Adam Bouland

Ph.d. candidate, Computer Science
Massachusetts Institute of Technology
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Interests

Quantum computation, computational complexity theory, and applications to physics.

Education

Massachusetts Institute of Technology, Cambridge, MA
Ph.D. Candidate in Electrical Engineering & Computer Science, 2011-Present
Advisor: Scott Aaronson, GPA: 5.0/5.0

University of Cambridge, Cambridge, UK
M.Phil. in Advanced Computer Science, 2011 (Advisor: Anuj Dawar)
M.A.St. in Applied Math and Theoretical Physics, 2010

Yale University, New Haven, CT
B.S. Computer Science & Mathematics, Physics, 2009
Summa Cum Laude, Distinction in Both Majors, GPA: 4.0/4.0

Awards

NSF Graduate Research Fellowship, 2011-2016
Marshall Scholar, UK Government, 2009-2011
George J. Schulz Prize, Yale Physics Department, 2009
Deforest Prize, Yale Mathematics Department, 2009
Howard L. Schulz Prize, Silliman College, Yale, 2009
Senior High Scholarship Award, Yale Science and Engineering Association, 2009
Junior High Scholarship Award, Yale Science and Engineering Association, 2008
Barry M. Goldwater Scholar, US Government, 2008
Junior Inductee into Phi Beta Kappa, Yale Chapter, 2007
Member, Johns Hopkins Study of Exceptional Talent

Positions

Research Assistant, Theory of Computation Group, MIT, 2011-Present
Research topics have included models of quantum computing which are weaker than BQP, the classification of quantum gate sets, classical complexity theory, and applications to physics. Advised by Scott Aaronson.

Research Visitor: U. Bristol, Aug. 2016 (Host: Ashley Montanaro), Tokyo Institute of Technology, Dec. 2016 (Host: Tomoyuki Morimae), Joint Center for Quantum Information and Computer Science (QuICS), University of Maryland, Aug. 2016 (Host: Stephen Jordan), Centre for Quantum Technologies (CQT), Singapore, Jan.-Apr. 2014, Jun.-Aug. 2015 (Host: Miklos Santha).

Research Student, Logic and Complexity Group, University of Cambridge, 2010-2011
Studied the parameterized complexity of graph isomorphism. Showed that graph isomorphism is fixed-parameter tractable in the tree-depth of a graph. Advised by Anuj Dawar.

Undergraduate Research in Algorithms, Yale University, 2009
Designed algorithms to improve multi-way sparse cuts in graphs. Advised by Daniel Spielman.

Cosmology Research, Yale, Stanford, 2008-2009
Created software to analyze cosmic microwave background anisotropies and galaxy cluster surveys. Advised by Richard Easther (Yale) and Risa Wechsler (Stanford).

Software Development Intern, Oracle Corporation, Summer 2008
Developed supply-chain planning tools in Java using advanced data structures**.**

Computational Mechanics Research, 2004-2007
Modeled shock mechanics, bulk metallic glasses, and faults using finite element, boundary element, and finite difference methods. Advised by Mostafiz Chowdhury (U.S. Army Research Lab, 2004-2006), Jan Schroers (Yale, 2007), and David Pollard (Stanford, 2008).

Teaching

Mentor, MIT SPUR Program for Undergraduate Research, MIT Undergraduate Research Opportunities Program, Summer 2012, 2013, 2014, Fall 2012, 2013, 2014, Spring 2015
Mentored undergraduate students on research projects in theoretical computer science and theoretical physics. Students and projects included:

- Xue Zhang: Quantum Computing with commuting gate sets (Summer 2014-Spring 2015)
- Mitchell Lee: Quantum Computing with Hidden Variables (Summer-Fall 2013)
- Hyun Sub Hwang: Quantum vs. Classical Oracles (Summer 2013)
- Lynn Chua: Psi-epistemic Theories (Summer-Fall 2012)
- Mark Velednitsky: Graph Isomorphism and Crossing Number (Summer 2012)

Teaching Assistant, Quantum Complexity Theory, MIT Subject 6.845, Fall 2014

Grader, Quantum Complexity Theory, MIT Subject 6.845, Fall 2012

Publications

S. Aaronson, A. Bouland, G. Kuperberg and S. Mehraban. "The Computational Complexity of Ball Permutations." In submission. arXiv: 1610.06646 (2016).

A. Bouland, L. Chen, D. Holden, J. Thaler, and P. N. Vasudevan. "On SZK and PP." In submission. ECCC TR16- 140 and arXiv:1609.02888 (2016).

N. Bao, A. Bouland, A. Chatwin-Davies, J. Pollack and H. Yuen. "Rescuing Complementarity with Little Drama." To appear in *Journal of High Energy Physics* (JHEP). arXiv: 1607.05141 (2016).

I. Arad, A. Bouland, D. Grier, M. Santha, A. Sundaram, and S. Zhang. "On the complexity of probabilistic trials for hidden satisfiability problems." In *Proc. Mathematical Foundations of Computer Science* (MFCS), volume 58 of LIPIcs, pages 12:1-12:14, arXiv: 1606.03585 (2016).

A. Bouland, L. Mančinska and X. Zhang. "Complexity classification of two-qubit commuting hamiltonians." In *Proc. Conference on Computational Complexity* (CCC), volume 50 of LIPIcs, pages 28:1-28:33, arXiv:1602.04145 (2016).

N. Bao, A. Bouland and S. Jordan. "Grover search and the no-signaling principle." *Physical Review Letters* 117, 120501, arXiv: 1511.00657 (2016).

S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. "The space `just above' BQP." In *Proc. ACM Conference on Innovations in Theoretical Computer Science* (ITCS), pages 271-280, arXiv: 1412.6507 (2016).

A. Bouland and S. Aaronson. “Generation of Universal Linear Optics by Any Beamsplitter.” *Physical Review A* 89, 062316 (2014). Editor’s Suggestion. arXiv:1310.6718.

S. Aaronson, A. Bouland, L. Chua and G. Lowther. “Psi-epistemic Theories: The Role of Symmetry.” *Physical Review A* 88, 032111 (2013). Editor’s Suggestion. arXiv:1303.2834.

A. Bouland, A. Dawar and E. Kopczyński. “On Tractable Parameterizations of Graph Isomorphism.” In *Proc. International Symposium on Parameterized and Exact Computation* (IPEC), Springer LNCS 7535, pp. 218-230, Springer (2012).

A. Bouland, R. Easther and K. Rosenfeld. “Caching and Interpolated Likelihoods: Accelerating Cosmological Monte Carlo Markov Chains”. *Jounal of Cosmology and Astroparticle Physics* (JCAP) 2011(05) (2011). arXiv: 1012.5299.

A. Bouland and M. Chowdhury. “Analytical Simulation and Verification of Air Gun Impact Testing” – ARL Technical Report No. 3559 (2005).

Expository Writings

“Establishing Quantum Advantage.” XRDS: Crossroads, The ACM Magazine for Students. Volume 23 Issue 1, Fall 2016, Pages 40-44 (2016).

Oral Presentations

“Grover search and the no-signaling principle.” N. Bao, A. Bouland and S. Jordan. U. Bristol Quantum Information seminar, Bristol. UK, August 2016.

“Equivalence of Adiabatic and Circuit Based Quantum Computing” and “Why physicists should care about the complexity zoo.” It from Qubit Summer School Focus Lectures. Waterloo, Canada, July 2016.

“Complexity classification of two-qubit commuting hamiltonians.” A. Bouland, L. Mančinska and X. Zhang. Presented at Computational Complexity Conference (CCC) 2016, Tokyo, Japan, June 2016.

“Complexity classification of two-qubit commuting hamiltonians.” A. Bouland, L. Mančinska and X. Zhang. Presented as a contributed talk at Quantum Information Processing (QIP) 2016, Banff, Canada, January 2016.

“The space `just above’ BQP.” S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. Innovations in Theoretical Computer Science (ITCS)‘16, Cambridge, MA, January 2016.

“The space `just above’ BQP.” S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. Invited talk, The space around BQP [workshop], Tokyo, Japan, December 2015.

“On the Complexity of Commuting Quantum Circuits.” A. Bouland, L. Mančinska and X. Zhang. Invited talk, QuICS Seminar, University of Maryland, September 2015.

“On the Complexity of Commuting Quantum Circuits.” A. Bouland, L. Mančinska and X. Zhang. Centre for Quantum Technologies - Computer Science Seminar, Singapore, August 2015.

"Generation of Universal Linear Optics by Any Beamsplitter." A. Bouland and S. Aaronson. Presented as a contributed talk at Quantum Information Processing (QIP) 2015, Sydney, Australia, January 2015.

"Any Beamsplitter Generates Universal Quantum Linear Optics." A. Bouland and S. Aaronson. Centre for Quantum Technologies - Computer Science Seminar, Singapore, February 2014.

"On Tractable Parameterizations of Graph Isomorphism." A. Bouland, A. Dawar and E. Kopczyński. International Symposium on Parameterized and Exact Computation (IPEC) 2012, Ljubljana, Slovenia, September 2012.

Poster Presentations

"On SZK and PP." A. Bouland, L. Chen, D. Holden, J. Thaler, and P. N. Vasudevan. To appear as a poster at QIP 2017, Seattle, Washington, January 2017.

"The Computational Complexity of Ball Permutations." S. Aaronson, A. Bouland, G. Kuperberg, and S. Mehraban. To appear as a poster at QIP 2017, Seattle, Washington, January 2017.

"Grover search and the no-signaling principle." N. Bao, A. Bouland and S. Jordan. QIP 2016, Banff, Canada, January 2016.

"The space `just above' BQP." S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. Gordon Research Conference on Quantum Science, Easton, MA, USA, August 2014.

"Any Beamsplitter and Any Phase Generate Universal Quantum Linear Optics." A. Bouland and S. Aaronson. QIP 2013, Beijing, China, January 2013.

Service & Outreach

Reviewer or Subreviewer for: Symposium on the Theory of Computing (STOC), Quantum Information Processing (QIP), Innovations in Theoretical Computer Science (ITCS), Theory of Computing (ToC), Symposium on Theoretical Aspects of Computer Science (STACS), Physical Review Letters (PRL), Physical Review A (PRA), Quantum Information & Computation (QIC), Quantum Information Processing (QINP), Information Processing Letters (IPL), IEEE Transactions on Neural Networks and Learning Systems (TNNLS), Computing and Combinatorics Conference (COCOON)

Co-organizer, Quantum CS (QuaCS) group meeting, 2015-present (joint with Robin Kothari).

Theory representative, CSAIL Student Committe, 2013