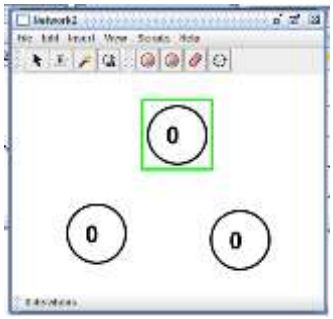
Lab 5 Extra – Creating Simple Neural Networks

Evolution and Learning in Computational and Robotic Agents
MSE 2400 Dr. Tom Way

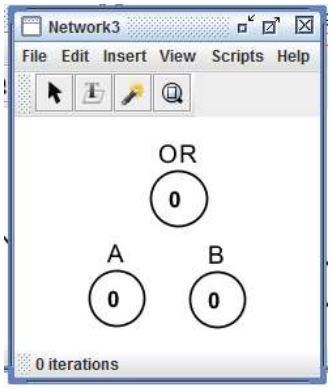
Description

This handout describes how to use Simbrain to create the simple neural networks described in Part 2 of the original Lab 5 handout. By following the guidelines here you should be able to construct the requested neural networks for: OR, AND, NOT and XOR.

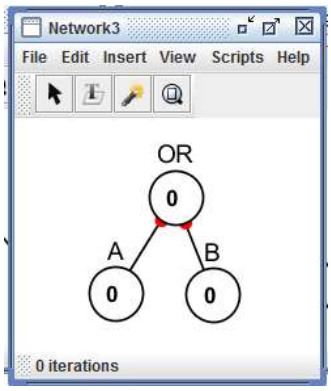
Creating OR, AND, NOT and XOR neural networks



1. Run Simbrain.
2. Insert a new network using the Insert > New Network menu selection or by clicking the (New Network) button.
3. Insert 3 nodes using the add node button, and arrange them as in the picture to the left.



4. Double-click on each node and enter a label for each. Label the top node "OR" and the other two "A" and "B".

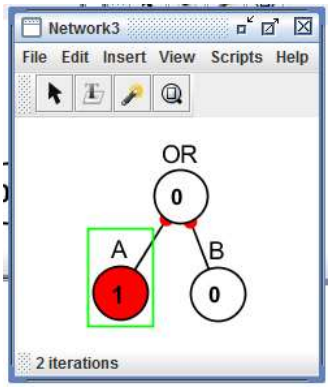


5. Connect the "A" and "B" source nodes to the top "OR" node. To do this, click on a bottom node, hit the "1" key to highlight it with a red box also, then click on the top node (green box), right-click on the top node Connect Neurons > One-to-one, then click OK. A connection will appear between the two.
6. Repeat this connection for the other source node. If any nodes are still have a red box, right-click on the node and select "Clear Source Neurons".

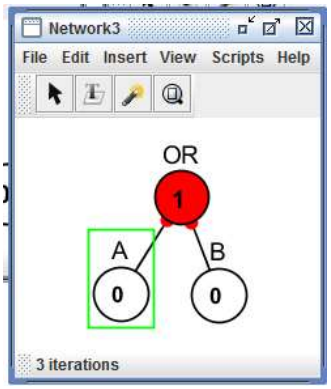
7. Next, set the Threshold of the OR node. Double-click on the node to bring up the Neuron Dialog. Expand the Settings and enter a "Spiking Threshold" value of 0.9 which indicates when the node will be activated. Under "More" set the "Input type" to be "Weighted" and not "Synaptic". Click OK to save the settings.

8. This OR network will now behave as follows:

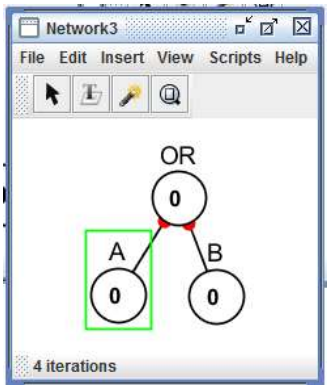
   If the value of either of the two source nodes, or both of the source nodes, is 1.0 (really, just greater than 0.9, the spiking threshold), the OR node will be activated.



9. To test this **OR network**, do the following:
   a. Click the A node and use the up arrow key to raise the activation value of the A node to be 1.0

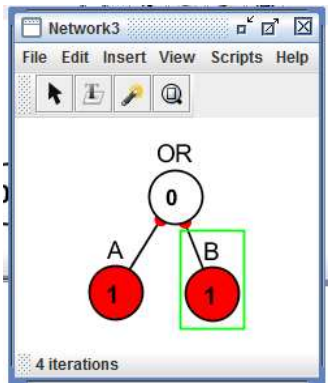


10. Click on the step button one time and observe what happens. Note that the OR node has been activated (red) and has an activation value of 1 while the A node is now 0.

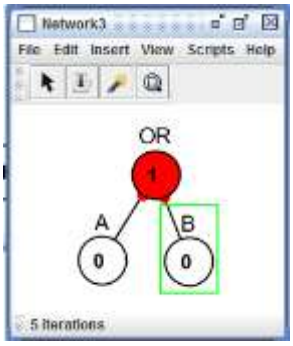


11. Click on the step button one more time and note that the OR node is now deactivated, back to 0. This is because both the A and B nodes had values of 0 so the OR node was not activated (values of A + B did not total greater than 0.9).

12. Repeat the test using the B node, observing the same activation behavior when clicking the step button one time and then a second time as before.

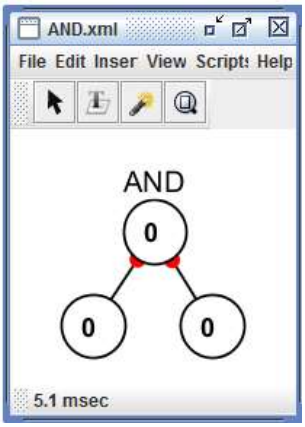


13. Finally, repeat the test using both A and B nodes, raising their values to 1.



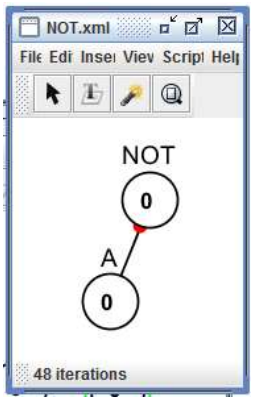
14. Click the step button and observe the OR node being activated. Click the step button again and OR is back to 0, as before.

15. Your OR network is now complete! Save it by selecting the File > Save menu choice and naming it "OR.xml" being sure to include the ".xml" file extension on the name.



16. Repeat the steps above to create an **AND network**. This time you will need a different "Spiking Threshold". To set the correct threshold, think about the behavior of the AND logic function. The AND node should be activated only if both values of the A and B nodes are 1. If only one of them has the value of 1 then the AND node should not be activated. Recall that the Spiking Threshold value of the AND node is simply the sum of all of the values of the connected nodes (A and B).

17. Test your AND network as you did with the OR network, and when satisfied that it is correct, save it as "AND.xml".



18. Next, create a **NOT network** consisting of just two nodes.

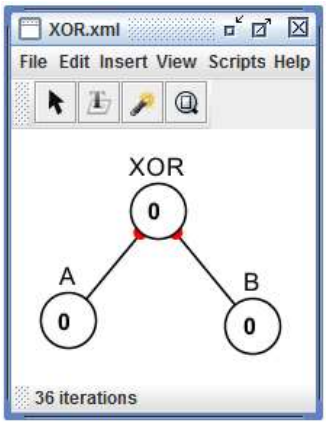
19. The NOT node will use a different "Update Rule" rather than Spiking Threshold. Double-click the NOT node and select "Binary" as the Update Rule. Expand the settings and set "On Value" to be 0 and the "Off Value" to be 1.

20. Consider what value is correct for "Threshold." The behavior of the NOT logic function is that if the input is 0 (false) then the output is 1 (true). And when the input is 1 (true) then the output is 0 (false).

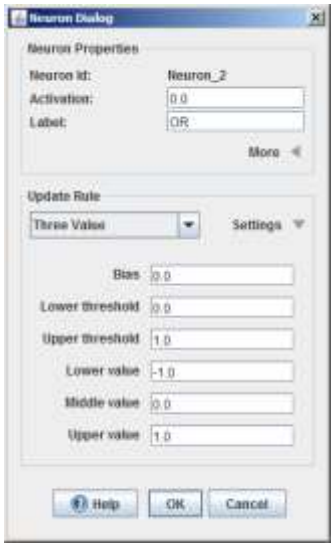
    Consider that when the A node has a value of 1 (set using the up arrow key) and then the step button is clicked, the value will go to the NOT node. And if the value coming in from the A node is 1 then you want the value of the NOT node to be 0 (or, for the NOT node's activation, you want it to display the "Off Value").

    Think next about what should happen if the A node has a value of 0. What value should the NOT node have after the step button is clicked? Set the Threshold of the NOT node so both of these cases work correct.

21. Test your NOT network with each of the two possible values for the A node. Once satisfied that it works correctly, save it as "NOT.xml".



22. Finally, create an **XOR network** in a similar way to how you created the OR and AND networks.



23. For the XOR node, use a yet another "Update Rule" than the others. Double-click the XOR node and select "Three Value" as the Update Rule.

24. Next, expand the settings. Consider what values to set for "Lower threshold", "Upper threshold", and the "Lower value", "Middle value" and "Upper value". Here is how these values work:

    When the sum of the connected nodes coming into the XOR node is **less than the "Lower threshold"** then the "Lower value" will be used as the activation value (the value you see in the XOR node). Similarly, if the sum of the values of the source nodes is **greater than the "Upper threshold"** then the "Upper value" will be displayed. Finally, when the sum of the source node values is **between the Lower and Upper thresholds**, then the "Middle value" will be displayed in the XOR node.

25. Recall that the logic of the XOR function works like this: When A and B have the same value (both 0 or both 1), then the XOR value is 0. If the A and B are different (one of them is 0 and the other is 1) then the XOR value is 1. Use this information to help determine what the various settings above should be.

26. Test your XOR network as you did with the OR and AND networks, trying all combinations of A and B values. When you are satisfied that it is correct, save it as "XOR.xml".

27. As a final step, have all four of these networks open on Simbrain at the same time and then save the entire workspace. Select File > Save Workspace and name your workspace "MSE2400TruthTables.zip".