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CS229 Project Proposal
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Life Sciences

Classifying functional neural cell types during virtual navigation in mice

We are PhD students in neuroscience in the lab of Lisa Giocomo. We study navigation and memory systems in the brain: specifically, the neural activity patterns that allow humans and animals to distinguish contexts and locations. We are interested in applying data analysis techniques learned in the class to data we have collected in lab, which consist of electrical and optical recordings from mouse neurons while the mice navigate in real and virtual environments.

The first data set has already been collected and consists of electrical recordings from neurons in mouse cortex while the animal runs in a real environment, followed immediately by a virtual reality (VR) environment. These recordings come from neurons in the medial entorhinal cortex (MEC), which contains a number of types of neurons that become active in specific spatial patterns relative to the environment currently being explored by the animal*. We are interested in whether these cell types can also be distinguished in VR, because this allows us to use a number of cutting-edge techniques that require the animal to be fixed in place. We will use techniques learned in the class, such as SVMs, to answer a supervised learning problem: How well can MEC cell types, defined based on real-world recordings, be distinguished from each other, based solely on VR activity patterns?

The second data set is currently being collected and consists of simultaneous optical recordings from hundreds of neurons in the hippocampus while the mouse navigates in VR. In this set of experiments, mice learn to distinguish between two VR contexts. After the mice are well trained, the animals are allowed to explore ambiguous environments that are linear morphs of the two previous contexts and report which context they believe they are exploring. With this behavior we hope to probe how the hippocampal representation of a memory changes as the sensory evidence for a competing memory increases. We hope to use classification techniques learned in this class to distinguish the neural representations of the two contexts and then apply those classifiers to the trials in which the animal is exploring morphed environments. This approach will tell us how "confident" the hippocampus is that the animal is in a particular context as a function of the amount of change sensory input. The shape of this function has important implications for theories of hippocampal computation.

* For more background, see the 2014 Nobel Prize:
https://www.nobelprize.org/nobel_prizes/medicine/laureates/2014/press.html