

Title: Imaging and decoding human brain activity during dynamic natural vision

Abstract: How does the brain represent visual information from the outside world? In my lab, we approach this question with a deep neural network that mimics neuronal circuitry and coding, and learns to solve computer vision tasks. Using this network as a computational model of the visual cortex, we develop novel encoding and decoding models to describe the bi-directional relationships between visual input and cortical activity measured with functional magnetic resonance imaging. Testing these models with imaging data from humans watching natural movies, we show that the encoding model can predict cortical responses and retrieve visual representations at individual brain locations, and that the decoding model can decipher the measured cortical activity to reconstruct the visual and semantic experiences. Both the encoding and decoding models utilize cortical representations of hierarchical, invariant, and nonlinear visual features. Being self-contained, efficient, and generalizable, these models constitute a computational workbench for high-throughput investigation of all stages of visual processing. We also anticipate that the general strategy for neural encoding and decoding via deep-learning models will be applicable to other sensory or cognitive experiences, e.g. speech, imagery, memories and dreams.