CIS6930 Intro to Computational Neuroscience Spring 2018

Home Work Assignment 2: Due Tuesday 02/27/18 before class

1. Use the passive membrane equations and build a compartmental model of a dendrite. Set the diameter of the dendrite as 2 μm and the length of the dendrite as 110 μm. Model the dendrite either as (a) 11 small compartments or (b) 1 large compartment and 1 small compartment. Add a synaptic compartment to the front end. You now have two different compartmental models one made of 12 compartments and one of 3 compartments. Activate the synapses using alpha functions and record the response at the other end. Do we really need the 10 small compartments, or does one large compartment suffice?

2. Use the passive membrane equations and build a compartmental model of a neuron comprising of a soma and a dendrite that branches in two. Inject currents a various locations on the two branches and show cases where the resultant voltage response at the soma is close to linear and cases where it is not so linear. Use diameters and lengths as in the previous question

3. Use the Hodgkin-Huxley equations to model a simple neuron that is an isopotential sphere. Does anything happen if the radius of the sphere is changed from 1 μm to 10 μm. If so (if not) why? You are required to do a literature search to find out what the typical values for the capacitance, leak conductance, and voltage-dependent sodium and potassium conductances per unit area are. Now inject a variety of current waveforms, starting from rectangular (of variable length) to alpha functions ($f(t) = \alpha t e^{-t/\tau}$) and report the sub-threshold and supra-threshold voltage response of your neuron.