

ALAN JAMES CAIN ✻ *Curriculum Vitæ*

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<i>Email address</i>	ajcain@fc.up.pt	<i>Nationality</i>	British citizen
<i>Web page</i>	www.fc.up.pt/pessoas/ajcain	<i>Languages</i>	English (Native), French (Intermediate), Portuguese (Basic), Japanese (Basic).

POSITIONS HELD

- Jul. 2009–Present* Research Fellow
Centro de Matemática da Universidade do Porto
Rua do Campo Alegre 687, 4169-007 Porto, Portugal
Research summary:
This position, an FCT-funded five-year personal research fellowship, made me responsible for choosing the direction of my research. So far, I have worked in several interrelated areas, both alone and with collaborators. One is hyperbolic semigroups, encompassing geometric, linguistic, and other generalizations of groups that are hyperbolic in the sense of Gromov. This has yielded results such as a polynomial-time algorithm for the word problem for hyperbolic monoids (improving on the previous-known exponential-time algorithm) and links between hyperbolicity and string-rewriting systems. Another is automatic presentations for relational structures. In joint work, I have classified various combinatorial structures that admit unary automatic presentations.
- Sep. 2008–Jun. 2009* Research Fellow
Centro de Álgebra da Universidade de Lisboa
Av. Prof. Gama Pinto 2, 1649-003 Lisboa, Portugal
♦ Research within the project ‘Semigroups and Languages’, funded by FCT and PID-DAC (PTDC/MAT/69514/2006).
Research summary:
I studied automatic Clifford semigroups and also studied (with collaborators) how automatic structures and Malcev presentations interacted with the new notion of Green index subsemigroups.
Teaching:
Postgraduate-level short course on automatic groups and semigroups.
- Sep. 2005–Aug. 2008* Research Fellow
School of Mathematics & Statistics, University of St Andrews
St Andrews, Fife KY16 9AJ, United Kingdom
♦ Member of Staff Council (March 2007–August 2008)
Research summary:
I worked as part of a large research team on the five-year interdisciplinary project ‘Critical Mass in Computational Algebra’, funded by the EPSRC (EP/C523229/1). In particular, I researched decision problems for automatic semigroups: given an automatic structure for a semigroup, is it possible to decide certain algebraic properties of the semigroup? In some cases, I proved that no such algorithm exists (for example, cancellativity and left-cancellativity are algorithmically undecidable). I also worked in related areas such as automaton semigroups (generalizing automaton groups) and automatic presentations. With collaborators, I classified all finitely generated cancellative semigroups that admit automatic presentations.

Teaching:

MT3600 'Fundamentals of Pure Mathematics' [with Prof. N. Ruškuc]

- ◆ Completely revised the course to concentrate on establishing the foundations of mathematics rigorously.
 - ◆ Student feedback was enthusiastically supportive, with 85% overall approval.
- Postgraduate-level short course on computing with automatic semigroups.

Sep. 2002–May 2005 Tutor & Computer laboratory demonstrator
School of Mathematics & Statistics, University of St Andrews
St Andrews, Fife KY16 9AJ, United Kingdom

- ◆ I tutored the first-year mathematics courses MT1002 and MT1003. The former course (covering both pure and applied mathematics) is a prerequisite for further mathematical study at St Andrews, and therefore it was essential to help the students achieve a thorough understanding of the concepts involved.
- ◆ My work as a computer laboratory demonstrator consisted of aiding students to use MAPLE to solve various problems related to their work in the first year courses MT1002 and MT1003, and marking their work. The marks a student received from this laboratory work made up 10% of his or her total mark for the course.

EDUCATION

Sep. 2002–Jul. 2005 Ph.D. in Mathematics
University of St Andrews
St Andrews, Fife KY16 9AJ, United Kingdom

Thesis: *Presentations for Subsemigroups of Groups*

Supervisors: Prof. E.F. Robertson
Prof. N. Ruškuc

Examiners: Dr M. Quick (Internal)
Prof. D.F. Holt (Univ. of Warwick, External)

- ◆ I won a Carnegie Doctoral Scholarship to fund my Ph.D. studies.
- ◆ My thesis was accepted with no corrections being required.

Summary of Ph.D. research:

My doctoral research spanned the boundary between mathematics, specifically algebra, and computer science, specifically the theory of algorithms. It focused on the study of combinatorial and computational properties of semigroups that can be embedded into groups. The most interesting semigroups are infinite. However, they sometimes have a finite description by means of a presentation or an automatic structure. My research studied both of these concepts and also Malcev presentations, a notion introduced in 1977 by J.-C. Spehner but neglected since then. In particular, I successfully linked the near-forgotten area of Malcev presentations with the new and active one of automatic semigroups. I then exploited this link in both directions, solving problems in the one area using the tools of the other.

Sep. 1998–Jul. 2002 M.Sci. in Mathematics with First-class Honours
University of Glasgow
Glasgow G12 8QQ, United Kingdom

- ◆ Cunninghame Prize in Mathematics; Class prizes in Mathematics in first and second year; Class prize in Computer Science in second year.
- ◆ President of the Maclaurin Society, the University of Glasgow student society for mathematics and statistics.

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- ◆ London Mathematical Society (Elected 2006)
- ◆ Edinburgh Mathematical Society (Elected 2003)

PUBLICATIONS

Presentations for Subsemigroups of Groups

Ph.D. thesis, University of St Andrews, 2005.

‘Subsemigroups of virtually free groups: finite Malcev presentations and testing for freeness’

[with E. F. Robertson & N. Ruškuc]

Mathematical Proceedings of the Cambridge Philosophical Society, 141, no. 1 (2006), pp. 57–66.

DOI: 10.1017/S0305004106009236 MR: 2238642 ZBL: 1115.20043

‘Subsemigroups of groups: presentations, Malcev presentations, and automatic structures’

[with E. F. Robertson & N. Ruškuc]

Journal of Group Theory, 9, no. 3 (2006), pp. 397–426.

DOI: 10.1515/jgt.2006.027 MR: 2226621 ZBL: 1151.20044

‘A group-embeddable non-automatic semigroup whose universal group is automatic’

Glasgow Mathematical Journal, 48, no. 2 (2006), pp. 337–342.

DOI: 10.1017/S0017089506003107 MR: 2256982 ZBL: 1108.20056

‘Cancellativity is undecidable for automatic semigroups’

Quarterly Journal of Mathematics, 57, no. 3 (2006), pp. 285–295.

DOI: 10.1093/qmath/hai023 MR: 2253587 ZBL: 1126.20039

‘A note on “Cancellativity is undecidable for automatic semigroups”’

Unpublished note, 2006.

‘Malcev presentations for subsemigroups of groups — a survey’

In C. M. Campbell, M. Quick, E. F. Robertson, & G. C. Smith, eds, *Groups St Andrews 2005* (Vol. 1), no. 339 in *London Mathematical Society Lecture Note Series*, pp. 256–268 (Cambridge: Cambridge University Press, 2007).

MR: 2328165

‘Cancellative and Malcev presentations for finite Rees index subsemigroups and extensions’

[with E. F. Robertson & N. Ruškuc]

Journal of the Australian Mathematical Society, 84, no. 1 (2008), pp. 39–61.

DOI: 10.1017/S1446788708000086 MR: 2469266 ZBL: 1156.20048

‘Automatic presentations for cancellative semigroups’

[with G. Oliver, N. Ruškuc & R. M. Thomas]

In C. Martín-Vide, H. Fernau, & F. Otto, eds, *Language and Automata Theory and Applications: Second International Conference, Tarragona, Spain, March 13–19, 2008*, no. 5196 in *Lecture Notes in Computer Science*, pp. 149–159 (Springer, 2008).

DOI: 10.1007/978-3-540-88282-4_15 MR: 2540320 ZBL: 1157.20332

‘Malcev presentations for subsemigroups of direct products of coherent groups’

Journal of Pure and Applied Algebra, 213, no. 6 (2009), pp. 977–990.

DOI: 10.1016/j.jpaa.2008.10.006 MR: 2498789 ZBL: 1178.20050

‘Automaton semigroups’

Theoretical Computer Science, 410, no. 47–49 (2009), pp. 5022–5038.

DOI: 10.1016/j.tcs.2009.07.054 MR: 2583696 ZBL: 1194.68133

‘Automatic presentations for semigroups’

[with G. Oliver, N. Ruškuc & R. M. Thomas]

Information and Computation, 207, no. 11 (2009), pp. 1156–1168.

DOI: 10.1016/j.ic.2009.02.005 MR: 2566948 ZBL: 1192.20040

‘Decision problems for finitely presented and one-relation semigroups and monoids’

[with V. Maltcev]

International Journal of Algebra and Computation, 19, no. 6 (2009), pp. 747–770.

DOI: 10.1142/S0218196709005366 MR: 2572873 ZBL: 1201.20055

‘Monoids presented by rewriting systems and automatic structures for their submonoids’

International Journal of Algebra and Computation, 19, no. 6 (2009), pp. 771–790.

DOI: 10.1142/S0218196709005317 MR: 2572874 ZBL: 1201.20054

‘Automatic semigroups and Bruck–Reilly extensions’

Acta Mathematica Hungarica, 126, no. 1–2 (2010), pp. 1–15.

DOI: 10.1007/s10474-009-8063-8 MR: 2593314

- ‘Automatic presentations and semigroup constructions’
 [with G. Oliver, N. Ruškuc & R. M. Thomas]
Theory of Computing Systems, 47, no. 2 (2010), pp. 568–592.
 DOI: 10.1007/s00224-009-9216-4 MR: 2652030 ZBL: 1204.68118
- ‘Deus ex machina and the aesthetics of proof’
Mathematical Intelligencer, 32, no. 3 (Sept. 2010), pp. 7–11.
 DOI: 10.1007/s00283-010-9141-z MR: 2721302 ZBL: 05820348
- An annotated translation of Yves Marie André’s *Essay on Beauty* (1741)
 (Ebook, 2010).
- ‘Unary FA-presentable semigroups’
 [with N. Ruškuc & R. M. Thomas]
International Journal of Algebra and Computation, 2012. Forthcoming.
- ‘Green index in semigroup theory: generators, presentations, and automatic structures’
 [with R. Gray & N. Ruškuc]
Semigroup Forum, Forthcoming.
 arXiv: 0912.1266
- ‘Plactic algebras admit finite Gröbner–Shirshov bases’
 [with R. Gray & A. Malheiro]
 Unpublished note, 2012.
 arXiv: 1205.4885
- ‘Automatic structures for subsemigroups of Baumslag–Solitar semigroups’
 Submitted.
- ‘Automatic Clifford semigroups’
 Submitted.
- ‘Hyperbolicity of monoids presented by confluent monadic rewriting systems’
 Submitted.
- ‘Markov semigroups, monoids, and groups’
 [with V. Maltcev]
 Submitted.
 arXiv: 1202.3013
- ‘Context-free rewriting systems and word-hyperbolic structures with uniqueness’
 [with V. Maltcev]
 Submitted.
 arXiv: 1201.6616
- ‘Finitely presented monoids with linear Dehn function need not have regular cross-sections’
 [with V. Maltcev]
 Submitted.
 arXiv: 1203.0473
- ‘For a few elements more: A survey of finite Rees index’
 [with V. Maltcev]
 In preparation.
- ‘Unary FA-presentable algebraic and relational structures’
 [with N. Ruškuc]
 In preparation.
- ‘Decision problems for word-hyperbolic monoids’
 In preparation.
- ‘Notions of hyperbolicity in monoids’
 In preparation.
- ‘On weak automatic presentations’
 In preparation.

SEMINARS AND CONFERENCE TALKS

- ‘Certain properties of subsemigroups of free groups’
 Seminar: University of St Andrews, 13th August 2003.
- ‘Automatic semigroups & Malcev presentations I’
 Informal seminar: Friday Group, University of St Andrews, 26th March 2004.

- ‘Automatic semigroups & Malcev presentations II’
 Informal seminar: Friday Group, University of St Andrews, 7th May 2004.
- ‘Malcev presentations’
 Seminar: University of St Andrews, 17th June 2004.
- ‘Malcev presentations’
 Conference talk: Postgraduate Pure Mathematics in the North East 2004, University of Newcastle, 28th June 2004.
- ‘Malcev presentations for subsemigroups of groups’
 Invited seminar: University of Glasgow, 13th October 2004.
- ‘A survey of Malcev presentations for subsemigroups of groups’
 Conference talk: Groups St Andrews 2005, University of St Andrews, 31st July 2005.
- ‘Decidability and undecidability for automatic semigroups’
 Invited seminar: University of Edinburgh & Heriot–Watt University (Joint), 15th November 2005.
- ‘An introduction to decidability for automatic semigroups’
 Short course: University of St Andrews, 28th November–12th December 2005.
- ‘Cancellative and Malcev presentations for subsemigroups and extensions’
 Conference talk: Semigroup Day ’06, Heriot–Watt University, 5th July 2006.
- ‘Decidability for automatic semigroups’
 Conference talk: International Workshop on Computational and Algorithmic Aspects of Semigroup Theory, University of St Andrews, 6th September 2006.
- ‘Automatic presentations for cancellative semigroups’
 Conference talk: 2nd International Conference on Language and Automata Theory and Applications, Universitat Rovira i Virgili, Tarragona, Spain, 18th March 2008.
- ‘Automatic presentations for semigroups’
 Conference talk: 2008 British Mathematical Colloquium, University of York, 27th March 2008.
- ‘Automaton semigroups’
 Seminar: Pure Mathematics Colloquium, University of St Andrews, 29th May 2008.
- ‘Automatic semigroups’
 Short course: Centro de Álgebra da Universidade de Lisboa, 22nd–29th October 2008.
- ‘Malcev presentations for subsemigroups of groups’
 Seminar: Centro de Álgebra da Universidade de Lisboa, 31st October 2008.
- ‘Automaton semigroups’
 Invited conference talk: North Britain Semigroups and Applications Network, University of St Andrews, 16th April 2009.
- ‘Automatic presentations and semigroups’
 Seminar: Centro de Matemática da Universidade do Porto, 25th September 2009.
- ‘Malcev presentations for subsemigroups of groups’
 Seminar: Centro de Matemática da Universidade do Porto, 30th October 2009.
- ‘Computing with automatic semigroups’
 Conference talk: Centro de Matemática da Universidade do Porto, 15th June 2010.
- ‘Automatic presentations and semigroups’
 Invited seminar: Centro de Álgebra da Universidade de Lisboa, 10th September 2010.
- ‘Hyperbolic and word-hyperbolic semigroups’
 Invited conference talk: North Britain Semigroups and Applications Network, University of St Andrews, 19th May 2010.
- ‘Unary FA-presentable algebraic and relational structures’
 Seminar: Centro de Matemática da Universidade do Porto, 15th February 2012.
- ‘Hyperbolicity for semigroups’
 Invited seminar: Centro de Álgebra da Universidade de Lisboa, 11th May 2012.