Integrate and Fire Neuron

Computational Neuroscience by University of Washington

In the next three questions, you will explore the integrate-and-fire neuron model. To do this, you should start by downloading the following code and tweak it to run "experiments" on the neuron:

MATLAB:

intfire.m

Python:

intfire.py

Part A

What is the largest current that will fail to cause the neuron to spike? Give your answer in pA and round down to the nearest 10 pA. Do not include units in your answer.

You should vary the input current gradually from very low to high values to find this value and then validate your answer with an analytical solution.

Part B

What is the maximum firing rate (spike count/trial duration) of this neuron? Give your answer in Hz and round your answer to the nearest integer value. Do not include the units in your answer.

Part C

Now let's consider the case that your neuron is not receiving simply a constant input, but a barrage of asynchronous inputs from many other neurons.

Model this with the following code by adding a white noise component to the input current (the constant part of the input current is reset to one nA):

MATLAB:

intfireNoise.m

Python:

intfire_noise.py

Plot the interspike interval distribution, that is, the distribution of the time intervals between spikes, for a range of different noise amplitudes. (Hints: this noise component is already implemented in the code: just switch it on. You can make use of the Matlab functions diff and hist. You will probably want to increase tstop, the length of time you are integrating for, by quite a bit to get a well-sampled histogram.)

How does this distribution change as you increase the amplitude of the noise input? (Stay within a range between 0 and 5 nA.)