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 cognitive neural circuits, with an overarching goal of designing efficient, biologically-constrained learning algorithms.

Education

University of California, San Diego   **Aug. 2024 – Present**
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

Bridging Critical Gaps in Convergent Learning: How Representational Alignment Evolves Across Layers, Training, and Distribution Shifts
C. Kapoor, S. Srivastava, M. Khosla
(Under review) - preprint

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*
Nature Communications, 2024 - paper, code

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 - code, 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

NeuroML Lab   **Aug. 2024 − Present**
Supervisor: Prof. Meenakshi Khosla   *La Jolla, CA*

- Leading the investigation in convergence of learnt representations of artificial and biological neural networks.
- Exploring network invariances across network layers and training, by identifying the *minimal* set of transformations to align representations.
- Examining responses of networks to out-of-distribution stimulus to uncover shared learning principles between systems.

Talmo Lab   **May 2023 − Aug. 2024**
Supervisor: Dr. Talmo Pereira   *Salk Institute, La Jolla, CA*

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

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

- Developed a distributed framework for large-scale ($\approx$ 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.

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 ($10 - 40$ nm) for Multiplexed Expansion Revealing (**multiExR**). This work has been published at Nature Communications.

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)

Students Mentored

- **Chanyoung Park**: Undergraduate Student at UC San Diego

Technical Skills

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