Chaitanya Kapoor

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(Nationality: Citizen of the United States of America)

Research Interests

My research interests lie at the intersection of Deep Learning and Neuroscience, aiming to understand and reverse engineer neural computation. I aim to develop computational models of such neural circuits, with an overarching goal of designing efficient, biologically-constrained learning algorithms.

Education

University of California, San Diego **Incoming**
Post-Baccalaureate Student (NeuroML Group) *La Jolla, CA*
Advisor: Meenakshi Khosla

Massachusetts Institute of Technology **Jan. 2024 – July 2024**
Visiting Student (Senseable Intelligence Group) *Cambridge, MA*

Thesis: LUMIN: Light-sheet Microscopy Analysis Unified with Distributed and Domain-Randomized Generative Models

Advisor: Satrajit Ghosh

Birla Institute of Technology and Science, Pilani **Nov. 2020 – July 2024**
B.E. (Hons.) in Electrical and Electronics engineering *Pilani, India*

Honors & Awards

04/24 **NeuroMatch Academy**: Computational Neuroscience Summer School
02/24 **COSYNE 2024:** Undergraduate Travel Grant Award
04/23 **OxML 2023:** ML × Health Summer School, Oxford Mathematical Institute

Publications

Multiplexed Expansion Revealing for Imaging Multiprotein Nanostructures in Healthy and Diseased Brain
J. Kang, M. Schroeder, Y. Lee, ***C. Kapoor****, E. Yu, T. B. Tarr, K. Titterton, M. Zeng, D. Park, E. Niederst, D. Wei, E. S. Boyden*
[Under review - Nature Communications]

RnR-ExM: Robust Non-Rigid Registration Challenge for Expansion Microscopy Volumes
E. Besier, R. Zhang, Y. Bando, Y. Quéméner, ***C. Kapoor****, M. Alawi, M. Hoffman, A. Dalca, A. Casamitjana, I. Arganda-Carreras, E. S. Boyden, H. Pfister, D. Wei*
IEEE International Symposium on Biomedical Imaging (IEEE ISBI), 2023 - **website**

Attention-enabled Deep Neural Network for Enhancing UAV-Captured Pavement Imagery in Poor Visibility
C. Kapoor*, A. Warrier, M. Singh, P. Narang, H. Puppala, R. Srinivas, A. P. Singh*
IEEE Multimedia Information Processing and Retrieval (IEEE MIPR), 2023 - **paper**

Fast and Lightweight UAV-based Road Image Enhancement Under Multiple Low-Visibility Conditions
C. Kapoor*, A. Warrier, M. Singh, P. Narang, H. Puppala, R. Srinivas, A. P. Singh*
PerCom Workshops (PerSASN 2023) - **paper**

Dense Residual Networks for Gaze Mapping on Indian Roads
C. Kapoor*, K. Kumar, S. Vishnoi, S. Ramanathan*
preprint

Research Experience

Senseable Intelligence Group **Jan. 2024 – Present**
Supervisor: Prof. Satrajit Ghosh *Massachusetts Institute of Technology, MA*

- Developed a distributed framework for large-scale ($\sim$ 1TiB) image segmentation for light-sheet microscopy images.
- Designed a domain-randomized generative model, using spherical harmonics to synthesize cortical sections of *ex-vivo* human brains to enable zero-shot segmentation.
- Worked on designing few-shot, *spatially* guided semantic segmentation algorithms for MRI segmentation.
- Proposed the use of a topologically aware Graph Neural Network which is capable of encoding spatial and anatomical constraints.

Talmo Lab **May 2023 – Present**
Supervisor: Dr. Talmo Pereira *Salk Institute, La Jolla, CA*

- Working on the development of methods for pose estimation and tracking to quantify animal behavior through robust tracking of anatomical landmarks in 3D.
- Designing algorithms utilizing projective geometry to create inputs for a CNN that leverages geometric reasoning.

Synthetic Neurobiology Group **Feb. 2022 – Jan. 2024**
Supervisors: Prof. Ed Boyden, Prof. Donglai Wei *Massachusetts Institute of Technology, MA*

- Worked on the development of a *generalist* 3D segmentation model for Expansion Microscopy (ExM) volumes for various animal species.
- Proposed a human-in-the-loop feedback learning mechanism, built on top of an existing deep learning framework, NucMM.
- Worked on developing a new joint-intensity and point-based, high throughput image registration algorithms having nanoscale precision ($\mathbf{10-40}$ nm) for Multiplexed Expansion Revealing **(multiExR)**. This work is currently under review at Nature Communications.

Camera Culture Group **August 2022 – Dec. 2023**
Supervisor: Dr. Ramesh Raskar *Massachusetts Institute of Technology, MA*

- Worked on extracting environments from surfaces of glossy objects from sparse, and unstructured views.
- Explored methods that incorporate shape priors, which enable us to turn everyday objects having unknown geometry into radiance-field camera to image the world from an objects perspective.

Invited Talks and Tutorials

02/24 **Automating behavior quantification using deep learning**, *COSYNE 2024*
06/23 **SIS Symposium, Harvard SEAS,** *Seeing Beyond the Camera*

Teaching Experience

Department of Mathematics, BITS Pilani **August 2023 – Dec. 2023**
Teaching Assistant *Pilani, India*

- **Undergraduate TA**: assisted with the course Combinatorial Mathematics (MATH F421)

Technical Skills

Languages: Python, C, MATLAB, Unix Shell Scripting , LaTeX
Technologies/Frameworks: Keras, Tensorflow, Numpy, PyTorch, Git, OpenCV