



Centre for Discrete Mathematics and Theoretical Computer Science
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CDMTCS: 2004 ANNUAL REPORT

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.

Director

Professor C.S. Calude

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 David Gauld (HOD Mathematics Department),
- Professor John Hosking (HOD, Computer Science).

Deputy Director

Dr. Michael J. Dinneen

Research Reports Coordinator

Dr. Michael J. Dinneen

Seminar Coordinator

Dr. Mark Wilson

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 Fé 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. Jürgensen (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

- Artificial Intelligence
- Combinatorial Optimisation
- Computability and Complexity
- Constructive Algorithmics
- 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 publishing, in co-operation with Springer-Verlag, the book Series Discrete Mathematics and Theoretical Computer Science and the Journal of Universal Computer Science.

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), P. Gibbons (Computer Science, Auckland), H. Guesgen (Computer Science, Auckland), P. R. Hafner (Mathematics, Auckland), F. Kroon (Philosophy, Auckland), B. Khoussainov (Computer Science, Auckland), R. Nicolescu (Computer Science, Tamaki), A. Nies (Computer Science, Auckland), E. O'Brien (Mathematics, Auckland), B. Pavlov (Mathematics, Auckland), I. Reilly (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. Păun (Institute of Mathematics, Romanian Academy, Romania), C.E. Praeger (University of Western Australia), L. Staiger (Martin-Luther-Universität Halle-Wittenberg, Germany), K. Svozil (Technische Universität, Vienna), D. Ștefănescu (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. Joshua Arulanandham, Natural Algorithms [PhD]
2. Gary Cleveland, Hierarchical Planning and Re-Planning [PhD]
3. Myra Cohen, A combinatorial Design Platform for Automating Software Test Coverage [PhD]
4. Cynthia Fok, Games Played on Finite Graphs [ME]
5. Matthew Goode, Computational Aspects of Phylogenetics [PhD]
6. Raimund Eimann, Entropy-based Detection of DDoS Attacks [PhD]
7. Robert Kieran, Optical switch [MSc]
8. Jeong Seon Koo, A Decision Support System for Air Pollution Health Risk Analysis [PhD]

9. Byung-Doo Lee, A Heuristic Life-and-Death Problem Solver for the Game of Go [PhD]
10. Yang Jia, Parsing-Based Similarity Measures [PhD]
11. Jeong Seon Koo, A Decision Support System for Air Pollution Health Risk Analysis [PhD]
12. Ute Loerch, Intelligent Question Answering in an Internet-Based Remote Learning Environment [PhD]
13. Sasha Rubin, Finite Automata and Algebraic Structures [PhD]
14. Chi-Kou Shu, Computing Exact Approximations of a Chaitin Omega Number [PhD]
15. Jamie Sneddon, Minors and Embeddings of Digraphs [PhD]
16. See Wand, Partial Randomness [PhD]
17. Anna Torstensson, Maximal Symmetry Groups of Hyperbolic 3-manifolds [PhD]
18. Qian Chen, Network Monitoring from a User's Perspective [MSc]
19. Jiafeng Qin, A Security Survey of PHP Scripts [MSc]
20. Ali al-Jumaily, A Lightweight Messaging Protocol for Mobile Communication [MSc]
21. Aisha Fenton, Restricted Broadcast Graphs [MSc]
22. Lea Chii Deng, Bioinformatics SARS [MSc]
23. Rongwei Lai, Network Design [MSc]
24. Terrence Wilson Johnson, Small World Graphs [MSc]
25. Bo Li, Geographic Reasoning Based on the Fuzzy Region Connection Calculus [MSc]
26. Tavish Fraser, Communicating Using Topological Maps [MSc]
27. Eric Shi, Artificial Intelligence in Real-Time Computer Games [MSc]
28. Xiaodong Yang, Dynamic-Heuristic Route Finding [MSc]
29. K. Lee, Direct and Inverse Uniqueness Theorems for Analytic Functions Smooth in the Unit Circle [MSc]
30. P. Leys, Turing Patterns for Diffusion-Reaction Equations in Biology [MSc]

Visitors

The Centre hosted the following visitors:

- Prof. Dan Archdeacon University of Vermont, USA
- Dr. M. Baroni, Christchurch University, NZ
- Prof. J. Casti, Technical University of Vienna, Austria
- Dr. G. J. Chaitin, IBM Research, New York, USA
- Prof. B. Courcelle, University of Marseille, France
- Prof. M. Deza, CNRS, Paris, France and Tokyo, Japan
- Prof. R. Downey, Victoria University of Wellington, NZ
- A/Prof. G. Farr, Monash University, Australia
- Prof. E. Goles, Director CONICYT, Santiago, Chile

- Prof. H. Maurer, Technical University of Graz, Austria
- Dr. F. Stephan, National ICT, Sydney, Australia
- Dr. D. Hirschfeldt, Chicago University, USA
- Prof. H. Ishihara, JAIST, Japan
- Prof. N. Jonoska, Tampa University, Florida, USA
- Prof. H. Jürgensen, University of Western Ontario, London, Canada
- Prof. M. Kudlek, Hamburg University, Germany
- Dr. W. Merkle, Heindelberg University, Germany
- Prof. Bojan Mohar University of Ljubljana, Croatia
- Prof. A. Muscholl, University Paris 6, France
- Prof. Bruce Richter University of Waterloo, Canada
- Dr. S. Tewijen, Technical University of Vienna, Austria
- Prof. L. Staiger, Martin-Luther-Universität Halle-Wittenberg, Germany
- Dr. Jan Reimann, Mathematisches Institut, Heidelberg University, Germany
- Prof. G. Rozenberg, Leiden University, Holland
- Prof. Mark Watkins Syracuse University, USA

Major Developments

The major activity of the Centre in 2004 was the organisation in co-operation with Massey University at Albany of The Eighth International Conference “DEVELOPMENTS IN LANGUAGE THEORY“ (DLT’04) will be held in Auckland on 13 – 17 December 2004, <http://www.cs.auckland.ac.nz/CDMTCS/conferences/dlt04/>. The conference, organised under the auspices of the European Association for Theoretical Computer Science (EATCS), was supported by the New Zealand Royal Society. The conference had five invited lectures by B. Courcelle (Marseille, France), R. Downey (Wellington, NZ), N. Jonoska (Tampa, US), A. Muscholl (Paris, France), G. Rozenberg (Leiden, Holland). The proceedings have appeared as

C. S. Calude, Elena Calude, M. J. Dinneen (eds.). *Proc. 8th International Conf. DLT’04*, Lecture Notes Comput. Sci. 3340, Springer, Heidelberg, 2004, 442 pp.

Other contributions to DLT’04 have been published in

C. S. Calude, Elena Calude, M. J. Dinneen. Supplemental Papers for DLT04, *CDMTCS Research Report* 252, 2004, 72 pp.

The DLT’04 Conference was accompanied by two thematic workshops:

The Workshop on “Automata, Structures and Logic” will be held in Auckland on 11–13 December 2004, <http://www.cs.auckland.ac.nz/was12004>. The abstracts of WASL’04 have been published in

B. Khossainov (editor). Abstracts of the Workshop on Automata, Structures and Logic, *CDMTCS Research Report*, 257, 2004.

The “International Workshop on Tilings and Cellular Automata” (WTCA’04) will be held in Auckland on 12 December 2004, <http://www.cs.auckland.ac.nz/dlt04/wtca/wtca.html>. A special issue of the journal *Fundamenta Informaticae* will include the contributions to WTCA’04. The pre-proceedings of WTCA’04 have been published in

M. Margenstern (editor). Proceedings of the International Workshop on Tilings and Cellular Automata, *CDMTCS Research Report 253*, 2004.

The CDMTCS has sponsored The 2004 NZIMA Conference “Combinatorics and its Applications” and the 29th Australasian Conference “Combinatorial Mathematics and Combinatorial Computing” (29th ACCMCC) will be held in Lake Taupo, from 13 to 18 December, 2004, <http://www.nzima.auckland.ac.nz/combinatorics/conference.html>.

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*, *Pattern Analysis and Applications Journal*, *Australasian Journal of Combinatorics*, *Philosophia Mathematica*, *Analele Universității București*, *Matematică-Informatică*, *Journal of Computing and Information*, *Fundamenta Informaticae*, *Romanian Journal of Information Science and Technology*.

Research Papers

More than 180 research papers have been published by faculty members and graduate students.

CDMTCS Research Reports

229. H. Ishihara. Informal Constructive Mathematics. 01/2004
230. S. Filipp and K. Svozil. Testing the Bounds on Quantum Probabilities. 01/2004
231. K. Svozil. Farewell to Quantum Contextuality?. 01/2004
232. K. Svozil. Single Particle Interferometric Analogues of Multipartite Entanglement. 01/2004
233. K. Svozil. Quantum Information via State Partitions and the Context Transition Principle. 01/2004
234. A. Nies, F. Stephan and S.A. Terwijn. Randomness, Relativization, and Turing Degrees. 02/2004
235. C.S. Calude and M.A. Stay. From Heisenberg to Goedel via Chaitin. 02/2004
236. C.S. Calude and S. Marcus. Mathematical Proofs at a Crossroad? 03/2004
237. H. Jürgensen, L. Staiger and H. Yamasaki. Finite Automata Encoding Geometric Figures. 04/2004
238. S. Filipp and K. Svozil. The min-max Principle Generalizes Tsirelson’s Bound. 04/2004
239. C.S. Calude, L. Staiger and S.A. Terwijn. On Partial Randomness. 04/2004
240. C.S. Calude, C. Campeanu and M. Dumitrescu. Automata Recognizing No Words: A Statistical Approach. 05/2004
241. C.S. Calude and H. Jürgensen. Is Complexity a Source of Incompleteness? 06/2004
242. A. Juarna and V. Vajnovszki. Fast Generation of Fibonacci Permutations. 07/2004
243. M. Stay. Inexpensive Linear-Optical Implementations of Deutsch’s Algorithm. 07/2004
244. D. Schultes. Rainbow Sort: Sorting at the Speed of Light. 07/2004
245. M. Harmer. Fitting Parameters for a Solvable Model of a Quantum Network. 07/2004
246. C.S. Calude and G. Păun. *Computing with Cells and Atoms: After Five Years*. 08/2004

- 247. C. Grozea. Plagiarism Detection with State of the Art Compression Programs. 08/2004
- 248. C.S. Calude. Algorithmic Randomness, Quantum Physics, and Incompleteness, 08/2004
- 249. M. Stay. Generalized Number Derivatives, 08/2004
- 250. T. Forster. An Introduction to WQO and BQO Theory (Preliminary Version), 09/2004
- 251. C.S. Calude and S. Rudeanu. Proving as a Computable Procedure, 10/2004
- 252. C.S. Calude, E. Calude, M.J. Dinneen (editors). Supplemental Papers for DLT04, 11/2004
- 253. M. Margenstern (editor). Proceedings of the International Workshop on Tilings and Cellular Automata, 11/2004
- 254. M.J. Dinneen and R. Lai. Properties of Vertex Cover Obstructions, 11/2004
- 255. M.R. Titchener, A. Gulliver, R. Nicolescu, U. Speidel and L. Staiger. Deterministic Complexity and Entropy, 12/2004
- 256. J.J. Arulanandham and M.J. Dinneen. Balance Machines: A New Formalism for Computing, 12/2004
- 257. B. Khossainov (editor). Abstracts of the Workshop on Automata, Structures and Logic, 12/2004
- 258. K. Svozil. Communication Cost of Breaking the Bell Barrier, 12/2004.

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/1c/>.
- 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).
- Three theoretical graduate courses CompSci 720 (Advanced Design and Analysis of Algorithms), CompSci 750 (Computational Complexity), and 755 (Unconventional Models of Computation) were taught by CDMTCS staff.
- Both the NZ and ACM local programming contests. Dr. Radu Nicolescu is currently the head judge for the Australasian South-Pacific Region, while Dr. Michael Dinneen is in charge of the Judging Systems for the region and the Auckland Site Director for the NZ contest. The University of Auckland team (Members: Robert Patrick Donald, Sam McCall and Jsun Pe; Coach Michael Dinneen) will represent NZ at the ACM world finals.
- Awards the “J.C. Butcher Award in Theoretical Computer Science”; Nicholas Hay is the third recipient of this award.

CDMTCS Seminars

1. Manfred Kudlek, Sequentiality, Parallelity, Probability and Universality in Petri Nets
2. Ludwig Staiger, On Partial Randomness
3. Bakh Khossainov, Computably Enumerable Algebras, their Isomorphisms and Expansion
4. Bakhadyr Khossainov, Finitely generated automatic groups
5. Ondrej Sykora, Fractional Lengths and Crossing Numbers

6. Michael Dinneen, A Method for Computing Graph Minor Obstruction Sets
7. Pavel Semukhin, An uncountable categorical theory whose only computable model is saturated
8. Marian Baroni, Constructive Order Completeness
9. Pavel Semiushkin, Classification of Complete Theories of Abelian Groups
10. Denis Hirschfeldt, Bounding Prime and Homogeneous Models
11. Graham Farr, Cost-effectiveness of algorithms
12. Eric Goles, Complexity of some 2-dimensional cellular automata
13. Cris Calude, From Uncertainty to Incompleteness via Randomness
14. Michel Deza, Zigzag Structure of Simple Polyhedra
15. Greg Chaitin, Against Real Numbers
16. Greg Chaitin, Leibniz, Information, Math and Physics
17. Helmut Jürgensen, Codes with Synchronization
18. Ludwig Staiger, Martingales, Lyapunov Exponent and Kolmogorov Complexity—An alternative view to s-gales and constructive dimension
19. Wolfgang Merkle, Kolmogorov-Loveland stochastic sequences with additional properties

Awards

1. Dr. P. Bonnington was elected President of the Combinatorial Mathematics Society of Australasia at its AGM in October in Brisbane.
2. Prof. M. Conder was elected President of the Council of NZRS.
3. A/Prof. H. Guesgen was awarded an U21 Fellowship for 2005.
4. Prof. B. Pavlov was elected a Fellow of NZRS.
5. Dr. U. Siegel was awarded the best paper award at CSNDSP04 in Newcastle-upon-Tyne.
6. Dr. M. Wilson was awarded a Vice-Chancellor's University Development Fund grant of \$137000.

C. Calude

Professor Cristian S. Calude