

Robert Robere

Assistant Professor
School of Computer Science
McGill University
Montréal, Québec, Canada
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Research Interests.

Computational complexity theory, particularly the fields of circuit complexity, proof complexity, and interactions between them.

Education.

- **Ph.D. in Computer Science** (2013 - 2018)
University of Toronto, Toronto, Canada.
Advisors: Toniann Pitassi and Stephen Cook
Thesis Title: *Unified lower bounds for monotone computation.*
Awarded the 2019 EATCS Distinguished Dissertation Award.
- **Master of Science in Computer Science** (2012-2013)
University of Toronto, Toronto, Canada.
Advisors: Toniann Pitassi and Stephen Cook
Project Title: *Average case lower bounds for monotone switching networks.*
- **Bachelor of Science in Computer Science (Honours)** (2007-2012)
Minor: Mathematics
Memorial University of Newfoundland, St. John's, Canada.
Graduated with First Class Distinction.
Awarded Medal of Academic Achievement in Computer Science (Graduated Top of Class).

Professional Experience.

- **Visiting Scientist** (January 2021 – May 2021)
Simons Institute, University of California, Berkeley, U.S.A.
Long-term participant in the program “Satisfiability: Theory, Practice and Beyond”.
- **Assistant Professor** (August 2020 –)
McGill University, Montréal, Québec, Canada.
- **Member** (September 2019 – August 2020)
CSDM Group, School of Mathematics, Institute for Advanced Study, Princeton, New Jersey, U.S.A.
- **Postdoctoral Research Fellow** (January 2019 – August 2019)
DIMACS, Rutgers University, New Brunswick, New Jersey, U.S.A.
- **Postdoctoral Research Fellow** (August 2018 – December 2018)
Simons Institute, University of California, Berkeley, U.S.A.
Simons-Berkeley Research Fellow in the program “Lower Bounds in Computational Complexity”.
- **Sessional Course Instructor** (January 2014 – May 2014, January 2016 – May 2016)
University of Toronto, Toronto, Canada.

- **Research Assistant** (September 2009 – January 2012)
Memorial University of Newfoundland, St. John's, Canada.
Supervisors: Todd Wareham and Antonina Kolokolova
- **Assistant System Programmer** (May 2009 – August 2009)
Memorial University of Newfoundland, St. John's, Canada.

Awards and Honours.

- Invited journal article “*On the power and limitations of branch-and-cut*” at CCC 2021.
(Honour reserved for top 5-10 papers in conference.)
- Co-recipient of the 2019 European Association for Theoretical Computer Science Distinguished Dissertation Award.
- NSERC Postdoctoral Fellowship, 2018-2020
Value: \$90,000.
- Walter C. Sumner Memorial Fellow, 2017-2018
Value: \$8,000.
- Invited journal article “*Exponential Lower Bounds for Monotone Span Programs*” at FOCS 2016.
(Honour reserved for top 5-10 papers in conference.)
- University of Toronto CSSU Instructor Award, 2014
Awarded for CSC373 – Algorithm Design and Analysis
- NSERC Alexander Graham Bell Canada Graduate Scholarship-Doctoral, 2014-2017
Value: \$105,000.
- Cognitive Science Society Prize for Best Student Paper, 2013
Awarded for the paper “*When almost is not even close: remarks on the approximability of HDTP*”. Received at the sixth conference of Artificial and General Intelligence, 2013.
- Memorial University Medal of Academic Achievement in Computer Science (Graduated Top of Class), 2012.
- Memorial University Faculty of Science Book Prize in Computer Science, 2011.
- NSERC Undergraduate Student Research Assistantship, 2011.
- Samuel, Millicent, and Thomas Grandy Scholarship, 2011.
- Memorial University Dean's List, 2008-2012.
- Memorial University Early Entrance Scholarship, 2007.

Funding Awarded.

- NSERC Discovery Grant, 2021-2026 (Value: \$230,000).
Title: *Towards a Unified Theory of Proof and Circuit Complexity*.
- NSERC Discovery Accelerator Supplement, 2021-2024 (Value: \$120,000)
Title: *Towards a Unified Theory of Proof and Circuit Complexity*.
- NSERC Discovery Launch Supplement, 2021-2022 (Value: \$12,500)
- McGill University Startup Grant, 2020-2023 (Value: \$120,000)

Professional Service.

- PC Member for the 31th International Joint Conference on Artificial Intelligence (IJCAI 2022).
- Co-organizer for invited workshop on “Propositional Proof Complexity” at FOCS 2021.
- PC Member for the 30th International Joint Conference on Artificial Intelligence (IJCAI 2021).
- PC Member for the 52nd Annual ACM Symposium on Theory of Computing (STOC 2020).
- Organizer for special session on Proof Complexity associated with the Gödel Lecture at the 2019 North American Annual Meeting for the Association for Symbolic Logic.
- External reviewer for the following conferences: Computational Complexity Conference (CCC), Computer Science in Russia (CSR), Foundations of Software Technology and Theoretical Computer Science (FSTTCS), Symposium on Foundations of Computer Science (FOCS), International Colloquium on Automata, Languages, and Programming (ICALP), International Joint Conference on Artificial Intelligence (IJCAI), International Conference on Theory and Applications of Satisfiability Testing (SAT), Symposium on Theoretical Aspects of Computer Science (STACS), Symposium on Theory of Computing (STOC), ACM-SIAM Symposium on Discrete Algorithms (SODA).
- External reviewer for the following journals: Algorithmica, Artificial Intelligence, Information Processing Letters, SIAM Journal of Computing (SICOMP), Theory of Computing.

Teaching.

I have been a course instructor for the following courses:

- COMP 360 — **Algorithm Design** at **McGill University** (Winter 2022).
- COMP 596 — **Propositional Proof Complexity** at **McGill University** (Fall 2021).
- COMP 362 — **Honours Algorithm Design** at **McGill University** (Winter 2021).
- COMP 598 — **Proof Complexity: Algorithms and Lower Bounds** at **McGill University** (Fall 2020).
- CS 452/508 — **Formal Languages and Automata** at **Rutgers University** (Spring 2019).
- CSC 363 — **Computability and Complexity** at **University of Toronto** (Spring 2016).
- CSC 373 — **Algorithm Design and Analysis** at **University of Toronto** (Spring 2014).

I have been a teaching assistant for the following courses, all at University of Toronto.

- CSC 463 — Computational Complexity and Computability. One appointment.
- CSC 438/2404 — Computability and Logic. Three appointments.
- CSC 373 — Algorithm Design and Analysis. Four appointments.
- CSC 2420 — Algorithm Design, Analysis, and Theory (Graduate course). One appointment.
- CSC 265 — Data Structures and Analysis (Advanced). One appointment.
- CSC 263 — Data Structures and Analysis. One appointment.
- CSC 165 — Mathematical Expression and Reasoning in Computer Science. One appointment.

Supervision.

Current Graduate Students.

- Stefan Grosser (McGill University, PhD, 2021 —)
- Gal Yehuda (Co-supervised, Technion, PhD, 2021 —)

Undergraduate Research Courses Supervised.

- Ben Davis, *Interpolation for Bounded Depth Frege*. (McGill University, COMP 396, Fall 2021)
- Ran Tao, *Proof Complexity of the Pigeonhole Principle*. (McGill University, COMP 396, Winter 2021)

Summer Research Students.

- William Pires (McGill University, Summer 2021)
- Ran Tao (McGill University, NSERC USRA, Summer 2021)
- Shoshana Simons (Rutgers University, NSF REU, Summer 2019)

Invited Talks, Plenary Lectures, and Notable Workshops Attended

- Mathematical Insights into Algorithms for Optimization Seminar
University of Copenhagen and University of Lund. (2021)
Invited Speaker.
Seminar Title: *Proof complexity lower bounds by composition*.
- Computational Complexity of Discrete Problems Workshop
Dagstuhl Workshop 21121 (2021).
Invited Speaker.
Seminar Title: *Duality Theorems for Amortized Circuit Complexity*.
- Theoretical Foundations of SAT/SMT Solving Workshop
Simons Institute (2021).
Invited Speaker.
Seminar Title: *Hard formulas in proof complexity by composition*.
- Oxford-Warwick Complexity Meetings
Online (2021).
Invited Speaker.
Seminar Title: *Amortized circuit complexity, formal complexity measures, and catalytic algorithms*.
- CombGeo Lab Big Seminar
Laboratory of Combinatorial and Geometric Structures, MIPT, Moscow, Russia. (2020)
Invited Speaker.
Seminar Title: *Nullstellensatz Size-Degree Tradeoffs from Reversible Pebbling*.
- DIMACS Theory Seminar
DIMACS, New Brunswick, U.S.A. (2019)
Invited Speaker.
Seminar Title: *Nullstellensatz Size-Degree Tradeoffs from Reversible Pebbling*.
- Association for Symbolic Logic North American Annual Meeting
New York City, U.S.A. (2019)
Speaker.
Seminar Title: *Circuits, Proofs, and Communication*.
- Symposium on 50 Years of Complexity Theory: A Celebration of the Work of Stephen Cook
Fields Institute, Toronto, Canada (2019)
Invited Speaker.
Seminar Title: *Algorithms, Proofs, and Communication: A Unified Perspective*.
- University of Chicago Theory Seminar
Chicago, U.S.A. (2019)
Invited Speaker.
Seminar Title: *Lifting with Simple Gadgets and Applications for Cutting Planes*.

- DIMACS Theory Seminar
DIMACS, New Brunswick, U.S.A. (2019)
Invited Speaker.
Seminar Title: *Lifting with Simple Gadgets and Applications for Cutting Planes.*
- Simons Institute Theory Seminar.
Berkeley, U.S.A. (2018)
Invited Speaker.
Seminar Title: *Lifting with Simple Gadgets and Applications for Cutting Planes.*
- Boolean Devices Workshop.
Simons Institute, Berkeley, U.S.A (2018)
Participant/Speaker.
Seminar Title: *Lifting Nullstellensatz Degree to Monotone Span Program Size.*
- Proof Complexity Workshop
Dagstuhl Seminar 18051, Germany (2018)
Participant/Speaker.
Seminar Title: *Lifting Nullstellensatz Degree to Monotone Span Program Size.*
- Hardness Escalation in Communication Complexity and Query Complexity (FOCS)
Berkeley, U.S.A. (2017)
Participant/Speaker.
Seminar Title: *Lifting Nullstellensatz Degree to Monotone Span Program Size.*
- Proof Complexity and Beyond Workshop
MFO Oberwolfach, Germany (2017)
Participant/Speaker.
Seminar Title: *Lower Bounds for Monotone Computation: Unified and Optimal.*
- KTH Royal Institute of Technology
Stockholm, Sweden (2017)
Invited Speaker.
Seminar Title: *Lower Bounds for Monotone Computation: Unified and Optimal.*
- Institute for Advanced Study
Princeton, U.S.A. (2017)
Invited Speaker.
Seminar Title: *Applications of Monotone Constraint Satisfaction.*
- IEEE Foundations of Computer Science (FOCS)
New Brunswick, U.S.A. (2016)
Plenary Speaker.
Seminar Title: *Exponential Lower Bounds for Monotone Span Programs.*
- BIRS Computational Complexity Workshop 16w5044
BIRS Centre, Banff, Canada (2016)
Participant/Speaker.
Seminar Title: *Unified Lower Bounds for Monotone Computation.*
- St. Petersburg Low Depth Complexity Workshop
St. Petersburg, Russia (2016)
Invited Speaker.
Seminar Title: *Unified Lower Bounds for Monotone Computation.*
- Third Annual Heidelberg Laureate Forum
Heidelberg, Germany (2015)
Participant

- China Theory Week
Shanghai Jiao Tong University, Shanghai, China (2015)
Participant/Speaker.
Seminar Title: *Path Graphs, Clique Trees, and Flowers.*

Publications.

Refereed Conference Papers.

1. Noah Fleming, Toniann Pitassi, Robert Robere. Extremely Deep Proofs. *To appear at ITCS 2022.*
2. Reyad Abed Elrazik, Robert Robere, Assaf Schuster, Gal Yehuda. Pseudorandom Self-Reductions for NP-Complete Problems. *To appear at ITCS 2022.*
3. Noah Fleming, Mika Göös, Stefan Grosser, Robert Robere. On Semi-Algebraic Proofs and Algorithms. *To appear at ITCS 2022.*
4. Robert Robere and Jeroen Zuiddam. Amortized Circuit Complexity, Formal Complexity Measures, and Catalytic Algorithms. *To appear at FOCS 2021.*
5. Noah Fleming, Mika Göös, Russell Impagliazzo, Toniann Pitassi, Robert Robere, Li-Yang Tan, Avi Wigderson. On the Power and Limitations of Branch-and-Cut. *Proceedings of the 36th annual Computational Complexity Conference (CCC 2021). (Invited to special journal issue.)*
6. Susanna de Rezende, Mika Göös, Jakob Nordström, Toniann Pitassi, Robert Robere, Dmitry Sokolov. Automating Algebraic Proof Systems is NP-Hard. *Proceedings of the 53rd Annual ACM Symposium on Theory of Computing (STOC 2021).*
7. Susanna de Rezende, Or Meir, Jakob Nordström, Toniann Pitassi, Robert Robere, Marc Vinyals. Lifting with Simple Gadgets and Applications to Circuit and Proof Complexity. *Proceedings of the 61st annual IEEE Symposium on Foundations of Computer Science (FOCS 2020).*
8. Susanna de Rezende, Or Meir, Jakob Nordström, Toniann Pitassi, Robert Robere. KRW Composition Theorems via Lifting. *Proceedings of the 61st annual IEEE Symposium on Foundations of Computer Science (FOCS 2020).*
9. Anna Gál, Robert Robere. Lower bounds for (Non-monotone) Comparator Circuits. *Proceedings of the 11th Innovations in Theoretical Computer Science conference (ITCS 2020).*
10. Susanna de Rezende, Or Meir, Jakob Nordström, Robert Robere. Nullstellensatz size-degree tradeoffs from reversible pebbling. *Proceedings of the 34th Annual Computational Complexity Conference (CCC 2019).*
11. Mika Göös, Pritish Kamath, Robert Robere, Dmitry Sokolov. Adventures in Monotone Complexity and TFNP. *Proceedings of the 10th Innovations in Theoretical Computer Science Conference (ITCS 2019).*
12. Edward Zulkoski, Ruben Martins, Christoph Wintersteiger, Robert Robere, Jia Liang, Vijay Ganesh. Extending Learning Sensitive Backdoors with Restarts. *Proceedings of the 24th International Conference on Principles and Practice of Constraint Programming (CP 2018).*
13. Robert Robere, Antonina Kolokolova and Vijay Ganesh. The Proof Complexity of SMT Solvers. *Proceedings of the 30th annual International Conference on Computer Aided Verification (CAV 2018).*
14. Toniann Pitassi and Robert Robere. Lifting Nullstellensatz to Monotone Span Programs over any Field. *Proceedings of the 50th annual ACM Symposium on the Theory of Computing (STOC 2018).* pp. 1207-1219.
15. Paul Beame, Noah Fleming, Russell Impagliazzo, Antonina Kolokolova, Denis Pankratov, Toniann Pitassi and Robert Robere. Stabbing Planes. *Proceedings of the 9th Innovations in Theoretical Computer Science Conference (ITCS 2018).*
16. Noah Fleming, Denis Pankratov, Toniann Pitassi, Robert Robere. Random $\Theta(\log n)$ -CNFs are hard for cutting planes. *Proceedings of the 58th annual IEEE Symposium on Foundations of Computer Science (FOCS 2017).*

17. Edward Zulkoski, Ruben Martins, Christoph Wintersteiger, Robert Robere, Jia Liang, Krzysztof Czarnecki, Vijay Ganesh. Relating complexity-theoretic parameters with SAT solver performance. *Pragmatics of Constraint Reasoning Workshop (POCR 2017)*.
18. Toniann Pitassi and Robert Robere. Strongly exponential lower bounds for monotone computation. *Proceedings of the 49th annual ACM Symposium on the Theory of Computing (STOC 2017)*. pp. 1246-1255.
19. Robert Robere, Toniann Pitassi, Benjamin Rossman, and Stephen A. Cook. Exponential lower bounds for monotone span programs. *Proceedings of the 57th annual IEEE Symposium on Foundations of Computer Science (FOCS 2016)*. (Invited to special journal issue.)
20. Yuval Filmus, Toniann Pitassi, Robert Robere and Stephen A. Cook. Average case lower bounds for monotone switching networks. *Proceedings of the 54th annual IEEE Symposium on Foundations of Computer Science (FOCS 2013)*, pp. 598-607
21. Tarek Richard Besold and Robert Robere. When almost is not even close enough: remarks on the approximability of HDTP. *Proceedings of the sixth annual conference on Artificial and General intelligence (AGI 2013)*, pp. 11-20. (Best Student Paper Award.)
22. Tarek Richard Besold and Robert Robere. A note on tractability and artificial intelligence. *Proceedings of the sixth annual conference on Artificial and General intelligence (AGI 2013)*, pp. 170-173.
23. Robert Robere and Tarek Richard Besold. Complex Analogies: Remarks on the Complexity of HDTP. *Proceedings of the 25th Australasian Joint Conference on Artificial Intelligence (AI 2012)*.
24. Todd Wareham, Iris van Rooij and Robert Robere. A Change for the Better? Assessing the Computational Cost of Re-representation. *Proceedings of the 11th International Conference on Cognitive Modeling (2012)*.

Refereed Journal Articles.

1. Noah Fleming, Denis Pankratov, Toniann Pitassi, Robert Robere. Random $\Theta(\log n)$ -CNFs are hard for cutting planes. *To appear in the Journal of the ACM*.
2. Susanna F. de Rezende, Or Meir, Jakob Nordström, Robert Robere. Nullstellensatz size-degree tradeoffs from reversible pebbling. *comput. complex.* **30**, 4 (2021).

Book Chapters.

1. Tarek R. Besold and Robert Robere. When Thinking Never Comes To A Halt: Using Formal Methods in Making Sure Your AI Gets the Job Done Good Enough. *Fundamental Issues of Artificial Intelligence (2016)*. Volume 376:43-62.

Manuscripts and Preprints.

1. Lalla Mouatadid and Robert Robere. Path graphs, clique trees, and flowers. *Manuscript*. (2015).