Assignment #2. Spike Data Analysis

- The report needs to be submitted in an electronic format (word document, pdf, etc.) via email (zenas.c.chao@gmail.com)
- Put your name in the filename.
- You need to submit your report before Nov 15. Late assignment will not be accepted.
- You are encouraged to discuss with your classmates, but you need to write the report yourself. Plagiarism will be severely punished!
- You need to attach your codes in the report. Remember to use "%" to comment your programs.

EXERCISE 2.1 (continued from exercise Part 6)
The vector 'ISI' is a huge list of numbers, indicating the time interval between spikes for all (1000) trials. We can use ISI histogram to summarize these ISI results.

1) Compute and plot the ISI histogram. Label the axes. HINT: Modify the code we used for the spike number histogram in the exercise.
2) Explain what you find.
3) What is the average ISI?
4) What is the most common ISI?
5) Are results from (3) and (4) the same?
6) Try to interpret the ISI histogram in terms of spike train data. Given the ISI plot, can you draw a representative spike train?

EXERCISE 2.2
We've studied a single data set. Let's now consider a second data set (download the file 'Spike_data_2.mat' from the class website) with the following properties:

Number of trials: 1000
Duration of each trial: 500 ms
Sampling rate: 1000 Hz.

Load this data set and determine:

1) The average number of spikes per trial
2) The average firing rate
3) The average ISI
4) Compute and plot the spike number histogram, and indicate the number of spikes per trial on the plot
5) Compute and plot the ISI histogram, and indicate the average ISI on the plot
6) Compute and plot the PSTH, and indicate the average value of each measure on the plot
7) Compare the results for 'Spike_data_1' and 'Spike_data_2'. How are they similar? How do they differ? Using all of the tools at your disposal, conclude that either they display similar activity, or they display different activity.
8) Describe in words how the activity in 'Spike_data_2' behaves.

EXERCISE 2.3
Consider a third data set (download the file 'Spike_data_3.mat' from the class website) with the same properties as above:

Number of trials: 1000
Duration of each trial: 500 ms
Sampling rate: 1000 Hz.

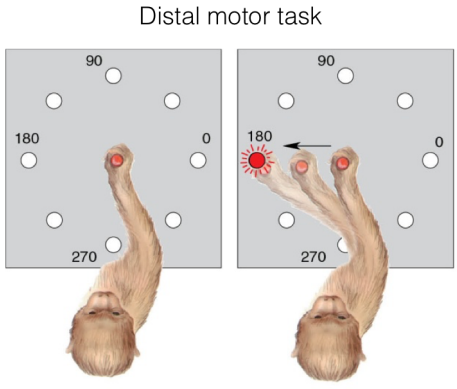
Load this data set and determine:
1) The average number of spikes per trial
2) The average firing rate
3) The average ISI
4) Compute and plot the spike number histogram, and indicate the number of spikes per trial on the plot
5) Compute and plot the ISI histogram, and indicate the average ISI on the plot
6) Compute and plot the PSTH, and indicate the average value of each measure on the plot
7) Compare the results for 'Spike_data_1', 'Spike_data_2', and 'Spike_data_3'. How are they similar? How do they differ?
8) Describe in words how the activity in 'Spike_data_3' behaves.

EXERCISE 2.4
Assume that 'Spike_data_1', 'Spike_data_2', and 'Spike_data_3' were collected under 3 different conditions (C1, C2, and C3, respectively). What will be your decoding strategy? That is, if you are given some spike data, how can you tell under which condition these spike data are collected?

1) Describe your strategy in words.
2) Download the file 'Spike_data_test.mat' from the class website, which contains 10 trials of test data. Can you tell under which condition these data were collected? C1, C2, or C3? How can you tell?

EXERCISE 2.5 (continued from exercise Part 7)

Download 'Spike_data_4.mat' from the class website. The spike data were collected during a distal motor task. There was a total of 158 trials. During each trial, the subject first needs to hold the joystick at the center position. An "INSTRUCTION" cue will later appear at one of the 8 positions to instruct the moving direction, which will be followed by a "GO" cue. The subject needs to move the joystick toward the cued direction after the GO cue.



The data contains following key variables:

1. **direction**: 158X1 vector that indicates the cued direction in each trial
2. **instruction**: 158X1 vector indicates the timings of the INSTRUCTION cues.
3. **go**: 158X1 vector indicates the timings of the GO cues.
4. **unit** (a structure array):
    - **unit(i).times**: the timings of spikes of neuron i (a total of 143 neurons recorded)
    - **unit(i).area**: the brain area where neuron i locates (MI: Primary motor cortex, PMd: Dorsal premotor cortex)

1) Plot the tuning curve for neuron 129, using spikes within ± 0.5 second around the INSTRUCTION cue. HINT: the code in exercise Part 7 uses spikes within ± 1 second around the GO cue.
2) Plot the total number of spikes for each neuron during the whole experiment (x-axis: neuron index, y-axis: total number of spikes).
3) Among 143 neurons, which neuron fires the most (most active)? Where is this neuron (which brain area)?