

# Kabir Dabholkar

GRADUATE STUDENT, TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

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## About Me

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- **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

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### 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

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- 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

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- *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

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### 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

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### 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

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