THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

December 16, 2010

Research and Study Leave Report
Name: Professor Cristian S. Calude
Department: Computer Science
Period of Leave: May, July–December 2010

Goals

To visit various colleagues to continue our joint research or to initiate new co-operations in algorithmic information theory and quantum computing, to attend a couple of international conferences (where I presented invited lectures), to support the major CDMTCS international conference *Unconventional Computing* (held in Tokyo, Japan in 2010), and to promote our PhD programme and to recruit good PhD candidates.

Main Activities

0. 25 May - 29 May 2010: Notre Dame, USA

- Participation to the "International Conference on Logic, Computability and Randomness", Notre Dame, USA. Presented the invited lecture "Finite-state Randomness".

1. 20 June - 19 July: Japan, Portugal, UK, Singapore

- Participation to the 9th International Conference "Unconventional Computing 2010" organised by the University of Tokyo and the CDMTCS. Presented the Opening Address.
- Visit to the Centro de Matemática e Aplicações Fundamentais (CMAF), Lisbon (host: Prof. Felix Costa).
- Participation to the 6th Conference on "Computability in Europe 2010"", Ponta Delgada, Azores, Portugal, University of Azores. Presented the talk "Finite-state complexity and randomness" and the invited lecture of Prof. Y. I. Manin, "Infinities in Quantum Field Theory and in Classical Computing: Renormalization".
- Participation to the "Workshop Developments in Computational Models", Edinburgh, UK. Presented the invited lecture "Understanding the Quantum Computational Speed-up via De-quantisation".
- Visit the Department of Mathematics, National University of Singapore. Joint work with Prof. F. Stephan.

2. 20 - 31 July : Auckland

Brief return to New Zealand.

- Auckland: Work with my graduate students A. Abbott, N. Kosta, Ali Akhtarzada, and T. Roblott.
- 22 July: External examiner Ewan Orr's Ph.D. Thesis. *Evolving Turing's Artificial Networks*, University of Canterbury, Christchurch, NZ.

3. 1 August - 19 September: Canada, Romania, Egypt, Austria

- Visit to Kingston University. Co-operation with Prof. K. Salomaa. Seminar: "Understanding the Quantum Computational Speed-up via De-quantisation". Discussions with Prof. S. Akl

and a prospective student interested to enrol in UoA PhD programme. Visit to the University of Western Ontario in London. Meetings with Prof. H. Jürgensen, Prof. S. Yu and Prof. G. Rozenberg. Seminar: "Finite-state Complexity and Randomness".

- Visit to the Institute of Mathematics of the Romanian Academy and the University of Bucharest in Bucharest. Work with Acad. S. Marcus on the physical nature of mathematics. Meetings with Prof. V. Căzănescu, Prof. A. Iorgulescu, Prof. S. Rudeanu, Prof. D. Vaida, Prof. T. Zamfirescu. Discussion about the organisation of the Seventh Congress of Romanian Mathematicians June 29-July 5, 2011, Brasov, Romania (elected member of the OC for Theoretical Computer Science). Co-operation with Dr. G. Păun (Curtea-de-Argeş).
- Participation to the 3rd International Workshop on "Physics and Computation", Luxor-Aswan, Egypt[1]. Presentation of the paper "Experimental Evidence of Quantum Randomness Incomputability". Moderated the closing meeting of the workshop. Work on quantum randomness with A. Abbott and K. Svozil.
- Visit to the Institute of Theoretical Physics of the Vienna University of Technology. Continued the work on quantum randomness with A. Abbott and K. Svozil. Started the work on the final negotiation for the cooperation IRSES Grant RANPHYS we have been awarded for 2011–2015 by the Unit P2 (Marie Curie FP7-PEOPLE-2010-IRSES).[2] Participating Institutions: École Normale Supérieure, Paris, École Polytechnique, Paris Vienna University of Technology, Vienna and UoA.

3. 18 September - 23 October: Auckland

- Work with my graduate students A. Abbott, N. Kosta, Ali Akhtarzada, and T. Roblott.
- Hosted the visit of Prof. F. Stephan, National University of Singapore. Work on Tadaki's conjecture.
- Writing some results obtained in my previous trips (see the section "Papers Submitted or in Preparation").

4. 23 October - 18 November: Germany, United Kingdom, Romania

- Visit Martin-Luther-Universität Halle-Wittenberg, Germany. Continued the joint work with Prof. Ludwig Staiger on finite-state randomness. Seminar: "Is Quantum Randomness Pseudo-randomness?"
- Visit Leipzig University, Germany. Host: Prof. Manfred Droste. Seminar: "Is Quantum Randomness Pseudo-randomness?"
- Visit Oxford University, UK (London Mathematical Society grant). Host: Dr. Bob Coecke. Work with Prof. S. Abramsky. Talks to Dr. Edward Blakey and Prof. Tim Palmer. Seminar: "Is Quantum Randomness Pseudo-randomness?"
- Visit Leeds University, UK (London Mathematical Society grant). Host: Prof. Barry Cooper. Seminars: "Is Quantum Randomness Pseudo-randomness?" and "Representation of Left-Computable ε–Random Reals".
- Visit Edinburgh University, UK (London Mathematical Society grant). Host: Dr. Elham Kashefi and hist PhD student Vedran Dunjko.
- Visit Heriot-Watt University, UK. Host: Dr. Erika Andersson. Seminar: "Is Quantum Randomness Pseudo-randomness?"

5. 18 November - 20 December: Auckland.

- Work with my graduate students A. Abbott, N. Kosta, Ali Akhtarzada, and T. Roblott.
- Finalising two papers (see the section "Papers Submitted or in Preparation").

[1] The CDMTCS was a co-sponsor of the meeting.

[2] The Hood Fellowship, 2008–2009, allowed me to do the ground work to form eminent partners in Europe for a project in Physics and Computation, leading to the successful grant application.

Publications

I. Papers in Refereed Journals

1. C. S. Calude, M. Cavaliere, R. Mardare. An observer-based de-quantisation of Deutsch's algorithm, *International Journal of Foundations of Computer Science*, to appear in January 2011.
2. C. S. Calude, A. Nies, L. Staiger and F. Stephan. Universal recursively enumerable sets of strings, *Theoretical Comput. Sci.*, to appear in December 2010.
3. C.S. Calude, E. Calude and K. Svozil. The complexity of proving chaoticity and the Church-Turing Thesis, *Chaos* 20 037103 (2010), 1–5.
4. C. S. Calude, N. J. Hay, F. Stephan. Representation of left-computable ε–random reals, *Journal of Computer and System Sciences*, 2010, DOI 10.1016/ j.jcss.2010.08.0001.
5. C. S. Calude, M. J. Dinneen, Monica Dumitrescu, K. Svozil. Experimental evidence of quantum randomness incomputability, *Physical Review A*, 82, 022102 (2010), 1–8.
6. C. S. Calude, L. Staiger. A note on accelerated Turing machines, *Mathematical Structures in Computer Science*, 20 (2010), 1011–1017. DOI: 10.1017/S0960129510000344.
7. C. S. Calude, E. Calude. The complexity of the Four Colour Theorem, *LMS J. Comput. Math.* 13 (2010), 414–425.
8. C.S. Calude. Simplicity via provability for universal prefix-free Turing machines, *Theoretical Comput. Sci.*, 412 (2010), 178–182. DOI: 10.1016/j.tcs.2010.08.002.
9. C.S. Calude, E. Calude. Evaluating the Complexity of Mathematical Problems. Part 2, *Complex Systems* 18 (2010), 387–401.
10. C.S. Calude, G. J. Chaitin. What is . . . a halting probability? *Notices of the AMS* 57, 2 (2010), 236–237.
11. C.S. Calude, M. Zimand. Algorithmically independent sequences, *Information and Computation* 208 (2010), 292–308.

II. Papers in Refereed Proceedings

1. C. S. Calude, M. J. Dinneen, Monica Dumitrescu, K. Svozil. Experimental evidence of quantum randomness incomputability, in H. Guerra (ed.). *Physics and Computation 2010, Pre-Proceedings*, CAMIT, University of Azores, 2010, 127–145.
2. C. S. Calude, K. Salomaa, T. K. Roblot. Finite-state complexity and the size of transducers, in I. McQuillan and G. Pighizzini (eds.). *12th International Workshop on Descriptional Complexity of Formal Systems (DCFS 2010)*, EPTCS 26, 2010, pp. 38–47, DOI:10.4204/EPTCS.31.6.
3. C. S. Calude, K. Salomaa, T. K. Roblot. Finite-state complexity and randomness, in F. Ferreira, H. Guerra, E. Majordomo, J. Rasga (eds). *Programs, Proofs, Processes, 6th Conference on Computability in Europe, CiE 2010, Abstract and Handbook Booklet*, Ponta Delgada, Azores, Portugal, University of Azores, 2010, 73–82.
4. A. A. Abbott, C. S. Calude. Understanding the quantum computational speed-up via de-quantisation, in S. B. Cooper, E. Kashefi, P. Panangaden (eds.). *Developments in Computational Models (DCM 2010)* EPTCS 26, 2010, pp. 1–12, DOI:10.4204/EPTCS.26.1.

III. Papers in Refereed Collective Books

1. C. S. Calude, G. Chaitin, E. Fredkin, T. Legget, R. de Ruyter, T. Toffoli, S. Wolfram. What is computation? (How) Does nature compute? in H. Zenil (ed.). *What is Computation? (How) Does Nature Compute?*, World Scientific, Singapore, to appear in 2011.
2. C. S. Calude, M. J. Dinneen, A. M. Gardner. Opening the book of randomness, in R. Copeland (ed.). *DIASPAR. A Mapping of Randomness*, 2010, section 39, 8 pp.
3. C. S. Calude. Randomness Everywhere: My Path to Algorithmic Information Theory, in H.

Zenil (ed.). *Randomness Through Computation*, World Scientific, Singapore, 2010, 125–133.

4. C. S. Calude, J. Casti, G. Chaitin, P. Davies, K. Svozil, S. Wolfram. Is the universe random? in H. Zenil (ed.). *Randomness Through Computation*, World Scientific, Singapore, 2010, 217–251.

IV. Book Editor

1. C. S. Calude, V. Sassone (eds). *TCS 2010. Proceedings of the 6th IFIP International Conference on Theoretical Computer Science*, Springer, Heidelberg, 2010, 398 pp.
2. C. S. Calude, M. Hagiya, K. Morita, G. Rozenberg (eds.). *Proc. 9th International Conference Unconventional Computation*, Lecture Notes Comput. Sci. 6079, Springer, Heidelberg, 2010, 194 pp.

V. Special Issue Editor

1. C. S. Calude, J. F. Costa (eds.). Special issue: *Unconventional Computation 2008, Selected papers*, *Natural Computing*, Springer, 4 (2010).

VI. Research Reports

1. A. Abbott, C. S. Calude, K. Svozil. A Quantum Random Number Generator Certified by Value Indefiniteness, *CDMTCS Research Report*, 396, 2010, 27 pp.
2. C. S. Calude, M. J. Dinneen, A. M. Gardner. Opening the Book of Randomness (Extended Version), *CDMTCS Research Report* 393, 2010, 19 pp.
3. A. A. Abbott, C. S. Calude. Von Neumann Normalisation of a Quantum Random Number Generator, *CDMTCS Research Report* 392, 2010, 26 pp.
4. C.S. Calude, E. Calude and K. Svozil. The Complexity of Proving Chaoticity and the Church-Turing Thesis, *CDMTCS Research Report* 384, 2010, 18 pp.
5. C.S. Calude, M. Cavaliere, R. Mardare. Computational Power of the Observer in De-Quantisations of Deutsch's Algorithm, *CDMTCS Research Report* 381, 2010, 11 pp.
6. A. A. Abbott, C. S. Calude. Understanding the Quantum Computational Speed-up via De-quantisation, *CDMTCS Research Report* 381, 2010, 13 pp.

VII. Miscellania Papers

1. C. S. Calude. Letter from Auckland 1, *Curtea de la Arge*[0], 1 December (2010), 19 (in Romanian).
2. C. S. Calude. News from NZ – 52, *Bull. Eur. Assoc. Theor. Comput. Sci. EATCS* 102 (2010), 33–49.
3. C. S. Calude. News from NZ – 51, *Bull. Eur. Assoc. Theor. Comput. Sci. EATCS* 101 (2010), 38–49.
4. "Resolved: God Exists." Review of R. Goldstein. *36 Arguments for the Existence of God: A Work of Fiction, Pantheon Books, NY, 2010*, `http://www.amazon.co.uk/gp/cdp/member-reviews/A3A7QOZ8WMS6LW/ref=cm_cr_dp_auth_rev?ie=UTF8&sort_by=MostRecentReview`, 5 May 2010.
5. C. S. Calude. Thinking about Professor Marcus, in L. Spandonide (ed.). *Education Show Protagonist: Solomon Marcus*, Spandugino Publishing House, Bucharest, 2010, 49–51. (in Romanian)
6. C. S. Calude. News from NZ – 50, *Bull. Eur. Assoc. Theor. Comput. Sci. EATCS* 100 (2010), 17–31.

VIII. Interviews

1. Marian Baroni. "Not too many jobs pay for doing what you like to do: mathematicians are. An interview with Cristian S. Calude" *Revista de Matematica din Galaţi* 34 (2010), 1–6 (in

Romanian); http://www.mategl.com/rmg.php.

IX. Papers Submitted or in Preparation

1. C. S. Calude, K. Salomaa, T. K. Roblot. Finite-state complexity, *Notre Dame Journal of Formal Logic*, submitted December 2010.
2. A. Abbott, C. S. Calude, K. Svozil. A quantum random number generator certified by value indefiniteness, *Applied Mathematics and Computation*, submitted December 2010.
3. A. A. Abbott, C. S. Calude. Von Neumann normalisation of a quantum random number generator, *Theoretical Computer Science C*, submitted December 2010.
4. C. S. Calude, K. Salomaa, T. K. Roblot. State-size hierarchy for FS-complexity, *International Journal of Foundations of Computer Science*, submitted November 2010.
5. C. S. Calude, J. P. Lewis. Is there a universal image generator? *Applied Mathematics and Computation*, submitted October 2010.
6. A. A. Abbott, C. S. Calude. Understanding the quantum computational speed-up via de-quantisation, *Mathematical Structures in Computer Science*, submitted in October 2010.
7. A. Abbott, C. S. Calude, K. Svozil. Quantum Randomness Incomputability, in preparation.
8. A. A. Abbott, M. Bechmann, C. S. Calude and A. Sebald. Nuclear Magnetic Resonance Implementations of the De-quantised Solution to the Deutsch-Jozsa Problem, in preparation.
9. C. S. Calude, F. Stephan. On a Problem by K. Tadaki, in preparation.
10. C. S. Calude, L. Staiger. A Characterisation of FS–Random Sequences, in preparation.

Steering Committee

1. Co-chair, *International Conference Series "Unconventional Computation"*, https://www.cs.auckland.ac.nz/CDMTCS/conferences/uc.
2. Member, *Developments in Language Theory*, http://www.cs.auckland.ac.nz/CDMTCS/conferences/dlt/DLTConfSeries.html, *International Workshop on Natural Computing, Physics and Computation*, http://www.pc.uac.pt.

Programme Committee

1. *Workshop on Reachability Problems 2011*, Genova, Italy, September 2011.
2. *8th Annual Conference on Theory and Applications of Models of Computation*, Tokyo, Japan, 2011.
3. *Annual International Conference on Information Theory and Application*, February 2011, Cebu Philippines.
4. *13th CATS 2011 Computing: The Australasian Theory Symposium*, Perth, Australia, January 2011.
5. *Workshop on Reachability Problems 2010*, Brno, Czech Republic, October 2010.
6. *Theoretical Computer Science, World Computer Congress*, Brisbane, Australia, September 2010. (Chair Track A)
7. *Workshop on Physics and Computation 2010*, Boat on the Nile, Egypt, September 2010.
8. *Workshop on Hypercomputation 2010*, Tokyo, Japan, June 2010.
9. *9th International Conference on Unconventional Computation*, Tokyo, Japan, June 2010.
10. *14th Developments in Language Theory (DLT'10)*, London, Ontario, Canada, August 2010.
11. *Infinite and Infinitesimal in Mathematics, Computing and Natural Sciences*, Cetraro, Italy, May 2010.

Organising Committee

1. *Workshop on Hypercomputation 2011*, Turku, Finland, June 2011.
2. *Workshop on Physics and Computation 2011*, Turku, Finland, June 2011.
3. *Seventh Congress of Romanian Mathematicians*, Brasov, Romania, June–July 2011.
4. *Workshop on Physics and Computation 2010*, Luxor-Aswan, Egypt, September 2010.
5. Co-organised with Barry Cooper the special session "Computability of the Physical" (speakers: S. Lloyd, Y. I. Manin, C. Moore, D. Wolpert), *CiE 2010*, Ponta Delgada, Portugal, June 2010.

Expert 2010

1. FP6 evaluator, European Commission - DG Research, Brussels, Belgium.
2. Expert evaluator, European Science Foundation, Strasbourg, France.

Grants

1. London Mathematical Society Travel Grant for a research visit to Oxford University, Leeds University and Edinburgh University, October-November 2010.
2. IRSES Grant RANPHYS (with G. Longo, ENS, Paris, T. Paul, École Polytechnique, Paris, K. Svozil, Vienna University of Technology, A. Abbott and M. J. Dinneen) Unit P2 (Marie Curie International Fellowships), 2011–2014.

Journal Boards Election in 2010

1. *Mathematical Structures in Computer Science*
2. *International Journal of Unconventional Computing*

Awards and Distinction

1. Visiting Professor, École Polytechnique, Paris, 2011.
2. *Member of the Informatics Section Committee*, Academia Europaea, 2010–2013.

Acknowledgment

I was privileged to travel to USA, Japan, Portugal, UK, Singapore, Canada, Romania, Egypt, Austria, Germany to meet/discuss/co-operate with very interesting people.

The *support* of the Research Committee of the University of Auckland, the Department of Computer Science and the Centre for Discrete Mathematics and Theoretical Computer Science, the University of Tokyo, Japan, Centro de Matemática e Aplicações Fundamentais, Lisbon, the University of Azores, Portugal, Edinburgh University, UK, the National University of Singapore, Vienna University of Technology, the Institute of Computer Science, Martin-Luther-Universität, Halle–Wittenberg University, Germany, Leipzig University, Germany, Oxford University, UK, Leeds University, UK, University of Edinburgh, UK, is acknowledged with gratitude.

Staff member:	Prof. C. S. Calude	C. Calude	Date: 6.12.2010
Approved by: Head of Department	Prof. G. Dobbie		Date:
Approved by: Dean of Science	Prof. G. Guilford		Date: