

Spike Triggered Averages: A Glimpse Into Neural Encoding

Total points 20

1. Which of the following is *not* an example of a linear filtering system?

1 point
- Let $x(t)$ denote the input signal and $y(t)$ denote the output signal.
- ☐

$y(t) = \int_0^\infty e^{-\tau} x(t - \tau) d\tau$
- ☐

$y(t) = 3x(t) - 5x(t - \tau)$,
where τ is positive.
- ☐

$y(t) = \sum_{n=0}^\infty a^n x(t - n\tau)$,
where a is between 0 and 1, and τ is positive.
- ☒

$y(t) = \cos[x(t - \theta)]$

- ☐

None of these.
- ☐

The set of all stimuli that elicit a spike.
- ☐

The set of stimuli preceding a spike, each averaged over time.
- ☐

The average time between spikes in a recording.
- ☒

The stimuli preceding a spike, averaged over all stimuli that elicited a spike.

3. The data set we have given you (see Quiz Instructions page in the Graded Quiz section) is comprised of a stimulus vector (named `stim`) and a binary vector (named `rho`). These two vectors are the same length because they represent measurements of two different quantities over the same time period. The binary vector has a 1 if a spike occurred in the time bin corresponding to the that index and a 0 otherwise. The sampling rate for the data set was 500 Hz.

2 points

How many milliseconds are there between adjacent samples (what is the sampling period)? Only enter the number, not the units. If your answer is not an integer, round to the nearest integer value.

Set the variable named `sampling_period` in `quiz2.m` equal to this value.

2

4. We wish to compute the spike-triggered average for this neuron over a window of width 300 ms. Suppose we do not care about the value exactly 300 ms before the spike. How many elements (time steps) will be in our resulting spike-triggered average vector? Set the variable named `num_timesteps` in `quiz2.m` equal to this value and enter it below.

2 points
- Hint: Your answer should be an even number.
- 150

5. In order to calculate the average, it is necessary for us to know how many time windows (stimulus vectors) we are averaging over. This is equal to the number of observed spikes. Write code to calculate the total number of spikes in the data set `ctp8.mat`. How many spikes were observed in this recording? You should not count any spikes that occur before 300 ms from the beginning of the recording.

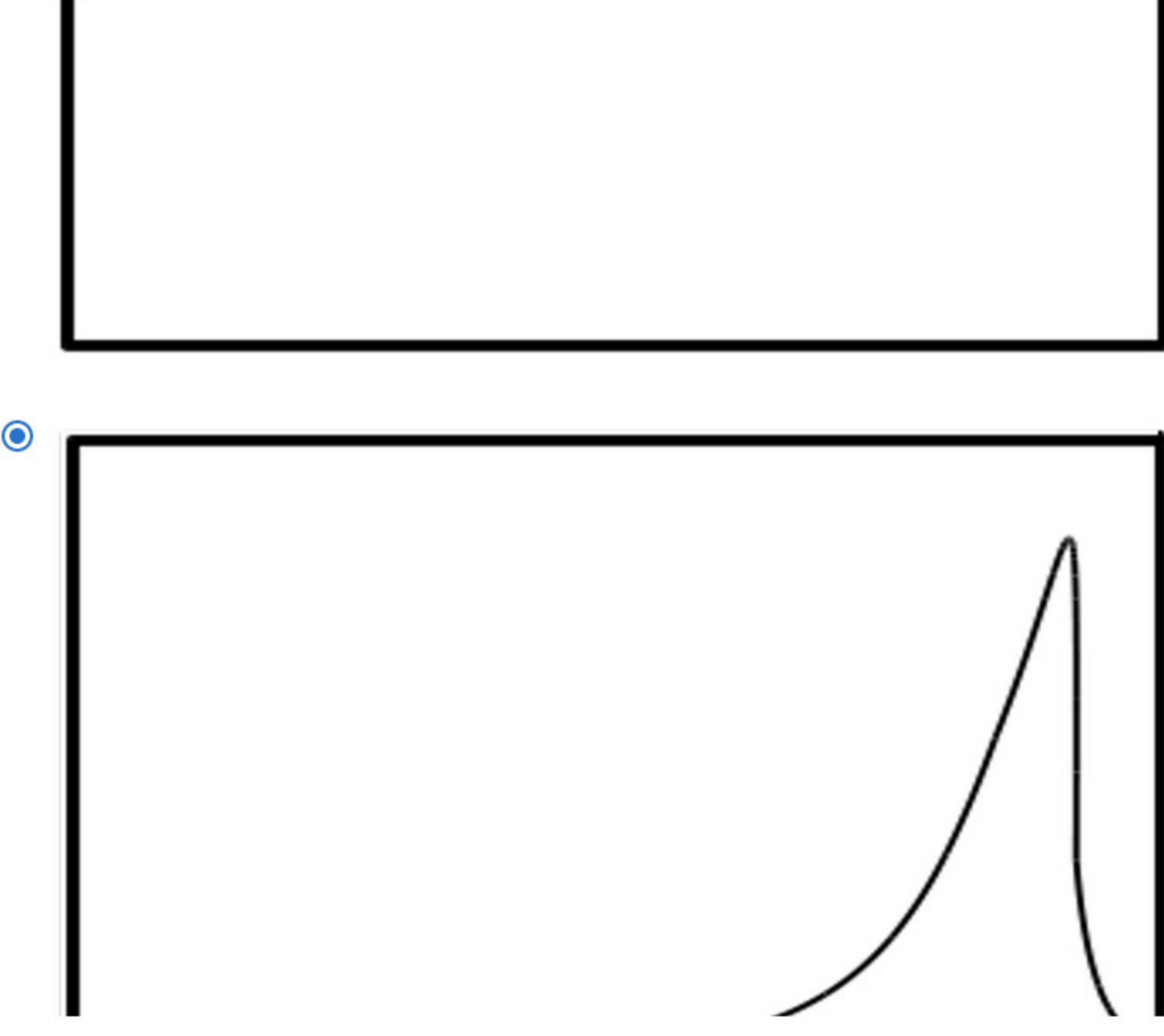
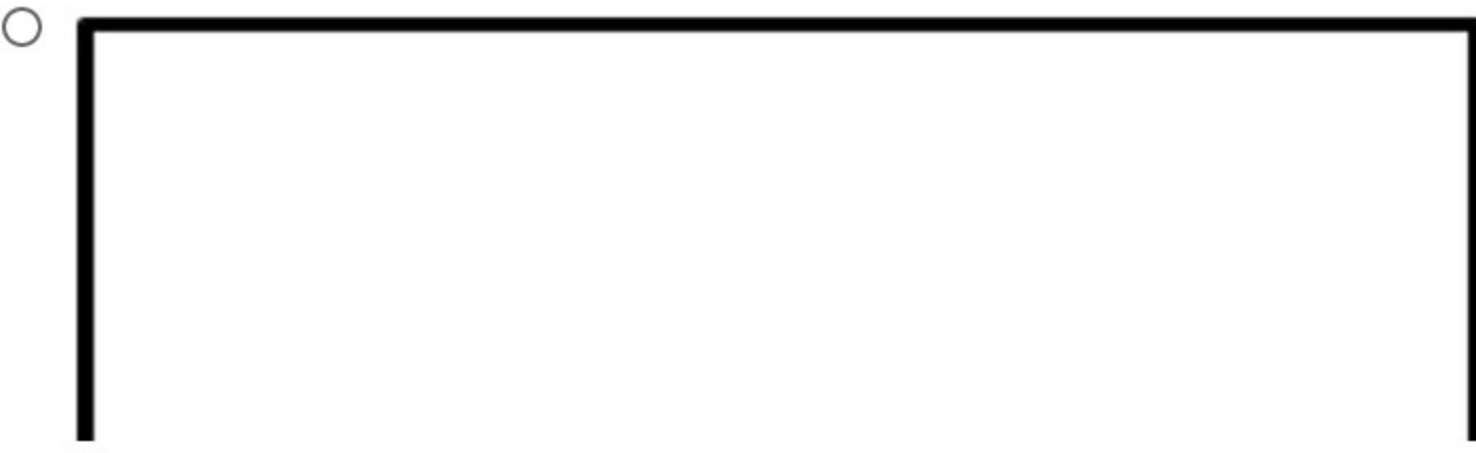
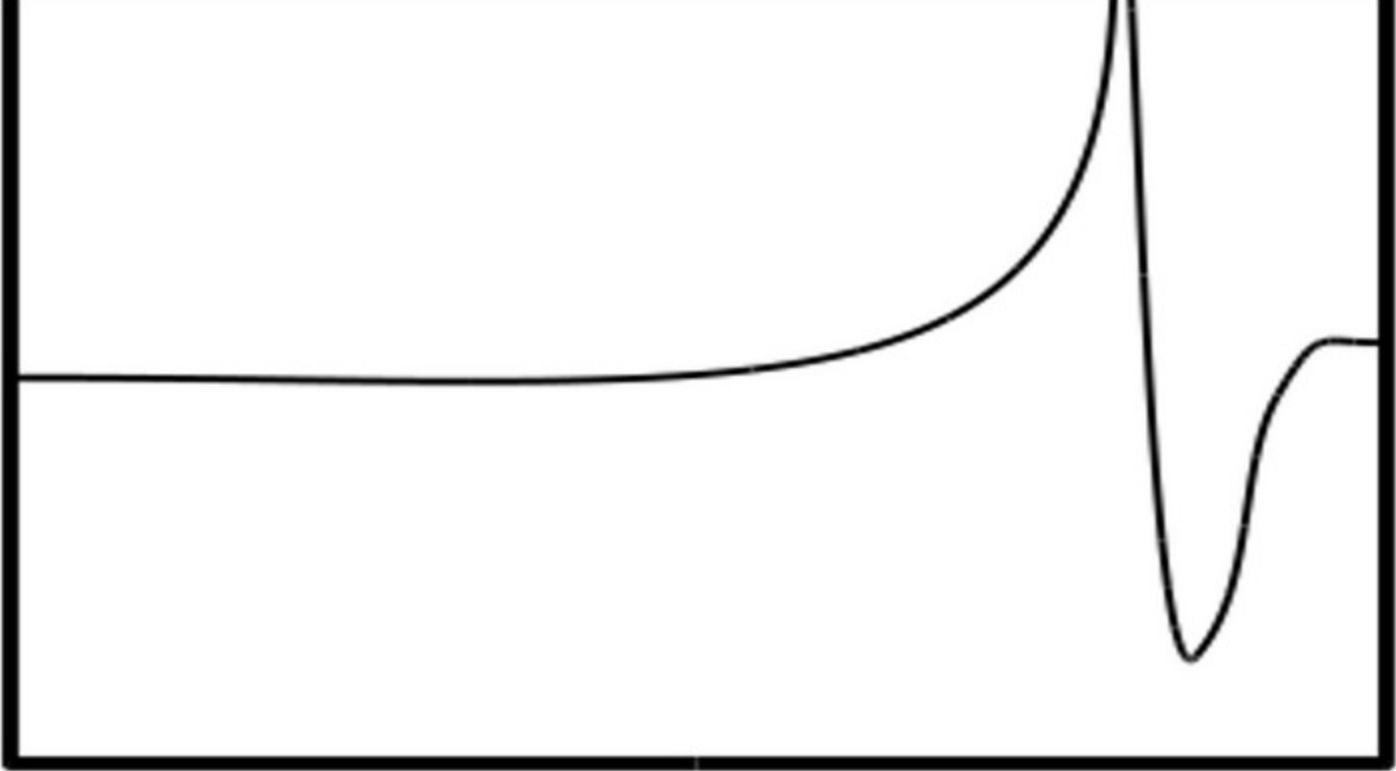
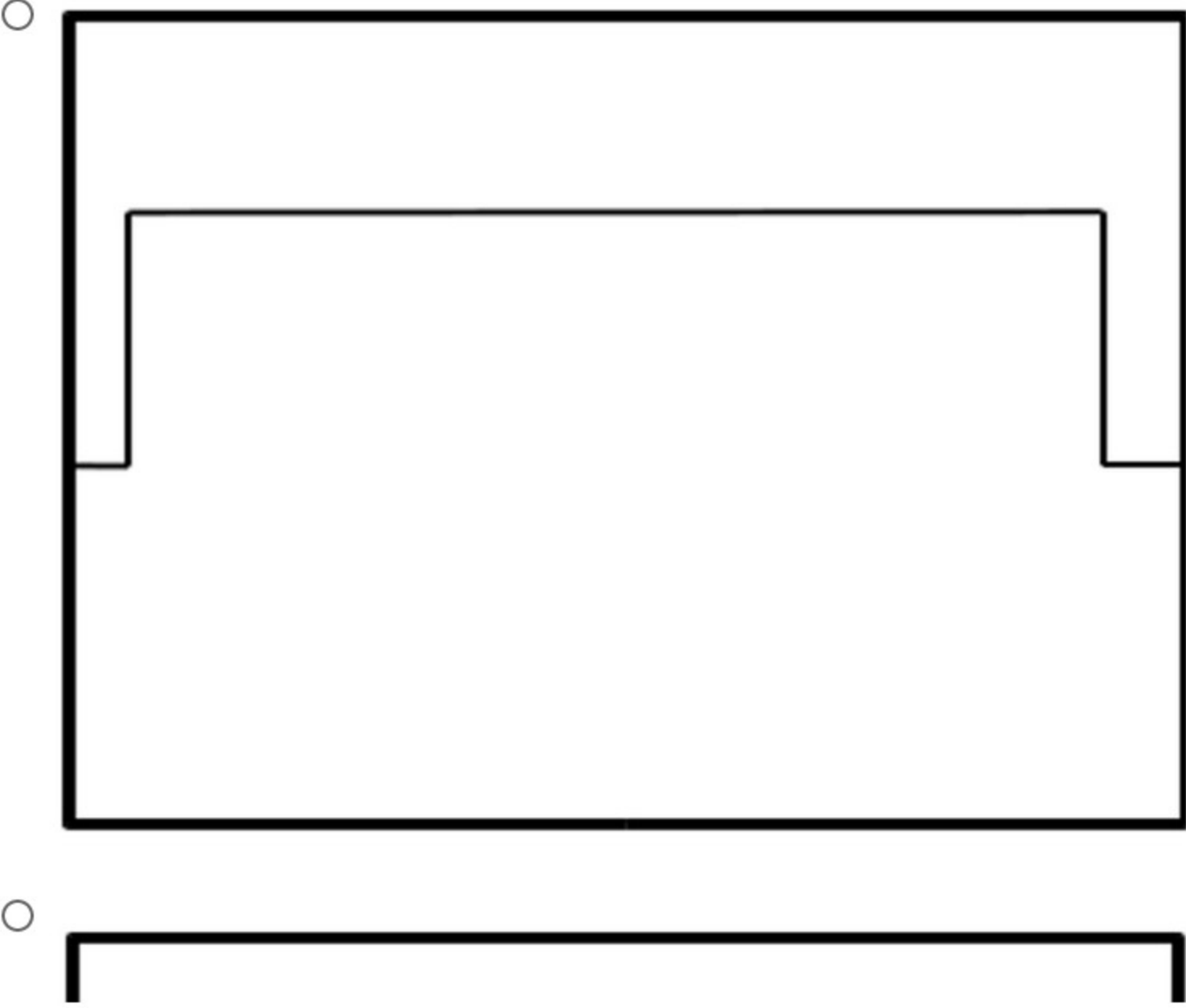
5 points

Set the variable named `num_spikes` in `compute_sta` equal to this value, or (better yet) use the expression/variable/code you used to calculate this value and set it equal to `num_spikes` so that your code will work for any set of parameters (different sampling rate, different time window in which average is calculated etc.) passed to `compute_sta.m`.

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6. Now we may compute the spike-triggered average. To do this, add code to `compute_sta.m`. Remember that the spike-triggered average is the element-wise mean of the time windows starting 300 ms before (exclusive) and ending 0 ms before a spike. Note that we have given you code to find all of the indices in the stimulus vector that

5 points



7. What is the nature of this neuron? That is, what mathematical operation of the stimulus does it compute?

2 points
- ☒

Leaky integration.
- ☐

No response.
- ☐

Running average/sum.
- ☐

Differentiation.

8. Which of the following stimuli would you expect this neuron to respond most strongly to? You may assume that all non-zero values of the stimulus have the same magnitude. That is, assume that all positive stimuli have a value of c and all negative stimuli have a value of $-c$ where $c > 0$.

1 point

☒

A constant positive value.

☐

A positive value followed by a negative value.

- ☐

A constant negative value.

9. Suppose we had reason to suspect that this neuron responded to two modes (features) of the stimulus. Which of the following methods is most likely to help us determine those two modes?

1 point
- ☐

Computing the spike-triggered average normally.
- ☐

Dividing the stimulus into two disjoint sets and computing the spike-triggered average for each of those sets independently.
- ☐

Computing the spike-triggered average to get the first mode and then subtracting it from the stimulus in each time window before a spike and then computing the spike-triggered average for the resulting signal to get the second mode.
- ☒

Principal component analysis/covariance analysis

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Daniel Engbert

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