

# Mihai Nica

Citizenship: Canada & Romania

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## EMPLOYMENT

**2020-now Assistant Professor**, University of Guelph

**2019-2020 Postdoctoral Fellow**, University of Toronto

**2017-2019 NSERC Postdoctoral Fellow**, University of Toronto

## EDUCATION

**2011-17 PhD, Courant Institute of Mathematical Sciences**, New York University

Advisor: Gérard Ben Arous

**2007-11 BMath, University of Waterloo**, Canada

Recipient of the Faculty of Mathematics Alumni Gold Medal for academic excellence

## RESEARCH INTERESTS

Probability theory, stochastic processes, random matrices, deep neural nets, machine learning

## PREPRINTS & PUBLICATIONS

1. **A derivative-free method for solving elliptic PDEs with deep neural networks** (with Han, J. and Stinchcombe, A.) Preprint [arXiv:2001.06145](https://arxiv.org/abs/2001.06145), 25 pages. To appear in *Journal of Computational Physics*
2. **One-sided reflected Brownian motions and the KPZ fixed point** (with Quastel, J. and Remenik, D.) Preprint [arXiv:2002.02922](https://arxiv.org/abs/2002.02922), 14 pages. Submitted.
3. **Finite depth and width corrections to the neural tangent kernel** (with Hanin, B.) *International Conference on Learning Representations Spotlight* (2020). Available at [arXiv:1909.05989](https://arxiv.org/abs/1909.05989)
4. **Uniform convergence to the Airy line ensemble** (with Dauvergne, D. and Virág, B.) Preprint [arXiv:1907.10160](https://arxiv.org/abs/1907.10160), 48 pages
5. **Solution of the Kolmogorov equation for TASEP** (with Quastel, J. and Remenik, D.) Preprint [arXiv:1906.01692](https://arxiv.org/abs/1906.01692), 12 pages. To appear in *Annals of Probability*
6. **Products of many large random matrices and gradients in deep neural networks** (with Hanin, B.) *Communications in Mathematical Physics* (2020) 376:287–322. Available at [arXiv:1812.05994](https://arxiv.org/abs/1812.05994)
7. **The landscape of the spiked tensor model** (with Ben Arous, G., Mei, S., Montanari, A.) *Communications on Pure and Applied Mathematics* (2019) 72:2282–2330. Available at [arXiv:1711.05424](https://arxiv.org/abs/1711.05424)
8. **Intermediate disorder limits for multi-layer semi-discrete directed polymers** Preprint [arXiv:1609.00298](https://arxiv.org/abs/1609.00298), 46 pages. Submitted.
9. **Intermediate disorder directed polymers and the multi-layer extension of the stochastic heat equation** (with Corwin, I.) *Electronic Journal of Probability* (2017) 22:1–49 Available at [arXiv:1603.08168](https://arxiv.org/abs/1603.08168)
10. **Decorated Young tableaux and the Poissonized Robinson-Schensted process.** *Stochastic Processes and their Applications*, (2017) 127:449–474. Available at [arXiv:1404.4015](https://arxiv.org/abs/1404.4015)
11. **Optimal strategy in “Guess Who?”: Beyond binary search.** *Probability in the Engineering and Informational Sciences*, (2016) 30: 576–592. Available at [arXiv:1509.03327](https://arxiv.org/abs/1509.03327)
12. **Stabilization time for a type of evolution on binary strings** (with Funk, J., Noyes, M.) *Journal of Theoretical Probability*, (2015) 28: 848–865. Available at [arXiv:1210.0444](https://arxiv.org/abs/1210.0444)

## SCHOLARSHIPS

- 2020 Vector Institute Postgraduate Affiliate Program**, Vector Institute [declined due to Guelph faculty position]
- 2017-19 NSERC Postdoctoral Fellowship**, Natural Sciences & Engineering Research Council of Canada
- 2011-16 MacCracken Fellowship**, New York University, support for PhD studies
- 2011 NSERC Canada Graduate Scholarship**, funding for PhD studies, Natural Sciences & Engineering Research Council of Canada [declined due to MacCracken]
- 2009 Arthur Beaumont Memorial Scholarship**, University of Waterloo, awarded to an outstanding student in the Applied Mathematics Department
- 2008-10 USRA Scholarship**, NSERC, awarded for undergraduate research (held three times)
- 2008 President's Research Award**, University of Waterloo, for undergraduate summer research
- 2007-11 William T. Tutte National Scholarship**, one of sixteen national scholarships awarded to incoming students in the Faculty of Mathematics at the University of Waterloo

## AWARDS & DISTINCTIONS

- 2018 F. V. Atkinson teaching award**, honours outstanding teaching by post-doctoral fellows and other junior research faculty at the University of Toronto math department
- 2014 Harold Grad prize**, awarded for outstanding performance and promise as a graduate student by the Courant Institute.
- 2011 Alumni gold medal**, Awarded to one graduating student in the Faculty of Mathematics at the University of Waterloo in recognition of outstanding academic achievements
- 2011 Putnam competition**, ranked in the top 220 out of 4,296 contestants
- 2010,11 University of Waterloo applied math speaker award**, award for the best speaker among undergraduate researchers as voted by peers (awards in two consecutive years)
- 2007 Ontario physics olympiad finals**, 6th place at the University of Toronto Physics Olympiad Preparation Program
- 2006 Canadian open mathematics challenge**, Provincial Gold Medal

## INVITED TALKS

- Jan 2020 A neural network method for solving elliptic and parabolic PDEs**, Modelling and Computational Science seminar, Ontario Tech University, Oshawa
- Nov 2019 Scaling limits of deep neural networks**, University of Guelph, Guelph
- Jul 2019 Gradients of ReLU networks on initialization**, Workshop on Theoretical Advances in Deep Learning at Istanbul Center for Mathematical Sciences, Istanbul
- Jun 2019 Phase transitions in random matrices and the spiked tensor model**, Fields Institute workshop on Applications to Random Matrices and Free Probability, Toronto
- Mar 2019 Deep neural networks and products of random matrices**, Workshop on Free Probability: the applied perspective, Centre de Recherches Mathématiques, Montreal
- Nov 2018 A central limit theorem for deep neural networks and products of random matrices**, Centre de Recherches Mathématiques Probability Seminar, Montreal
- Nov 2018 A central limit theorem for deep neural networks and products of random matrices**, Fields Institute Probability Seminar, Toronto
- May 2018 On the complexity of random functions**, Physics of Information Lab, Applied Math Department, University of Waterloo
- Mar 2018 Phase transitions in the spiked tensor model**, Colloquium, Department of Mathematics and Statistics, Queen's University

- Jan 2018** **Phase transitions in the spiked tensor model**, Fields Institute Probability Seminar, Toronto
- Dec 2017** **Intermediate disorder limits for multi-layer random polymers**, University of Rochester Probability Seminar
- May 2017** **Intermediate disorder limits for multi-layer random polymers**, University of Wisconsin Madison Probability Seminar
- Feb 2017** **Intermediate disorder limits for multi-layer random polymers**, Temple University Probability Seminar
- Feb 2017** **Intermediate disorder limits for multi-layer random polymers**, Northwestern University Probability Seminar
- Jan 2017** **Intermediate disorder limits for multi-layer random polymers**, Probability Seminar at the Centre de Recherches Mathématiques, Montreal
- Sep 2016** **Intermediate disorder limits for multi-layer random polymers**, Toronto Probability Seminar at the Fields Institute, Toronto
- Apr 2016** **Intermediate disorder directed polymers and the multi-layer stochastic heat equation**, Finger Lakes Probability Seminar at Cornell University
- Nov 2015** **Convergence of non-intersecting random walks**, AMS Sectional Meeting (special session on "Probability, Combinatorics, and Statistical Mechanics") at Rutgers University
- May 2015** **Three ways to think about a certain model of vicious walkers**, Clay Math Institute Workshop on Random Polymers and Algebraic Combinatorics at University of Oxford
- Nov 2014** **Exactly solvable Young diagram processes related to last passage percolation**, Northeast Probability Seminar at Columbia University
- Nov 2014** **Exactly solvable Young diagram processes related to last passage percolation**, Cornell Probability Seminar at Cornell University
- Jul 2014** **Exactly solvable Young diagram processes related to last passage percolation**, Seminar on KPZ at the University of California, Berkeley

## OTHER PRESENTATIONS

- Aug 2018** **Gradients of neural nets and products of random matrices**, Poster presentation at workshop "Statistical Physics and Machine Learning back together", Institut d'Études Scientifiques de Cargèse, Corsica
- July 2017** **Intermediate disorder limits for multi-layer random polymers**, Poster presentation at Park City Math Institute Random Matrices Workshop
- Sep 2016** **Intermediate disorder limits for multi-layer random polymers**, Poster presentation, conference on "Quantum integrable systems, conformal field theories and stochastic processes" at Institut d'Études Scientifiques de Cargèse, Corsica
- Jul 2015** **Random processes from the Robinson-Schensted-Knuth correspondence**, CRM-PIMS summer school at McGill University
- Jul 2014** **Poissonized Robinson-Schensted tableaux**, Cornell Probability Summer School

## SERVICE

- 2017-19** **Co-organizer** for the Toronto Probability Seminar
- 2014-15** **Co-organizer** for the Courant Graduate Student Probability Seminar  
(I also gave 7 talks in this seminar between 2013–2016.)

## TEACHING ACTIVITIES

### AWARDS

**2018 F. V. Atkinson teaching award**, honours outstanding teaching by post-doctoral fellows and other junior research faculty at the University of Toronto math department.

### COURSES TAUGHT

**Spring 2020 Instructor & coordinator**, MAT234, Differential Eqns for Mech. Eng., University of Toronto  
**Spring 2019 Instructor & coordinator**, MAT234, Differential Eqns for Mech. Eng., University of Toronto  
**Spring 2019 Instructor**, MAT223, Linear Algebra 1, University of Toronto  
**Fall 2018 Instructor**, MAT135, Calculus 1A, University of Toronto  
**Spring 2018 Instructor**, MAT136, Calculus 1B, University of Toronto  
**Fall 2017 Instructor**, MAT135, Calculus 1A, University of Toronto  
**Summer 2016 Instructor**, Math-UA.121, Calculus I, New York University

### TA EXPERIENCE

**Spring 2016 Recitation Leader**, Math-UA.233, Theory of Probability, NYU  
**Fall 2015 Recitation Leader**, Core-UA.107, Probability, Statistics, and Decision Making, NYU  
**Fall 2014 Recitation Leader**, Core-UA.107, Probability, Statistics, and Decision Making, NYU  
**Spring 2014 Instructor**, Written Exam Workshop, NYU  
**Fall 2013 Teaching Assistant**, Math-GA.2911, Limit Theorems II (Graduate), NYU  
**Spring 2013 Teaching Assistant**, Math-GA.2901, Basic Probability (Graduate), NYU  
**Fall 2012 Instructor**, Written Exam Workshop, NYU  
**2011 Tutor**, Mathematics Tutorial Centre, University of Waterloo

### OTHER TEACHING ACTIVITIES

**Fall 2019 Instructor**, MAT1128HF, Topics in Probability. I taught the introduction (6 hours of lectures) to a graduate course (11 students) on KPZ universality, University of Toronto

**Fall 2019 “Collaborating with Learning Experts to Improve Success in Calculus for STEM Majors”**, co-author (with Sarah Mayes-Tang, Andrea Graham, Jeff Pike) of a scholarship of teaching and learning paper about review sessions to improve student outcomes in first year Calculus classes which we ran in Fall 2018 and Spring 2019. In preparation.

**Fall 2019 TA Training Coordinator**, organize and run training workshops for 100 TAs at the University of Toronto

**Fall 2019 “Active Learning 101: A guide for new instructors in large classrooms”**, co-author (with Yvon Verberne and Melissa Emory) of a 17 page guide to creating active learning questions that work well in large classrooms. Available at [http://www.math.toronto.edu/mnica/CoP\\_Guide.pdf](http://www.math.toronto.edu/mnica/CoP_Guide.pdf)

**Summer 2019 “Adapting Inquiry Based Learning questions for large classrooms”**, Presentation at MAA Mathfest, Cincinnati

**Summer 2019 “Starting a Calculus Community of Practice”**, with Sarah Mayes-Tang, Presentation at MAA Mathfest, Cincinnati

**Summer 2019 Fields Undergraduate Summer Research Program**, co-supervisor (with Adam Stinchcombe) of three students working on “Machine Learning Methods for Numerical Solutions of Partial Differential Equations”, Fields Institute, Toronto

**2018-2019 Facilitator: Teaching Community of Practice**, organized and facilitated a Community of Practice for early career instructors at the University of Toronto

**2012-14 Volunteer Instructor** for Courant Splash (annual outreach program for high school students)