

Computational Neuroscience and Neurotheory: Homework 2

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1 Question 1.

Figure 1 shows the voltage and current traces for an integrate and fire neuron with excitatory synaptic conductances and spikes at given time points. The first presynaptic action potential at 100 ms causes an increase in input current, resulting in an increase in voltage. This small increase in voltage is not enough to drive a spike in the postsynaptic neuron. The next presynaptic action potentials at 200 ms and 230 ms (and similarly for 300 ms and 320 ms spikes) both cause small increases in voltage, but are not close enough to each other to elicit a spike. The spikes at 400 ms and 410 ms in the presynaptic neuron are close enough in time to cause the postsynaptic cell to cross the threshold and spike.

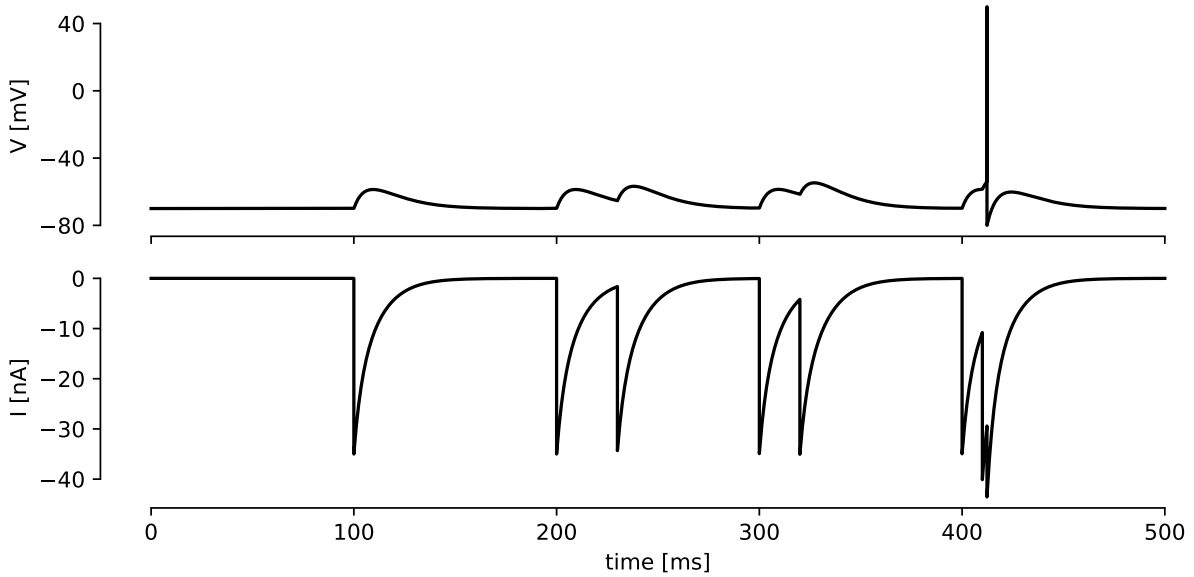


Figure 1: Integrate and fire neuron with excitatory synaptic conductances.

2 Question 2.

- (a) The relationship between the input standard deviation σ_V and the standard deviation of the membrane voltage is shown in figure 2. As expected, this relationship is linear and follows the $y = x$ line.

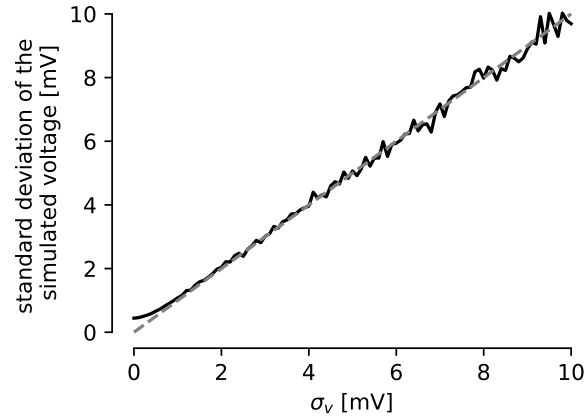


Figure 2: Relationship between input standard deviation and standard deviation of the voltage

- (b) The relationship between the input standard deviation and the firing rate is shown in figure 3. The relationship here is similar to the relationship observed for the Hodgkin-Huxley model. Here, an initial level of noise (0.5 mV) does not drive any firing, but as noise is added there is a large jump between (1-2 mV), before the firing rate starts increasing linearly.

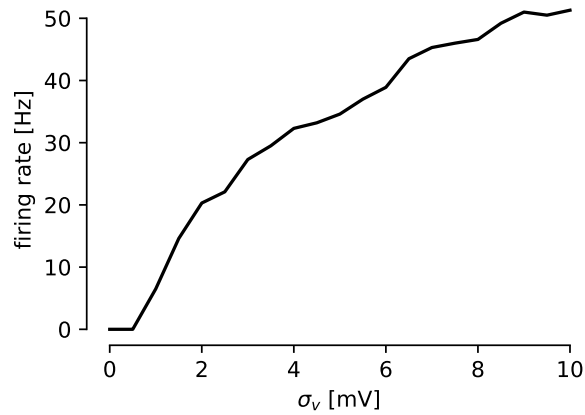


Figure 3: Relationship between input standard deviation and firing rate.