Mohit Kulkarni

mkulkarni@ethz.ch | m2kulkarni | m2kulkarni.github.io

Education

University of Zurich and ETH Zurich *2023-2025* (expected)
M.Sc, Neural Systems and Computation

Indian Institute of Technology, Kanpur *2019-2023*
B.S, Mathematics and Scientific Computing. Minor in Machine Learning

Research Interests

Mathematical Data Science | Theoretical & Systems Neuroscience | Dynamical Systems | Machine Learning

Posters and Publications

K Daie, M Rozsa, P Humpreys, T P Lillicrap, C Clopath, A Grabska-Barwinska, L Kinsey, **M Kulkarni**, M M Botvinick, K Svoboda; **"Optical brain computer interface for measuring circuit plasticity during learning."** Program No. 115.08. 2022 Neuroscience Meeting Planner. Chicago, IL: Society for Neuroscience, 2022. Online.

Scholarships and Grants

- *Mar 2022:* Recipient of the Undergraduate Travel Grant to attend COSYNE 2022 in Lisbon, Portugal
- *2019-2023:* Awarded the INSPIRE Scholarship by Department of Science and Technology, Govt. of India

Research Experience

Research Assistant, Allen Institute for Neural Dynamics *Jan 2022 – May 2023*
Research Assistant, Svoboda Lab *Sep 2020 – Dec 2021*
Dr. Karel Svoboda

- Analysed 2P calcium imaging data recorded in mice during a Brain Computer Interface (BCI) behavioral task
- Developed recurrent neural network (RNN) models to test the hypothesis that learning involves out of manifold network reorganization of neural activity, comparing the activity reorganization to experimental data
- Analysed activity and behavior correlates during learning, to test the alternate hypothesis that behavioral changes, and not network reorganization, is what drives learning

Visiting Researcher, Imperial College London *Jun 2021 – Sep 2021*
Prof. Dan Goodman and Dr. Friedemann Zenke (FMI, Basel) *SNUFA*

- Created SNUFA100, 2 new datasets for systematic evaluation of Spiking Neural Networks (SNNs)
- Audio data, from the Librispeech ASR corpus, was converted into spike trains using an artificial model of inner ear
- The first dataset SNUFA100 is created for a word identification challenge, with 100,000+ words in 100 classes. The second dataset SNUFA100_sentences, contains 10,000+ sentences, and is created for a keyword spotting challenge

Selected Projects

Alignment and Analysis of a Confocal Microscope *Aug 2022 – Dec 2022*
Prof. Venkata Jayasurya Yallapragada, *Dept. of Physics, IIT Kanpur*

- Helping build a confocal Microscope for imaging experiments on quantum dots and nanoscale particles
- Currently developing a pipeline to characterize quantum state using autocorrelation analysis on single photon detector

Neural Turing Machines | *Course Project, Computational Cognitive Science* *Documentation*
Prof. Nisheeth Srivastava, *Dept. of Computer Science and Engineering, IIT Kanpur*

- Conducted literature review on the development of memory augmented machines and their differentiable variants
- Built upon an existing implementation of NTM to include priority & lexicographic sort and added GPU support

The Omniglot Project *Overview*
Brain and Cognitive Society, IIT Kanpur

- Aimed at understanding the problem of meta learning using the Omniglot dataset of handwritten characters
- Implemented Memory-Augmented Neural Network (MANN) to solve one-shot classification and text generation

Autonomous Humanoid(AUTOMI) *Github*
Team Humanoid, IIT Kanpur

- Implemented real-time path planning using Obstacle Dependent Gaussian Potential Field (ODG-PF)
- Developed a Gazebo simulation for AUTOMI v1, designed for autonomous navigation in a static environment using techniques like depth estimation, SLAM, object recognition, object avoidance and lane detection

PETcat *Github*

Robotics Club, IIT Kanpur

- Developed a simultaneous localization and planning (SLAM) algorithm for a biologically inspired robotic cat
- Benchmarked and optimized open source implementations of SLAM with multi-threading, storage optimization

Technical Skills

Programming: Python, C/C++, R **Libraries:** Pytorch, Tensorflow, OpenCV, ROS **Tools:** LaTeX, Git, i3wm

Talks

Does the Brain do Backpropagation | *BCS, IIT Kanpur* *Recording and Slides*

- JC talk: Presented the credit assignment problem and the literature surrounding bio-plausible learning rules

Computational theories of the Brain | *BCS, IIT Kanpur* *Slides*

- JC talk: A general overview of theories of computation in the brain and specifically, predictive processing

Mentorship

Dynamics of Life | *Stamatics, IIT Kanpur* *Outline*

- Mentored a group of 30 in a reading project on nonlinear dynamics and chaos in naturally occurring phenomenon

Models of Memory | *BCS, IIT Kanpur* *Documentation and Poster*

- Experimented with classical memory retrieval models like the Hopfield model and implemented neural network models of memory retrieval like NTM and MANN

Relevant Courses

Mathematics	Mathematics of Data Science*	Neural Network Theory*	High Dimensional Statistics*
	Linear Algebra	Analysis-I	Abstract Algebra
	Differential geometry	Probability and Statistics	Ordinary Differential Equation
	Complex Analysis	Topology	Partial Differential Equation
Computer Science	Intro to Neuroinformatics*	Data Structures	ML for Signal Processing
	Statistical Simulation	Intro to Electronics	Comp Cognitive Science

(*): Ongoing Courses

Extra-Curricular Activities

Group Leader | *Brain and Cognitive Society, IIT Kanpur* *May 2021 – Apr 2022*

- Conducted an "Introduction and Topics in Brain Sciences" workshop, with lectures on ML/DL, RNNs, SNNs, and RL
- Led a two-tier team of 20 to conduct and organize projects in brain sciences with participation from over a 100 people

Secretary | *Robotics Club* *Apr 2020 – Apr 2021*

- Part of a 25 member team responsible to plan and execute ideas to increase participation in robotics related activities

Student Guide | *Counselling Services* *Nov 2020 – Nov 2021*

- Guided 6 freshmen through admission, orientation, and helped organise orientation for over 1200 students

Conferences and Workshops

Brain Computation and Learning | IISc Bangalore *Jan 2023*

COSYNE 2022 | Lisbon, Portugal *Mar 2022*

Neuromatch Academy *July 2020*

Vijyoshi Camp 2019 | *IISER, Kolkata* *Dec 2019*