo Lee, A Heuristic Lifeand Death Problem Solver for the Game of Go [PhD]
6. Daniel Bertinshaw, Weighted Update Games [MSc]
7. Jamie Sneddon, Minors and Embeddings of Digraphs [PhD]
8. Anna Torstensson, Maximal Symmetry Groups of Hyperbolic 3manifolds [PhD]
9. 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. Yun-Bum Kim, Graph Compounding for the (Degree, Diameter) Problem [MSc]

Visitors

The Centre hosted the following visitors:

- Prof. L. Staiger, Martin Luther Universitat Halle-Wittenberg, Germany
- Prof. J. Casti, Technical University Vienna, Austria
- Prof. R. Lupacchini, Bologna University, Italy
- Dr. J. Reimann, UC Berkeley, USA
- Prof. E. Goles, Valparaiso Institute of Complex Systems, Chile
- A/Prof. M Zimand, Towson University, USA
- Dr. N. Lehmann, Fribourg University, Swizerland
- Prof. E. Song, Namseoul Univ. Koreaa
- Dr. P. Brodhead, UF Gainesville, USA
- Dr. G. Barmpalis, UVW, NZ
- Prof. R. Downey, UVW, NZ
- W. Blott, Google, Sydney, Australia
- Dr. N. Greenberg, VUW, NZ
- Dr. V. Barany, RWTH Aachen, Germany
- Joe Miller, U Connecticut, USA
- Dr. A.Montalban, Univ of Chicago, USA
- Dr. H. Koehler, Massey Palmerston Nth, NZ
- Prof. R. Thomas, Univ of Leicester, UK
- Prof. P. Cholak, Notre dame University, USA

Major Developments

University of Auckland Team (Andrew Olsen, Robert Bowmaker and Stephen Merriman, trained by Dr. Michael Dinneen, pictured [here](#)) finished [11th from 88](#) in the [31st ACM International Collegiate Programming Contest World Finals](#) (March 12-16, 2007 Hilton Tokyo Bay Hotel) and won a Bronze Medal.

The major activity of the Centre in 2007 have been the organisation of the [Sixth International Conference UC'07](#) held at [Queen's University \(Kingston\)](#), Canada, on 13-17 August 2007.

The proceedings of UC'06 have appeared as

S. G. Akl, C. S. Calude, M. J. Dinneen, G. Rozenberg, H. T. Wareham (eds.). *Proc. 6th International Conference Unconventional Computation*, Lecture Notes Comput. Sci. 4618, Springer, Heidelberg, 2007, 241 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.

Special Session [Mathematical Truth and Provability in the 21st Century](#) at the [6-th Congress of Romanian Mathematicians](#). was organized by C. Calude and D. Bridges (External Researchers Representative, Canterbury University).

The [The Workshop on Computability and Complexity](#) organized by C. Calude and A. Nies, was held at the CDMTCS on 7 December 2007.

The [Computer Science Graduate Workshop](#) was held at the University of Auckland on 26 October 2007.

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 150 research papers have been published by faculty members and graduate students.

CDMTCS Research Reports

The following 23 reports were published in 2007:

294 G.J. Chaitin. *How Much Information Can There Be in a Real Number*

01/2007

295 M.C. Wilson. *Random and Exhaustive Generation of Permutations and Cycles*

01/2007

296 A. Raichev and M.C. Wilson. *A New Method for Computing Asymptotics of Diagonal Coefficients of Multivariate Generating Functions*

01/2007

297 N.J. Hay, A. Shorin and J. Wang (editors) *University of Auckland Computer Science Graduate Workshop 2006*

01/2007

298 L. Staiger. *Prefix-free Lukasiewicz Languages*

01/2007

299 K. Svozil. *Physical Unknowables*

01/2007

300 N.J. Hay. *Universal Semimeasures: An Introduction*

02/2007

301 G. Pritchard and M.C. Wilson. *Asymptotics of the Minimum Manipulating Coalition Size for Positional Voting Rules under IC Behaviour*

- 02/2007
 302 C.T. Chong, A. Nies and L. Yu. *Higher Randomness Notions and Their Lowness Properties*
 03/2007
 303 A. Nies. *Describing Groups*
 03/2007
 304 R.W. Doran. *The Gray Code*
 03/2007
 305 G.J. Chaitin. *An Algebraic Characterization of the Halting Probability*
 04/2007
 306 C.S. Calude and J. Gruska. *Quantum Informatics and the Relations Between Informatics, Physics and Mathematics: A Dialogue*
 05/2007
 307 A. Raichev and M.C. Wilson. *Asymptotics of Diagonal Coefficients of Multivariate Generating Functions*
 05/2007
 308 M. Zimand. *Two Sources Are Better than One for Increasing the Kolmogorov Complexity of Infinite Sequences*
 05/2007
 309 C.S. Calude, E. Calude and S. Marcus. *Proving and Programming*
 06/2007
 310 S. Drape. *The Suitability of Different Binary Tree Obfuscations*
 06/2007
 311 S. Drape and A. Majumdar. *Design and Evaluation of Slicing Obfuscation*
 06/2007
 312 C.S. Calude and L. Staiger. *On Universal Computably Enumerable Prefix Codes*
 10/2007
 313
 Y.-B. Kim and M.J. Dinneen
A Repository of Compound Graphs for use in Large Network Design
 11/2007
 314 E. Goles, Cedric Littleand and I. Rapaport. *The Underlying Optimal Protocol of Rule 218 Cellular Automaton*
 11/2007
 315 A. Leitsch, G. Schachner and K. Svozil. *How to Acknowledge Hypercomputation?*
 12/2007
 316 B. Whitworth. *The Physical World as a Virtual Reality*
 12/2007

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), 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 who won the Bronze Medal at the ACM World Finals in Tokyo, March 2007.
- The [Computer Science Graduate Workshop](#) was held at the University of Auckland on 26 October 2007
- The “J.C. Butcher Award in Theoretical Computer Science” was awarded to Matthew Pearson Steel.

CDMTCS Seminars

1. E. Goles. The Underlying Optimal Protocol of Rule 218 Cellular Automata
2. C. Calude. Representation of Computably Enumerable ϵ -Random Reals
3. N. Greenberg. Effective Packing Dimension in the Turing Degrees

4. J. Liu. Unary Automatic Graphs: An Algorithmic Perspective
5. V. Barany. Automatic omega-Words
6. B. Khoussainov. THree Lectures on Automatic Structures
7. S. Rubin. Automatic Structures and Injective Presentations
8. J. Miller. Weak Lowness Notions
9. A. Montalban. Well-Quasi-Orderings and Computability Theory
10. H. Koehler. Domination Normal Form - Decomposing Relational Database Schemas
11. J. Liu. On Complexity of Ehrenfeucht-Fraisse Games
12. R. Thomas. Finite Automata and Algebraic Structures
13. A. Nies. Automatic Structures of High Ranks
14. N. Lehmann. Argumentation Systems & Join Trees
15. M. Zimand. Extractors Via Constructions of Cryptographic Pseudo-Random Generators

Professor Cristian S. Calude
Centre for Discrete Mathematics and Theoretical Computer Science