an introduction to neural networks

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what even is a neural network

- a computer program modeled after the human brain

- used for problems that cannot be hard-coded

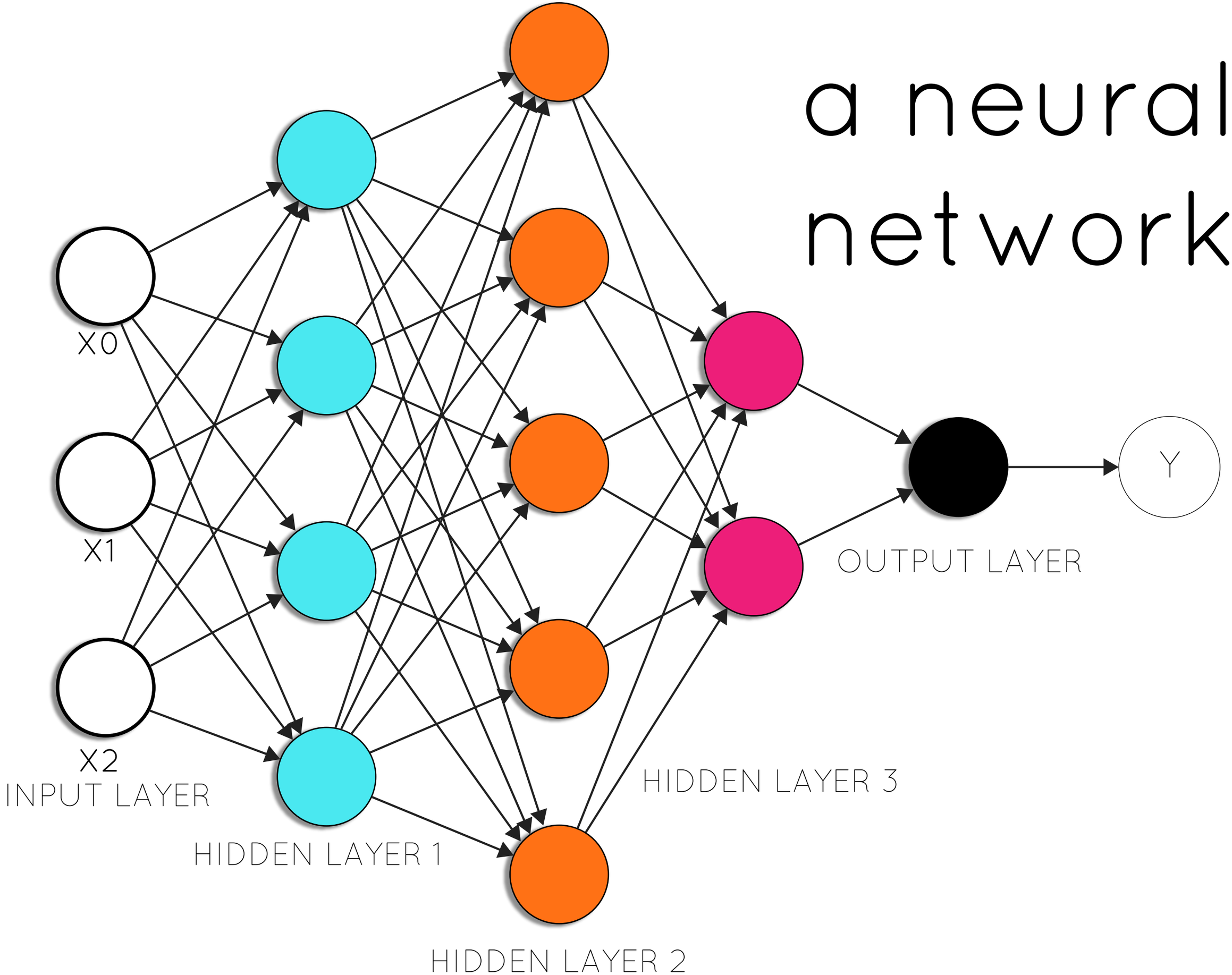
- specified by:

  - architecture

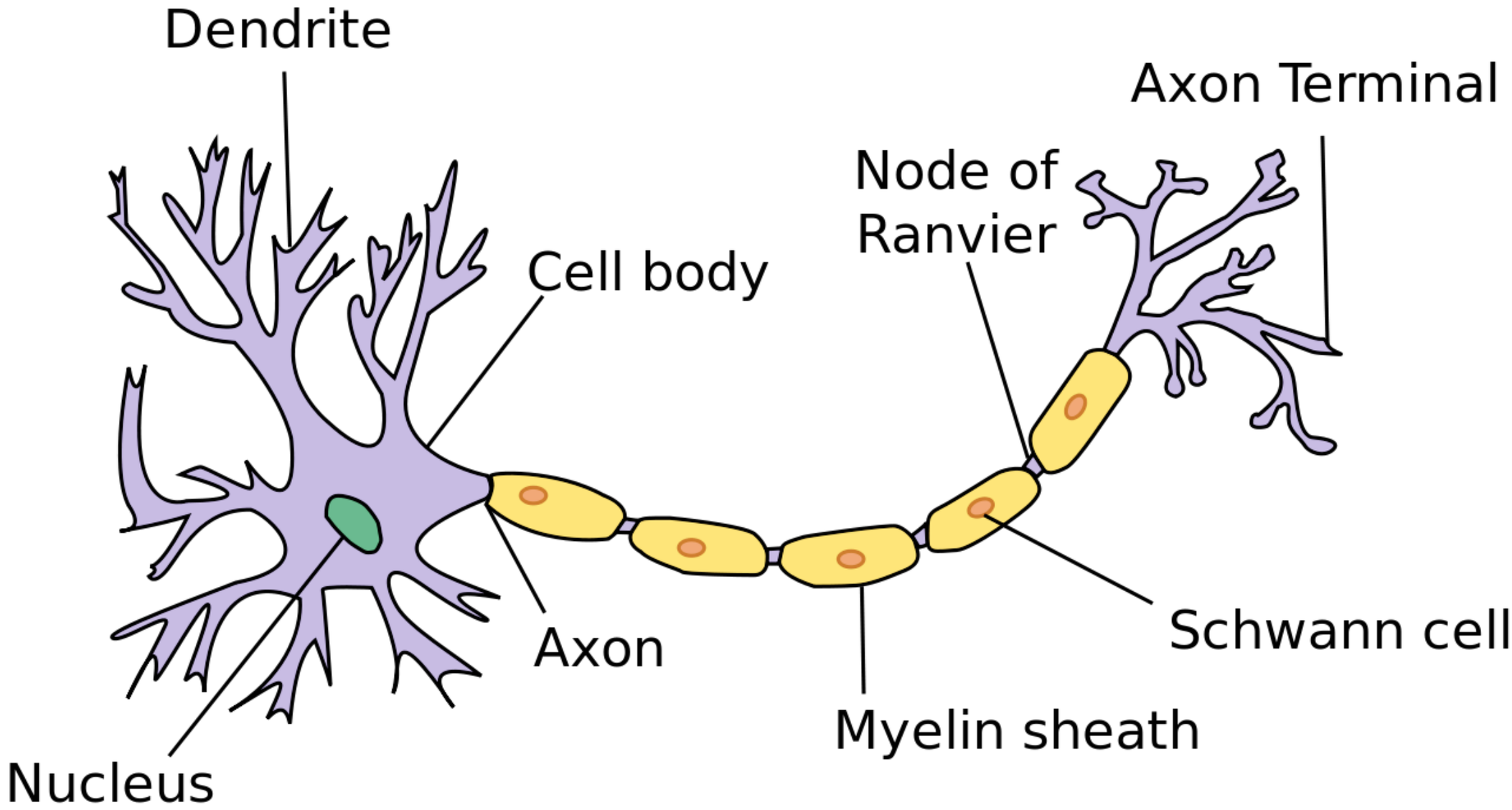
  - activity

  - learning

a neural network



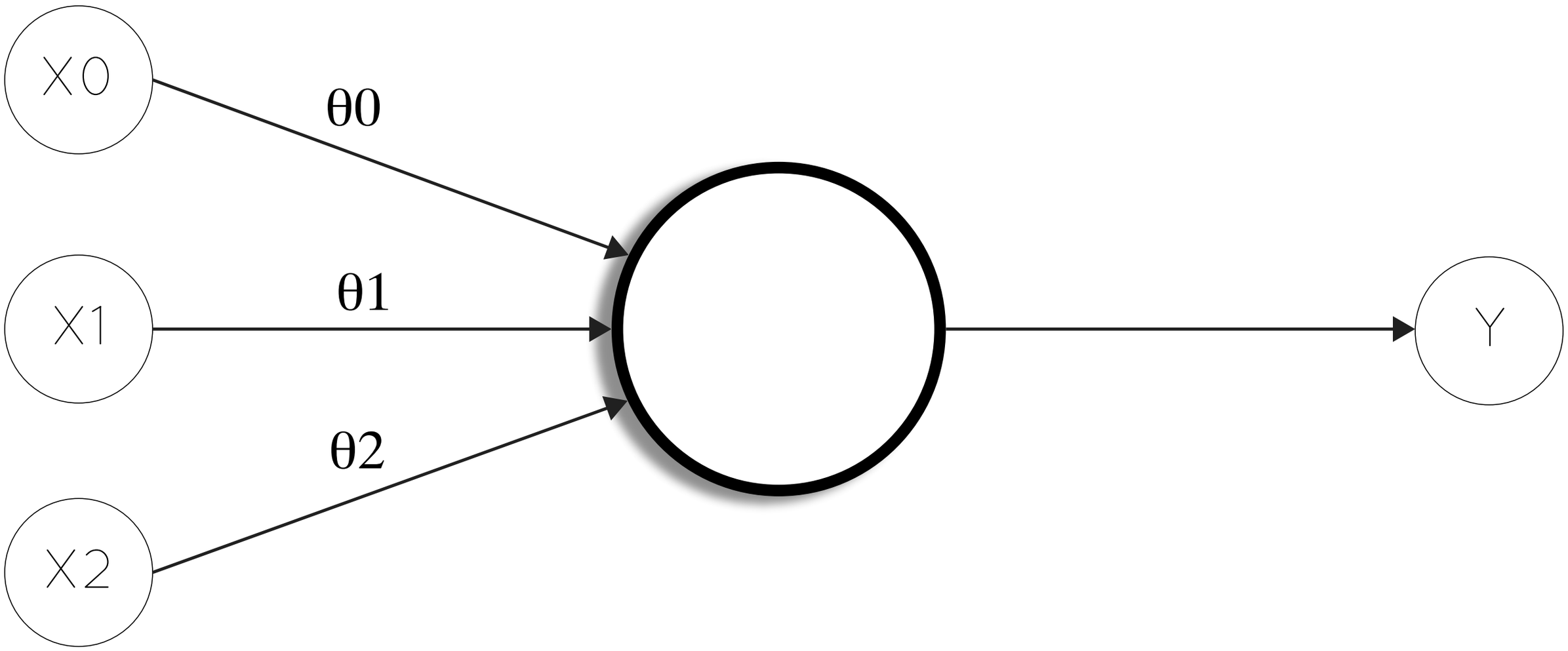
neurons


Dendrite
Cell body
Axon Terminal
Node of Ranvier
Nucleus
Axon
Myelin sheath
Schwann cell

single synthetic neuron

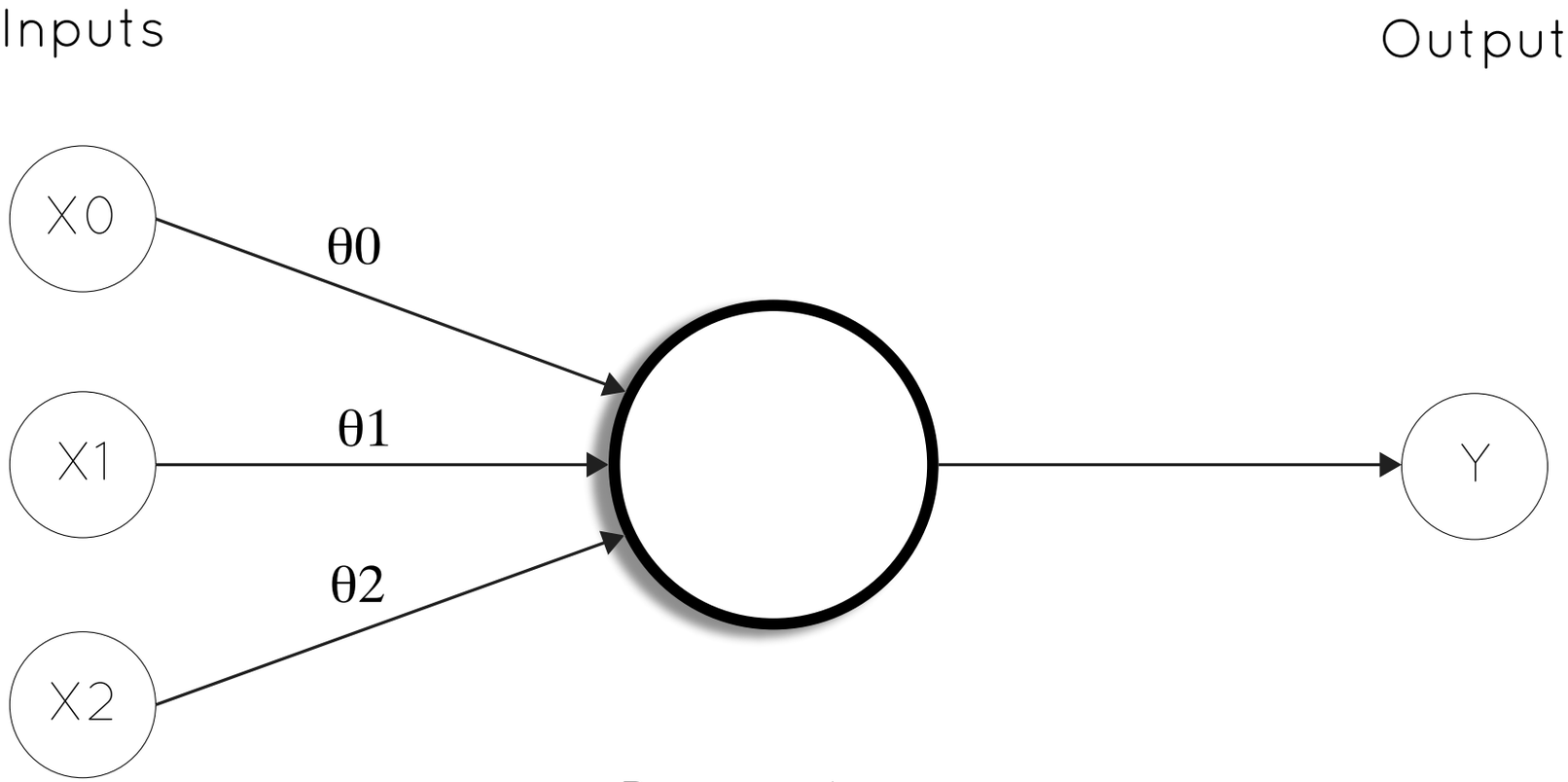
Inputs

Output



the **bias unit** &
the **activation function**

X0 is called the 'bias unit,' and it was always be equal to one

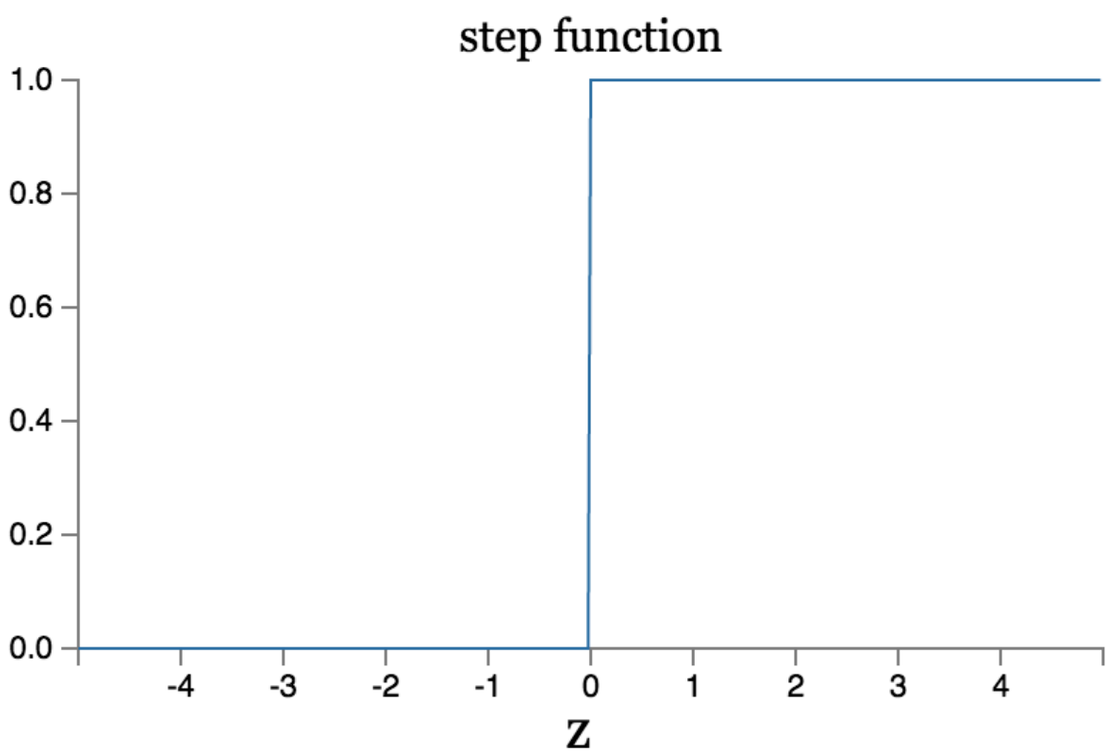


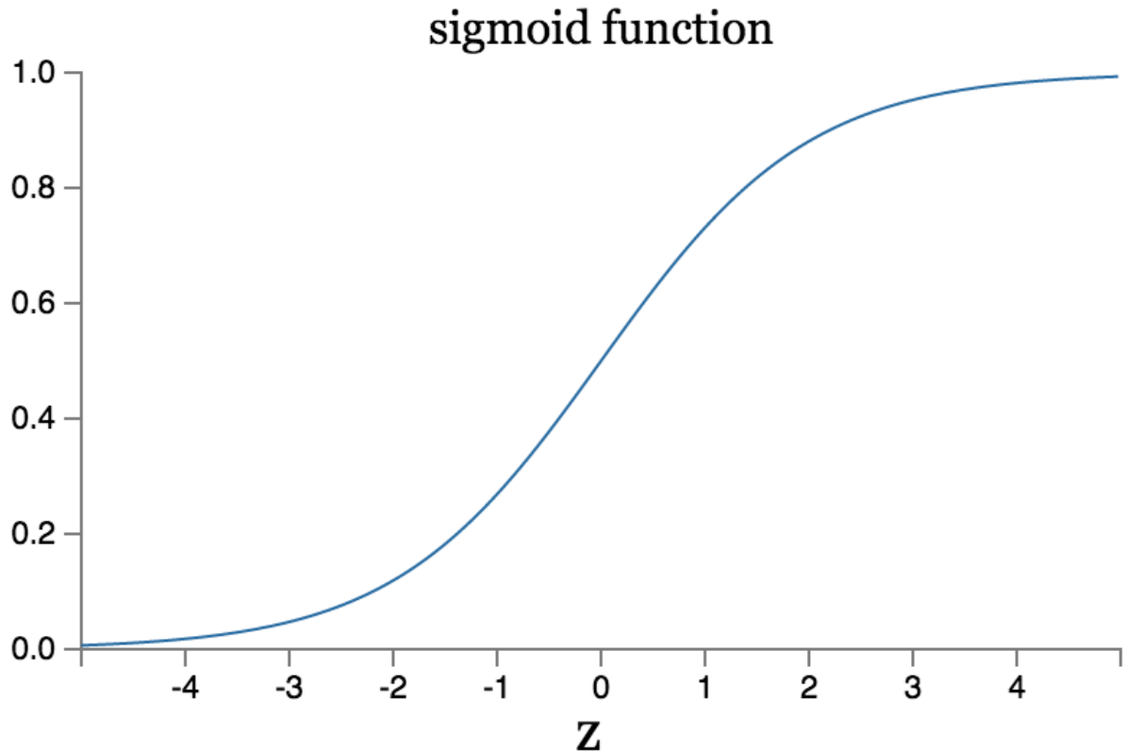
Parameters

$$\begin{bmatrix} X0 & X1 & X2 \end{bmatrix} * \begin{bmatrix} \theta 0 \\ \theta 1 \\ \theta 2 \end{bmatrix} = (\theta 0 * X0) + (\theta 1 * X1) + (\theta 2 * X2)$$

this is what ultimately gets fed to the neuron

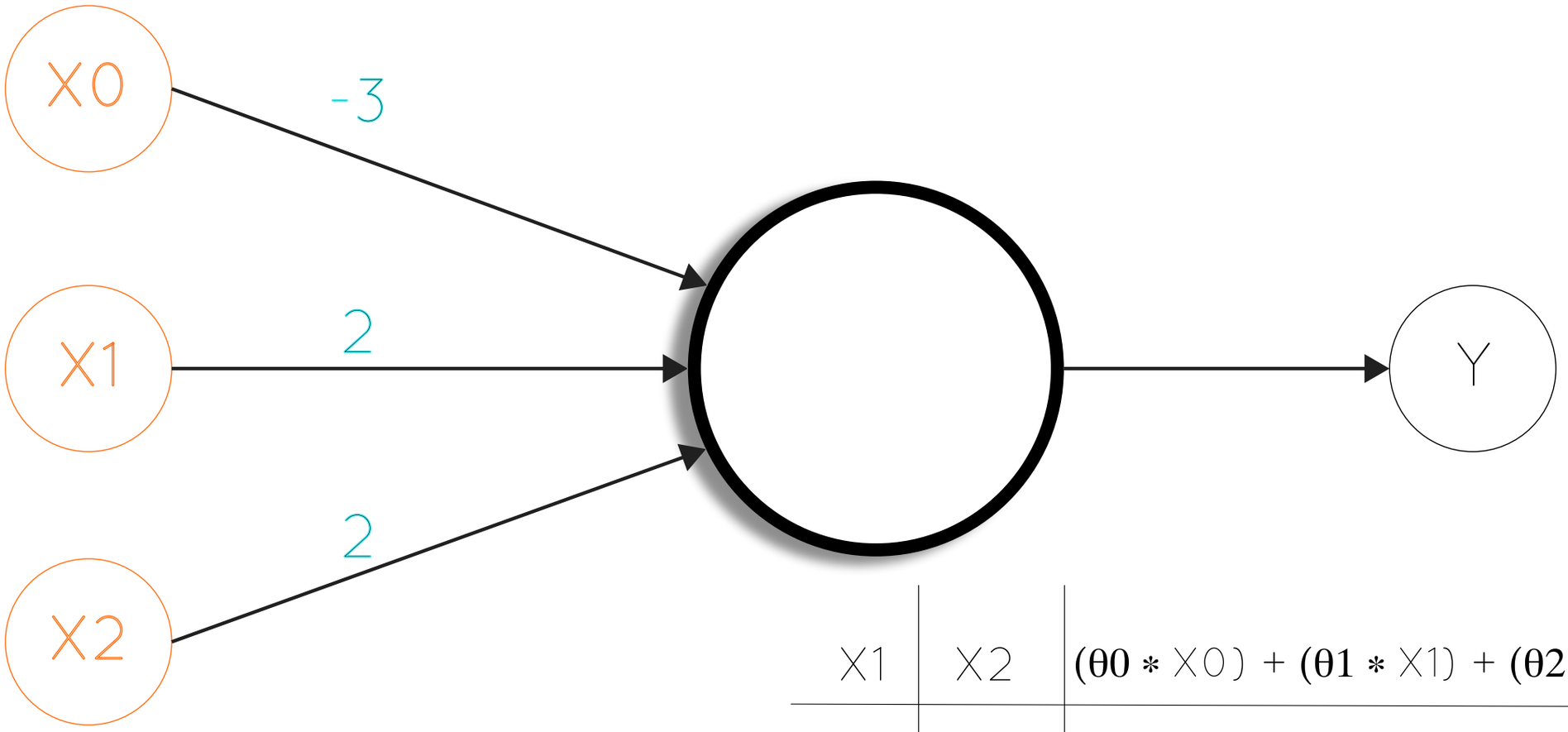
activation functions:
perceptrons and **sigmoids**





example neuron: **AND**

Remember:
X0 = 1



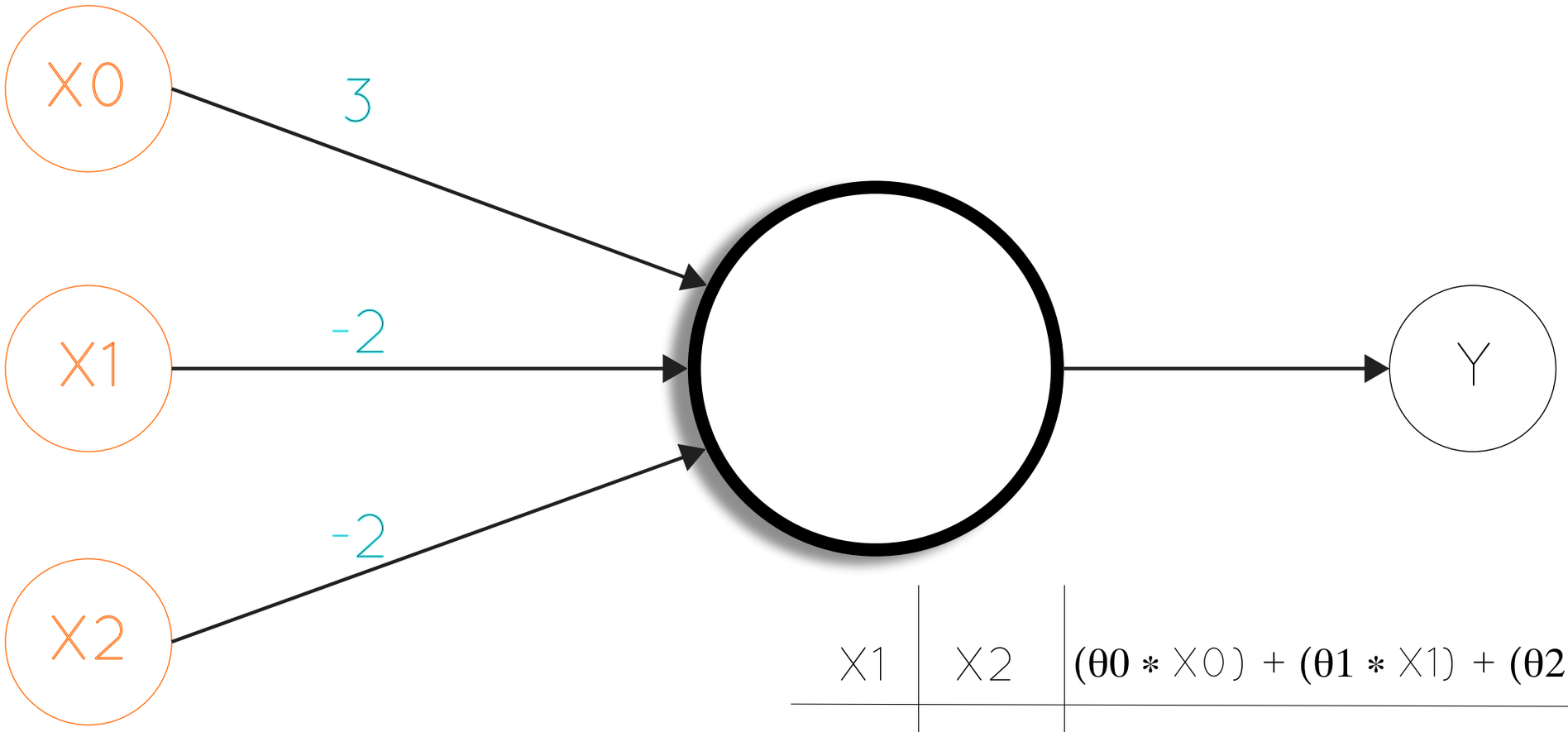
$$\begin{bmatrix} X0 & X1 & X2 \end{bmatrix}$$

$$\begin{bmatrix} -3 \\ 2 \\ 2 \end{bmatrix}$$

X1	X2	$(\theta 0 * X0) + (\theta 1 * X1) + (\theta 2 * X2)$	Y
0	0	-3	0
0	1	-1	0
1	0	-1	0
1	1	1	1

example neuron: **NAND**

Remember:
X0 = 1



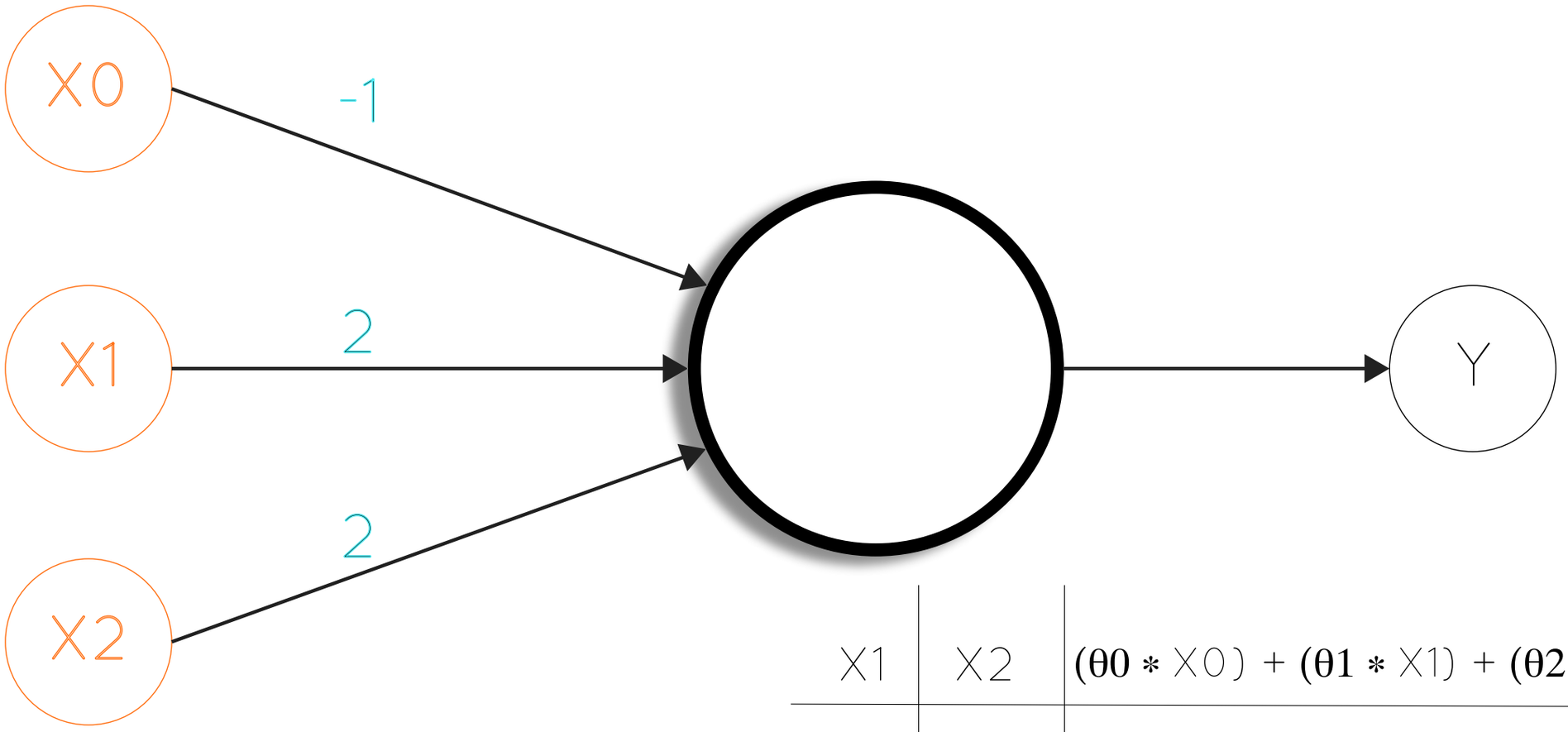
$$\begin{bmatrix} X0 & X1 & X2 \end{bmatrix}$$

$$\begin{bmatrix} 3 \\ -2 \\ -2 \end{bmatrix}$$

X1	X2	$(\theta 0 * X0) + (\theta 1 * X1) + (\theta 2 * X2)$	Y
0	0	3	1
0	1	1	1
1	0	1	1
1	1	-1	0

example neuron: **OR**

Remember:
X0 = 1



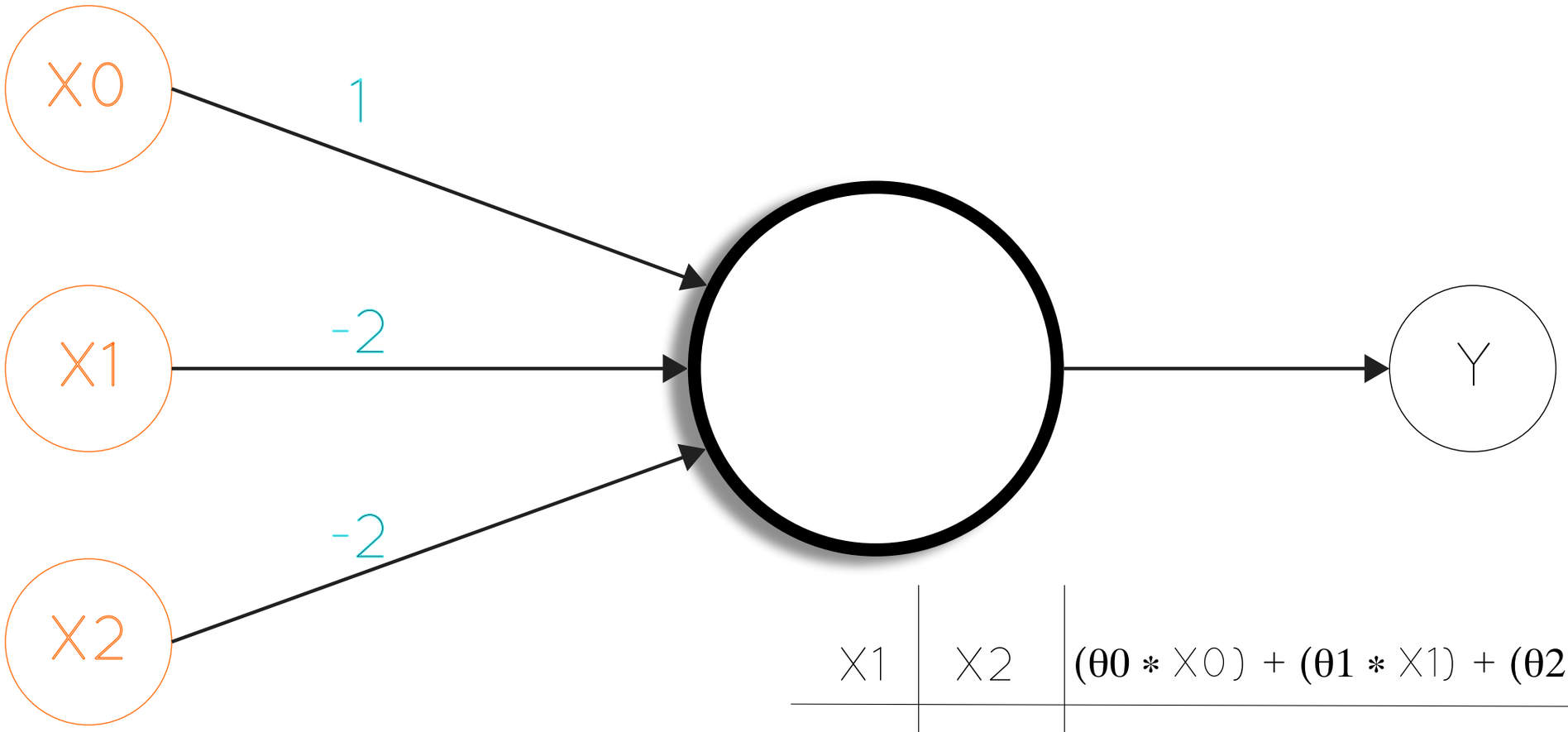
$$\begin{bmatrix} X0 & X1 & X2 \end{bmatrix}$$

$$\begin{bmatrix} -1 \\ 2 \\ 2 \end{bmatrix}$$

X1	X2	$(\theta 0 * X0) + (\theta 1 * X1) + (\theta 2 * X2)$	Y
0	0	-1	0
0	1	1	1
1	0	1	1
1	1	3	1

example neuron: **NOT**

Remember:
X0 = 1



X1	X2	$(\theta 0 * X0) + (\theta 1 * X1) + (\theta 2 * X2)$	Y
0	0	1	1
0	1	-1	0
1	0	-1	0
1	1	-3	0

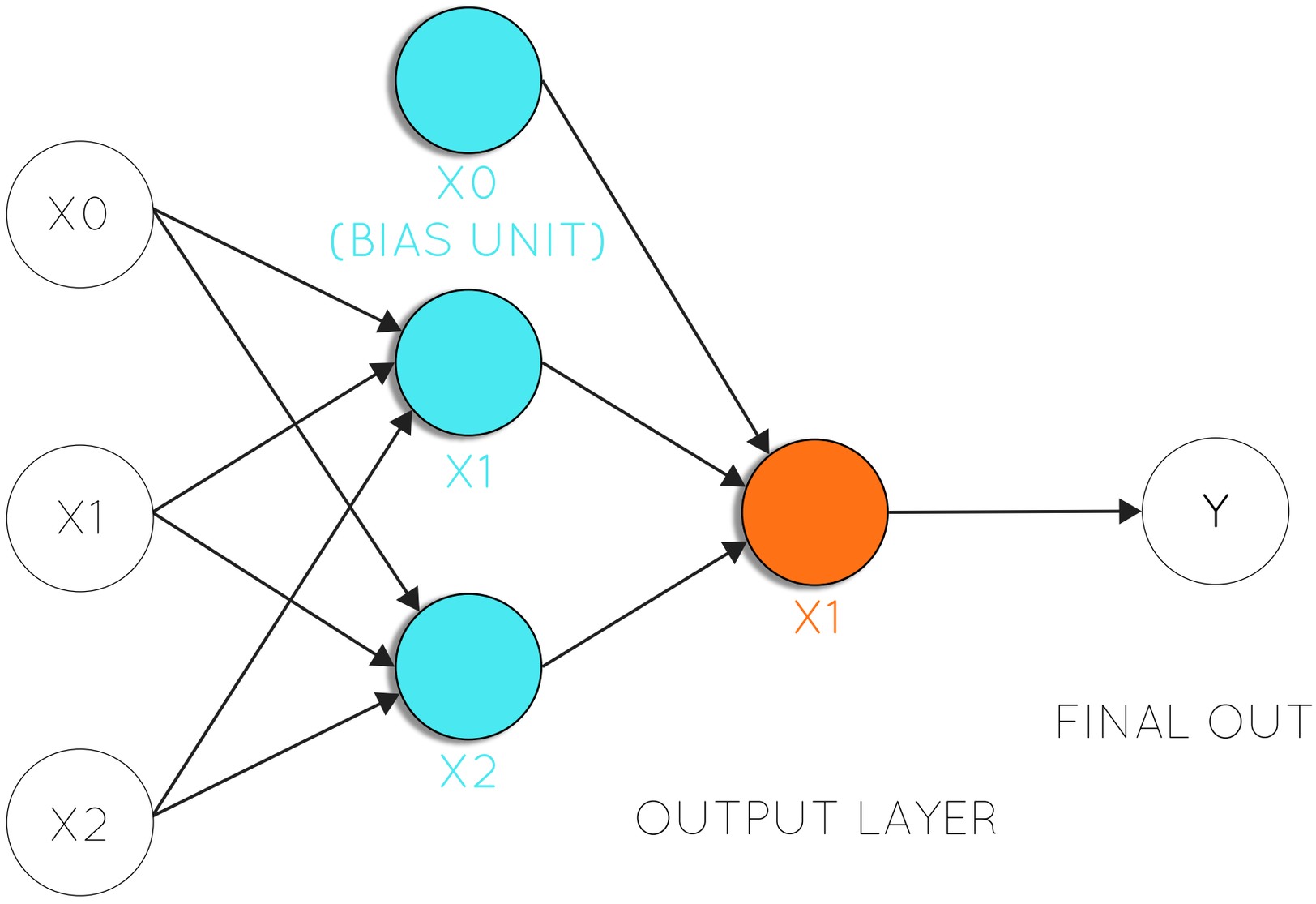
$$\begin{bmatrix} X0 & X1 & X2 \end{bmatrix}$$

$$\begin{bmatrix} 1 \\ -2 \\ -2 \end{bmatrix}$$

the **xor** function

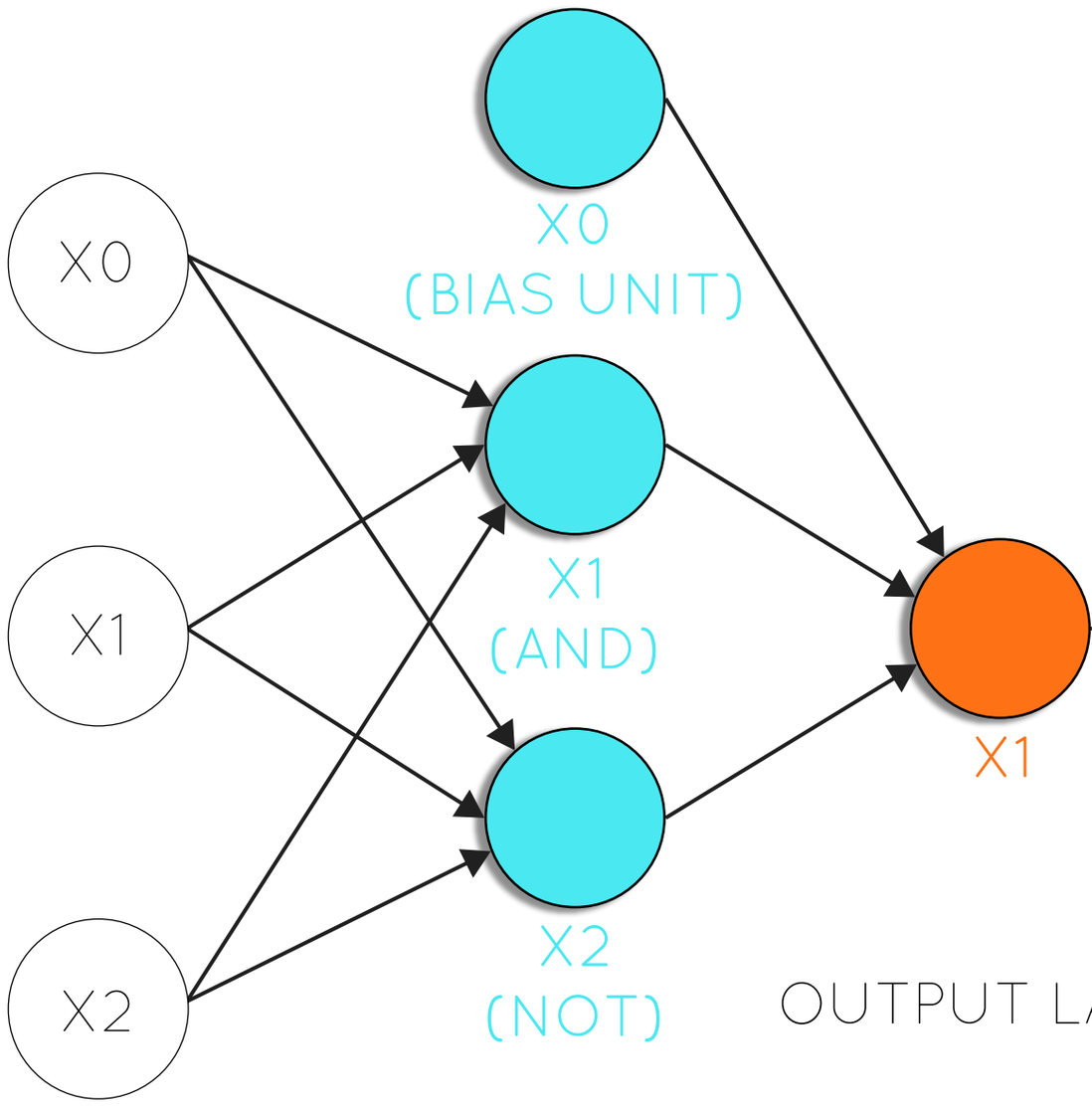
X1	X2	Y
0	0	0
0	1	1
1	0	1
1	1	0

the **xor** function



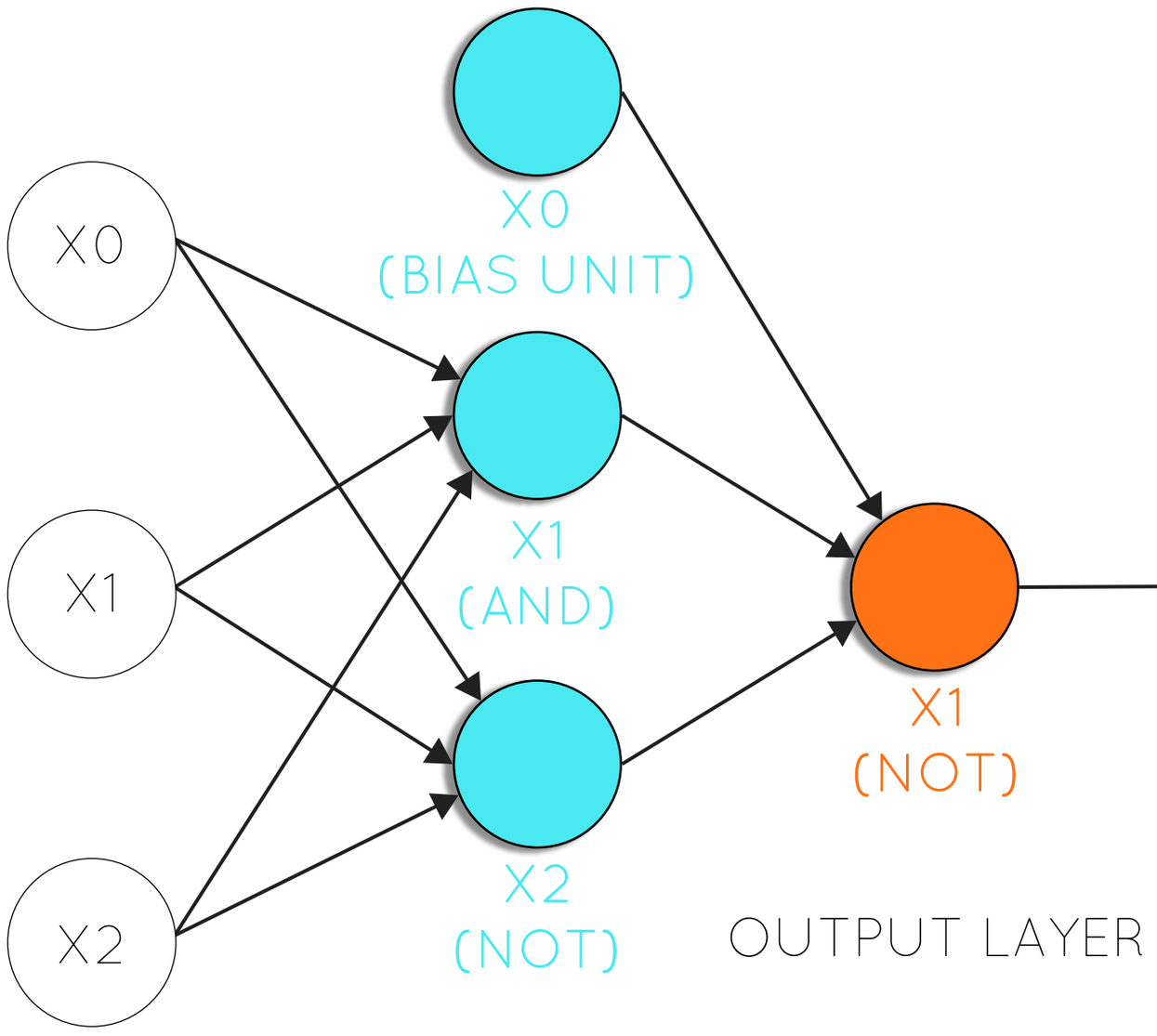
X1	X2	Y
0	0	0
0	1	1
1	0	1
1	1	0

the **xor** function



X1	X2	Y
0	0	0
0	1	1
1	0	1
1	1	0

the **xor** function



X1	X2	Y
0	0	0
0	1	1
1	0	1
1	1	0

a deeper dive:

INPUT LAYER: HIDDEN LAYER: OUTPUT LAYER:

X1	X2	X1	X2	X1 = Y	
0	0	0	1	0	0
0	1	0	0	1	1
1	0	0	0	1	1
1	1	1	0	0	0