Biological Neural Computation Term Project

Firing Event Detection & Classification on Drosophila Sensillum Recording Data

You are given two data sets (MAp.mat and MHp.mat). (Hint: You can use function "load" to load the data). MAp means the stimulus is pure methyl acetate. Similarly, MHp means pure methyl hexonoate.

Each data matrix consists of 8 trials (8 rows). The sampling rate is 15000Hz. Each trace has a length of 60s. The odor stimulus was turned on at the 10^{th} second for 1 second in each trace. So activities before 10s are spontaneous activities.

The data is completely raw, so you may want to do some preprocessing, such as filtering, to make your life easier.

One basic rule is, if you are using some algorithm requires training or modeling, you should split the dataset into two parts. One part is for you to train your algorithms (training set), one part is for you to validate your trained algorithm (testing set) to prevent overfitting. And you are expected to report your algorithms performance on both data sets.

Before diving into the tasks, plot those raw traces and observe different firing patterns.

The first goal you want to achieve is to robustly detect firing events, which includes large/small spikes and "oscillations". The challenge is mainly in the detection of sub-threshold oscillations (see slide 11,12). If the oscillations are too small to be robustly detected, can you come up with a method to reasonably estimate the firing rate for those oscillations (MAp.mat will be a good dataset for this task)? (You should be able to justify your estimation.) Then, try your best to classify those firing events into three categories: large spikes, small spikes and oscillations. Note: Detection and classification do not have to be two separate steps. This mainly depends on your algorithm.

Once you've achieved the first goal, you can choose either one of the following two tasks:

1. Try to classify mixed spikes (as shown in slide 15) into two categories with a reasonable model. That's been said, you should be able to justify why this model/method is used, why it fits the data. (There are a couple of traces with mixed spikes in MHp.mat.) Don't simply set a single threshold for spike amplitudes. You are expected to utilize other features of the spikes.
2. Try to model oscillations. Can oscillations be modelled as a mixture of response from two neurons? Can your model show the dynamics being observed in real data (from regular spiking to oscillation, the decrease of oscillation amplitude and the recovery of regular spikes etc.)? Note: Each trace contains activities from two olfactory receptor neurons (slide 4,5).