BIM 280: HOMEWORK 2

Part 4: Conceptual Questions

1. **Compare the measures of entropy (E_C, E_T) for the same neuron for the same stimulus. What is the relationship between E_C and E_T?**

    For all the four cases (two neurons X two events), E_C is around 50-60% of E_T. For the neuron sig003a, (E_C/E_T) is 0.5518 and 0.4938 respectively for events 1 and 6. For the neuron sig016b, (E_C/E_T) is 0.5929 and 0.5798 respectively for events 1 and 6. Additionally, in general, time entropy is a measure of the unpredictability of the timing of the neuron's spikes, while count entropy is a measure of the unpredictability of the number of spikes produced by the neuron over a given period.

2. **What would you think is going to happen to E_T if we select a bin size smaller than 5 ms.**

    When we increase the bin size, E_T decreases. For the instance of sig003a_event 6, for 5 ms E_T is 6.322 and for 20 ms E_T is 6.187. So I would expect an opposite effect when the bin size gets smaller. That is to say, if we select a bin size smaller than 5 ms, such as 1 ms, E_T should increase. However, I checked the results for the same example (sig003a_event 6). For both 1 ms and 5 ms bins, E_T is 6.322. I am guessing that the bin sizes smaller than 5 ms are not informative so that the unpredictability of the timing of the neuron's spikes is the same.

3. **Based on the observation of the PSTHs for the two neurons for the two locations, which neuron would convey more information about the stimulus location?**

    It seems like neuron sig003a (in the first row below) would convey more information about the stimulus location. Because its PSTH for events 3 and 6 looks more different, especially around 0.15 s. It gives specific responses for events 3 and 6 compared to neuron sig016b.
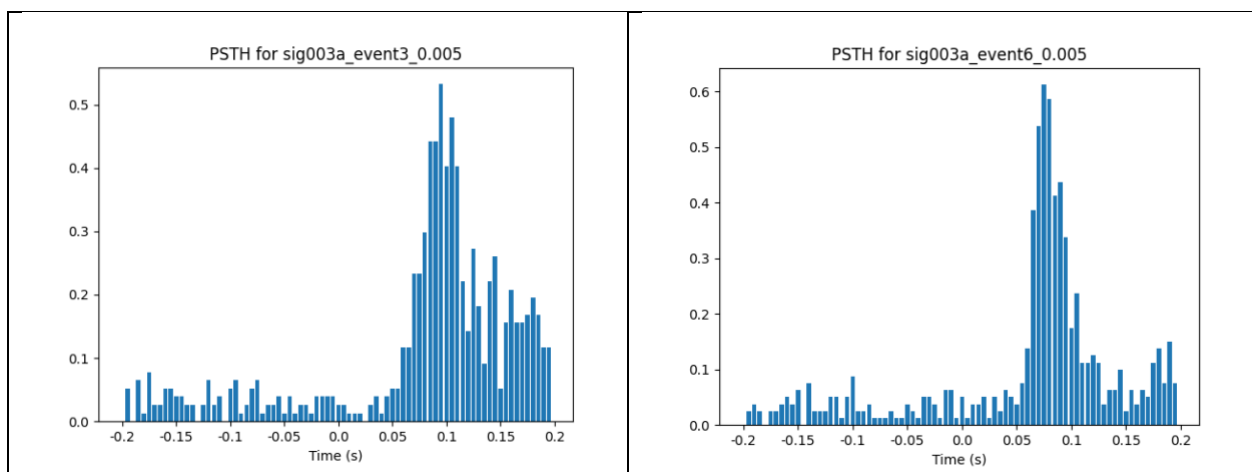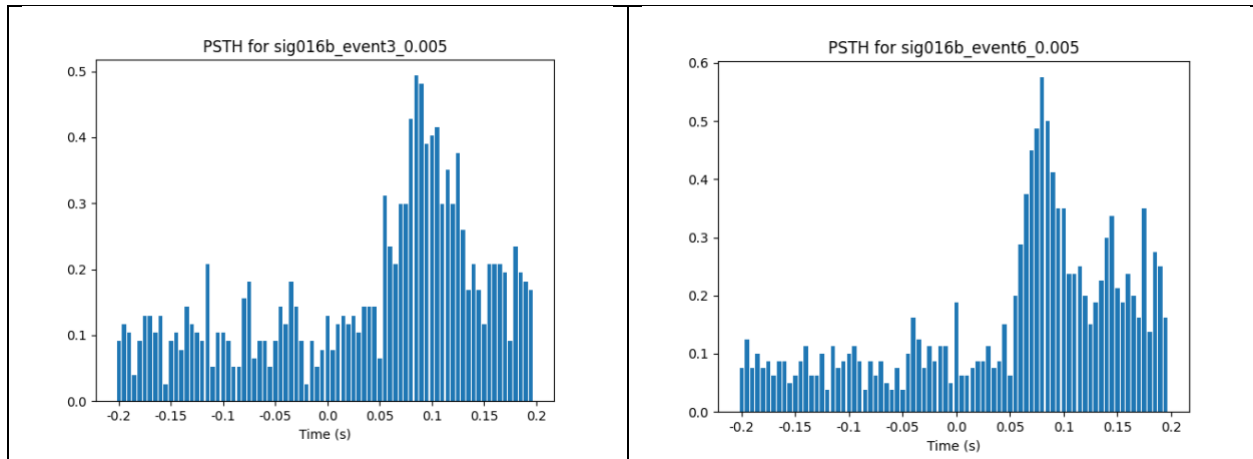
4. **How do the quantities measured in part 2b and 2c relate to the observations you made in 2a?**

We are told to skip this question.

5. **Are the neurons synergic or redundant?**

The synergy redundancy for neurons sig003a and sig016b is 0.3056. Meaning, the combined activity of these two neurons is more effective than the activity of any one neuron alone. Therefore, they are synergic.

Part 5: Extra Credit (2 points)

a. Find the timing and count entropies, mutual information, joint mutual information, and synergy redundancy for 1ms, 10ms, and 20ms. Is there a noticeable trend? Provide numerical evidence and plots in your explanation as well as a possible explanation of the results.

The results shown below are for the neuron 'sig003a' for 1, 5, 10, and 10 ms bin sizes. The results for count entropy, count mutual info, joint mutual info (based on spike count), and synergy redundancy are same across all bin sizes. The noticeable trend is seen findings related to spike timing. Both timing entropy and timing mutual info decreased as the bin sizes increased. The potential explanation for this trend is that we have less information about the pattern of spike timing as the bin size increases. This increase seems not to affect the spike count across a trial for a given neuron, at least in this example.

Sig003a	1 ms	5 ms	10 ms	20 ms
Timing entropy	*Event 3:* 6.267 *Event 6:* 6.321	*Event 3:* 6.267 *Event 6:* 6.321	*Event 3:* 6.267 *Event 6:* 6.271	*Event 3:* 6.187 *Event 6:* 6.153
Count entropy	*Event 3:* 3.458 *Event 6:* 3.122	*Event 3:* 3.458 *Event 6:* 3.122	*Event 3:* 3.458 *Event 6:* 3.122	*Event 3:* 3.458 *Event 6:* 3.122
Count Mutual Info	0.099	0.099	0.099	0.099
Timing Mutual Info	0.9997	0.9997	0.9615	0.9057
Joint mutual info	0.534	0.534	0.534	0.534
Synergy redundancy	0.306	0.306	0.306	0.306