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Final Project Proposal

Based on the paper I presented, *Reliable sequential activation of neural assemblies by single pyramidal cells in a three-layered cortex* by Gilles Laurent et al., I would like to use a publicly available dataset to find evidence for neurons firing in specific sequences dependent on the stimuli presented. There are many publicly available datasets that contain neural signals, including Neurodata Without Borders (NWB) and Collaborative Research in Computational Neuroscience (CRCNS). I will use data recording single neurons using a Utah Multi-Electrode Array placed in the visual cortex of anesthetized macaque monkeys from CRCNS [2]. In the paper presented by Laurent et al., they stimulated single pyramidal neurons in layer 3 of turtle cortices and recorded the response of the surrounding neurons. The data I will use involves a visual stimulus being presented to the monkey in the form of a flash on a screen. Rather than a single pyramidal neuron being stimulated, this experiment involves the activity of many neurons in the primary visual cortex due to the visual stimuli presented to the monkeys. The data includes ten recording sessions from three animals with arrays of spike trains from 207 neurons in the format [#neurons #image #trials #milliseconds]. Example images can be seen in figure 1. Using this data, I will identify neurons who increase firing rate by 1 standard deviation above baseline firing rate after stimulus is presented (followers). Based on the firing-rate onset time, I will rank order each follower and identify reliable sequences that occur when visual stimuli are presented.

Figure 1: Example stimuli presented to the animals.

The main problem I see arising is that the data is too noisy and there is not a clear order of firing among the recorded neurons. Visual data is very high-dimensional and there are many neurons being recorded, so there are a lot of sources of noise and uncertainty that can affect each neuron's specific firing-onset time. There are also 270 different images being shown, so there may be no similarity in the response of the neurons in the visual cortex. Another challenge would be the discrepancy between the 3 animals that are being recorded. There will be different placement of the electrodes and different spatiotemporal dynamics among the animals, so grouping activity across animals will not result in accurate data.

To counteract these issues, I will identify followers in trials that share the same stimulus that are recorded from the same animal. This will decrease the amount of variability among different trials used to see how reliable sequences are. Also, the animals are anesthetized, meaning there will be minimal movement artifacts that will interfere with the stimulus response. Another way to decrease the variability is to use simpler stimuli. Rather than using trials when the animals are presented with natural images, I will use grating images (example on far right of figure 1). The data includes gratings presented at

different orientations. By identifying followers and rank-ordering according to firing-onset time using neural activity that are in response to the same grating, there may be reliable sequences that emerge.

References

1. Hemberger, M., Shein-Idelson, M., Pammer, L., and Laurent, G. (2019). Reliable sequential activation of neural assemblies by single pyramidal cells in a three-layered cortex. Neuron 104: 353-369.
2. Ruben Coen-Cagli, Adam Kohn, Odelia Schwartz; "Flexible Gating of Contextual Influences in Natural Vision." Nature Neuroscience, 2015. http://dx.doi.org/10.1038/nn.4128