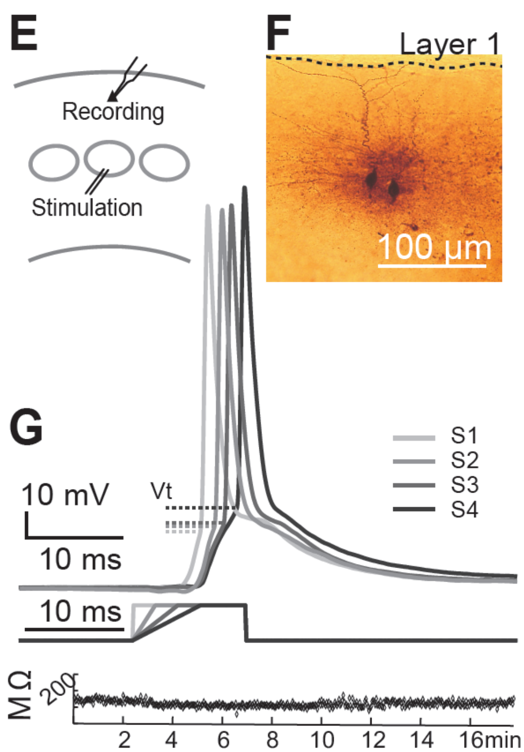
1. Load the data saved in the file ‘02Dec08-cell_002.pkl’. It is the whole cell patch clamp recording from a layer 2/3 pyramidal neuron in mouse somatosensory cortex, from the following experiment:



In this experiment , we are interested in how the slope of injection currents in L4 affects the response of pyramidal neurons in L2/3. As shown in **E**, the layer 2/3 pyramidal neuron was recorded while the layer 4 of the corresponding column where the recorded neuron resides was stimulated with an electrode. In **F** shown biocytin stained recorded cells, confirming that they are pyramidal neurons. The stimuli were injection currents with the same peak amplitude, but different rising slopes, as shown in **G**, middle. In total, 4 different slopes are used. In G upper lines are representative membrane potentials of the recorded neuron in response to different stimuli.

The data in the file is organized as follows:
The information is stored in a dictionary, with the following fields (key: value pairs):

‘Ch1Data’: M-by-N numpy array; current injection to check the input resistance of the cell, pA. M is number of data point in each trial and N is number of trials
‘Ch3Data’: M-by-N numpy array; stimulation current, nA. M and N as above
‘Ch2Data’: M-by-N numpy array; membrane potential recorded, mV. M and N as above
‘SamplInterv’: 1-by-1 numpy array; sampling interval in second
‘ExperimentalTimeLine’: N-by-1 numpy array; time when each trial started in second. First trial starts at time 0
(other fields are not important for our exercise thus not described)

1) calculate the spike count and spike time for each trial (spike count is the number of spikes observed in each trial)
2) decide the stimulus presented in each trial
3) plot raster plot for 10 randomly chosen trials in each stimulus condition together in one figure
4) plot PSTH for each stimulus condition
5) plot the neuron tuning curve in response to the stimuli

2. Load the data saved in the file ‘arrayData.pkl’. It contains data from the paper: https://www.nature.com/articles/nn.3979; in short, it is multi-electrode recordings from a 10x10 electrode array implanted in V4 of adult macaques, while the macaques were watching artificially generated visual stimuli. The data is in the following format:

The .pkl contains a single entry, which is a dictionary with one field named ‘Data’. The field contains a 2300 element list, which corresponds to 2300 trials performed. Each element in the list is a dictionary containing two fields:

‘response’: N-by-3 numpy array; N is number of spikes (or spike-like events) detected. 1st column is the electrode on which the event is detected. 2nd column is the unit code of identified cluster (presumably a single neuron) from the corresponding electrode the spike comes from. A unique electrode-unit pair represents an unique unit (presumably an unique neuron) identified; e.g. 1st column with value of 20 and 2nd column with value of 1 means that this spike comes from unit 1 on electrode 20. Unit 1 on a different electrode, e.g. 10 is a different neuron from electrode 10, unit 1. Events with the same electrode-unit code means that these putative spikes are coming from the same neuron. Value of 0 or 255 in 2nd column represent noise (not a spike, but possibly caused by animal movement, instrument noise etc.). 3rd column is the event time in seconds. Stimulus onset at 0s and lasted 2s.

‘ori’:stimulus orientation in each trial

1. Plot PSTH for all non-noise units, for each stimulus condition (different orientations)
2. Plot the tuning curve for different orientations for all non-noise units

3 and 4 should be skipped
3. Calculate pairwise spike count correlation for all non-noise units for each stimulus condition, and plot them. How does the correlation coefficient affect the population coding (i.e. if the two stimuli can be reliably decoded from neural response)?
4. Calculate pairwise spike time correlation for all non-noise units and plot them