Mihai Nica

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Employment

2020-now **Assistant Professor**, University of Guelph
Affiliations: Vector Institute and CARE-AI

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

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

Education

2017 **PhD, Courant Institute of Mathematical Sciences**, New York University
Advisor: Gérard Ben Arous

2011 **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. **Solving Elliptic Equations with Brownian Motion: Bias Reduction and Temporal Difference Learning** (with Martin C, Zhang H, Costacurta J, and Stinchcombe A) to appear in *Methodology and Computing in Applied Probability*. Available at arXiv:2008.00144.
2. **A derivative-free method for solving elliptic PDEs with deep neural networks** (with Han J and Stinchcombe A) *Journal of Computational Physics* (2020) 419. Available at arXiv:2001.06145
3. **One-sided reflected Brownian motions and the KPZ fixed point** (with Quastel J and Remenik D) *Forum of Mathematics, Sigma* (2020) 8. Available at arXiv:2002.02922
4. **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
5. **Uniform convergence to the Airy line ensemble** (with Dauvergne D and Virág B) Preprint arXiv:1907.10160, 48 pages. Submitted.
6. **Solution of the Kolmogorov equation for TASEP** (with Quastel J and Remenik D) *Annals of Probability* (2020) 48:2344–2358. Available at arXiv:1906.01692
7. **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
8. **The landscape of the spiked tensor model** (with Ben Arous G, Mei S and Montanari A) *Communications on Pure and Applied Mathematics* (2019) 72:2282–2330. Available at arXiv:1711.05424
9. **Intermediate disorder limits for multi-layer semi-discrete directed polymers** *Electronic Journal of Probability* (2021) 26:1-50 Available at arXiv:1609.00298
10. **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

11. **Decorated Young tableaux and the Poissonized Robinson-Schensted process**. *Stochastic Processes and their Applications*, (2017) 127:449–474. Available at `arXiv:1404.4015`
12. **Optimal strategy in "Guess Who?": Beyond binary search**. *Probability in the Engineering and Informational Sciences*, (2016) 30: 576–592. Available at `arXiv:1509.03327`
13. **Stabilization time for a type of evolution on binary strings** (with Funk J and Noyes M) *Journal of Theoretical Probability* , (2015) 28: 848–865. Available at `arXiv:1210.0444`

Grants & Fellowships

2017-19 **NSERC Postdoctoral Fellowship**, Natural Sciences & Engineering Research Council of Canada

2011-16 **MacCraken 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 MacCraken]

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)

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

2020 **Vector Institute Postgraduate Affiliate Program**, Vector Institute [declined due to Guelph faculty position]

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

2010 **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)

2008 **President's Research Award**, University of Waterloo, for undergraduate summer research

Invited Talks

Mar 2021 **Log-normal behaviour in deep neural networks and products of random matrice**, Probability Seminar, University of Waterloo, Waterloo

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

Fall 2020 **Instructor**, MATH*1200, Calculus 1, University of Guelph [Synchronous online]

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

Spring 2020 Invited seminar speaker' for University of Waterloo STAT946: Mathematics of Data Science on *Random Features and the Neural Tangent Kernel*. Playlist and notes available at `https://www.youtube.com/playlist?list=PLOpo-gE90mduFQybZ3hzQwrT3CvWhB_zL`

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`

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)