Neuron Sandbox Teacher Worksheet 1

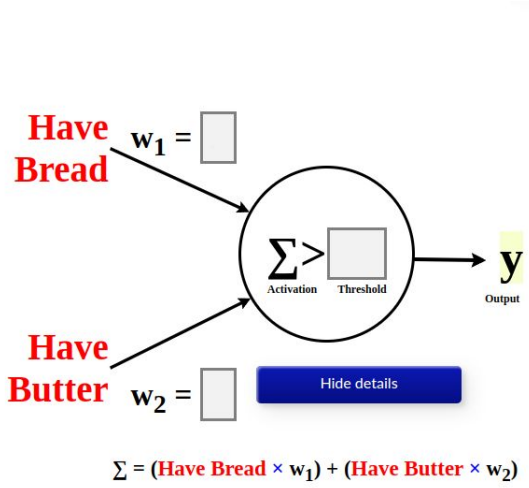
https://www.cs.cmu.edu/~dst/NeuronSandbox

Can I Make Buttered Toast?

I need both bread and butter.

Inputs

Have Bread	Have Butter



Outputs

Activation Σ	Current Output Σ >	Desired Output

Can I make buttered toast? To do that, I need both bread and butter. Let's work through the steps to make a neuron answer this question.

1. There are four cases to consider, depending on whether we have bread, butter, neither, or both. Fill in the four rows of the Inputs table with 0 (false) or 1 (true) to lay out the four cases.
   - Students need to realize they can't use the same pattern for both columns, e.g., if the first column is "0, 0, 1, 1" then the second column must be "0, 1, 0, 1" in order to correctly generate all four combinations. See the answer key on the next page.

2. The Desired Output is the correct answer for each case. We can make buttered toast only if we have both bread and butter. Fill in the Desired Output column with the correct 0 and 1 values.
   - The Desired Output should be 1 for the case where both inputs are 1 since we must have both bread *and* butter to make buttered toast. It should be 0 for all other cases.

3. Decide on weight and threshold values that will get the neuron to solve the problem. In the neuron diagram at the center of the figure, fill in values for weights w_1 and w_2 and the threshold.
   - The two inputs are treated identically so they should have the same weights. For simplicity, use a weight of 1.
   - For the case where we have both bread and butter, if the weights are 1, the activation is 2. Students may try to set the threshold at 2, but this won't work because the activation must be *greater than* the threshold. A threshold of 1.5 works nicely, but 1 will also work. Anything less than 1 will not work.

4. Using the weights you selected, compute the activation value for each of the four cases and write it in the Activation column.

- Students need to remember that the activation is a sum of products:

  Activation = Have Bread × w_1 + Have Butter × w_2

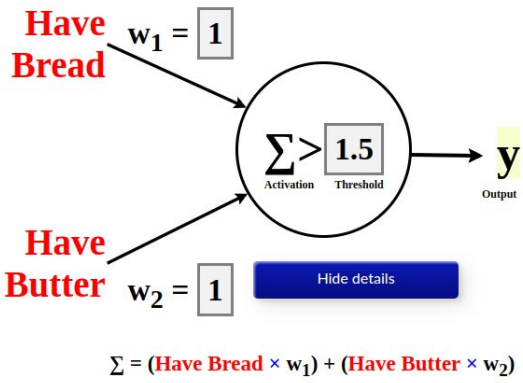
5. Compare the activation with the threshold. If the value in the Activation column is greater than the threshold you selected, put a 1 in the Current Output column. Otherwise put a 0 there. Do this for all four cases.

- Again, the activation must be *strictly greater than* the threshold, so an activation of 2 will not exceed a threshold of 2.
- Setting the threshold to 1 will work because in cases where we have only bread or only butter, the activation will be 1, which is not strictly greater than the threshold. However, it will be easier for students to understand if we use a threshold of 1.5.

6. If the current Output matches the Desired Output for all four cases, your solution is correct.

Answer Key: Can I Make Buttered Toast?

Inputs	
Have Bread	**Have Butter**
0	**0**
0	**1**
1	**0**
1	**1**



Outputs		
Activation Σ	**Current Output Σ > 1.5**	**Desired Output**
0	**0**	0
1	**0**	0
1	**0**	0
2	**1**	1