# CENTRE FOR DISCRETE MATHEMATICS AND THEORETICAL COMPUTER SCIENCE

http://www.cs.auckland.ac.nz/CDMTCS

**Annual Report 2008**

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. Alexander Raichev

**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 (1941-2006), E. Goles (Adolfo Ibanez University, 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 Affliations**
- 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, post-doctoral researchers, and doctoral students,
- to organize conferences, summer schools, workshops and seminars,
- to publish, in co-operation with Graz University of Technology and Turku University, the Journal of Universal Computer Science.

**Participating Members**
The Centre includes the following faculty members:

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. Khoussainov (Computer Science), R. Nicolescu (Computer Science, Tamaki), A. Nies (Computer Science), E. O'Brien (Mathematics), B. Pavlov (Mathematics), A. Raichev (Computer Science), 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 (FernUniversitat 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-Universitat Halle-Wittenberg, Germany), K. Svozil (Technische Universitat, 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. Theoretical Agent Safety [PhD]
5. Byung Doo 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]
10. Jiamou Liu. Automatic Structures [PhD]
11. Sidney Markowitz. Simulation Models of Prebiotic Evolution of Genetic Coding [PhD]
12. Pavel Semukhin. Computable structures [PhD]
13. David Carl Uthus. Reinforcement Learning in Dynamic Environments [PhD]
14. Yun-Bum Kim, Graph Compounding for the (Degree, Diameter) Problem [MSc]
15. Mike Stay. Higher Category Theory of Computation and some Relationships with Physics [PhD]
16. Hector Zenil. Experimental AIT [PhD]
17. Yun-Bum Kim, Membrane Computing [PhD]
18. M. Khosravani, Graph Algorithms [PhD]
19. M. Brough. Sequential Automatic Algebras[MSc]
20. S. Hoehna. Algorithms for Efficient Phlyogentic MCMC [MSc]
21. J. Heled. Modeling the Interface between Population Genetics and Phylogenetics [PhD]
22. R. Reyhani. Social choice
23. A. Gandhi. Applications of Automatic Structures to databases [PhD]

**Visitors**

The Centre hosted the following visitors:

- Prof. L. Staiger, Martin Luther Universitat Halle-Wittenberg, Germany
- Prof. J. Casti, Technical University Vienna, Austria
- Dr. J. Reimann, UC Berkeley, USA
- Prof. E. Song, Namseoul Univ. Koreea
- Dr. G. Barmpalis, UVW, NZ
- Prof. R. Downey, UVW, NZ
- Dr. N. Greenberg, VUW, NZ
- Dr. A.Montalban, Univ of Chicago, USA
- Prof. L. Ruskey, Univ of Victoria, Canada
- Dr. B. Csima, University of Waterloo, Canada
- Dr. N. Duta, Nuance Communications, USA
- Prof. F. Stephan, NU Singapore
- Dr. C. Mueller, Jacobs University, Germany
- B. Brenet, ENS, France
- Prof. H. Maurer, TU Graz, Austria
- Dr. S. Legg, Swiss Finance Institute, Swizerland
- Prof. H. Maurer, TU Graz, Austria
- Prof. P. Potgieter, U. South Africa
- Prof. G. Farr, Monash Univ., Australia
- M. Pena, Madrid, Universidad Politecnica de Madrid, Spain
- Dr. L. Kot, Cornell Univ., USA
- Prof. S. Binns, King Fahd Univ., Saudi Arabia

**Major Activities**

The major activity of the Centre in 2008 has been the organisation of the Seventh International Conference **UC'08** held at the Technical University in Vienna, Austria, Canada, on 25-28 August

2008.
The volume including the proceedings of UC'08 has appeared as

C. S. Calude, J. F. Costa, R. Freund, M.Oswald, G. Rozenberg (eds.). Proc. 7th International Conference Unconventional Computation, Lecture Notes Comput. Sci. 5204, Springer, Heidelberg, 2008, X, 259 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.

University of Auckland Team--Heather Macbeth, Matthew Steel, Matthew Gatland, Dr. Michael Dinneen (coach)--reclaimed the South-Pacific Champions title at the 32nd ACM International Collegiate Programming Contest World Finals (April 6-9, 2008. Banff, Canada).

The Workshop on Physics and Computation 2008, part of UC'08, was held at Vienna University of Technology, Austria on 25-28 August 2008.

The Workshop "Grand Challenges of Unconventional Computation", part of The 20th Anniversary Conference of Academia Europaea, was be held in Liverpool, UK on 17 September, 2008.

The Fourth International Conference on Combinatorial Mathematics and Combinatorial Computing (4ICC) will be held in Auckland, 15-19 Dec, 2008.

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 co-operates 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, Science*.

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

**CDMTCS Research Reports**
The following 27 reports were published in 2008:

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| 317 | C.S. Calude and M. Zimand | Algorithmically Independent Sequences | Jan-08 |
| 318 | A.A. Abbott and M.J. Dinneen | An Investigation of Algorithms to Aesthetically Draw Cayley Graphs | Mar-08 |
| 319 | K. Svozil | Aesthetic Complexity | Apr-08 |

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| 320 | C.S. Calude, B. E. Carpenter | A Dialogue on the Internet | Apr-08 |
| 321 | J. Teutenberg (editor) | Proceedings of the Computer Graduate Workshop 2007 | Apr-08 |
| 322 | A. Raichev and M.C. Wilson | A New Approach to Asymptotics of Maclaurin Coefficients of Algebraic Functions | Apr-08 |
| 323 | A. Raichev and M.C. Wilson | Asymptotics of Coefficients of Multivariate Generating Functions: Improvements for Smooth Points | May-08 |
| 324 | C.S. Calude | Incompleteness: A Personal Perspective | Jun-08 |
| 325 | G.J. Chaitin | The Halting Probability via Wang Tiles | Jun-08 |
| 326 | C.S. Calude, A. Nies, L. Staiger and F. Stephan | Universal Recursively Enumerable Sets of Strings | Jun-08 |
| 327 | C.S. Calude and J.F. Costa (editors) | Pre-proceedings of the Workshop Physics and Computation | Jul-08 |
| 328 | C.S. Calude and N.J. Hay | Every Computably Enumerable Random Real Is Provably Computably Enumerable Random | Jul-08 |
| 329 | M.J. Dinneen and A.J.L. Fenton | A New Linear-Time Dominating Number Algorithm for Graphs of Bounded Pathwidth | Jul-08 |
| 330 | B Kjos-Hanssen, A. Nies, F. Stephan and L. Yu | Higher Kurtz Randomness | Aug-08 |
| 331 | S. Figueira, J. Miller and A. Nies | Indifferent Sets | Aug-08 |
| 332 | M. Hoyrup | Computability, Randomness and Ergodic Theory on Metric Spaces | Sep-08 |
| 333 | C.R. Gonzalez | Randomness and Ergodic Theory: An Algorithmic Point of View | Sep-08 |
| 334 | L. Staiger | On Oscillation-free ε-random Sequences | Sep-08 |
| 335 | J. Mielke | Refined Bounds on Kolmorgorov Complexity for ω-Languages | Sep-08 |
| 336 | M.J. Dinneen and M. Khosravani | Searching for Spanning k-Caterpillars and k-Trees | Sep-08 |
| 337 | G.J. Chaitin | Evolution of Mutating Software | Oct-08 |
| 338 | C.S. Calude, H. Juergensen and L. Staiger | Topology on Words | Nov-08 |
| 339 | C.S. Calude | Simplicity via Provability for Universal Prefix-free Turing Machines | Nov-08 |
| 340 | C. Muller and M. Kohlhase | Communities of Practice in Mathematical E-Learning | Nov-08 |
| 341 | C. Muller and M. Kohlhase | Context-Aware Adaptation. A Case Study on Mathematical Notations | Nov-08 |
| 342 | R. Nicolescu, M.J. Dinneen and Y.-B. Kim | Structured Modelling with Hyperdag P Systems: Part A | Dec-08 |
| 343 | C.S. Calude and E. Calude | Evaluating the Complexity of Mathematical Problems. Part 1 | Dec-08 |

**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), CompSci 314 (Data Communications Fundamentals), CompSci 320 (Applied Algorithmics), CompSci 369 (Bioinformatics).
- 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.
- The Computer Science Graduate Workshop was held at the University of Auckland on 26 October 2008
- The "J.C. Butcher Award in Theoretical Computer Science" was awarded to Alastair Avery Abbott.

**CDMTCS Seminars**

- Frank Ruskey, Recent results on Venn diagrams
- Barbara Csima, Computable Categoricity, University of Waterloo, Canada
- Petrus H Potgieter. The notion of "recursive" subset in Euclidean space and related questions
- Christine Mueller. Context-aware Conversion A Case Study on Mathematical Notations
- Nicolae Duta. A Survey of the Machine Learning Techniques Employed in Language, Speech, Vision and Biometric Applications
- Hermann Maurer. Theory Is Important but Dangerous
- Frank Stephan. Universal Recursively Enumerable Sets of Strings
- George Barmpalias. Domination, Measure and Minimal Degrees
- Sebastian Hoehna. Clock-constrained Tree Proposal Operators in Bayesian Phylogenetic Inference
- Stephen Binns. A New Quasi-Metric on the Cantor Set
- Noam Greenberg. Effective Packing Dimension in the Turing Degrees

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