Subhadra Mokashe

✉ subhadram@brandeis.edu

Education

2020 – present **Graduate Program in Neuroscience**
Brandeis Univeristy

2012 – 2017 **BS-MS**
Indian Institute of Science Education and Research, Pune

Research and work experience

2024 – 2024 **Predoctoral Research Intern**
Flatiron Institute

2023 – 2023 **Research Intern**
Systems Neuroscience Approaches to General Intelligence (SyNAGI), IBM

2020 – present **Graduate Research Assistant**
Brandeis University

2018 – 2019 **Associate in Research**
Duke University

Publications

1. Learning sequences of temporally correlated patterns
Subhadra Mokashe and Nicolas Brunel (2024, Manuscript in preparation).
2. Multistability in neural systems with random cross-connections.
Jordan Breffle, Subhadra Mokashe, Siwei Qiu, Paul Miller. Biol Cybern 117, 485–506 (2023) (link)
3. Role of slow temporal dynamics in the reliable activity of stochastically driven neurons
Subhadra Mokashe and Suhita Nadkarni (2020). (Preprint)(in press at IBRO Neuroscience Reports)
4. Masters thesis: Effect of intrinsic and extrinsic noise on the network motif of mutually inhibiting neurons (2017).

Research skills

- **Languages**: Python, C++, R, MATLAB, Fortran (10+ years of experience in programming) Github .
- **Frameworks & Tools**: PyTorch, TensorFlow, Keras, skikitlearn (6+ years of experience in machine learning and deep learning) .
- **Science Communication Tools**: matplotlib, LaTex, Jupyter, Photoshop, Blender.
- **Background** in computational and theoretical neuroscience, PDE theory, stochastic processes, information theory, statistical physics, non-linear dynamics, neural network dynamics, reinforcement learning, and theory of unsupervised and supervised learning rules.
- **Experience** in statistical machine learning, deep learning using convolutional, recurrent, and graph neural networks. Research experience with transformers and perceiver architectures and Natural language processing using attention-based algorithms.
- **Research Experience** in audio recording, segmentation, and analysis (from songbirds).

Awards, Honors, & Fellowships

- Gatsby foundation travel grant for Junior Scientists Workshop on Recent Advances in Theoretical Neuroscience, Trieste, 2024.
- PhD Conference Award, Brandeis University, 2024.
- Travel and Research Grant, Brandeis University, 2024

- Simons Foundation MBL Scholarship Award for the summer school Methods in Computational Neuroscience 2021.
- COSYNE travel grant 2020.
- INSPIRE - Scholarship for Higher Education (SHE), Department of Science and Technology, Govt. of India 2012-2017. Stipend and contingency funds for research expenses during the BS-MS program.

Abstracts selected for presentations

- S. Mokashe, P. Miller. Competition between reactivating memories as a mechanism for long-delay credit assignment, Junior Scientists Workshop on Recent Advances in Theoretical Neuroscience, 2024.
- S. Mokashe, N. Brunel. Learning sequences of correlated patterns in recurrent networks. Cosyne 2020, Neuromatch conference 2020, Monsoon Brain Meeting 2020, CNS 2020, Bernstein Conference 2020.
- S. S. Mokashe, S. Nadkarni. Role of slow temporal dynamics in the reliability of stochastically driven neurons. Program No. 590.13. 2016 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2016. Online.

Research talks

- Spotlight talk "Competition between reactivating memories as a mechanism for long-delay credit assignment" at the 5th International Convention on the Mathematics of Neuroscience and Artificial Intelligence, Rome, 2024 (link).
- Contributed talk "Learning sequences of correlated patterns" at Bernstein Conference Sept 29- Oct 1 2020 (link).
- Talk "Learning sequences of correlated patterns " at Monsoon Brain meeting June 24 - 26, 2020.
- Talk "Learning sequences of correlated patterns" at "neuromatch conference" March 30 - 31, 2020.
- Invited talk titled "Role of slow temporal dynamics in the reliable activity of stochastically driven neurons" at Biomodeling group meeting, Pune, March 27, 2017.

Ongoing research projects and collaborations

- **Preferential reactivation of memories in conditioned taste aversion paradigm**
  -with Paul Miller. The thesis project investigates temporal credit assignment and characterizing preferential replay between two competing memories. We build a spiking recurrent network model to study how an interfering input could overshadow the primary input as the cause of illness in the conditioned taste aversion paradigm.
- **Temporal filters of sensory neurons**
  -with Joshua Sanford-Pughe and Dmitri Chklovskii. We investigate sensory processing of inputs in terms of predictive coding and temporal filtering of inputs. We propose that sensory neurons predict the next input by constructing a model of the relevant features in the world and function as low rank forecasters.
- **Multimodal alignment of latent features in auto-encoding transformers**
  -with Takuya Ito and James Kozloski. This research internship project investigates how multimodal alignment of concept representations could help with transfer learning and adaptive tasks. To capture the influence of attention mechanisms in multi-sensory integration in the brain, we implement an auto-encoding transformer model. We observe that multimodal training helps in creation of more decodable latent representations.
- **Learning sequences of correlated patterns in neural networks**
  -with Nicolas Brunel. We study the learning of sequences where the stream of inputs the network receives is correlated in time and how the time scales of correlation affect the memory representation in neural networks and the capacity of these networks. We also explore how the properties of the neurons and the inputs affect the network dynamics.

Advanced training workshops and schools

- Methods in Computational Neuroscience, MBL, Woods Hole, MA. August 1 - August 27, 2021.
- Neuromatch Academy (interactive track) July 13-31, 2020
- Computational Approaches to Memory and Plasticity(CAMP) organized by NCBS, Banglore, India. (2014).

Teaching, Outreach, and Mentorship

- Graduate Peer connect mentor for 2022-2023: helping students adjust to graduate school.
- Quantitative Reasoning Tutor for MKTYP program at Brandeis University for 2022-2023.
- Teaching assistant for BIOL107a - Data Analysis and Statistics Workshop, Fall 2021, Brandeis University.
- Disha, IISER Pune, India: Science outreach and primary education to underprivileged children, especially girls (2012-2017). Tutored one underprivileged student in Biology for grades 11 and 12 to get admitted to IISER-Pune, which was a success.
- IISER Pune: Mentored two undergraduate students for their summer internships (2017) and a visiting research student (2016) from UW-La Crosse at the Computational Neurobiology lab, IISER.

Previous research experience

- **Investigating the role of sparse connectivity in output precision**
  -with James Murray. We examine the effect of sparse connectivity on the precision output sequential activity using a biologically plausible learning paradigm: Random feedback local online learning (RFLO). We also study how non-sparse coding could help the network learn a generalization task better than sparse coding.
- **Consolidation of memories in the cortico-hippocampal network**
  -with Stefano Fusi, and James Fitzgerald. We investigate how the brain solves the generalization/memorization trade-off during systems consolidation of memories. We study how the predictability of the inputs and the sparseness in the hippocampus, modeled as an autoencoder, shapes whether the cortico-hippocampal network memorizes or generalizes a given input.
- **Characterising strongly coupled dynamically balanced networks**
  -with Jonathan Touboul. This work shows that strongly coupled networks in which inhibition dominates without a specific synaptic scaling can achieve dynamically balanced networks. We also derive a description of the return to balance voltage dynamics.
- **Dynamics of randomly connected bistable neural networks**
  -with Jordan Breffle, and Paul Miller. We characterize the dynamics of finite-sized neural networks, and the neurons are bistable and randomly connected. We compare the dynamics of finite networks to the mean-field limit when the neurons have a biologically plausible transfer function.
- **Characterization of optimal phase difference for communication between oscillating neuronal networks**
  -with Ila Fiete. To determine how the latency in communication is modulated by the relative phase difference in receiver and transmitter networks, we derive an analytical solution for the optimal phase difference for communication as a function of the network parameters and simulate the networks to test the theory.
- **Effect of noise on switching frequency of two mutually inhibiting neurons**
  -with Suhita Nadkarni. We inspect how neural networks where regular activity could be a functional requirement maintain regular activity despite the noisy framework that the network operates. We find that the network achieves robustness to noise via a match between slow ion channel closing time scales and noise frequencies.