Neehar Kondapaneni

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My research interests are in *machine teaching for humans* and *eXplainable AI*. I am developing algorithms to (1) identify the features used by models to achieve superhuman performance on visual tasks and (2) teach those features to human learners.

Education

California Institute of Technology — Sept 2018 - Present
Computation & Neural Systems, PhD Candidate

University of California - San Diego — 2014 - 2017
B.S. Neuroscience and Physiology, Minor in Computer Science — GPA: 3.91/4.00
Magna Cum Laude

Publications

Representational Similarity via Interpretable Visual Concepts - ICLR 2025
Neehar Kondapaneni, Oisin Mac Aodha, Pietro Perona

Text-image Alignment for Diffusion-based Perception - CVPR 2024
Neehar Kondapaneni*, Markus Marks*, Manuel Knott*, Rogério Guimarães, Pietro Perona

Less is More: Discovering Concise Network Explanations - ICLR Re-Align Workshop 2024
Neehar Kondapaneni*, Markus Marks, Oisin Mac Aodha, Pietro Perona

Visual Knowledge Tracing - ECCV 2022
Neehar Kondapaneni, Oisin Mac Aodha, Pietro Perona

A Number Sense as an Emergent Property of the Manipulating Brain - Scientific Reports 2024
Neehar Kondapaneni, Pietro Perona

Transformation of Cortex-wide Emergent Properties during Motor Learning - Neuron 2017
Hiroshi Makino, Chi Ren, Haixin Liu, An Na Kim, Neehar Kondapaneni, Xin Liu, Duygu Kuzum, Takaki Komiyama

Preprints

A Closer Look at Benchmarking Self-Supervised Pre-training with Image Classification
Markus Marks, Manuel Knott, Neehar Kondapaneni, Elijah Cole, Thijs Defraeye, Fernando Perez-Cruz, and Pietro Perona

Research Projects

Caltech Vision Lab
Advisor: Dr. Pietro Perona

Representational Similarity via Interpretable Visual Concepts (2025)
- Posed a new question for the XAI community: Can we develop XAI methods to explain the difference between the models?
- Proposed a method that quantifies representational similarity through interpretable visual concepts, allowing users to visualize similarities and differences between models.
- Showed that models learn unique and important concepts and developed a test to show that conceptual differences can be linked to model.
- Showed that LLVMs can be used to examine complicated model differences.

Text-image Alignment for Diffusion-based Perception (2024)
- Proposed a novel technique for prompting the diffusion backbone. Applied a captioning model on the dataset to generate prompts for the diffusion backbone. Found that this enforced text and image alignment and improved the intermediate feature maps.
- Extended this idea to the cross-domain setting and found that aligning the prompt to target domains improved performance on several datasets.
- Achieved *SOTA* results in NYUv2 Depth, Pascal to Watercolor2K, and Cityscapes to Nighttime Driving.

Less is More: Discovering Concise Network Explanations (2023)
- Developed a dataset to measure the conceptual alignment between model concepts and human expert-defined concepts.
- Developed a method to compare how different XAI methods aligned to human expert-defined concepts.
- Proposed an XAI method to reduce explanation complexity while preserving explanation alignment to human expert concepts.

Visual Knowledge Tracing (2022)
- Introduced visual knowledge tracing as a novel problem for the computer vision community, where the goal is to predict a student's response to a visual stimulus given their history of responses.
- Collected three new datasets for evaluating models for visual knowledge tracing.
- Proposed and evaluated prototype and exemplar cognitive models, and LSTM and transformer neural network model. All models predicted student responses significantly above chance, with the LSTM as the top performer.

A Number Sense as an Emergent Property of the Manipulating Brain (2020)
- Developed a *cross-modal unsupervised* learning framework where self-directed actions act as a supervisory signal for perception.
- Our framework organizes numerosity sensitive neurons in an abstract, generalizable representation that reproduces classic results in psycophysics.

Komiyama Lab - Transformation of Cortex-wide Emergent Properties during Motor Learning
Advisor: Dr. Takaki Komiyama (2014 - 2016)
- Designed a motor learning task for mice, built hardware and software to collect data, trained mice, and analyze the neural recordings.
- Developed and implemented algorithms to (1) match image annotations across image channels of immunohistochemistry and (2) partial automation of parsing and annotating videos of mouse behavior .
- Found motor learning modulates whole brain activity by creating a sequential activity pattern, driven by the pre-motor cortex, that is temporally compressed over the course of learning.

Teaching

Selected Topics in Computational Vision (EE/CNS/CS 148)
- (2025, **Head TA**) Oversaw the development of an introductory course for deep learning to help undergraduates learn skills important in machine learning engineering.
- (2023, **Head TA**) Oversaw the development of new course material to focus on recent advances in AI, including transformers, diffusion models, and large language models.
- (2022) Developed and delivered a lecture introducing the mathematical details and intuition behind transformers and vision transformers' attention, including high-level differences between CNNs and ViTs and differences in their latent representations. (Slides)
- (2021) Provided tutoring and guidance to students on class material. Worked closely with Amazon SageMaker EDU team to provide a managed environment for students to train their models. Developed tutorials to teach students how to use PyTorch, Docker, and AWS.

Activities

Reviewer - ICCV 2025, ICLR 2025, ICCV 2023, Neurips 2023 (Workshop)
SURF Mentor
Andrew Zabelo (2023 - current) is an undergraduate at Caltech. We are studying how to use distillation from vision-language models to improve zero-shot performance for action recognition in video.
Daniel Israel (2021- 2022) is a current graduate student UCLA. Daniel assisted in creating ablation experiments to study the limits of our number sense model.
STEM Stall - brought STEM to a rural community through demos and question and answer sessions.
Freshman Summer Research Institute - Co-mentored an incoming freshman from a minority background. Taught them the basics of computer vision research through a project analyzing images collected from camera traps in the wild.
Rise Tutoring (2018-2020) - tutored underprivileged Pasadena high-school students in mathematics.