

Supplemental materials to:

Schettino (2014) **NeuroLab: a set of graphical computer simulations to support neuroscience instruction at the high school and undergraduate level.**

This document contains the full text of the two assignments described in the main article: Temporal Integration and Axonal Guidance as I provide them to my students. Their job is to provide me with a single, one-sided page containing images of their runs of the simulations and to answer the questions. I give up to three extra credit points for each assignment, depending on the quality. I sometimes give four points to very high quality work.

A full set of assignments, notes and the “Working with Netlogo” document that explains to my students how I would like for them to carry out their work is available for free download as a PDF file at:

<https://sites.lafayette.edu/schettit/neurolab/>

Your feedback in the form of comments or new ideas to improve the simulations as well as to produce new ones is greatly appreciated.

Luis F. Schettino
Psychology Department
Lafayette College
Easton, PA 18042
schettit@lafayette.edu

Temporal Integration

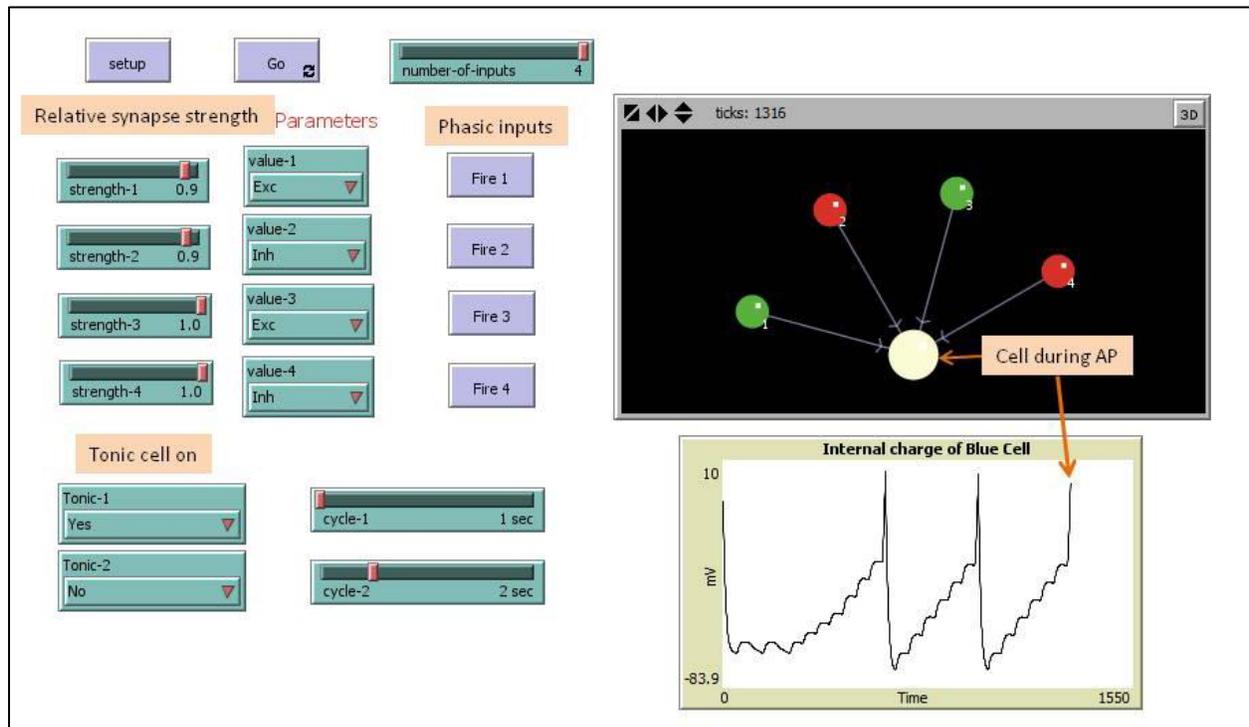


Figure 1. The temporal integration simulation interface

Introduction to Neuroscience 2nd Assignment: Temporal Integration

This assignment will allow you to explore the way in which neurons “integrate” or add up their inputs and decide whether they too should produce an action potential.

Open the *Integration.nlogo* model. Go to the *Info* tab and read carefully the information provided there. Once you have done so, go back to the *Interface* tab and run the simulation. Since you cannot control precisely which neuron is inhibitory or excitatory, simply click on the **Setup** button until you come up with a configuration you like.

Exercises:

- 1- Set one of your excitatory inputs (neurons 1 or 2) to Tonic. At what strength and cycle do you have to set that input in order to make the blue neuron to fire in 10 to 12 EPSPs (not more, not less)? Here you may want to slow down the simulation to give yourself enough time to interact with it.
- 2- Set one of your inhibitory inputs to Tonic. Set its cycle to 3 sec and its strength to 0.8. Press the **Go** button. Then press repeatedly the **Fire** button of an excitatory neuron. How many times do you have to press it as fast as you can in order to get the blue neuron to fire? Why?
- 3- If you have two tonic excitatory cells, what kind of input is more efficient at getting the blue neuron to fire: both inputs with the same cycle at 4 sec or one neuron with a cycle of 4 sec and the other in a cycle of 3? (Hint: hover the mouse over the plot to see the values on each axis.)

Explain why this is the case.

Axonal Guidance

The axonal guidance simulation assignment asks students to find out the functions of each of four different factors in the path-finding mechanisms for a set of axons. Each factor can be turned on or off using simple switches and the effects of each manipulation is readily observable.

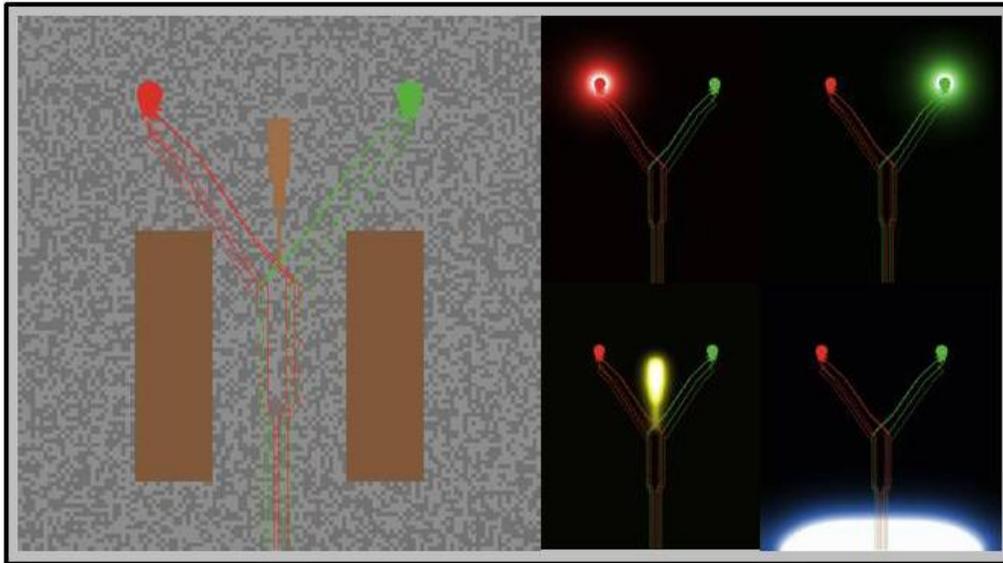


Figure 2. The axonal guidance simulation (left). The gradients of different attractant and repellant factors that guide the axons to their targets (right).

Introduction to Neuroscience NetLogo Assignment: Axonal Guidance

This simulation looks at the way that axons find their targets during development. Axons produce a 'growth cone' on their tips that look for particular substances thanks to receptors on its membrane.

Now it is your turn to do a little experimentation. Open the *Axonal Guidance.nlogo* simulation and run it as usual, by pressing first **Setup** and then **Go**. As you can see, from a set of 20 axons (10 red, 10 green) with random locations within a 'fiber tract', their growth cones begin moving towards the top and decussate (separate) by color and continue moving towards the target that matches their own color.

How does the system work? By now you know about axons being guided through chemical cues in the form of attractants and repellants. This simulation is based on the same principles. Your job will be to find out what each of the substances at play in this simulation is doing to guide the axons to their developmental targets.

Exercise:

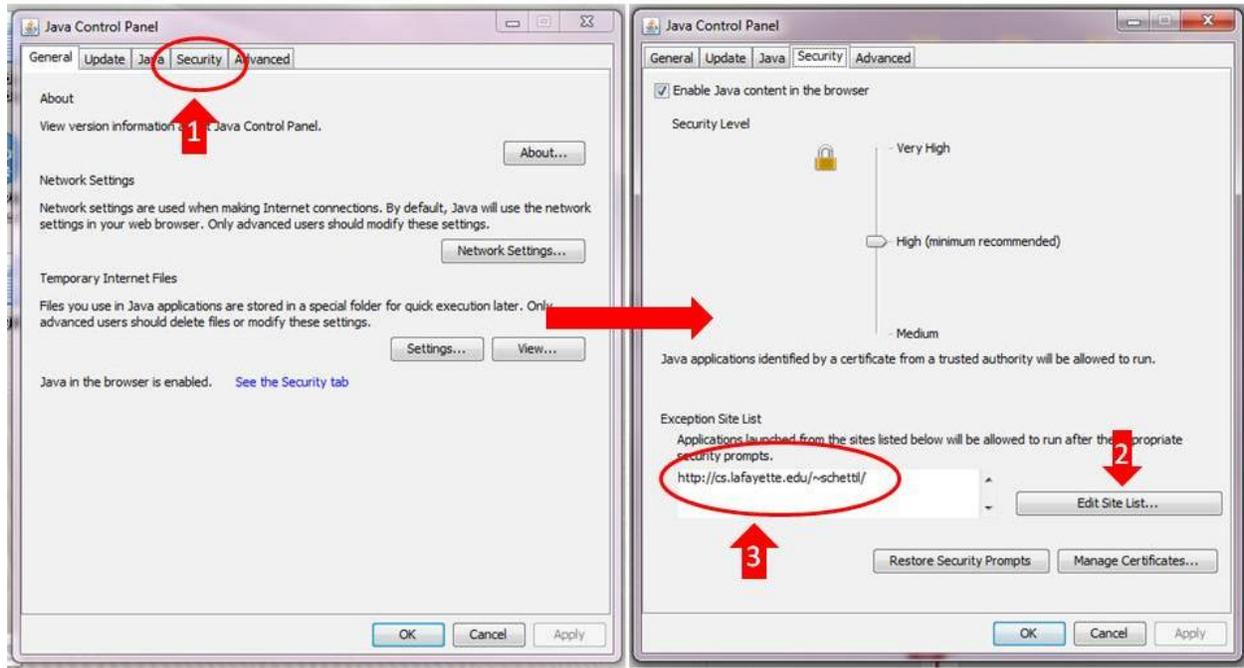
The switches on the left hand side of the interface panel allow you to turn on and off the substances released by the targets, the midline and the side structures. Once you run a trial (when the axons stop moving), you can then press the "show-factor" buttons to see the diffusion of each one of the substances. Note that even though it may not be visible, the substance may nonetheless reach farther than it seems. The iteration counter ('ticks') can give you a sense of how long the system has been running.

By turning on and off the substance-release switches, you can observe changes in the behavior of the axons.

Questions:

- What does each substance do? (is it an attractant or a repellant?)
- How did you figure it out?

Problems with Java



The latest Java update prevents the running of applets from http sites that are not 'secure' (https). In order to allow the website to run the NeuroLab simulations it is necessary to add the website to the exception list in the security tab of the Java Control Panel.

To get to the control panel in windows go to the Start button → all programs, look for the Java Folder and click on Configure Java. Then move to the Security Tab and add the website address as seen above (it must finish with a forward slash): `http://cs.lafayette.edu/~schettl/`