

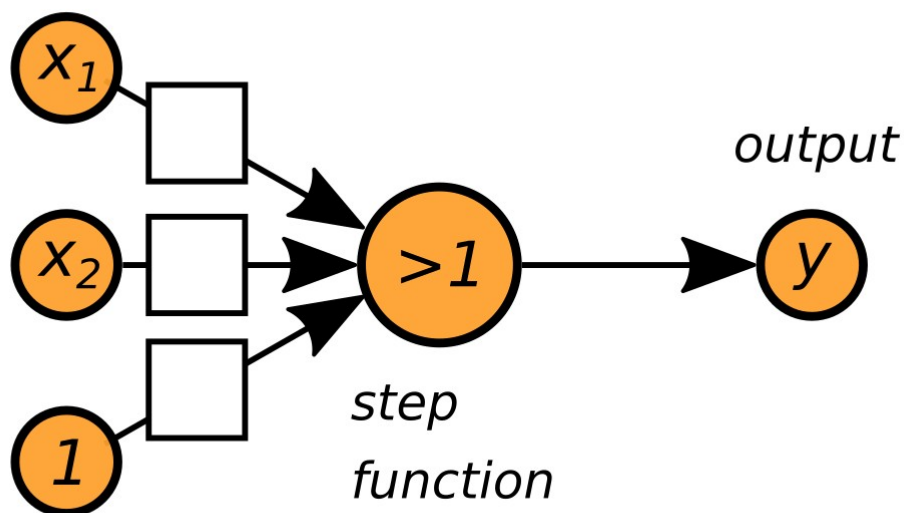
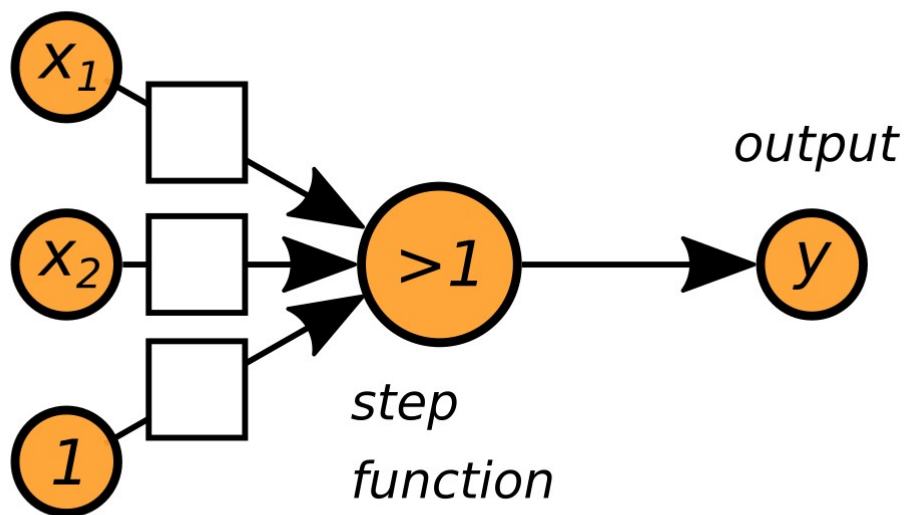
Artificial Neural Networks

In this exercise, we will build a pen-and-paper neural network for two datasets:

| Logical AND | | |
|-------------|----|--------|
| x1 | x2 | output |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

| Logical OR | | |
|------------|----|--------|
| x1 | x2 | output |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

Your task is to set the weights in the two networks (for AND and OR) in such a way that it gives the correct result for all four data points. As an activation function we use the **step function**: it returns 1 if the weighted sum of the inputs is larger than 1.

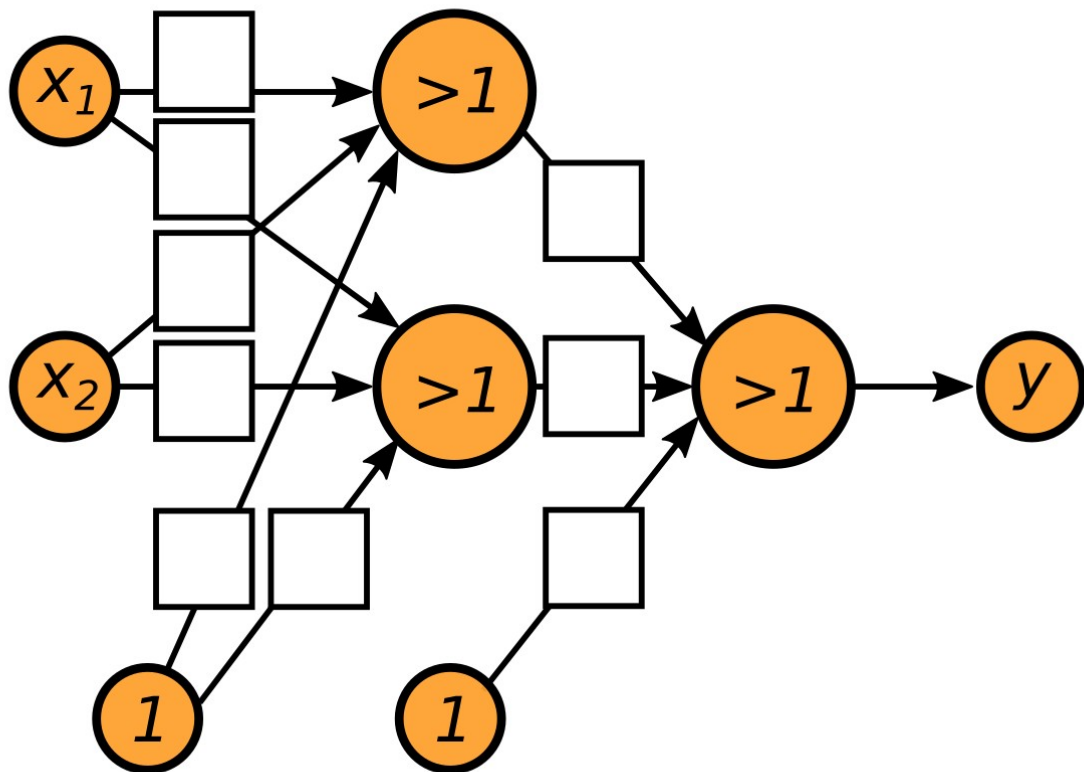


Feed-Forward-Network

Now let's try something more complicated: The XOR function, a nonlinear function.

| Logical XOR | | |
|-------------|----|--------|
| x1 | x2 | output |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

To model this dataset we need a neural network with two layers. You will need to set the weights for all three neurons.



Hint #1: The XOR function can be expressed as:

$$\text{XOR}(x_1, x_2) = \text{OR}(\text{AND}(x_1, \text{not } x_2), \text{AND}(\text{not } x_1, x_2))$$

Hint #2: Ask the teacher about the biases