

**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/Biological_neural_network)

[http://en.wikipedia.org/wiki/Spiking\\_neural\\_network](http://en.wikipedia.org/wiki/Spiking_neural_network)

**Running Neuron:**

In the first model, STM, we have created a GUI for you. With the second model of the WTA network, we would like for you to experience the ‘research’ mode of running NEURON.....to display menus: `nrncontrolmenu()`, `nrnsecmenu(yyyy)`, `nrnpointmenu (yyyy)`, etc. For instance, in the WTA model, `nrnsecmenu (0.5,1)` displays the parameters of the cell in case you want to change them. The command `nrnpointmenu(I2Isyn[i])` displays the parameters of synapse [i]. An easier alternative to set the weight of synaptic connection `I2Isyn[0]` in the WTA model to, say 20, is to use the command “`I2Isyn[0].initW = 10`”.

All commands related to NEURON can be found at the website -

[http://www.neuron.yale.edu/neuron/static/docs/help/quick\\_reference.html](http://www.neuron.yale.edu/neuron/static/docs/help/quick_reference.html)

## **ACTIVITY SHEETS**

Run the two models provided to you: STM, and WTA. Then answer the following questions:

**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.