

Kabir Dabholkar

GRADUATE STUDENT, TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

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About Me

- **Research interests:** Computational/theoretical neuroscience, machine learning for science. High-dimensional models of brain-dynamics, inferred from neural/behavioral data: their analysis and evaluation. Individuality, dynamics of learning and neural representations in biological and artificial systems. Developing numerical tools based on dynamical systems, machine learning, and statistical physics.

Research Experience

Computational Neurobiology Lab, IISER Pune

WITH PROF SUHITA NADKARNI

Summer 2018, Fall 2018, Spring 2019,
Spring 2021

- Worked on a spatially detailed stochastic model of the Schaffer Collateral axon in the hippocampus to study calcium signalling at the CA3 presynapse and its role in presynaptic short-term plasticity. Explored how mishandling of internal calcium stores could be implicated in neurodegenerative disease.

Neuronal Connectivity Laboratory, IISER Pune

WITH PROF AURNAB GHOSE

Summer 2019

- Implemented software tools and algorithms to extract single-neuron fluorescence traces from calcium imaging data of zebrafish whole brains and slices, to study neural circuits underlying internal states of hunger and satiety.

Barak Lab, Technion

WITH PROF OMRI BARAK

Master's project 2020–21

- Studied variability in recurrent neural network (RNN) models of neural computation. Developed methods to filter the space of RNN models based on behavioral perturbations.

Barak Lab, Technion

WITH PROF OMRI BARAK

PhD 2021–2025

- Studying the dynamics of exploration and learning in biological and artificial systems in a space of solutions to a computational task, and the persistence of behavioral individuality in these systems despite their flexibility and susceptibility to drift.
- Refining the model-selection process for dynamical latent variable models inferred from spiking neural data, to encourage simple representations of latent structure. Analysis with Hidden Markov Models and state-of-the-art latent variable models.
- Developing tools for the analysis of RNNs using Koopman theory.
- **PhD thesis:** *From data to models to understanding*

Publications

- Kabir Dabholkar and Omri Barak. *Finding separatrices of dynamical flows with Deep Koopman Eigenfunctions*. Advances in Neural Information Processing Systems 34 (2025).
- Kabir Dabholkar and Omri Barak. *When predict can also explain: few-shot prediction to select better neural latents*. arXiv:2405.14425 (2024). (Under review)
- Elia Turner, Kabir Dabholkar, and Omri Barak. *Charting and navigating the space of solutions for recurrent neural networks* Advances in Neural Information Processing Systems 34 (2021).

Selected Talks and Poster Presentations

- *Finding Separatrices of Dynamical Flows with Deep Koopman Eigenfunctions* — contributed talk, CRSy Neuro-Cybernetics at Scale, Lisbon, 2025
- *When Predict Can Also Explain: Few-Shot Prediction to Select Better Neural Latents* — poster, Computational and Systems Neuroscience (COSYNE), Montreal, 2025
- *Characterising Differences Across Trained Recurrent Neural Networks* — poster, Computational and Systems Neuroscience (COSYNE), online, 2021
- *Generalisation in Data-Constrained Recurrent Neural Networks* — poster, Israel Society for Neuroscience (ISFN) Annual Meeting, online, 2021
- *Simulating Short-Term Plasticity with Altered Internal Calcium Stores in the Alzheimer's Presynaptic Terminal* — poster, No Garland Neuroscience (NGN), IISER Pune, 2020

Teaching Experience

Teaching Assistant, Mathematical models in Neuroscience

Faculty of Medicine, Technion

LECTURER: PROF OMRI BARAK

Winter 2021-22

- Graduate course on mathematical models in neuroscience targeted towards graduate students with an experimental background but limited mathematical and programming knowledge.
- Conducted tutorials and prepared material in the form of Jupyter notebooks.

Teaching Assistant, Neuromatch Academy: Computational Neuroscience

Online

Summer 2021

- A month-long, worldwide, virtual computational neuroscience summer school.

Teaching Assistant, Computational Approaches to Memory and Plasticity (CAMP) with a focus on dynamical neuroscience

IISER Pune

July 11-25, 2023

- Conducted tutorials on task-trained Recurrent Neural Networks (RNNs) and how to analyse them with dynamical systems. To this end, I prepared Jupyter notebooks and interactive problem solving sessions. Also prepared psychophysics experiments to compare human and RNNs on similar tasks.
- Guided student projects developed from my tutorials.

Education

5-year Integrated BS-MS at Indian Institute of Science Education and Research (IISER)

Pune

2016-2021

- **1st and 2nd year** introductory courses in Mathematics, Physics, Biology, Chemistry, Earth Sciences and Social Sciences.
- **3rd and 4th year** elective courses: Neurobiology I and II, Genetics, Introductory Immunology; Numerical Analysis, Graph Theory, Algorithms; Statistical Mechanics I; Biostatistics, Data Science, Bioinformatics, Numerical Computation using MATLAB.
- **5th year Master's thesis** titled *Towards mechanistically informed Recurrent Neural Network models of neural population dynamics*, under the supervision of Prof Omri Barak (Technion).
- CGPA **9.0/10** (with distinction).

Awards and Scholarships

- DST - INSPIRE Scholarship 2016-2021
- Olga and Jules Craen Young Musician of the Year 2018