Shahab Azarfar

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Research Interests

Geometric and Probabilistic Deep Learning, Physics-Informed Machine Learning, Equivariant Representation Learning, Computational Optimal Transport Theory, Koopman Operator approach to Dynamic Data Analysis, Manifold Learning, Kernel methods in Machine Learning.

Research Experience

May 2023 -	**Postdoctoral Research Associate**, Mentor: Prof. Stephen Baek School of Data Science, University of Virginia.

May 2022 - Apr. 2023	**Postdoctoral Research Associate**, Mentors: Prof. Heman Shakeri and Prof. Mohammad Fallahi-Sichani, School of Data Science and Biomedical Engineering Department, University of Virginia.

Investigated Topics:

- Modeling the drug-response of a cancer cell population at the single-cell level through Optimal Transport theory and kernel-based Distribution Regression

- Connections between the dynamics of the intracellular chemical reaction networks and the Koopman operator theory

Jan. - Jun. 2020	**Postdoctoral Fellow**, Mentor: Prof. Matilde Marcolli, Mathematics Department, University of Toronto.

Investigated Topics:

- Connections between Dynamic Optimal Transport theory / Schrödinger bridge and generative statistical models.

- Geometric information theory in statistical inference and neural network training.

- Geometric models of primary visual cortex in neuroscience.

| Sep. 2018 - Aug. 2019 | **Postdoctoral Research Associate**,
Mentor: Prof. Masoud Khalkhali,
Mathematics Department, University of Western Ontario. |

Investigated Topics:

- Asymptotic eigenvalue distribution of particular large random matrix models originated from quantum gravity.

- Combinatorics of graphs embedded on Riemann surfaces with nontrivial topology corresponding to the above-mentioned matrix models.

- Applications of Random Matrix Theory in Quantum Information Theory, in particular, investigation of data transmission through noisy quantum channels.

Education

2014 - 2018	**Ph.D.**, Applied Mathematics and Mathematical Physics, University of Western Ontario, Canada
2012 - 2014	**M.Sc.**, Applied Mathematics and Mathematical Physics, Concordia University, Canada
2008 - 2011	**M.Sc.**, Mechanical Engineering, Tehran Polytechnic, Iran
2004 - 2008	**B.Sc.**, Mechanical Engineering, Tehran Polytechnic, Iran

List of Publications

1. Azarfar, S., & Khalkhali, M., *Random Finite Noncommutative Geometries and Topological Recursion*, under review at *Annales de l'Institut Henri Poincaré (D)*. (PDF)

2. Cheng, X., Zhang, S., Nguyen, P., Azarfar, S., Chern, G., & Baek, S., *Convolutional Neural Networks for Large-Scale Dynamical Modeling of Itinerant Magnets*, under review at *Physical Review Research*. (PDF)

3. *Topological Recursion and Random Finite Noncommutative Geometries*, Ph.D. Thesis (2018), Supervisor: Prof. M. Khalkhali. (PDF)

4. *On Variational Formulas on Spaces of Quadratic Differentials*, M.Sc. Thesis (2014), Supervisor: Prof. D. Korotkin. (PDF)

5. *Geometric Structure of Hamiltonian Dynamics*, M.Sc. Thesis (2011), Supervisor: Prof. N. Boroojerdian. (in Persian)

Attended Summer Schools

- *Algebraic Geometry in High-Energy Physics*, University of Saskatchewan, Saskatoon, Canada, 2019.

- *Random Matrix Theory*, Institute for Advanced Study/Park City Mathematics Institute, Utah, USA, 2017.

- *Dyson-Schwinger Equations, Topological Expansions, and Random Matrices*, Columbia University, New York, USA, 2017.

Selected Talks

- *Blobbed Topological Recursion for Dirac Ensembles*, Fields Institute for Research in Mathematical Sciences, 2022.

- *The Wiener Measure, Brownian Bridge, and Feynman-Kac Formula*, University of Western Ontario, 2017.

- *A Generalization of the Heisenberg Commutation Relation*, University of Western Ontario, 2016.

- *The Dimension of the Space of Automorphic Forms and the Riemann-Roch Theorem*, University of Western Ontario, 2016.

- *The Selberg Trace Formula*, University of Western Ontario, 2015.

- *On the Proof of Weyl Integration Formula*, University of Western Ontario, 2015.

Programming Skills   Python, MATLAB

Teaching Experience

Winter 2020	**Instructor**, Mathematics Department, University of Toronto
	Course Title: Applications of Linear Programming
Winter 2013	**Instructor**, Mathematics Department, Concordia University
	Course Title: Fundamental Concepts of Algebra
2012 - 2018	**Teaching Assistant**, Mathematics Department, Concordia University and University of Western Ontario
	Course Titles: Real Analysis I, Methods of Calculus, Methods of Finite Mathematics, Methods of Matrix Algebra

References

- Prof. Stephen Baek
  University of Virginia,   baek@virginia.edu

- Prof. Matilde Marcolli
  California Institute of Technology,   matilde@caltech.edu

- Prof. Masoud Khalkhali
  University of Western Ontario,   masoud@uwo.ca

- Prof. Heman Shakeri
  University of Virginia,   hs9hd@virginia.edu

- Prof. Mohammad Fallahi-Sichani
  University of Virginia,   fallahi@virginia.edu