

## Noah Fleming

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## Research Interests

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Computational complexity theory: proof complexity, circuit complexity, communication complexity and interactions between them. The theory and practice of SAT solving, and property testing.

## Education and Employment

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- **Postdoctoral Research Fellow** 2021 – Present  
University of California, San Diego, USA.  
Hosted by Russell Impagliazzo and Samuel Buss
- **M.V. Raghunathan Research Fellow** 2021  
Simons Institute, University of California, Berkeley, California, USA.  
Satisfiability: Theory, Practice, and Beyond Program.
- **Ph.D. in Computer Science** 2017 – 2021  
University of Toronto, Toronto, Canada.  
Advisor: Toniann Pitassi  
Title: *The Proof Complexity of Integer Programming.*
- **M.Sc. in Computer Science** 2015 – Aug 25, 2017  
University of Toronto, Toronto, Canada.  
Advisor: Toniann Pitassi  
Project Title: *Linear Threshold Proof Systems.*
- **B.Sc. Double Major in Computer Science and Pure Mathematics** 2010 - 2015  
Memorial University of Newfoundland, St. John's, Canada.  
Graduated with First Class Distinction.

## Visiting Positions

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- **National Institute of Informatics**, Tokyo, Japan Summer 2019  
*Research intern in Theoretical Computer Science.*  
Supervisor: Yuichi Yoshida.
- **Simons Institute**, Berkely, U.S.A. Fall 2018  
*Visiting Graduate Student*  
Lower Bounds in Computational Complexity Program.
- **Institute for Advanced Study**, Princeton, U.S.A. Fall 2017  
*Visiting Graduate Student.*

## Awards and Honours

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- UCSD CSE Postdoctoral Fellowship (\$62, 000 USD) 2021 - 2023
- Invited special issue journal article “On the power and limitations of branch and cut” at CCC 2021. 2021  
Honour reserved for the top 5-10 papers in the conference.
- NSERC Postdoctoral Fellowship (PDF) (\$90, 000 CAD) 2021 - 2023
- Graduate Completion Award (\$1, 600 CAD) 2021
- Acres Productive Technologies Inc./Joseph Yonan Memorial Fellowship (\$2, 000 CAD) 2020
- Ontario Graduate Scholarship (\$15, 000 CAD) 2020
- Walter C. Sumner Memorial Fellowship (\$8, 000 CAD) 2020
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- Mitacs Globalink Research Award - Japan Society for the Promotion of Science 2019  
(¥534, 000 YEN)
- NSERC Alexander Graham Bell Canada Graduate Scholarship - Doctoral (CGSD) 2017 - 2020  
(\$105, 000 CAD)
- NSERC Alexander Graham Bell Canada Graduate Scholarship - Master’s (CGSM) 2015 - 2016  
(\$17, 500 CAD)
- NSERC Undergraduate Student Research Award (\$4, 500 CAD) 2015
- NSERC Undergraduate Student Research Award (\$4, 500 CAD) 2014
- NSERC Undergraduate Student Research Award (Declined) (\$4, 500 CAD) 2014
- The Gary Bourne Memorial Scholarship (\$1, 090) 2014
- The Julius and Bella Levkovitz Memorial Scholarship (\$700 CAD) 2014
- The Samuel, Millicent and Thomas Grandy Memorial Scholarship (\$925 CAD) 2014
- The Women’s Association of Memorial University of Newfoundland Faculty/Staff 2014  
Scholarship (\$700 CAD)
- The Mrs. E.D. Matthews Memorial Scholarship in Mathematics and Statistics (\$500 CAD) 2013
- CUPE 1615 Scholarship (\$500 CAD) 2013

## Publications

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### Peer Reviewed Conference Publications

- Noah Fleming, Toniann Pitassi, Robert Robere. Extremely Deep Proofs. *To Appear at ITCS (2022)*.
- Noah Fleming, Mika Göös, Stefan Grosser, Robert Robere. On Semi-Algebraic Proofs and Algorithms. *To Appear at ITCS (2022)*.
- Noah Fleming, Mika Göös, Russell Impagliazzo, Toniann Pitassi, Li-Yang Tan, Robert Robere, Avi Wigderson. On the Power and Limitations of Branch and Cut. *Proceedings of the 36th Computational Complexity Conference (CCC 2021)*.  
[doi: 10.4230/LIPIcs.CCC.2021.6](https://doi.org/10.4230/LIPIcs.CCC.2021.6)  
**Invited to the special journal issue for CCC 2021.**
- Chunxiao Li, Jonathan Chung, Soham Mukherjee, Marc Vinyals, Noah Fleming, Antonina Kolokolova, Alice Mu, Vijay Ganesh. On the Hierarchical Community Structure of Practical SAT Formulas. *Proceedings of the 24th International Conference on the Theory and Applications of Satisfiability Testing (SAT 2021)*.  
[doi: 10.1007/978-3-030-80223-3\\_25](https://doi.org/10.1007/978-3-030-80223-3_25)
- Chunxiao Li, Noah Fleming, Marc Vinyals, Toniann Pitassi, Vijay Ganesh. Towards a Complexity-Theoretic Understanding of Restarts in SAT Solvers. *Proceedings of the 23rd International Conference on the Theory and Applications of Satisfiability Testing (SAT 2020)*.  
[doi: 10.1007/978-3-030-51825-7\\_17](https://doi.org/10.1007/978-3-030-51825-7_17)
- Noah Fleming, Yuichi Yoshida. Distribution-Free Testing of Linear Functions on  $\mathbb{R}^n$ . *Proceedings of the 11th Innovations in Theoretical Computer Science Conference (ITCS 2020)*.  
[doi: 10.4230/LIPIcs.ITCS.2020.22](https://doi.org/10.4230/LIPIcs.ITCS.2020.22)
- Paul Beame, Noah Fleming, Russell Impagliazzo, Antonina Kolokolova, Denis Pankratov, Toniann Pitassi, Robert Robere. Stabbing Planes. *Proceedings of the 9th Innovations in Theoretical Computer Science Conference (ITCS 2018)*.  
[doi: 10.4230/LIPIcs.ITCS.2018.10](https://doi.org/10.4230/LIPIcs.ITCS.2018.10)
- 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)*.  
[doi: 10.1109/FOCS.2017.19](https://doi.org/10.1109/FOCS.2017.19)

### In Submission

- Vipul Arora, Arnab Bhattacharyya, Noah Fleming, Esty Kelman, Yuichi Yoshida. Testing Real Polynomials.

## Peer Reviewed Journal Publications

- Noah Fleming, Denis Pankratov, Toniann Pitassi, Robert Robere. Random  $\Theta(\log n)$ -CNFs are Hard for Cutting Planes. Accepted to the Journal of the ACM (JACM 2021).
- Noah Fleming, Pravesh Kothari, Toniann Pitassi. Semialgebraic Proofs and Efficient Algorithm Design. *Foundations and Trends® in Theoretical Computer Science*, 14 (1-2): 1-229 (2019).  
doi: [10.1561/04000000086](https://doi.org/10.1561/04000000086)
- Noah Fleming, Antonina Kolokolova, Renesa Nizamee. Complexity of Alignment and Decoding Problems: Restrictions and Approximations. *Machine Translation*, 29 (3-4): 163-187 (2015).  
doi: [10.1007/s10590-015-9172-5](https://doi.org/10.1007/s10590-015-9172-5)

## Book Chapters

- Noah Fleming, Toniann Pitassi. Reflections on Proof Complexity and Counting Principles. In Ivo Düntsch and Edwin Mares, editors, *Alasdair Urquhart on Nonclassical and Algebraic Logic and Complexity of Proofs*, Outstanding Contributions to Logic. Springer International Publishing (2022).  
doi: [10.1007/978-3-030-71430-7](https://doi.org/10.1007/978-3-030-71430-7)

## Professional Service

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- **Head Coach**, University of Toronto International Collegiate Programming Contest (ICPC) Team  
University of Toronto, Toronto, Canada 2018 – 2021
- **Seminar Organizer**, Satisfiability: Theory, Practice, and Beyond Program  
Simons Institute, Berkeley, Canada 2021
- **Lead Mentor**, Undergraduate Summer Research Program  
University of Toronto, Toronto, Canada 2016  
Held weekly meetings with for undergraduate students participating in the Undergraduate Summer Research Program to help guide them in their summer research projects.
- **External Reviewer**
  - Conferences: FOCS, STOC, CCC, ITCS, SODA, SAT, ISAAC, ICALP, LICS, ESA, STACS.
  - Journals: Theory of Computing, Information Processing Letters.

## Teaching Experience

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### Student Supervision

- Felipe Heap. Co-supervised Research Internship with Toniann Pitassi. 2019

### Course Instruction

- CSC199: Seminar Course on the Theory of SAT. Fall 2021  
This seminar covered topics in propositional and algebraic proof systems, and algorithms for satisfiability (SAT solvers).  
Co-taught with Sam Buss, Sicun Gao, and Russell Impagliazzo.
- CSC165: Mathematical Expression and Reasoning for Computer Science. Winter 2017  
Co-taught with Toniann Pitassi.

### Teaching Assistantships

- CSC438/2404: Computability and Logic (Graduate Course). 1.5 appointments.
- CSC373: Algorithm Design and Analysis. 2 appointments.
- CSC363: Computational Complexity and Computability. 1 appointment.
- CSC263: Data Structures and Analysis. 1 appointments.
- CSC263: Data Structures and Analysis (Course Design and Preparation). 1 appointments.
- CSC165: Mathematical Expression and Reasoning for Computer Science. 12 appointments.

### Selected Invited Talks and Workshops

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- Oxford-Warwick Complexity Meeting  
Online. 2021  
Invited Speaker.  
Seminar Title: *Extremely Deep Proofs*.
- MIAO Video Seminar, University of Copenhagen  
Copenhagen, Denmark. 2021  
Invited Speaker.  
Seminar Title: *On the Complexity of Branch-and-Cut*.
- Simons Institute  
Berkeley, California, USA. 2021  
Invited Speaker.  
Seminar Title: *The Proof Complexity of Integer Programming Solvers*.

- Simons Institute  
 Berkeley, California, USA. 2021  
 Invited Speaker.  
 Seminar Title: *The Proof Complexity of Practical Integer Programming.*
- Institute for Advanced Study  
 Princeton, New Jersey, USA. 2020  
 Invited Speaker.  
 Seminar Title: *Recent Progress on Cutting Planes Proofs.*
- BIRS Proof Complexity Workshop 20w5144  
 BIRS Centre, Banff, Canada. 2020  
 Participant/Speaker.  
 Seminar Title: *Semialgebraic Proofs and Efficient Algorithm Design.*
- Simon Fraser University Theory Seminar  
 Simon Fraser University, Vancouver, Canada. 2019  
 Invited Speaker.  
 Seminar Title: *Stabbing Planes.*
- Memorial University of Newfoundland Computer Science Seminar.  
 Memorial University of Newfoundland, St. John's, Canada. 2018  
 Invited Speaker.  
 Seminar Title: *Random CNF formulas are hard to refute in Cutting Planes.*
- Proof Complexity Workshop  
 Dagstuhl, Germany. 2018  
 Participant/Speaker.  
 Seminar Title: *Stabbing Planes.*
- Proof Complexity and Beyond Workshop  
 MFO Oberwolfach, Germany. 2017  
 Participant/Speaker.  
 Seminar Title: *Random  $\Theta(\log n)$ -CNF formulas Are Hard for Cutting Planes.*