Mohit Kulkarni

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Education

Indian Institute of Technology, Kanpur 2019-2023 *(expected)*
B.S., Mathematics and Computing CPI: 8.7/10.0

Vidyadham Junior, Aurangabad 2019
Maharashtra State Board of Higher Secondary Education Score: 87.8 %

Podar International School, Aurangabad 2017
Indian Certificate of Secondary Education Score: 95.6 %

Research Interests

Dynamical Systems, Theoretical Neuroscience, Machine Learning, Neural Networks, Fluid Mechanics

Research Experience

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, **SNUFA**
- The datasets, derived from **LibriSpeech ASR Corpus**, are based on **spike trains** converted from auditory data
- The first challenge, SNUFA100, is a **word spotting** challenge, while the second challenge SNUFA100_sentences is based upon **keyword spotting**
- Used **Surrogate gradient learning** based SNN models for our baseline

Research Assistant, Svoboda Lab Sep 2020 – Present
Dr. Karel Svoboda and Dr. Kayvon Daie

- Working on **dynamics of learning and plasticity** in the Somatosensory cortex.
- Experimented with more biologically plausible learning algorithms such as **Feedback Alignment**, **localised hebbian learning** etc.
- Currently working with **recurrent and chaotic** models of learning(**FORCE** etc.)
- Data analysis techniques such as **PCA**, **GPFA**, **Correlation** analysis were used

Selected Projects

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

- Explored Neural Turing Machine as a memory augmented neural network
- Conducted a **literature review** on models prior to NTM and those developed further due to NTM(For e.g. Differentiable Neural Computers(DNC))
- Built upon an existing open-source implementation to add **priority & lexicographic sort** tasks and added GPU support. Also experimented with memory initialisation.

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

- This project was aimed at understanding and solving the problem of **one-shot learning** using the Omniglot Dataset of handwritten characters
- Implemented SOTA meta-learning models, such as MANN, to solve one-shot classification and generative problem.
- Used architectures like **GANs, VAEs, LSTMs and bayesian statistics** to develop models in PyTorch.

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

- Involved in the development of a complete, highly optimised software stack for **AUTOMI**
- AUTOMI v1 is designed for autonomous navigation in a static environment using techniques like **depth estimation, SLAM, object recognition, avoidance, lane detection** etc.
- The software stack is based on **ROS**, with image processing using **OpenCV**.

PETcat *Github*

Robotics Club, IIT Kanpur

- Aimed at developing a biologically inspired robotic cat.
- Simultaneous Localization and Planning Algorithms like **orb-SLAM, gmapping, roVIO** were implemented and benchmarked.
- Currently involved in optimization of software stack using **storage optimization, multi-threading** etc.

Relevant Courses

Linear Algebra, Analysis-I, Neurobiology, Several variable calculus and Differential geometry*, Probability and Statistics, Fluid Mechanics, Data Structures*, Computational Cognitive Science, Complex Analysis
* - *ongoing courses*

Technical Skills

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

Talks and Mentorship

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

- Journal Club talk at BCS, IIT Kanpur, where we discussed biologically plausible learning rules and future directions the field can take.

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

- Mentored a group of 30 Freshman and Sophomores in a reading project on Nonlinear Dynamics and Chaos in Nature
- Primarily based on Steven Strogatz's Nonlinear Dynamics and Chaos.

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

- Looked at some classical memory retrieval methods like hopfield model and mean-field theory
- Also worked with a more realistic sequential neural network model for recall tasks(For eg, NTM, MANN etc)

Extra-Curricular Activities

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

- Overall Head for all activities BCS conducts such as Journal Clubs, Research Symposiums etc
- Conducted 7 projects related to Neuroscience and sister fields in the summer of 2021

Secretary | *Robotics Club* Apr 2020 – Apr 2021

- Part of a 25 member team responsible to suggest 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