Thesis Defense

MACHINE LEARNING DEPARTMENT

The When, Where and Why of Human Memory Retrieval

Abstract:

Memory retrieval is fundamental in our daily experiences, whether it is to recognize a friend, to decide what to order from a menu or to navigate on the street. The process of memory retrieval, however, is latent and embedded among other cognitive processes such as perceptual encoding, decision making, and motor response. To track precisely when memory retrieval takes place, my research isolates individual cognitive processes from observed neural signal, by modeling the psychological activity in subjects' minds as a sequence of latent stages.

With precise timing of when memory retrieval occurs, I then examine where in the brain there is greater activity during the moment of memory retrieval. Developing a method that aligns neural recordings across subjects, and with better spatial resolution of an ECoG dataset, I provide a detailed mapping of the contributions of individual brain regions in a working memory task.

To further understand why memories are retrieved the way they are, I compare how well different cognitive mechanisms achieve the computational goal of a memory task. Principle of rationality posits that human cognition should adapt optimally to the task demands in the environment through learning and evolution. The more optimal cognitive mechanisms are more favorable to be used by human cognition. In a semantic fluency task, I demonstrate that an alternative memory search mechanism derived from reinforcement learning outperforms existing cognitive mechanisms both in their performance over simulations and in accounting for human behavioral data.

As a whole, my thesis work provides an integrated theory of human memory retrieval by uncovering its temporal dynamics, neural correlates, and underlying computational goal.

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