Mohit Kulkarni

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Education

Indian Institute of Technology, Kanpur 2019-2023 *(expected)*
B.S., Mathematics and Scientific Computing. Minor in Cognitive Science *8.1/10*

Vidyadham Junior, Aurangabad 2019
Maharashtra State Board of Higher Secondary Education *88.6%*

Podar International School, Aurangabad 2017
Indian Certificate of Secondary Education *96.2%*

Scholarships and Grants

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

Research Interests

Theoretical and Systems Neuroscience, Dynamical Systems, Machine Learning, Optical Imaging, Robotics

Publications

K Daie, M Rozsa, P Humpreys, T Lillicrap, C Clopath, A Grabska-Barwinska, L Kinsey, **M Kulkarni**, M Botvinick, K Svoboda **"Optical brain computer interface for measuring circuit plasticity during learning"**. *SfN 2022*

Research Experience

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

- Worked on analysing **two-photon calcium imaging** data recorded in mice during a **Brain-Computer Interface (BCI)** behavioral task
- Developed **recurrent neural network** models to analyse and test the hypothesis that learning involves **out of manifold** network reorganization of neural activity
- Currently working on understanding **learning through the lens of behavior**, testing 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

- Worked on creating 2 new datasets for a **Spiking Neural Network(SNN)** challenge, in collaboration with the **SNUFA** workshop
- The datasets, derived from **LibriSpeech** ASR Corpus, are based on auditory data converted to **spike trains**. We used **surrogate gradient learning** based baseline for the datasets
- The first challenge, SNUFA100, is a **word identification** challenge, while the second challenge SNUFA100_sentences is based upon **keyword spotting** in a sentence

Selected Projects

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

- Involved in building a **Confocal Microscope** for imaging of quantum dots and nanoscale particles
- Developing a pipeline to characterize quantum state using **autocorrelation analysis** on single photon-detectors

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

- Conducted a literature review on the development of **memory augmented** machines and the 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

- Aaimed at understanding the problem of **meta learning** using the **Omniglot Dataset** of handwritten characters
- Implemented Memory-Augmented Neural Network to solve **one-shot classification** and **text generation** problem.

Autonomous Humanoid(AUTOMI) *Github*

Team Humanoid, IIT Kanpur

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

PETcat *Github*

Robotics Club, IIT Kanpur

- Aimed at developing **localization and planning (SLAM)** model for a biologically inspired robotic cat.
- Benchmarked open source implementations of SLAM and optimized them using **multi-threading** and **storage optimization**

Relevant Courses

Mathematics: Linear Algebra, Analysis-I, Abstract Algebra, Differential geometry, Probability and Statistics, Ordinary Differential Equation, Partial Differential Equation, Complex Analysis, Statistical Simulation
Others: Neurobiology, Fluid Mechanics, Data Structures, Bioinformatics, Optical Imaging, ML for Signal Processing

Technical Skills

Programming: Python, C/C++, R **Tools:** LaTeX, Bash, Git
Libraries: Pytorch, Tensorflow, OpenCV, Numpy, Gazebo, ROS, DeepLabCut

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

Mentorship

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

- Mentored a group of 30 Freshman and Sophomores in a reading project on Nonlinear Dynamics and Chaos with an emphasis on naturally occuring phenomenon

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

- Experimented with classical memory retrival models like the hopfield model and the mean-field theory. Implemented neural network models of memory retrival like Neural Turing Model and Memory Augmented Neural Network

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 and assignments on ML/DL, RNNs, SNNs, and RL.
- Oversaw 15 secretaries and conducted 7 projects in brain sciences with participation from over 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 – Present

- Helped 6 freshmen students get used to campus life and quickly adjust to college environment

Camps and Workshops

COSYNE 2022 | Lisbon, Portugal Mar 2022

Recurrent Neural Networks for Neuroscience | *COSYNE Tutorial* Feb 2021

Neuromatch Academy July 2020

Vijyoshi Camp 2019 | *IISER, Kolkata* Dec 2019