Neuronal Dynamics

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Leaky Integrate-And-Fire Model

Exercise 1

The goal of these exercises is to acquire some familiarity with python and the class of Leaky Integrate-And-Fire models. To this end, you will need to install python and brian on your computers.

For linux users, this is as simple as

```
$ sudo apt-get install python-numpy python-scipy python-matplotlib ipython brian
```

Alternatively, also on Windows and Mac OS, you can download and install the anaconda python distribution (*http://continuum.io/downloads*), which gives you a basic setup. You will have to manually install the BRIAN simulator environment, see *http://brian2.readthedocs.org/en/latest/introduction/install.html*.

Exercise 2

Use the function *LIF.LIF_Step* to simulate a Leaky Integrate-And-Fire neuron stimulated by a current step of a given amplitude. The goal of this exercise is to modify the provided python functions and use the *numpy* and *matplotlib* packages to answer the following questions.

2.1 What is the minimum current step amplitude *I_amp* to elicit a spike with model parameters as given in *LIF.LIF_Step*?

2.2 Plot the injected values of current step amplitude against the frequency of the spiking response (you can use the inter-spike interval to calculate this – let the frequency be $0Hz$ if the model does not spike, or emits only a single spike) during a $500ms$ current step.

Exercise 3

Use the function *LIF.LIF_Sinus* to simulate a Leaky Integrate-And-Fire neuron stimulated by a sinusoidal current of a given frequency. The goal of this exercise is to modify the provided python functions and use the *numpy* and *matplotlib* packages to plot the amplitude and frequency gain and phase of the voltage oscillations as a function of the input current frequency.

3.1 For input frequencies between $0.1Hz$ and $1.Hz$, plot the input frequency against the resulting *amplitude of subthreshold oscillations* of the membrane potential. If your neuron emits spikes at high stimulation frequencies, decrease the amplitude of the input current.

3.2 For input frequencies between $0.1Hz$ and $1.Hz$, plot the input frequency against the resulting *frequency and phase of subthreshold oscillations* of the membrane potential. Again, keep your input amplitude in a regime, where the neuron does not fire action potentials.