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 *8/10*

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%*

Research Interests

Theoretical & Systems Neuroscience | Dynamical Systems | Machine Learning | Optical Imaging | Robotics

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-Present:* Awarded the INSPIRE Scholarship by Department of Science and Technology, Govt. of India

Research Experience

Research Assistant, Allen Institute for Neural Dynamics *Jan 2022 – Present*

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 – Present*

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, Bash, Git

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	Linear Algebra	Analysis-I	Abstract Algebra
	Differential geometry	Probability and Statistics	Ordinary Differential Equation
	Complex Analysis	Topology	Partial Differential Equation
Computer Science	Set Theory	Data Structures	ML for Signal Processing
	Statistical Simulation	Bioinformatics	Comp Cognitive Science
Miscellaneous	Neurobiology	Optical Imaging	Introduction to Electronics
	Fluid Mechanics	Moral Thinking	Philosophy of Science

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 – Present*

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

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*