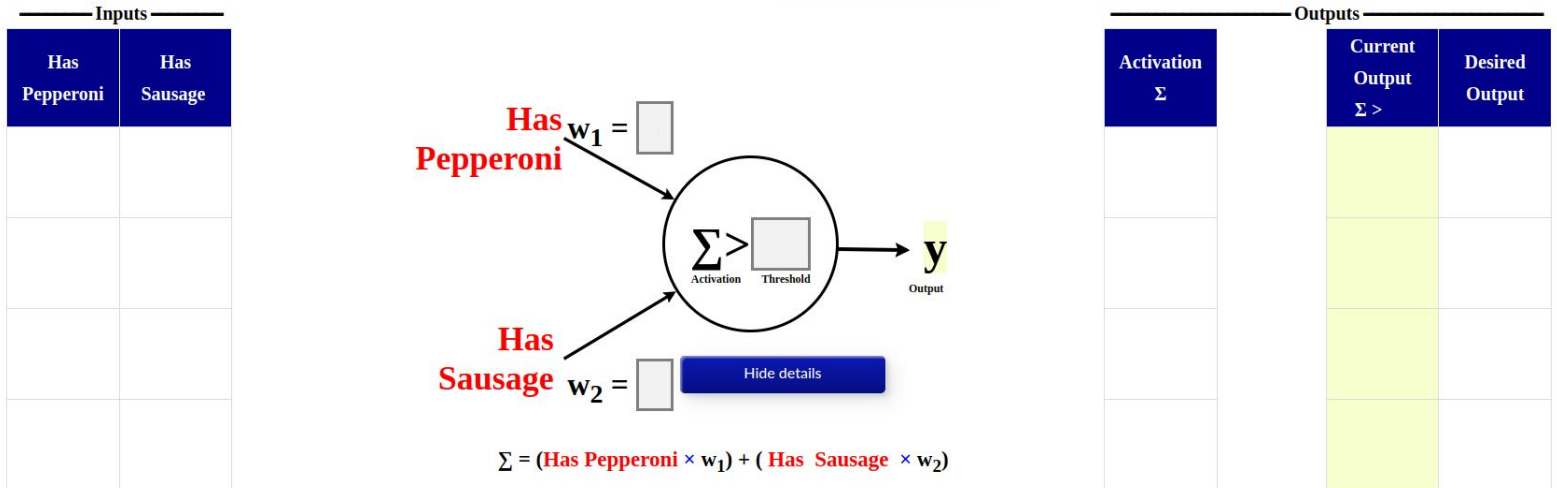


# Neuron Sandbox Teacher Worksheet 2

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

## Does This Pizza Have Meat?

If it includes either pepperoni or sausage, then it has meat.



Does this pizza have meat? It has meat if its toppings include either pepperoni or sausage (or both).. Let's work through the steps to make a neuron answer this question.

- There are four cases to consider, depending on whether we pepperoni, sausage, 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.
- The Desired Output is the correct answer for each case. The pizza has meat if its toppings include pepperoni or sausage. Fill in the Desired Output column with the correct 0 and 1 values.
  - The Desired Output should be 0 for the case where we have neither pepperoni nor sausage, since then there is no meat. It should be 1 for all other cases.
- 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 only pepperoni or only sausage, if the threshold is 1, the solution will not work because the net activation must be above the threshold, not at threshold. A value of 0.5 works nicely, but any value greater than or equal to 0 and less than 1 will 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:

$$\text{Activation} = \text{Has Pepperoni} \times w_1 + \text{Has Sausage} \times w_2$$

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.

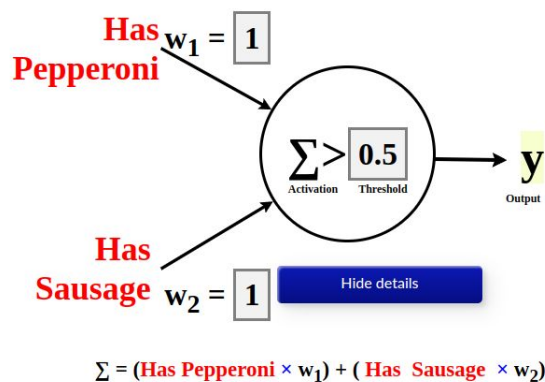
- Again, the activation must be *strictly greater than* the threshold, so an activation of 1 will not exceed a threshold of 1.
- Setting the threshold to 0 will work because in cases where we have only bread or only butter, the activation will be 1, which is strictly greater than the threshold. However, it will be easier for students to understand if we use a threshold of 0.5.

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

- Notice that this “or” solution uses the same weights as the “and” solution (Worksheet 1); the only difference is the threshold.

## Answer Key: Does This Pizza Have Meat?

Inputs	
Has Pepperoni	Has Sausage
0	0
0	1
1	0
1	1



Outputs		
Activation $\Sigma$	Current Output $\Sigma > 0.5$	Desired Output
0	0	0
1	1	1
1	1	1
2	1	1