simon.william.mackenzie@gmail.com
Google Scholar
Languages: French and English

Simon Mackenzie

Research interests Algorithms and lower bounds, with particular interests in communication complexity, fair division, exact and exponential-time algorithms, mechanism design, and computational social choice.

Research Profile

Selected results from collaborative work include:

- **Communication complexity and interlacing (2025–26):** I refuted the strongest form of the direct sum conjecture for total functions in deterministic communication complexity (STOC 2025). I then helped develop relaxed interlacing into a reusable framework that proves NP-completeness of computing deterministic communication complexity from a truth table, resolving a conjecture posed by Yao in 1979. Together, these results anchor a broader interlacing programme for hardness and protocol structure in communication complexity.
- **Fair division (2016–26):** I developed bounded envy-free cake-cutting protocols for four agents and for any number of agents (STOC and FOCS 2016), settling a longstanding open problem and leading to an invited *Communications of the ACM* article. Recent work covers goods, chores, and cake (EC 2026); best-of-both-worlds fairness for mixed goods and chores; optimal subsidy bounds; counterexamples to EFX for submodular and subadditive valuations; and the incompatibility of EF1 and Pareto optimality for submodular valuations.
- **Algorithms, apportionment, and mechanism design:** I resolved the 2024 threshold-monotonicity conjecture for Sampford apportionment. Other work includes NP-completeness of the winner problem for balanced knockout tournaments, exponential-time approximate counting (ESA 2026), and a strategyproof-in-expectation constant-factor approximation for three-facility location, addressing a question from 2010.

Academic and Professional Experience

UNSW Sydney, Australia 2024–2026
School of Computer Science and Engineering; research and teaching appointments

Lecturer, COMP3821 Term 3, 2026
Extended Algorithm Design and Analysis; lecturer in charge: Serge Gaspers.

Postdoctoral Fellow Feb 2026 – Dec 2026
Adviser: Haris Aziz

Lecturer, COMP9020 Term 2, 2026
Foundations of Computer Science

Postdoctoral Fellow 2024, 2025
Adviser: Serge Gaspers; May–Sep 2024 and Aug–Dec 2025

Science Communicator, *Up and Atom* 2022–2024
Scriptwriting, animation, and field production for mathematics and theoretical computer science videos.

Postdoctoral Fellow, Data61, CSIRO, Australia Mar 2019 – Feb 2022
Advisers: Haris Aziz and Toby Walsh

Postdoctoral Fellow, Carnegie Mellon University, United States Sep 2016 – Sep 2018
Adviser: Ariel Procaccia

Education

PhD, UNSW Sydney, Australia 2017
Thesis: *Upper Bounds for Cake Cutting*; Supervisor: Serge Gaspers; Co-supervisor: Toby Walsh

MSc in Computer Science, University of Birmingham, United Kingdom Sep 2011 – Sep 2012
Thesis: *Computing Stable Sets in Pillage Games*; Supervisor: Manfred Kerber

BSc in Physics, University of Birmingham, United Kingdom Sep 2008 – Jul 2011

Conference Publications

[1] Haris Aziz, Xinhang Lu, Simon Mackenzie, and Mashbat Suzuki. "Fair Division with Indivisible Goods, Chores, and Cake". In: *Proceedings of the 27th ACM Conference on Economics and Computation (EC)*. Forthcoming. 2026. arXiv: 2511.04891 [cs.GT].

[2] Katie Clinch, Serge Gaspers, Simon Mackenzie, and Qi Wang. "Faster Exponential-Time Approximate Counting via Bounded Self-Reductions". In: *Proceedings of the European Symposium on Algorithms (ESA)*. Forthcoming. 2026. arXiv: 2607.06393 [cs.DS].

[3] Simon Mackenzie and Abdallah Saffidine. "Refuting the Direct Sum Conjecture for Total Functions in Deterministic Communication Complexity". In: *Proceedings of the 57th Annual ACM Symposium on Theory of Computing (STOC)*. 2025, pp. 572–583.

[4] Paul Gölz, Anson Kahng, Simon Mackenzie, and Ariel D. Procaccia. "The Fluid Mechanics of Liquid Democracy". In: *Proceedings of the 14th International Conference on Web and Internet Economics (WINE)*. 2018, pp. 188–202.

[5] Nika Haghtalab, Simon Mackenzie, Ariel D. Procaccia, Oren Salzman, and Siddhartha Srinivasa. "The provable virtue of laziness in motion planning". In: *Proceedings of the International Conference on Automated Planning and Scheduling*. Vol. 28. 2018, pp. 106–113.

[6] Anson Kahng, Simon Mackenzie, and Ariel D. Procaccia. "Liquid Democracy: An Algorithmic Perspective". In: *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 32. 1. 2018, pp. 1095–1102.

[7] Haris Aziz, Sylvain Bouveret, Jérôme Lang, and Simon Mackenzie. "Complexity of manipulating sequential allocation". In: *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 31. 1. 2017.

[8] Haris Aziz, Jiashu Chen, Aris Filos-Ratsikas, Simon Mackenzie, and Nicholas Mattei. "Egalitarianism of random assignment mechanisms". In: *Proceedings of the 15th International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*. 2016, pp. 1267–1268.

[9] Haris Aziz and Simon Mackenzie. "A discrete and bounded envy-free cake cutting protocol for any number of agents". In: *2016 IEEE 57th Annual Symposium on Foundations of Computer Science (FOCS)*. IEEE. 2016, pp. 416–427.

[10] Haris Aziz and Simon Mackenzie. "A discrete and bounded envy-free cake cutting protocol for four agents". In: *Proceedings of the forty-eighth annual ACM symposium on Theory of Computing*. 2016, pp. 454–464.

[11] Haris Aziz, Serge Gaspers, Joachim Gudmundsson, Simon Mackenzie, Nicholas Mattei, and Toby Walsh. "Computational aspects of multi-winner approval voting". In: *Proceedings of the 14th International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*. 2015, pp. 107–115.

[12] Haris Aziz, Serge Gaspers, Simon Mackenzie, Nicholas Mattei, Nina Narodytska, and Toby Walsh. "Equilibria under the probabilistic serial rule". In: *IJCAI*. 2015.

[13] Haris Aziz, Serge Gaspers, Simon Mackenzie, Nicholas Mattei, Nina Narodytska, and Toby Walsh. "Manipulating the probabilistic serial rule". In: *AAMAS*. 2015.

[14] Haris Aziz, Simon Mackenzie, Lirong Xia, and Chun Ye. "Ex post Efficiency of Random Assignments." In: *AAMAS*. 2015.

[15] Serge Gaspers and Simon Mackenzie. "On the number of minimal separators in graphs". In: *International Workshop on Graph-Theoretic Concepts in Computer Science*. Springer. 2015, pp. 116–121.

[16] Haris Aziz, Serge Gaspers, Simon Mackenzie, Nicholas Mattei, Paul Stursberg, and Toby Walsh. "Fixing a balanced knockout tournament". In: *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 28. 1. 2014.

[17] Haris Aziz, Serge Gaspers, Simon Mackenzie, and Toby Walsh. "Fair Assignment of Indivisible Objects under Ordinal Preference". In: *AAMAS*. Vol. 14. 2014, pp. 1305–1312.

Journal Publications

[1] Paul Gölz, Anson Kahng, Simon Mackenzie, and Ariel D. Procaccia. "The fluid mechanics of liquid democracy". In: *ACM Transactions on Economics and Computation* 9.4 (2021), pp. 1–39.

[2] Anson Kahng, Simon Mackenzie, and Ariel D. Procaccia. "Liquid democracy: An algorithmic perspective". In: *Journal of Artificial Intelligence Research* 70 (2021), pp. 1223–1252.

[3] Haris Aziz and Simon Mackenzie. "A bounded and envy-free cake cutting algorithm". In: *Communications of the ACM* 63.4 (2020), pp. 119–126.

[4] Haris Aziz, Serge Gaspers, Simon Mackenzie, Nicholas Mattei, Paul Stursberg, and Toby Walsh. "Fixing balanced knockout and double elimination tournaments". In: *Artificial Intelligence* 262 (2018), pp. 1–14.

[5] Serge Gaspers and Simon Mackenzie. “On the number of minimal separators in graphs”. In: *Journal of Graph Theory* 87.4 (2018), pp. 653–659.

[6] Haris Aziz and Simon Mackenzie. “Bounded and envy-free cake cutting”. In: *ACM SIGecom Exchanges* 15.2 (2017), pp. 30–33.

[7] Haris Aziz, Serge Gaspers, Simon Mackenzie, and Toby Walsh. “Two desirable fairness concepts for allocation of indivisible objects under ordinal preferences”. In: *ACM SIGecom Exchanges* 14.2 (2016), pp. 16–21.

[8] Haris Aziz, Serge Gaspers, Simon Mackenzie, and Toby Walsh. “Fair assignment of indivisible objects under ordinal preferences”. In: *Artificial Intelligence* 227 (2015), pp. 71–92.

[9] Manfred Kerber, Simon Mackenzie, and Colin Rowat. “Pillage games with multiple stable sets”. In: *International Journal of Game Theory* 44 (2015), pp. 993–1013.

Preprints and Manuscripts

- Haris Aziz, Simon Mackenzie, and Mashbat Suzuki. *Sampford Apportionment Satisfies Threshold Monotonicity*. SSRN preprint. Resolves the threshold-monotonicity conjecture of Correa et al. (2024).
- Haris Aziz, Simon Mackenzie, and Mashbat Suzuki. *Anchoring for Truthfulness: The Random-Anchor Volume Mechanism for Multi-Facility Location*. arXiv: 2608.16550 [cs.GT].
- Simon Mackenzie and Mashbat Suzuki. *When One Good Is Not Enough: EF1 and Pareto Optimality Are Not Compatible for Submodular Valuations*. arXiv: 2607.17811 [cs.GT]. Under review for the International Conference on Web and Internet Economics (WINE).
- Haris Aziz, Xiaolin Bu, Xinhang Lu, Simon Mackenzie, Mashbat Suzuki, Biaoshuai Tao, and Toby Walsh. *Best-of-Both-Worlds Fairness for Mixed Goods and Chores*. arXiv: 2607.10232 [cs.GT]. Under review for the ACM-SIAM Symposium on Discrete Algorithms (SODA).
- Xinhang Lu, Simon Mackenzie, and Mashbat Suzuki. *Optimal Subsidy Bounds for Goods and Chores: One Dollar Each Suffices*. arXiv: 2607.10089 [cs.GT]. Under review for the ACM-SIAM Symposium on Discrete Algorithms (SODA).
- Simon Mackenzie and Mashbat Suzuki. *Counterexamples to EFX for Submodular and Subadditive Valuations*. arXiv: 2605.06451 [cs.GT]. Original preprint; subsequently combined with the paper of Akrami, Mayorov, Mehlhorn, Srinivas, and Weidenbach.
- Katie Clinch, Serge Gaspers, Tao Zixu He, Simon Mackenzie, and Tiankuang Zhang. *A Faster Randomized Algorithm for Vertex Cover: An Automated Approach*. arXiv: 2510.09027 [cs.DS].
- Serge Gaspers, Tao Zixu He, and Simon Mackenzie. *NP-Completeness of Deterministic Communication Complexity via Relaxed Interlacing*. arXiv: 2508.05597 [cs.CC].
  Interactive Lean proof inspector (LLM-assisted experiment) (scope and assumptions).
- Haris Aziz, Serge Gaspers, and Simon Mackenzie. *Computational Complexity of Hall Set Problems*. Manuscript.
- Ben Abramowitz, Simon Mackenzie, and Nicholas Mattei. *Balancing Approximations in Facility Location*. Manuscript. Under review for the International Conference on Web and Internet Economics (WINE).

Related work on formal verification includes Beyond the Library’s formalisation of our direct-sum paper and Bertram, Lai, and Hsu’s verification of a three-agent variant of our cake-cutting protocol. I am interested in how such tools relate to my work.

Awards

ICAPS Best Paper Award 2018

Malcolm Chaikin Prize for Research Excellence in Engineering 2018

CISRA Best Research Paper Prize 2016
School of Computer Science and Engineering, UNSW Sydney

Best MSc Project for Outstanding Research Quality 2012
University of Birmingham Computer Science Department

Teaching Experience

UNSW Sydney

COMP3821 Extended Algorithm Design and Analysis 2024–2026
Lectures and day-to-day delivery: Term 3, 2026; lecturer in charge: Serge Gaspers.
Project supervisor and tutor: Feb–May 2024; Sep–Dec 2025.

COMP9020 Foundations of Computer Science 2024–2026
Lecturer: Term 2, 2026.
Tutor: May–Aug 2024; Feb–Apr 2025. Guest lecturer: Feb–Aug 2024.

COMP3121 Algorithm Design and Analysis Sep 2024 – Dec 2024
Guest lecturer

COMP4141 Theory of Computer Science Feb 2024 – May 2024
Tutor

Supervision

Rayan Shahara, Honours Thesis Feb 2026 – Dec 2026
Research Topic: *OXS Valuations in Fair Division* (provisional)

Tao Zixu He, Honours Thesis Sep 2024 – Sep 2025
Research Topic: *NP-Hardness of Communication Complexity*

Tao Zixu He, Special Research Project May 2024 – Sep 2024
Research Topic: *Measure and Conquer for Randomised Algorithms*

Qi Wang, Master's Thesis May 2024 – Sep 2024
Research Topic: *Exponential-Time Approximate Counting Algorithms*

Media Features

Selected coverage includes **Scientific American**, **Quanta Magazine**, **Science News** (2023), **The Sydney Morning Herald**, and a 2025 UNSW Newsroom feature on the STOC 2025 direct-sum result. My work on cake cutting was also highlighted in Colin Stuart's book *10 Things You Need to Know About Numbers*. It has been popularised through videos on channels including "Numberphile", "Science4All", and "Up and Atom" (2024), with millions of views.

Lance Fortnow and Bill Gasarch discussed my cake-cutting paper on the Computational Complexity blog. They subsequently named it complexity theory paper of the year. Richard Lipton and Ken Regan later discussed the CACM version in *Gödel's Lost Letter and P=NP*.

Invited Talks

- Dagstuhl Seminar 16232: *Fair Division*, Schloss Dagstuhl, 2016
- Highlights of Algorithms (HALG), 2017
- Malcolm Chaikin Invited Talk, 2019
- IJCAI Sister Conference Track, 2019
- Max Planck Institute, virtual invited talk, July 2026

Academic Service

- Journal referee in 2026 for *Autonomous Agents and Multi-Agent Systems*, *Journal of the ACM*, *Mathematical Social Sciences*, and *Social Choice and Welfare*.
- Conference referee for AAAI, AAMAS, SODA, EC, and related venues.

References

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Toby Walsh tw@cse.unsw.edu.au
Nicholas Mattei nsmattei@tulane.edu