Software Expt. #6 THREE NEURAL NETWORKS:

(i) Short-term memory, (ii) Winner-take-all, and (iii) Half-center oscillator

Content areas: Basic neuroscience covered in biology, physiology, psychology, and engineering courses

Pre-Requisite Knowledge

- cell biology
- human nervous system

Learning Objectives

After this lesson, students should be able to:

- Begin understanding how networks of neurons might implement functions in brains.
- Use a computational model to help predict characteristics of simple neural circuits

Time Required

Keywords sensory neuron, muscle potential, neural circuit

Summary This lesson illustrates how networks of neurons connected by synapses might perform interesting functions in brains. It is thus a logical culmination of the previous lessons which focused on single neuron properties and how synapses help neurons communicate with each other.

INTRODUCTION / MOTIVATION

We will consider three interesting neural networks to motivate how neurons in brain might be organized to implement to control the multitude of systems within the body.

Details about spiking neural networks and how researchers are using it can be found at several websites including site such as the following:
http://www.willamette.edu/~gorr/classes/cs449/brain.html
http://en.wikipedia.org/wiki/Biological_neural_network
http://en.wikipedia.org/wiki/Spiking_neural_network

SOFTWARE EXPERIMENT #6 ASSIGNMENT

STM WTA Tutorial

[adapted from a similar GENESIS tutorial (Bower and Beeman, 2007) by Charlie Franklin and Henry Chen, converted to notebook by Ziao Chen]

Assuming that NEURON and jupyter notebook are already installed on your systems, open a terminal (Linux/Mac) or a prompt (Windows) and enter 'jupyter notebook'. Go to the folder where you saved the notebook tutorial from the jupyter notebook file browser and click on the notebook file ' S6_STM_WTA'. This will open the notebook and start the tutorial.

Note about parameters on the screen:

- Clicking on the tabs 'Short-Term Memory' and 'Winner-Take-All' lets you switch between the two network models.
- Synapses are all excitatory in STM and all inhibitory in WTA. A common synaptic weight is used for all synapses in each network.
- You can set the amplitude of - (i) two current pulses injected into one cell in STM, (ii) one long current injection into each of the 5 cells in WTA.
- Click on 'Run & Show!' to run the simulation after you set up the parameters.

QUESTION 1: Explain the functioning of the 'short term memory' network. Provide all details.

QUESTION 2: Explain the functioning of the Winner-Take-All network providing all details

QUESTION 3: How would the behavior of the short-term-memory network, and the winner-take-all network change if spike frequency adaptation were to be included?

QUESTION 4: Explain biological applications that might use the short-term memory network, a winner-take-all network, and the half-center oscillator.