Cognitive Science
UC San Diego

Vijay Veerabadran's Dissertation Defense

Comparing human and machine visual perception

Thursday, March 7th, 2024
9:00AM-11:00AM
Public Engagement Building (PEB), Room 721
or
Join with Zoom

Abstract

Human and machine visual perception — what are their similarities and differences? Deep learning-based computer vision models used in machine perception have become increasingly capable in recent times, even surpassing human-level task performance. In this dissertation, we compared these two perceptual systems to reveal their common features which underlie their high task performance. In our innovative study using a time-unlimited forced-choice psychophysics approach, we uncovered surprising evidence that human perception is also influenced by barely-noticeable adversarial image perturbations intended to deceive computer vision models. Through an in-depth analysis of the perturbations' traits, we discovered that humans are especially sensitive to adversarial perturbations that target shape features of images, highlighting shape sensitivity as a key feature of human visual perception. This result inspired us to further enhance shape processing in machine perception. Taking biological inspiration from orientation-tuned lateral connections between neurons in the primary visual cortex — which play a pivotal role in biological shape learning — we developed LocRNN, a deep recurrent neural network model for parameter-efficient learning of long-range global shape cues. LocRNN's enhanced shape learning was vividly demonstrated by its zero-shot generalization performance to novel test-time difficulty levels of two challenging shape integration tasks. Further, LocRNN displayed an emergence of adaptive computation, by increasing prediction latency on more challenging task instances and reducing latency on relatively easier instances. Indeed, both LocRNN and humans have increased response time as a function of path integration distance. We hypothesize that further incorporation of biologically inspired computations will result in increased alignment to human visual perception which can be tested by future human-machine comparison studies.

Committee members:

Virginia de Sa (Chair) - UCSD Cognitive Science
Andrea Chiba - UCSD Cognitive Science
Eran Mukamel - UCSD Cognitive Science
Zhuowen Tu - UCSD Cognitive Science
Garrison W. Cottrell - UCSD Computer Science
Michael C. Mozer - Google DeepMind