Computer Science 511
Theoretical Machine Learning

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Background

Neuroscience tools help answer the fundamental question of how neurological behavior in the brain is related to actions initiated by the mind. One aspect of this question is how changes in context impact behavior, and the hippocampus has been shown to be crucial in switching between these contexts. Place cells in the hippocampus fire when a rat is in a specific location in the room, and these place cells change firing location in different physical environments. Place cells also change firing locations, called remapping, when rats change cognitive contexts: remapping occurs when a rat is must deal with different frames of reference despite being in the same physical space. How remapping occurs with respect to specific behaviors, as well as what activity occurs in the hippocampus during a context switch, are poorly understood. This project seeks to provide answers to these questions using data that are already collected. Recordings from the CA1 region of rats using a virtual reality apparatus (Aronov & Tank, unpublished data) were taken after experimenters trained rats to perform two distinct behaviors (different trajectories) in a single virtual environment. We will build on previous work to develop a classifier that will take CA1 spiking data from a rat to predict which task the rat is performing.

Techniques

We plan on investigating the effectiveness of various graphical models to classify context, including hidden Markov models, conditional random fields, and others. Our theoretical work will consist of deriving an Expectation Maximum update rule for our custom-made graphical model, as well as attempting to place upper bounds on the generalization error of our final model.