Mikail Khona

Personal Info

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Current Experience

May 2023 -   **Massachusetts Institute of Technology**, MA
September   *Research Scientist Intern*
2023   Supervisor: Hidenori Tanaka
              Studying causal reasoning in transformer-based large language models (LLMs). Developing mechanistic interpretability technique to reverse engineer transformers on synthetic algorithmic reasoning tasks.

Education and Research

2018 - 2024   **Massachusetts Institute of Technology**, MA
(expected)   *PhD candidate in Physics*
               Advisor: Ila Fiete, Secondary: Mehran Kardar
               Graduate research in theoretical and computational systems neuroscience and deep learning.

Summer 2021   **Methods in Computational Neuroscience (MCN) Summer School**, Marine Biological Laboratory, Woods Hole MA

2014 - 2018   **Indian Institute of Technology (IIT), Bombay**, India
               Bachelor of Technology in Engineering (GPA: 9.6/10)
               Major: Engineering Physics (+honours in Physics)
               minor: Mathematics

High School   **The Bombay Scottish School**, Mahim, India

Publications

○ Khona, Mikail, Fiete, Ila. **Attractor and Integrator Networks in Neuroscience**. Nature Reviews Neuroscience. *[link]*

○ Schaeffer, Rylan, Khona, Mikail, Meshulam, Leenoy, Fiete, Ila. **No Free Lunch from Deep Learning in Neuroscience: A Case Study through Models of the Entorhinal-Hippocampal Circuit**. NeurIPS. 2022. *[link]*

○ Schaeffer, Rylan, Khona, Mikail, Fiete, Ila. **Reverse-engineering recurrent neural network solutions to a hierarchical inference task for mice**. NeurIPS. 2020. *[link]*

○ Khona, Mikail*, Chandra, Sarthak*, Fiete, Ila. **Spontaneous emergence of topologically robust grid cell modules: A multiscale instability theory**. Submitted. *[link]*

○ Duan, Sunny*, Khona, Mikail*, Bertagnoli, Adrian*, Fiete, Ila. **See and Draw: Generation of complex compositional movements from modular and geometric RNN representations**. Proceedings of Machine Learning Research. *link*

○ Khona, Mikail*, Chandra, Sarthak*, Ma, Joy, Fiete, Ila. **Winning the lottery with neurobiology: faster learning on many cognitive tasks with neural connectivity constraints**. Neural Computation (2023). *[link]*

○ G. Madirolas, A. Al-Asmar, L. Gaouar, L. Marie-Louise, A. Garza-Enriquez, M. Khona, C. Ratzke, J. Gore, A. Pérez-Escudero. **A taste for numbers: *Caenorhabditis elegans.* foraging follows a low-dimensional rule of thumb**. Nature communications biology (2023). *[link]*

○ Schaeffer, Rylan*, Bordelon Blake*, Khona, Mikail*, Pan, Weiwei, Fiete, Ila. **Efficient Online Inference for Nonparametric Latent Variable Time Series**. UAI. 2021. *[link]*

○ Rylan Schaeffer, <u>Khona, Mikail</u>, Zachary Robertson, Akhilan Boopathy, Kateryna Pistunova, Jason W. Rocks, Ila Rani Fiete, Oluwasanmi Koyejo. **Double Descent Demystified: Identifying, Interpreting Ablating the Sources of a Deep Learning Puzzle**. *[arXiv link]*

<div align="center">Publications in prep/to appear</div>

○ Mikail Khona*, Sarthak Chandra*, Talia Konkle, Ila Fiete. **Self-organized emergence of modularity, hierarchy, and topography from competitive synaptic growth in a developmental model of the visual pathway**
○ Mikail Khona*, Rylan Schaeffer*, Ila Fiete. **Self-Supervised Learning of Representations for Space Generates Multi-Modular Grid Cells (to appear, NeurIPS, 2023)**

Awards / Achievements

2022 - 2023	K. Lisa Yang ICoN Graduate Student Fellow ($100k)
2021 - 2022	MathWorks Science Fellowship (one of 20 across the School of Science at MIT) ($100k)
2018 - 2019	Seigel Fellowship, Department of Physics ($100k)
2016 - 2018	Institute Academic Award for the highest GPA among undergraduates in the Physics department at IIT Bombay (9.95/10)
2016 - 2017	DAAD-WISE scholarship for an undergraduate project in Germany in 2017 [declined].
2014	An All India Rank of 562/1.4M (Percentile 99.96) in the **IIT - JEE** 2014.
2014	INSPIRE Scholarship for Higher Education - A scholarship awarded by the Government of India to meritorious students in high school who plan to pursue a degree in the natural sciences.

Relevant courses

IIT-Bombay	Mathematics and Statistics: Real analysis, Complex analysis, Differential equations, General Topology, Abstract Algebra, Lie groups and Lie Algebras, Stochastic processes. Physics: Statistical physics, Advanced statistical physics, Quantum mechanics sequence (I,II,III).
MIT	Mathematics: Probability Theory, Computational neuroscience. Physics: Statistical physics for biology, Systems Biology

Technical Skills

advanced	Deep learning with Python: Pytorch
advanced	Scientific computing with Python (NumPy, SciPy, NetworkX, etc..) and MATLAB