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-informed models.

Education

University of California, San Diego   **Sep. 2025 – Present**
PhD Student (Cognitive Science)   *La Jolla, CA*

University of California, San Diego   **Aug. 2024 – Aug. 2025**
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*

Selected Publications

Partial Soft-Matching For Neural Representational Comparison
__C. Kapoor__, A. H. Williams, M. Khosla
(Under Review)

Bridging Critical Gaps in Convergent Learning: How Representational Alignment Evolves Across Layers, Training, and Distribution Shifts
__C. Kapoor__, S. Srivastava, M. Khosla
Neural Information Processing Systems (NeurIPS), 2025 - **paper**, **code**, **CCN Extended Abstract**

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**, **news story**

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**

Research Experience

NeuroML Lab   **Aug. 2024 – Aug. 2025**
Supervisor: Prof. Meenakshi Khosla   *La Jolla, CA*

- Leading the development and design of new optimal transport-based representational similarity metrics allowing for matching and detection of single-neuron tuning outliers across biological and artificial neural networks.
- Led a large-scale study spanning CNNs, ViTs, LLMs to understand the minimal set of transformations that align internal network representations.
- Found that simple geometric invariances drive convergence, rapid cross-network alignment occurs far earlier than thought, and alignment robustness degrades proportionally with OOD shift—insights. This work has been published at NeurIPS.

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*

Honors & Awards

10/25 **NeurIPS 2025**: Student Travel (Scholar) Award
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

Students Mentored

- **Pratham Yashwante**: Masters Student at UC San Diego
- **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

References

Meenakshi Khosla: Assistant Professor of Cognitive Science and Computer Science and Engineering, UC San Diego. (Contact: mkhosla@ucsd.edu)
Edward S. Boyden: Y. Eva Tan Professor in Neurotechnology, MIT. (Contact: eboyden@mit.edu)
Satrajit S. Ghosh: Director of Open Data in Neuroscience Initiative and Senior Research Scientist, MIT. (Contact: satra@mit.edu)
Talmo D. Pereira: Salk Fellow and Principal Investigator, Salk Institute for Biological Studies. (Contact: talmo@salk.edu)
Donglai Wei: Assistant Professor of Computer Science, Boston College. (Contact: donglai.wei@bc.edu)