Assignment 3

Neuroscience 9520
Computational Models in Neuroscience
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Due Oct 7 2012 11:59pm EST

Submit your assignment as a single `.pdf` file sent by email to `paul@gribblelab.org` with the subject line `compneuro assignment 3`. Please name the pdf file with your last name and the assignment number, for example `gribble3.pdf`.

1 Extending our Model of a Neuron

In the Ekeberg (1991) article we looked at in class, in Section 2.3 they introduce two new channels into the model: a calcium channel and a calcium-dependent potassium channel.

As a result, they are able to demonstrate the phenomenon of after-hyperpolarization (see Ekeberg et al., 1991 Figure 3).

Your task is to alter the model code that we studied in class to include the two new channels, and to use the model to simulate the after-hyperpolarization effect.

1. Alter the `neuron(state, t)` function to include the two new channels. You will need to implement equations 10, 11, 12, 13, and 14 in the Ekeberg (1991) paper. You will also need to add the current from the two new channels to the `dEdt` expression at the bottom of `neuron(state, t)`.

2. Demonstrate the after-hyperpolarization effect shown in Ekeberg et al., 1991 Figure 3: Set the `I_Ext` parameter equal to `2.0e-09`. Simulate 200 ms with a step size of 0.1 ms with the following initial states: `state0 = [-70e-03, 0, 1, 0, 0, 0]`. What is the inter-spike interval between spike 1 and 2, between 2 and 3, and between 3 and 4?

3. Repeat your simulation setting `I_Ext` first to `4.0e-09` and then `6.0e-09`. Again, what is the first, second and third inter-spike interval?

4. Can you explain why the after-hyperpolarization effect occurs?