Final Project Proposal

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March 8, 2021

1 Background

Visual stimuli can be reliably represented by sparse populations of primary visual cortex (V1) neurons (Yoshida and Ohki, 2020). However, it is yet unclear whether higher visual areas directly downstream of V1, such as lateromedial area (LM), would still follow the same stimulus encoding principles. It is also unknown whether such sparse and reliable coding of visual stimuli persists after rapid adaptation modulates the firing rate of neural populations (Jin et al., 2019).
Here we will take calcium imaging datasets recorded from V1 and LM when mice are viewing static gratings of eight different orientations before or after undergoing rapid adaptation, simulate the computations executed by V1 and LM neurons, and analyze the impact of adaptation as well as the position in visual pathway hierarchy on the encoding of simple visual stimuli.

2 Proposed Project

As described in Yoshida and Ohki (2020), respectively for V1 and LM populations, first we will compare the distributions of neurons responsive to each different grating orientation to gauge the sparseness of population coding. Then we shall pass our stimuli through a set of Gabor filters to extract their visual features, and use non-adapted population response matrix to train a linear decoder. Next, the decoder will be deployed on population response in the test set to reconstruct the input images (framework written by Kato and Ohzawa). Neural activity before and after adaptation will be used to decode the presence and identity (orientation) of gratings. We will finally quantify the similarity between reconstructed images with the actual input using pixel-wise Pearson correlation coefficient to assess how adaptation might affect the accuracy of encoding.

sparseness estimation: ori responsive distribution. determine cell selection in training set
feature extraction: stimuli gabor filter
decoder training: before-adp pop resp
reconstruction: use decode to recon grating