CENTRE FOR DISCRETE MATHEMATICS

AUCKLAND WAIKATO

& THEORETICAL COMPUTER SCIENCE

Centre for Discrete Mathematics and Theoretical Computer Science
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CDMTCS: 1995 ANNUAL REPORT

1. **Directors** Professor D. S. Bridges (Waikato) and Professor C. S. Calude (Auckland)

2. **AURC Representative on Management Committee** Not nominated.

3. **Participating members** The CDMTCS includes the following faculty members: P. Bonnington (Mathematics, Tamaki), D. S. Bridges (Mathematics, Waikato), C. Calude (Computer Science, Auckland), J. Cleary, (Computer Science, Waikato), M. D. E. Conder (Mathematics, Auckland), R. W. Doran (Computer Science, Auckland), A. G. French (Mathematics, Waikato), J. Gibbons (Computer Science, Auckland), P. Gibbons (Computer Science, Auckland), H. Guesgen (Computer Science, Auckland), P. R. Hafner (Mathematics, Auckland), F. Kroon (Philosophy, Auckland), M. Lennon (Computer Science, Tamaki), I. Melchert (Mathematics, Waikato), S. Reeves (Computer Science, Waikato), M.R. Titchener (Computer Science, Tamaki), I. H. Witten (Computer Science, Waikato).

4. **International Board** The following distinguished experts are serving on the CDMTCS International Advisory Board: M. Arslanov, R. C. Backhouse, J. Casti, G. J. Chaitin, C. J. Colbourn, E. W. Dijkstra, J. H. Dinitz, J. A. Goguen, R. L. Graham, J. Hartmanis, H. Jürgensen, C. C. Lindner, R. Mathon, B. D. McKay, A. Nerode, G. Rozenberg, A. Salomaa, J. Seberry, D. van Dalen.

5. **Aim** The Centre, which is a joint venture involving the Computer Science and Mathematics Departments of the Universities of Auckland and Waikato, was founded in 1995 to support basic research on the interface between mathematics and computing, to increase local knowledge in these areas, and to broaden research skills in New Zealand.

   The aim of the Centre's Management Committee is to build one of the world's best centres in Discrete Mathematics and Theoretical Computer Science, comparable to those of the most important similar centres in North America and Europe. By doing so, the Committee hopes to foster research and development in these areas within the South Pacific region, and to create links between researchers in that region and their counterparts in the rest of the world.

6. **Research Matters** The research aims of the Centre are in the following broad areas:

(a) *Artificial Intelligence*: theoretical aspects of artificial intelligence; formal concepts of artificial intelligence; efficient algorithms for solving complex AI problems like scheduling, planning, constraint satisfaction, etc.

(b) *Combinatorial Optimization*: computational techniques for the efficient construction and analysis of many optimal types of combinatorial configurations (including graphs, codes and designs), using deterministic methods exploiting symmetries and algebraic properties, and, when deterministic methods become infeasible, probabilistic methods such as simulated annealing, hill-climbing, and genetic programming.

(c) *Computability and Complexity*: computability and non-computability in pure mathematics (in particular, functional analysis and operator theory), theoretical physics (specifically, quantum mechanics), theoretical economics, and other areas; complexity of computation in those fields. Algorithmic information theory.

(d) *Constructive Algorithmics*: methods for calculating programs from their specifications, and the design of notations for such calculation; also, the investigation of software support for the calculational process.

7. **Research Grants**

(a) M. Apperley, J. Grundy, S. Reeves and J. Venable, FoRST Grant $ 360,000 (over 3 years),

(b) S. Reeves, UWRC Grant, $ 10,500 (over 2 years),

(c) C.S. Calude, AURC Grant, $ 5,000

(d) M.D.E. Conder, AURC Grant, $ 1,000

(e) M.D.E. Conder, Marsden Fund Award, $ 84,000 (over 3 years)

(f) M.D.E. Conder, Claude McCarthy Fellowship, $ 5,000

(g) H. Guesgen, AURC Grant, $1,008

(h) I. Witten et al. NZ Lottery Grants Board, $ 20,000

(i) I. Witten et al., FoRST Grant, $192,000 (over 5 years)

(j) R. Nicolescu & M.R. Titchener, AURC Grant, $ 13,000

(k) M.R. Titchener, AURC Grant, $ 2,500

(l) M.R. Titchener & Ulrich Guenther, AURC Grad Fund, $ 2,700

8. **Educational Activities**
The Centre has supported the following undergraduate and graduate courses:

(a) 0654.418/518 Foundations of Mathematics (taught by A.G. French and D.S. Bridges)

(b) 26.225 Discrete Mathematics (taught by Paul Bonnington and John Pearson)

(c) 26.315 Logic (taught by Maths and Philosophy Departments)

(d) 26.325 Combinatorial Structures (taught by Margaret Morton)

(e) 07.350 Mathematical Foundations of Computer Science (taught by Cristian Calude and Fred Kroon),

(f) 26.416 Algebraic Combinatorics (taught by Marston Conder)

(g) 07.755 Algorithmic Information Theory (taught by Cristian Calude)

(h) 07.320 Algorithmics (taught by Peter Gibbons and Cristian Calude)

(i) 07.750 Program Derivation (taught by Jeremy Gibbons)

(j) 07.720 Advanced Design and Analysis of Algorithms (taught by Peter Gibbons)

(k) 07.457 Data Structures (taught by Ioan Tomescu, Bucharest University, CDMTCS visitor),

(l) 07.458 Computation Theoretic Aspects of Cellular Automata (taught by Sheng Yu, University of Western Ontario, CDMTCS visitor),

(m) 07.765 Advanced Artificial Intelligence (taught by Hans Guesgen)

(n) 0654.317 Discrete Mathematics & Theoretical Computer Science (taught by D.S Bridges, A.G. French, K.A. Broughan and I. Melchert)

(o) 0654.240 Mathematical Foundations of Computer Science (taught by G. French and I. Melchert)

(p) 0657.416A Topics in Artificial Intelligence (taught by I. Witten)

(q) 415.742 Data Communications (taught by Peter Fenwick and M.R. Titchener)

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

(a) Asat Arslanov (PhD student, "Theoretical Computer Science"),

(b) Elena Calude (PhD student, "Theoretical Aspects of Artificial Intelligence"),

(c) Peter Dobcsanyi (PhD student, "Combinatorial Computation using Distributed Processing"),

(d) Matt Humphrey (PhD student, "Human-computer Interaction Using Relational Algebra"),

(e) Stuart Inglis (PhD student, "Textual Image Processing"),

(f) James Webb: (PhD student, "Computational Techniques for Solving Chessboard Problems"),

(g) S. Irvine (PhD student),

(h) John Pearson (PhD student, "Studies in Combinatorics and Group Theory"),

(i) Cameron Walker (PhD student, "Compact Presentations for the Symmetric Groups"),

(j) Michael Wang (PhD student, "Constructive Aspects of the Dirichlet Problem"),

(k) Craig Nevill-Manning (PhD student, "Programming by Example"),

(l) Tony Smith (PhD student, "Probability-based Grammar Induction"),

(m) Ulrich Guenther (PhD student, "Robust Image Compression Coding"), Wang Yuchuan (PhD student, "Constructive aspects of the Dirichlet Problem"),

(n) Robyn Curtis (Masters student, "The Cycle Double Cover Problem")

(o) Samantha Stephenson (Masters student, "Sharply Transitive Sets and Finite Projective Planes"),

(p) Brent Martin (Masters student, "Instance-based Learning: Nearest Neighbour with Generalisation"),

(q) James Littin (Masters student, "Learning Rules with Inter-attribute Dependencies").

9. **Visitors** Prof. Helmut Jürgensen (University Western Ontario, Canada), Prof. Ioan Tomescu (Bucharest University, Romania), A/Prof. Sheng Yu (University Western Ontario, Canada), Prof. Tudor Zamfirescu (Dortmund University, Germany), Dr Mike Newman (Australian National University), Dr Eamonn O'Brien (Australian National University), Prof Cheryl Praeger (Univerity of Western Australia).

10. **Financial Statement** The Centre has been started only for half a year, so there has been no financial activity for 1995.

11. **Publications and Technical Reports**

- C. P. Bonnington, C. H. C. Little, *Foundations of Topological Graph Theory*, Springer-Verlag, 1995.
- C. P. Bonnington, W. Imrich and N. Seifter, Geodesics in transitive graphs, *J. Combin. Theory Ser.* B, 1995.
- C. P. Bonnington, D. Archdeacon and J. Siran, A Nebesky-type characteristation for relative maximum genus, *Technical Report 329,* Dept. of Math., The Uni. of Auckland, 1995.
- C. P. Bonnington, W. Imrich and M. Watkins, Separating double rays in locally infinite planar graphs, *Discrete Math.*, 145:61-72, 1995.
- D. S. Bridges and G. B. Mehta. *Representations of Preference Orderings*, Lecture Notes in Economics and Mathematical Systems 422, Springer-Verlag, Berlin, 1995.
- D. S. Bridges. Constructive mathematics and unbounded operators-A reply to Hellman, *J. Phil. Logic* 24 (1995), 549-561.

- C. Calude. What is a random string? *J. UCS*, Vol. 1,1 (1995), 48-66.
- C.Calude, M.Zimand. Effective category and measure in abstract complexity theory—extended abstract, *Proceedings FCT'95*, Lectures Notes in Computer Science 965, Springer-Verlag, Berlin, 1995, 156-171.
- C.Calude. What is a random string?—Extended Abstract, in W.Depauli-Schimanovich, E.Koehler, F.Stadler (eds.). *The Foundational Debate, Complexity and Constructivity in Mathematics and Physics,* Kluwer, Dordrecht,1995, 101-113.
- C.Calude, D.I.Campbell, K.Svozil, D.Ştefănescu. Strong determinism vs. computability, in W.Depauli-Schimanovich, E.Koehler, F.Stadler (eds.). *The Foundational Debate, Complexity and Constructivity in Mathematics and Physics,* Kluwer, Dordrecht,1995, 115-131.
- G.J.Chaitin, A.Arslanov, C.Calude. Program-size complexity computes the halting problem, *EATCS Bull*, 57 (1995), 198-200.
- M.D.E. Conder, Two-element generation of the finite reflection groups, *Quarterly Journal of Mathematics (Oxford) Ser.2* **46** (1995), 95–106.
- M.D.E. Conder & Jianbei An, The Alperin and Dade conjectures for the simple Mathieu groups, *Commmunications in Algebra* **23** (1995), 2797–2823.
- M.D.E. Conder & M.J. Morton, Classification of trivalent symmetric graphs of small order, *Australasian Journal of Combinatorics* **11** (1995), 139–149.
- M.D.E. Conder & B.J. Everitt, Regular maps on non-orientable surfaces, *Geometriae Dedicata* **56** (1995), 209–219.
- M.D.E. Conder, P.J. Lorimer & C.E. Praeger) Constructions for arc-transitive digraphs, *Journal of the Australian Mathematical Society* **59** (1995), 61–80.
- M.D.E. Conder & Jianbei An, On the numbers of 2-weights, unipotent conjugacy classes, and irreducible Brauer 2–characters of finite classical groups, *Proceedings of the American Mathematical Society* **123** (1995), 2297–2304.
- M.D.E. Conder, Semi-automated theorem proving: the impact of computers on pure mathematics research, in: *Innovative Use of Technology in Teaching and Research in Mathematics* (Proceedings of the First Asian Conference on Technology in Mathematics, Singapore, December 1995), pp. 1–8.
- Gibbons, J. 'An Initial-Algebra Approach to Directed Acyclic Graphs'. *LNCS 947: Third International Conference on the Mathematics of Program Construction*, Kloster Irsee, July 1995, ed Bernhard Moeller, Springer-Verlag, 282–303.
- Gibbons, J. 'Dotted and Dashed Lines in Metafont'. *Proceedings of the TEX Users' Group Annual Meeting*, ed Robin Fairbairns, St Petersburg Beach, Florida, July 1995.
- Gibbons, J. 'Hey—it Works!'. *TEX and TUG News*, 4(1), 1995, 4–9.
- Gibbons, J. 'Hey—it Works!'. *TEX and TUG News*, 4(2), 1995, 3–6.
- Gibbons, J. 'Hey—it Works!'. *TEX and TUG News*, 4(3), 1995.
- Gibbons, P.B. and Mathon, R., Signings of group divisible designs and projective planes, *Australasian Journal of Combinatorics* 11 (1995), 79 - 104.
- H.W. Guesgen and J. Hertzberg. Spatial persistence, *Applied Intelligence* (Special Issue on Spatial and Temporal Reasoning), 1995.
- H.W. Guesgen. On linguistic variables and fuzzy sets for hybrid spatial reasoning. In *Proc. IJCAI-95 Workshop on Fuzzy Logic in Artificial Intelligence,* pages 1–9, Montréal, Canada, 1995.
- H.W. Guesgen. Integrating qualitative and quantitative spatial reasoning. In *Proc. IJCAI-95 Workshop on Spatial and Temporal Reasoning,* pages 87–94, Montréal, Canada, 1995.
- R. Weissschnur, J. Hertzberg, and H.W. Guesgen. Experiences in solving constraint relaxation networks with Boltzmann machines. In *Proc. CP-95 Workshop on Over-Constrained Systems,* pages 103–109, Cassis, France, 1995.

- H.W. Guesgen and A. Philpott. Heuristics for solving fuzzy constraint satisfaction problems. In *Proc. ANNES-95,* pages 132–135, Dunedin, New Zealand, 1995.
- H.W. Guesgen. Attacking the complexity of fuzzy constraint satisfaction problems. In *Proc. FLAMOC-96,* pages 66–72, Sydney, Australia, 1996.
- Reeves, S. (1995) Computer support for students' work in a formal system: MacPICT, *International Journal on Mathematical Education in Science and Technology*, vol. 26, no. 2, pp.159-175.
- Reeves, S., Goldson, D., Fung, P., O'Shea, T., Hopkins, M. and Bornat, R. (1995) The Calculator Project - Formal Reasoning about Programs, in *Proceedings of SRIG-ET'94,* IEEE Computer Society Press, pp.166-173.
- Reeves, S. and Cranefield, S. (eds.) (1995) *Proceedings of the Second New Zealand Computer Science Research Students' Conference,* Department of Computer Science, University of Waikato, Hamilton, New Zealand.
- Reeves, S. (1995) Better Software in the Future?, *New Zealand Journal of Computing,* volume 6, number 1A, pp. 53-58.
- Reeves, S. (1995) A Teaching and Support Tool for Building Formal Models of Graphical User-Interfaces , *Working paper 95/21,* Department of Computer Science, University of Waikato, August 1995.
- Conklin, D. and Witten, I.H. (1995) Multiple viewpoint systems for music prediction, *J New Music Research,* 24 (1) 51-73, March.
- Thimbleby, H., Witten, I.H., and Pullinger, D. (1995) Concepts of cooperation in artificial life, *IEEE Trans Systems, Man and Cybernetics,* 25 (7) 1166-1171, July.
- McQueen, R.J., Garner, S.R., Nevill-Manning, C.G., and Witten, I.H. (1995) Applying machine learning to agricultural data, *J Computing and Electronics in Agriculture,* 12 (4) 275-293.
- Bell, T.C., Moffat, A., Witten, I.H., and Zobel, J. (1995) The MG retrieval system: compressing for space and speed, *Communications of the Association for Computing Machinery,* 38 (4) 41-42, April.
- Smith, T.C. and Witten, I.H. (1995) Probability-driven lexical classification: a corpus-based approach, *Pacific Association for Computational Linguistics Conference,* 271-283, Brisbane, Australia, April.
- Witten, I.H., Cunningham, S.J., Vallabh, M., and Bell, T.C. (1995) A New Zealand digital library for computer science research, *Proc Digital Libraries '95,* 25-30, Austin, Texas, June.
- Bell, T.C., Bensemann, G., and Witten, I.H. (1995) Computer Science Unplugged: Capturing the interest of the uninterested, *Proc NZ Computer Conference,* Wellington, New Zealand, August.
- Garner, S.R., Holmes, G., McQueen, R.J., and Witten, I.H. (1995) Machine learning from agricultural databases: practice and experience, *Proc NZ Computer Conference,* Wellington, New Zealand, August.
- Nevill-Manning, C.G., Holmes, G., and Witten, I.H. (1995) The development of Holte's 1R classifier, *Proc ANNES'95,* 239-242, Dunedin, New Zealand, November.
- Inglis, S. and Witten, I.H. (1995) Document zone classification using machine learning, *Proc Digital Image Computing: Techniques and Applications,* Brisbane, Australia, December.
- Cleary, J.G., Teahan, W.J., and Witten, I.H. (1995) Unbounded length contexts for PPM, *in Proc Data Compression Conference,* edited by J.A. Storer and M. Cohn, pp 52-61. IEEE Press, Los Alamitos, CA.
- Moffat, A., Neal, R., and Witten, I.H. (1995) Arithmetic coding revisited, *in Proc Data Compression Conference,* edited by J.A. Storer and M. Cohn, pp 202-211. IEEE Press, Los Alamitos, CA.
- Smith, T.C. and Witten, I.H. (1995) A genetic algorithm for the induction of natural language grammars, *Proc IJCAI-95 Workshop on New Approaches to Learning for Natural Language Processing,* 17-24, Montreal, Canada.
- Witten, I.H., Moffat, A., and Bell, T.C. (1995) Compression and full-text indexing for digital libraries, *Advances in digital libraries,* edited by N.R. Adam, B. Bhargava, and Y. Yesha, pp 181-203. Springer Verlag (Lecture Notes in Computer Science series), February.

- Witten, I.H. (1995) PBD systems: when will they ever learn? *PBD Workshop, ML'95,* 1-9, Tahoe City, CA, July.
- Greenberg, S., Darragh, J.J., Maulsby, D.L., and Witten, I.H. (1995) Predictive interfaces: what will they think of next? *Extra-ordinary human-computer interaction: interfaces for users with disabilities,* edited by A.D.N. Edwards, pp 103-140. Cambridge University Press, Cambridge, UK.
- Moffat, A., Bell, T.C., and Witten, I.H. (1995) Lossless compression for text and images, *Int J High-Speed Electronics,* (special issue on Signal Compression). Also published as Chapter ? of Signal Compression, edited by N.S. Jayant, Work Scientific, Singapore.
- Inglis, S. and Witten, I.H. (1995) Eyeing up the magic eye, *NZ Science Monthly,* 6 (4) 6-7, May.
- Maulsby, D. and Witten, I.H. (1995) Learning to describe data in actions, *Proc Workshop on Programming by Demonstration, ML'95,* 65-73, Tahoe City, CA, July.
- Nevill-Manning, C.G. and Witten, I.H. (1995) Detecting sequential structure, *Proc Workshop on Programming by Demonstration, ML'95,* 49-56, Tahoe City, CA, July.
- Garner, S.R., Cunningham, S.J., Holmes, G., Nevill-Manning, C.G., and Witten, I.H. (1995) Applying a machine learning workbench: experience with agricultural databases, *Proc Workshop on Applications of Machine Learning, ML'95,* 14-21, Tahoe City, CA, July; Also available as Working Paper 95/13, Department of Computer Science, University of Waikato.
- M. R. Titchener, "T-code set size reference tables", *Tamaki T–Code Project Series*, Nov. 1995.
- M. R. Titchener and S. Wackrow "TCODE software documentation", *Tamaki T–Code Project Series*, Oct. 1995.
- U. Günther and M. R. Titchener, "Calculating the expected synchronization delay for T-Code sets", *Tamaki T-Code Project Series* Vol. 1, No. 7, Oct. 1995, submitted *IEE Pt F, Communications* in Oct. 1995.
- M. R. Titchener, "Generalized T-codes: an extended construction algorithm for self synchronizing codes", *Tamaki T–Code Project Series*, Sept 1995, submitted *IEE Pt F, Communications*, Sept. 1995.
- U. Günther, R. Nicolescu, M. R. Titchener, "Even T-code sets", *Tamaki Report Series*, No. 10, Sept. 1995.

For the Directors,

C. Calude

Professor C. S. Calude