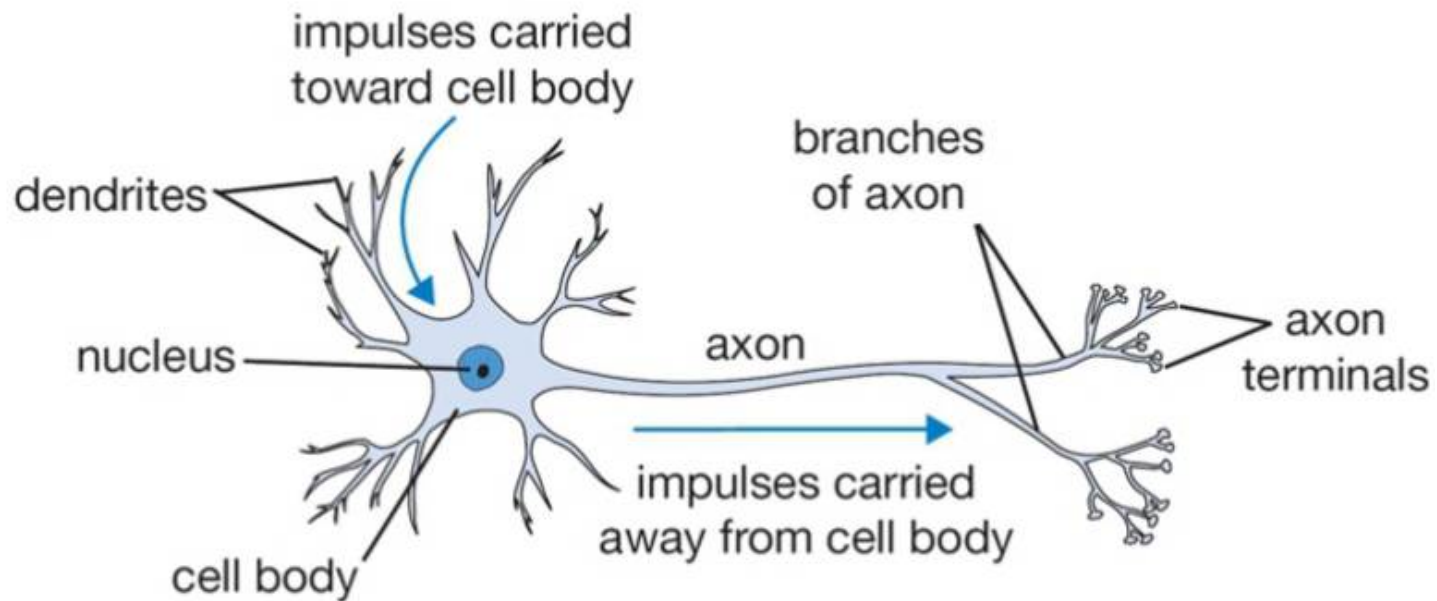
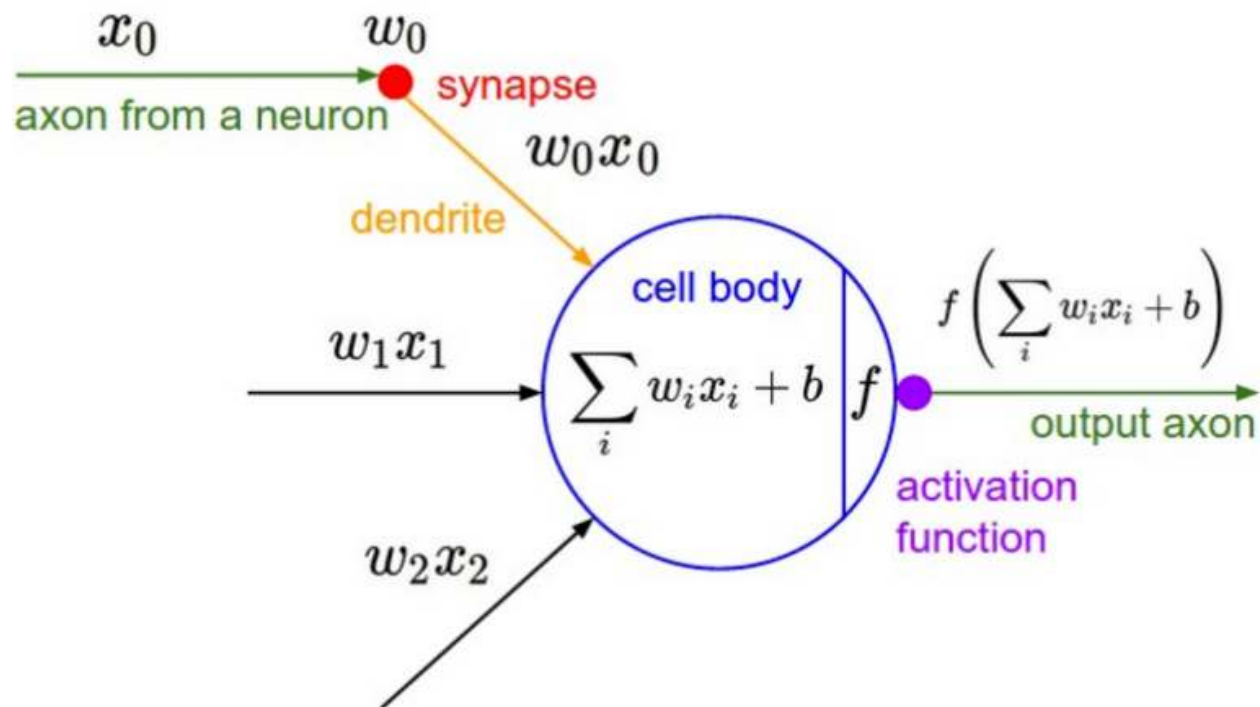


Artificial Neural Network

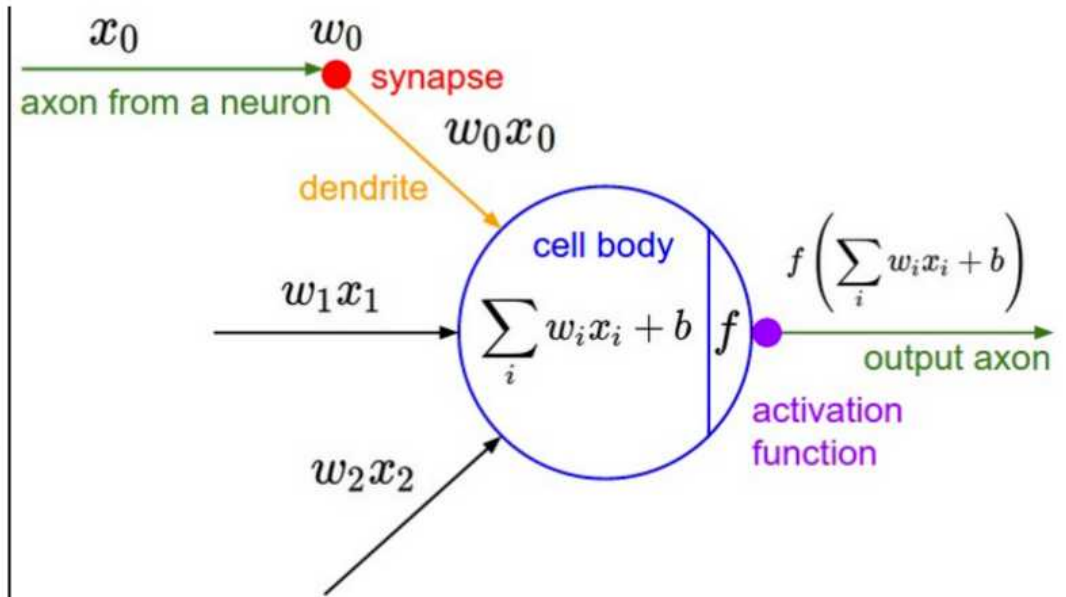
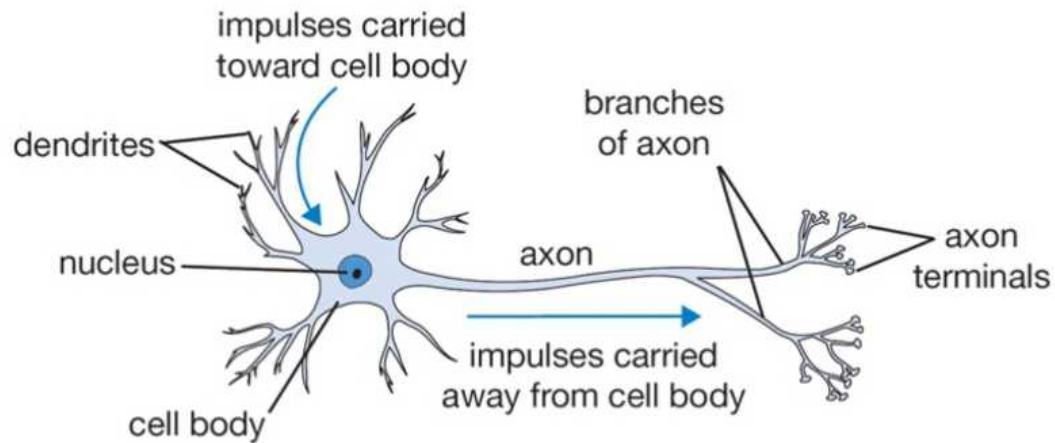
Deep Learning Idea is from our brain



Deep Learning Idea is from our brain

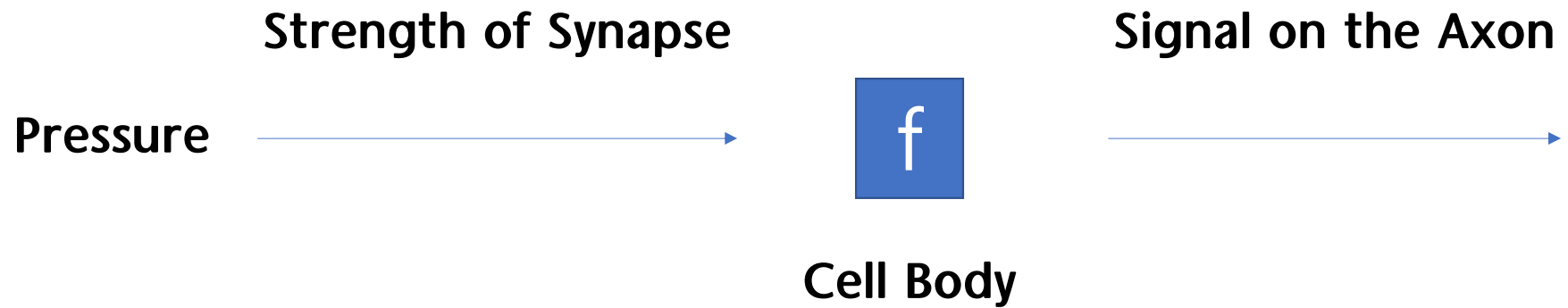


Deep Learning Idea is from our brain

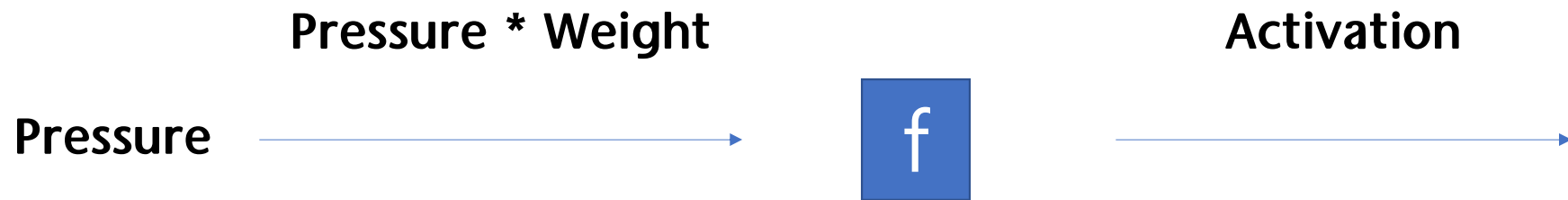


A cartoon drawing of a biological neuron (left) and its mathematical model (right).

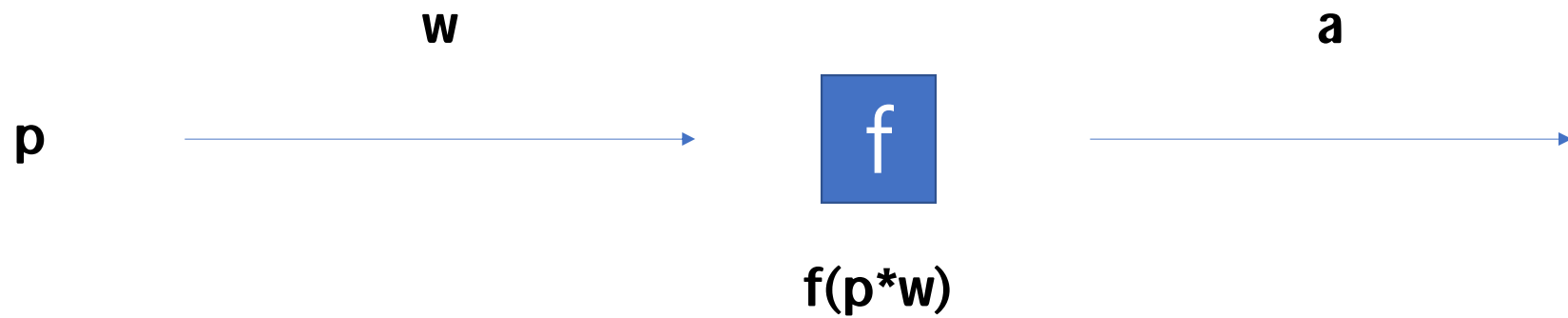
Single Input Neuron



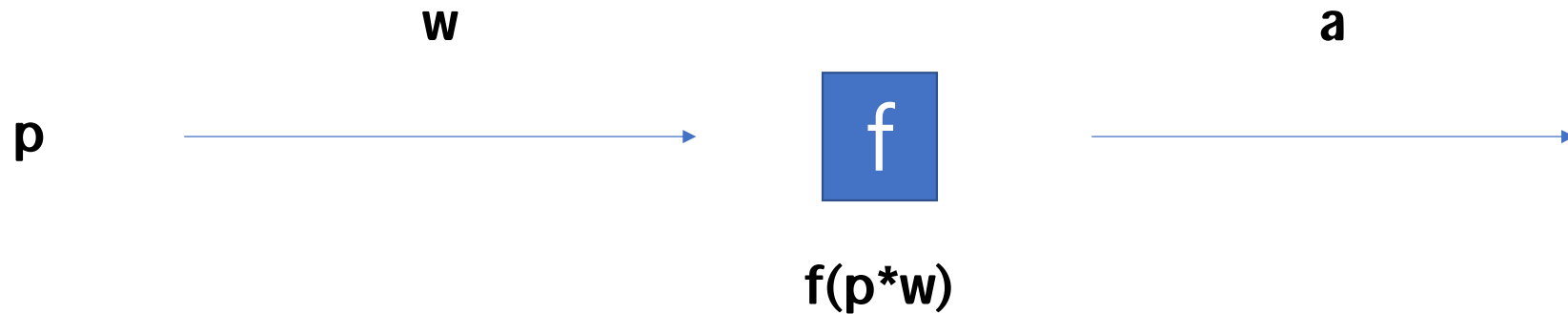
Terms we use in deep learning



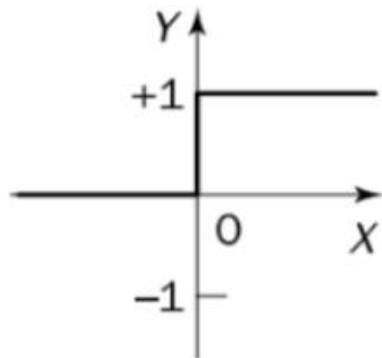
Activation Function



Activation Functions

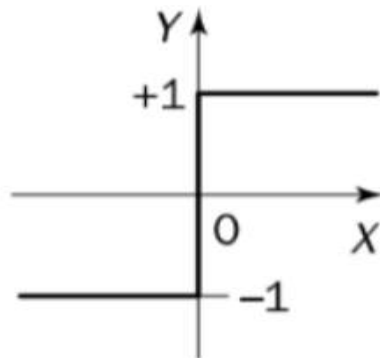


Step function



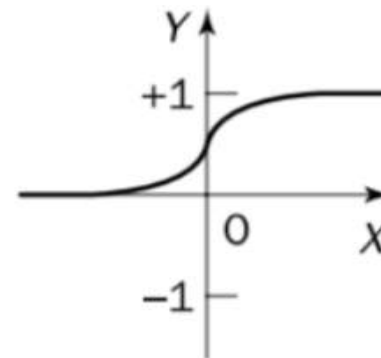
$$Y_{step} = \begin{cases} 1, & \text{if } X \geq 0 \\ 0, & \text{if } X < 0 \end{cases}$$

Sign function



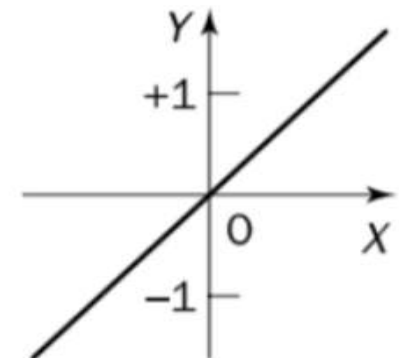
$$Y_{sign} = \begin{cases} +1, & \text{if } X \geq 0 \\ -1, & \text{if } X < 0 \end{cases}$$

Sigmoid function



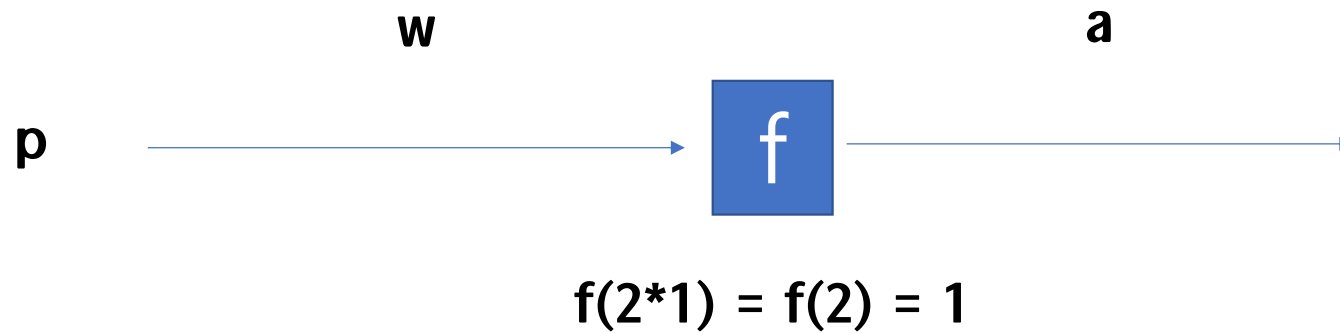
$$Y_{sigmoid} = \frac{1}{1 + e^{-X}}$$

Linear function

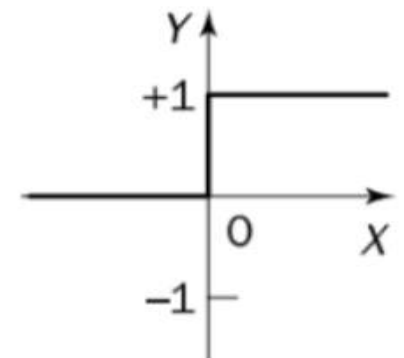


$$Y_{linear} = X$$

When $w=2$, $p=1$

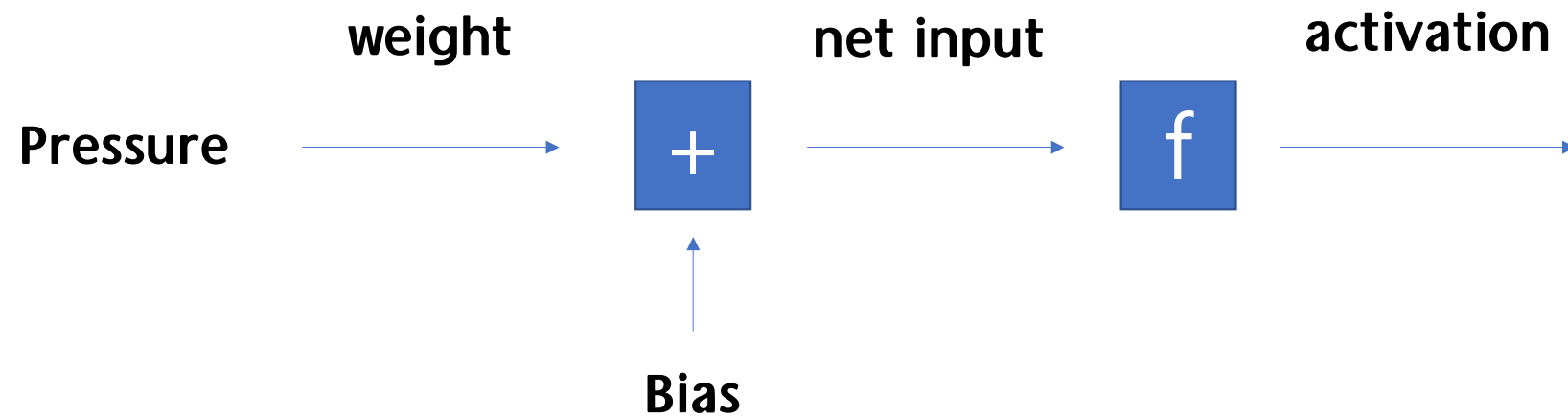


Step function

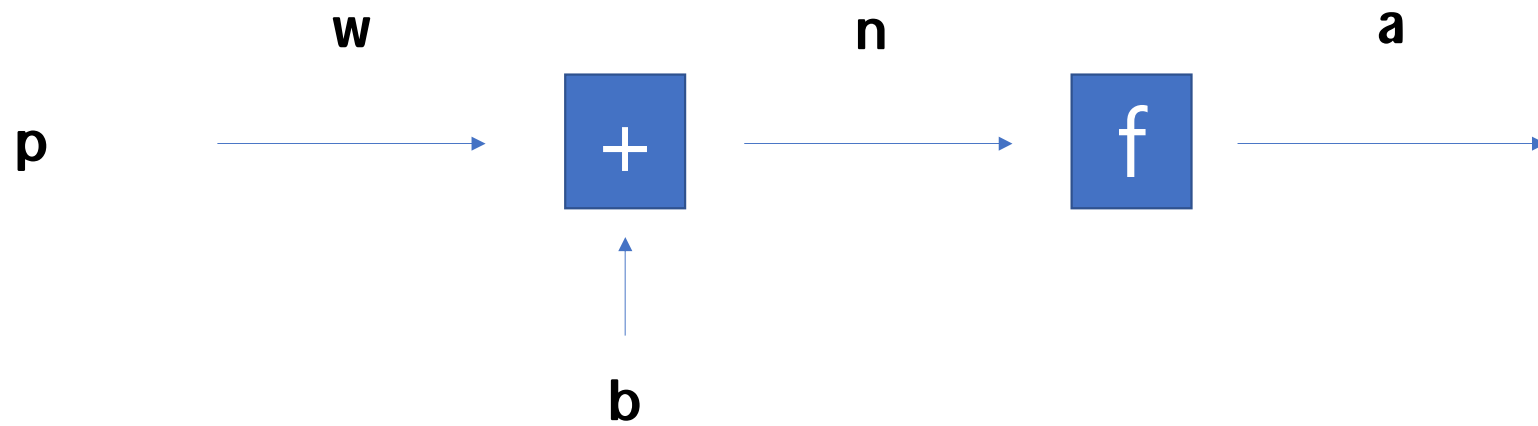


$$Y_{step} = \begin{cases} 1, & \text{if } X \geq 0 \\ 0, & \text{if } X < 0 \end{cases}$$

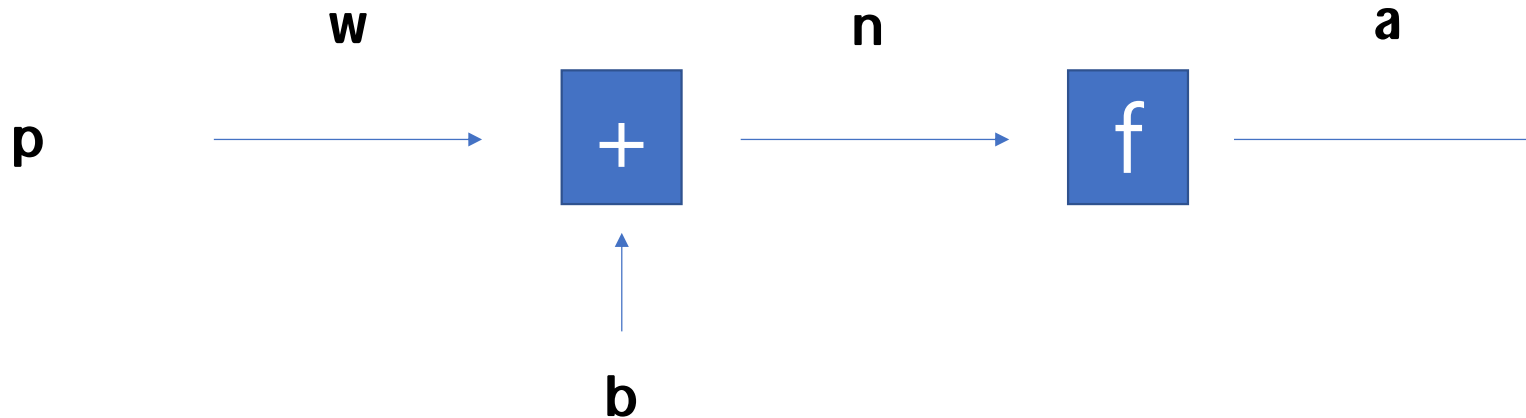
We can give Bias



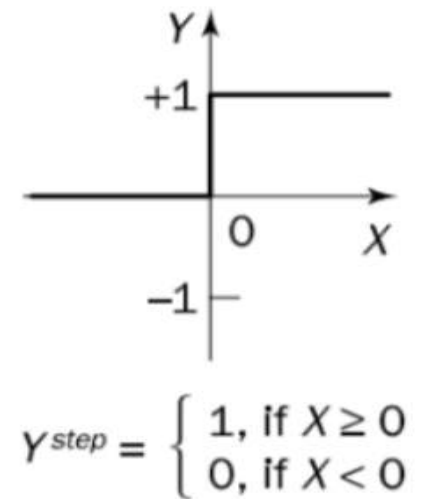
Single Input Neuron



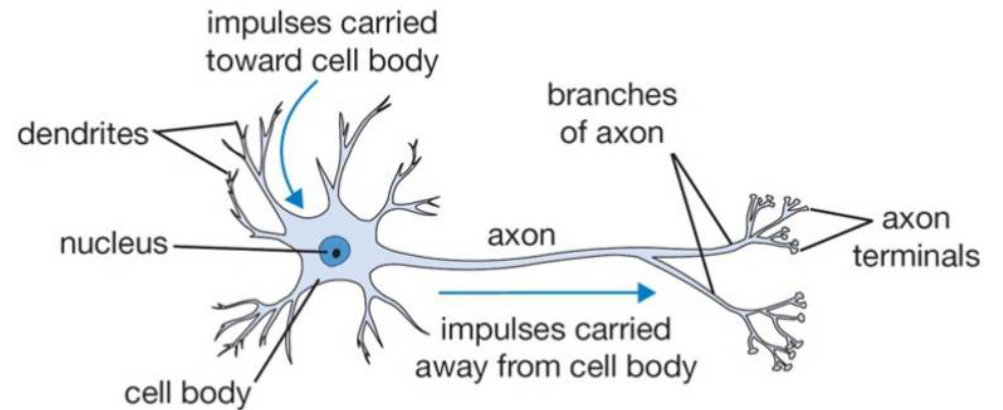
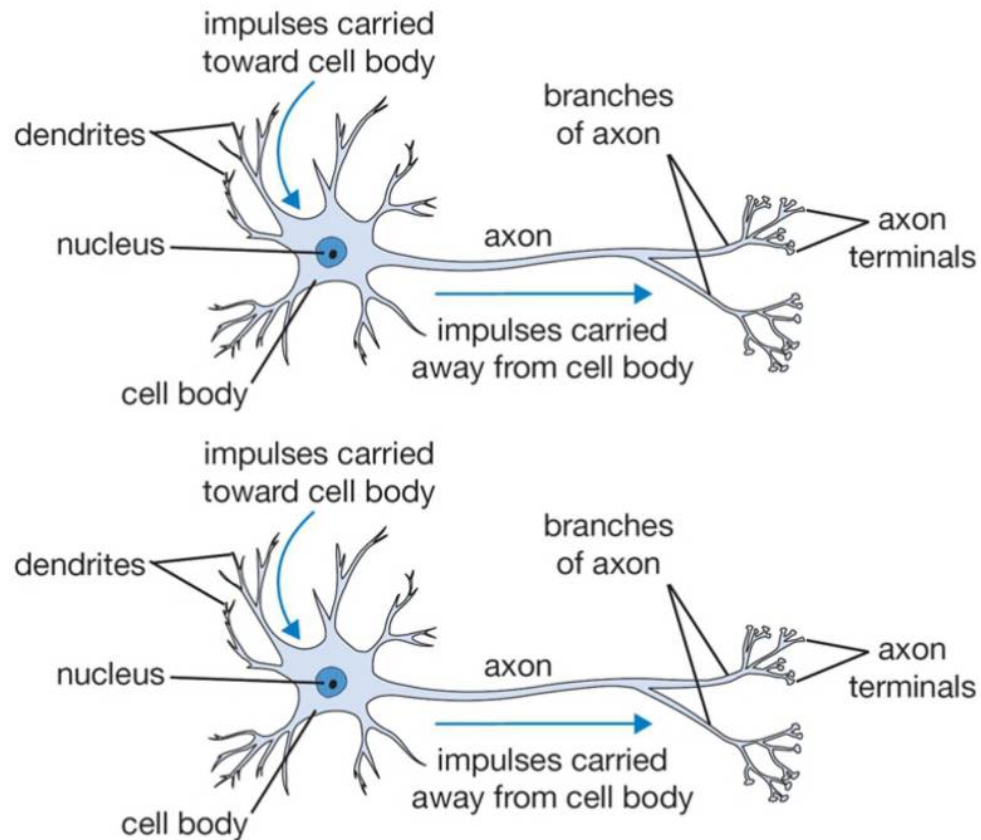
When $w=1$, $p=2$ then $a=+1$
When $w=1$, $p=1$ then $a=-1$



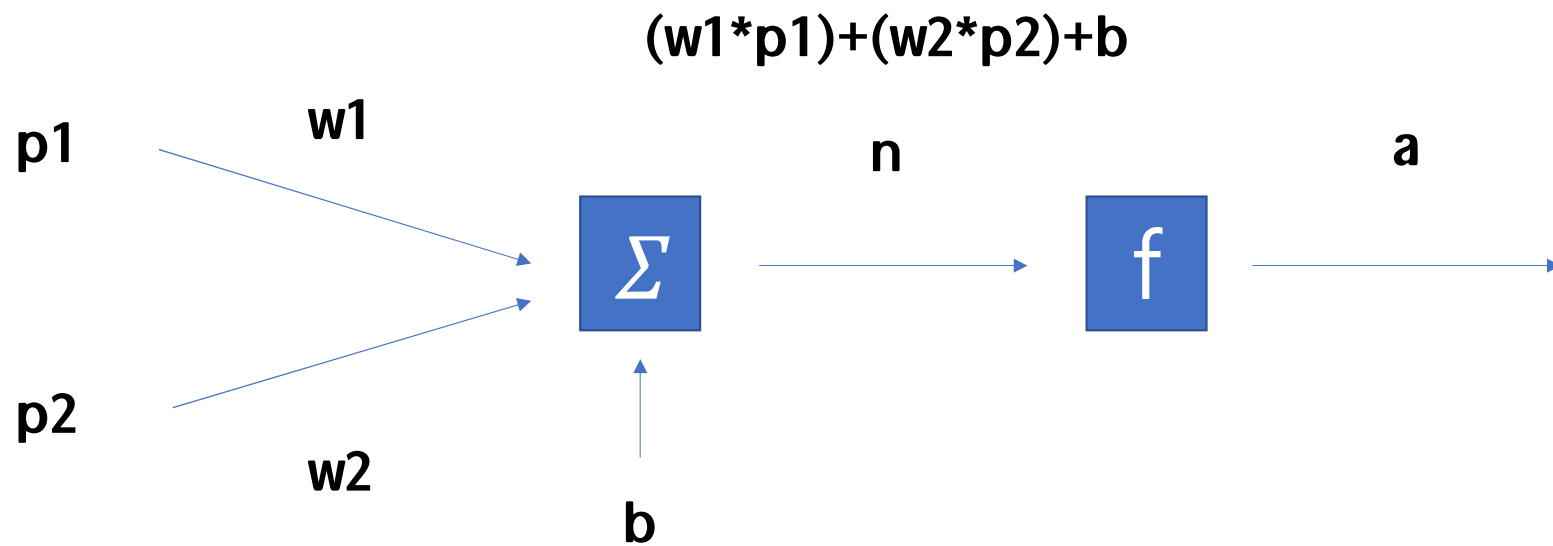
Step function



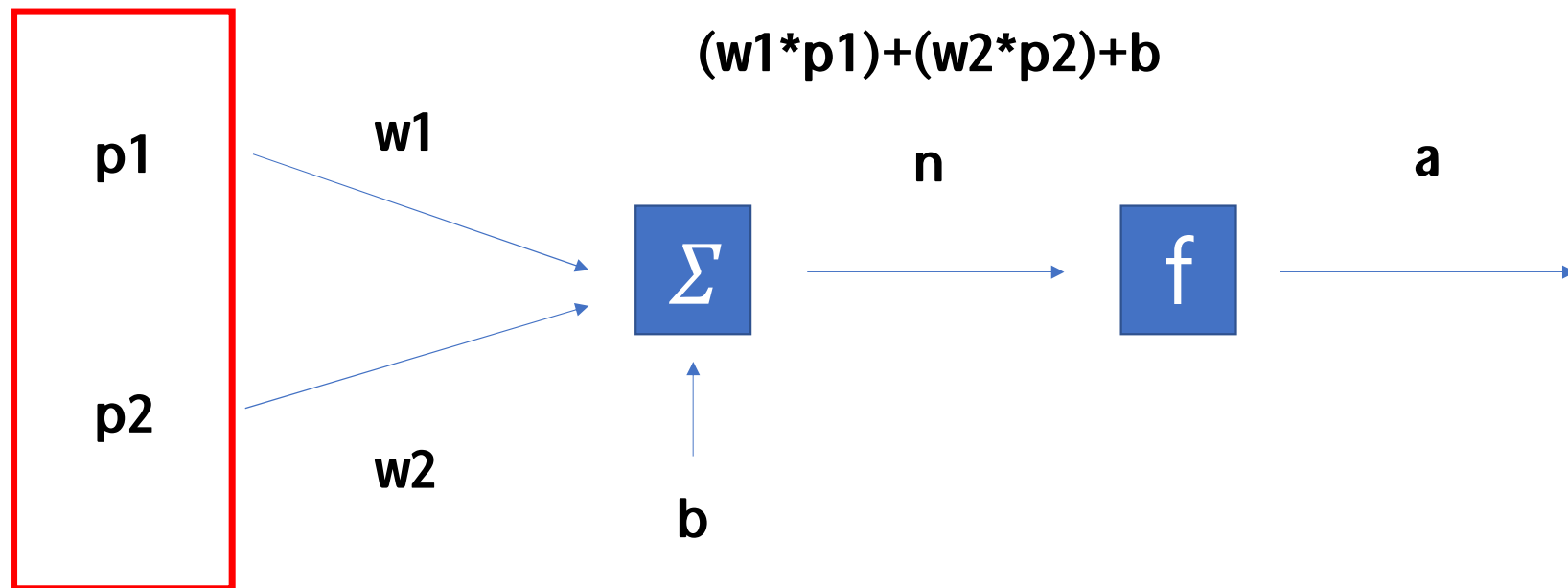
Real neuron has multiple input



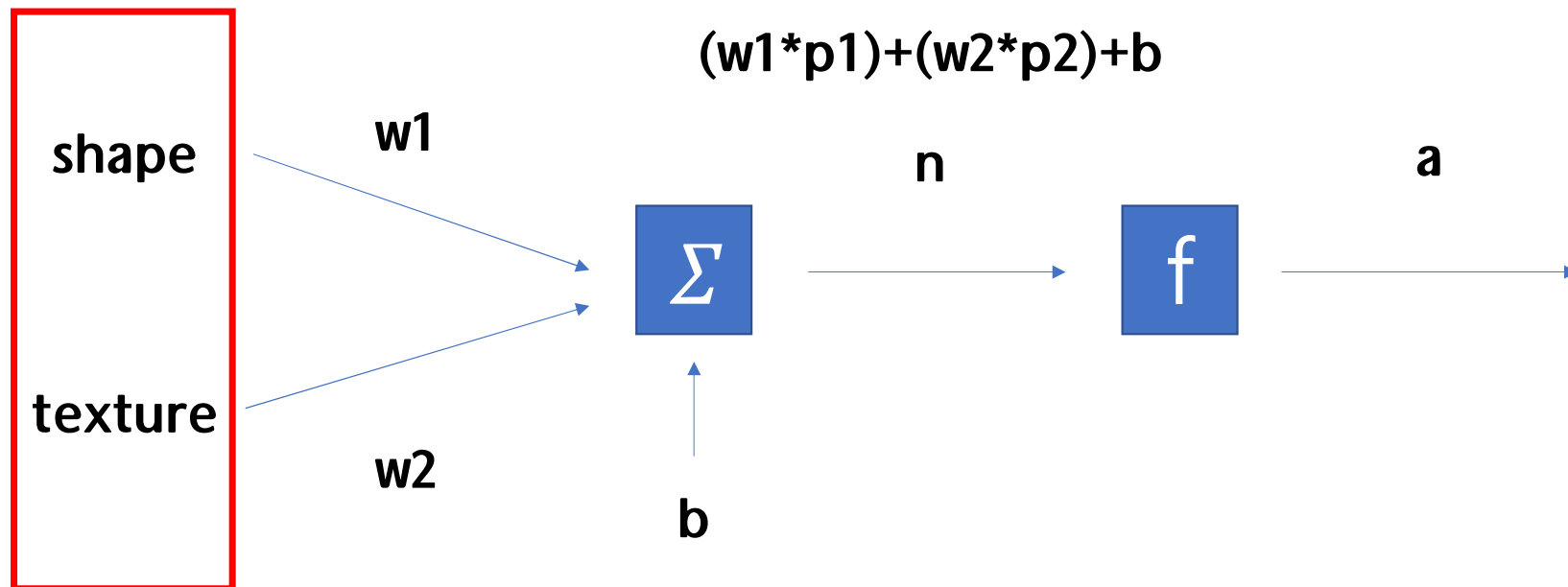
Multiple input neuron (perceptron)



Input are features we know from data



Input are features we know from data



Define input features

Shape = 1 when shape is round

Shape = 0 when shape is not round

Texture = 1 when texture is smooth

Texture = 0 when texture is not smooth

Define input as [shape, texture]

Apple will be present [1,1]

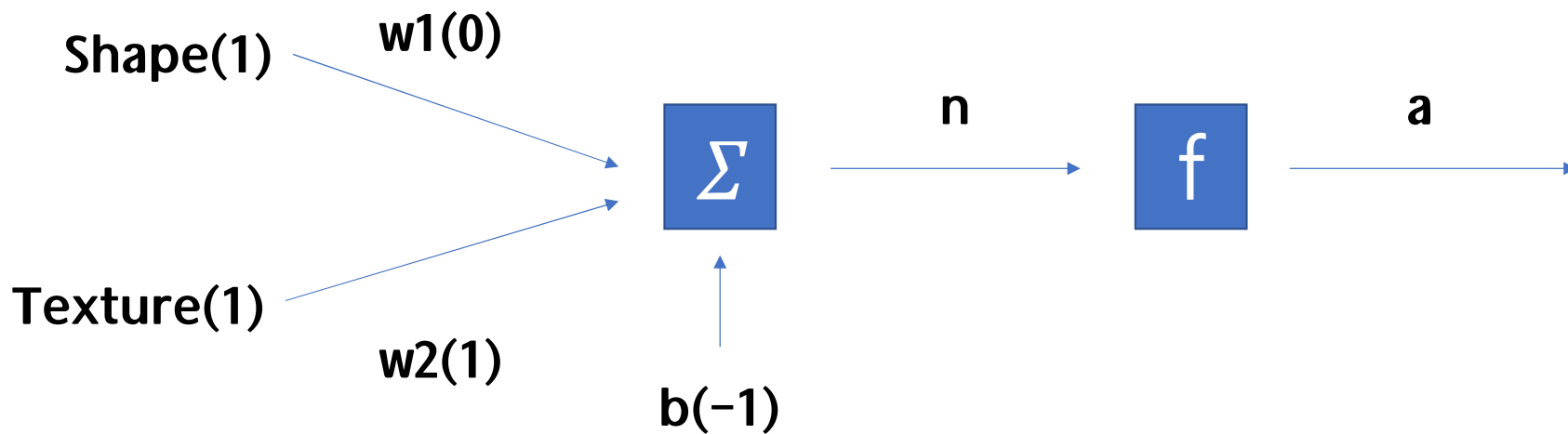
Ball will be present [1,0]

Define output

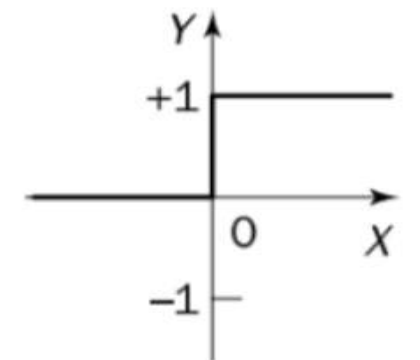
1 = Apple / -1 = Ball

When apple is on hand

$$(0*1)+(1*1)-1=0$$

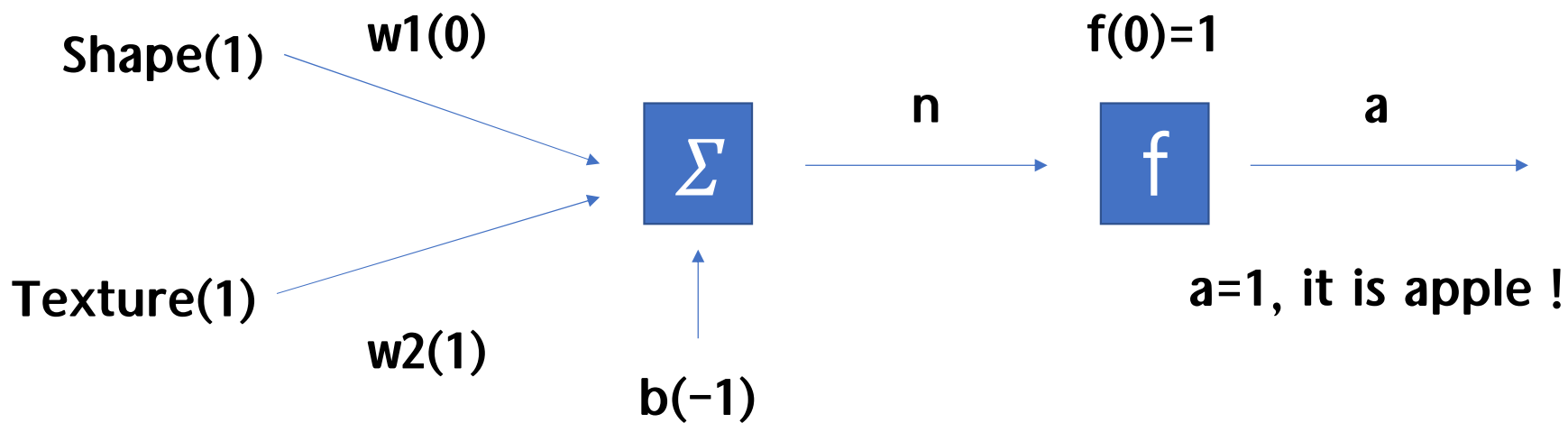


Step function

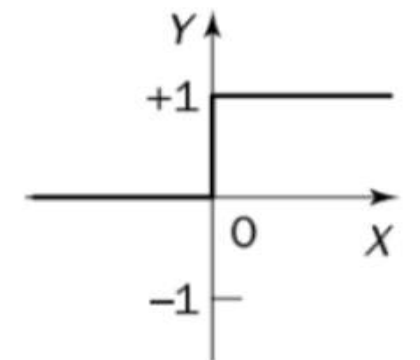


$$Y_{step} = \begin{cases} 1, & \text{if } X \geq 0 \\ 0, & \text{if } X < 0 \end{cases}$$

When apple is on hand



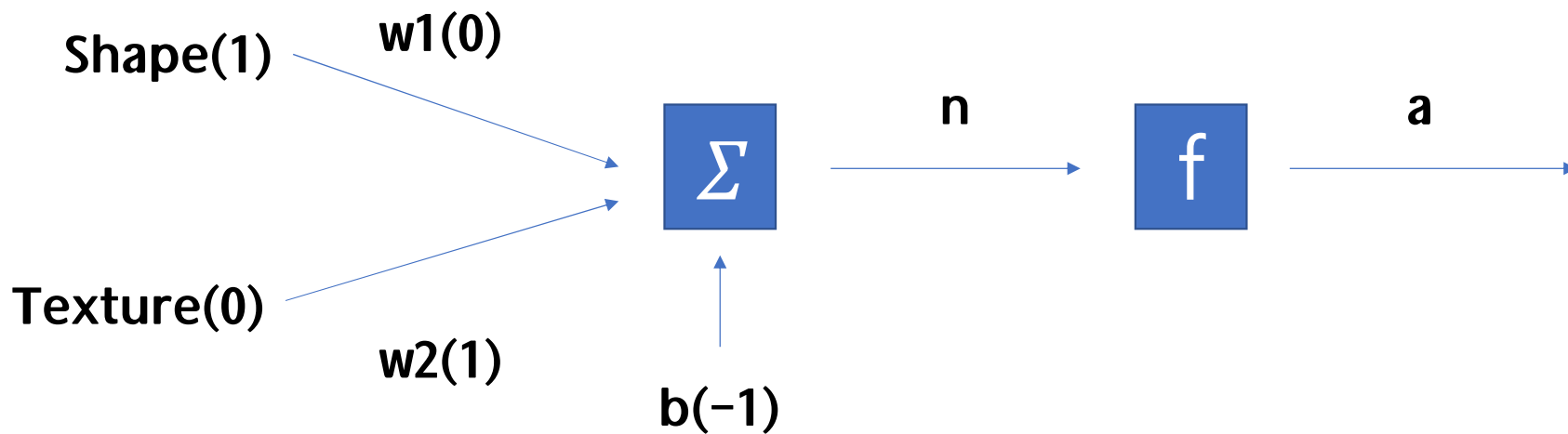
Step function



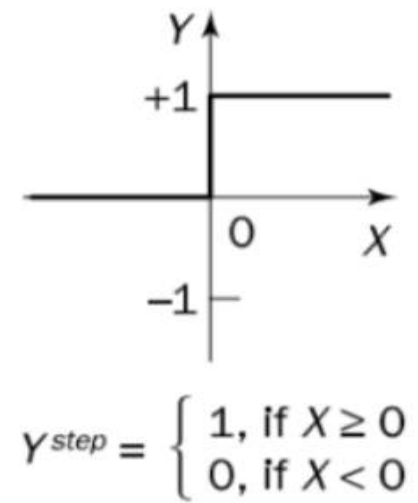
$$Y_{step} = \begin{cases} 1, & \text{if } X \geq 0 \\ 0, & \text{if } X < 0 \end{cases}$$

When ball is on hand

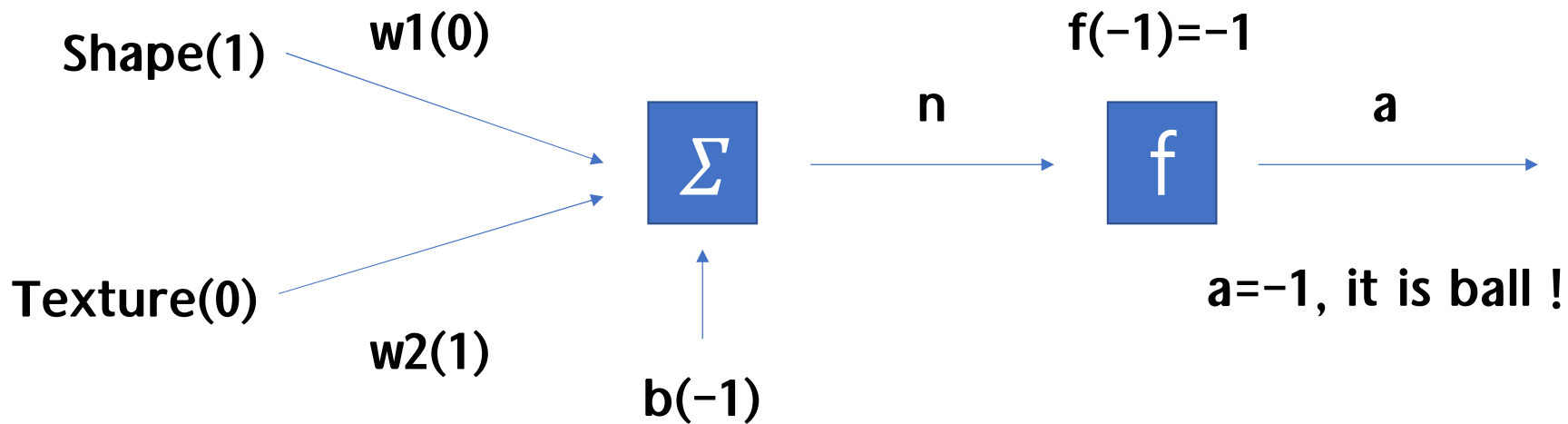
$$(0*1)+(1*0)-1=-1$$



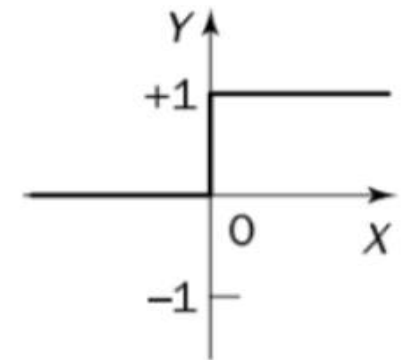
Step function



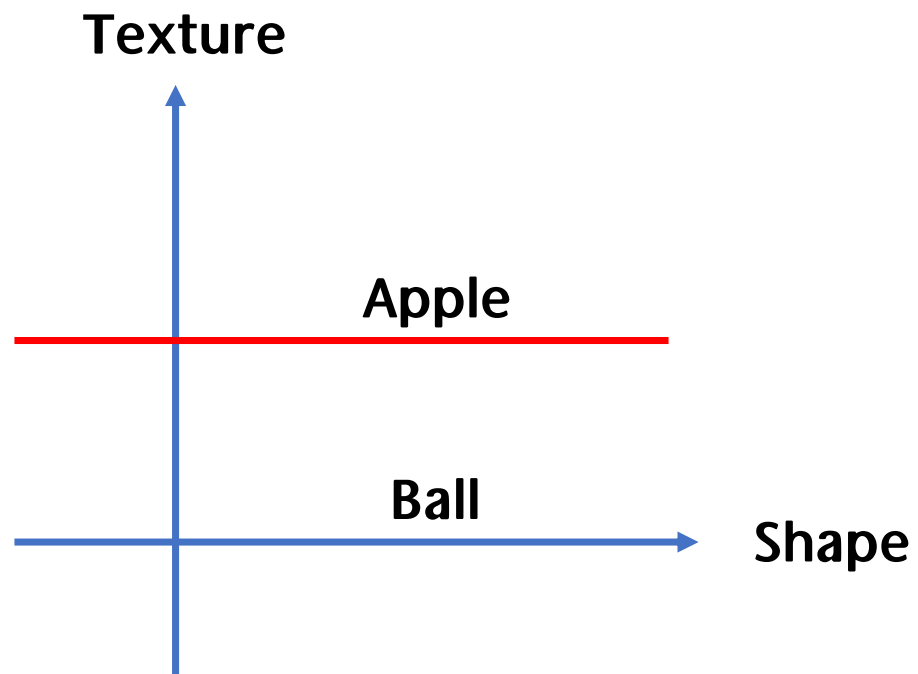
When ball is on hand



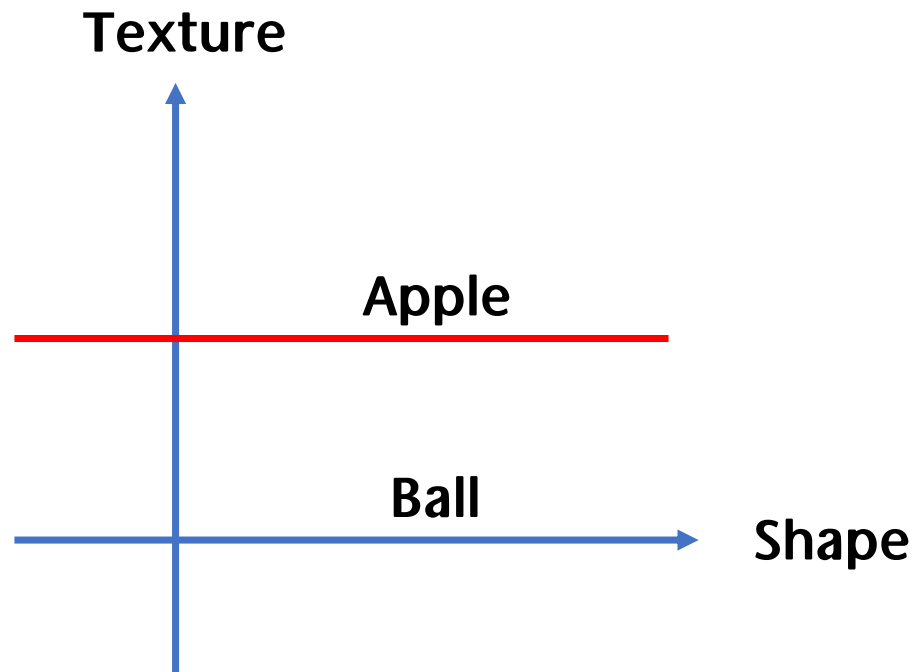
Step function



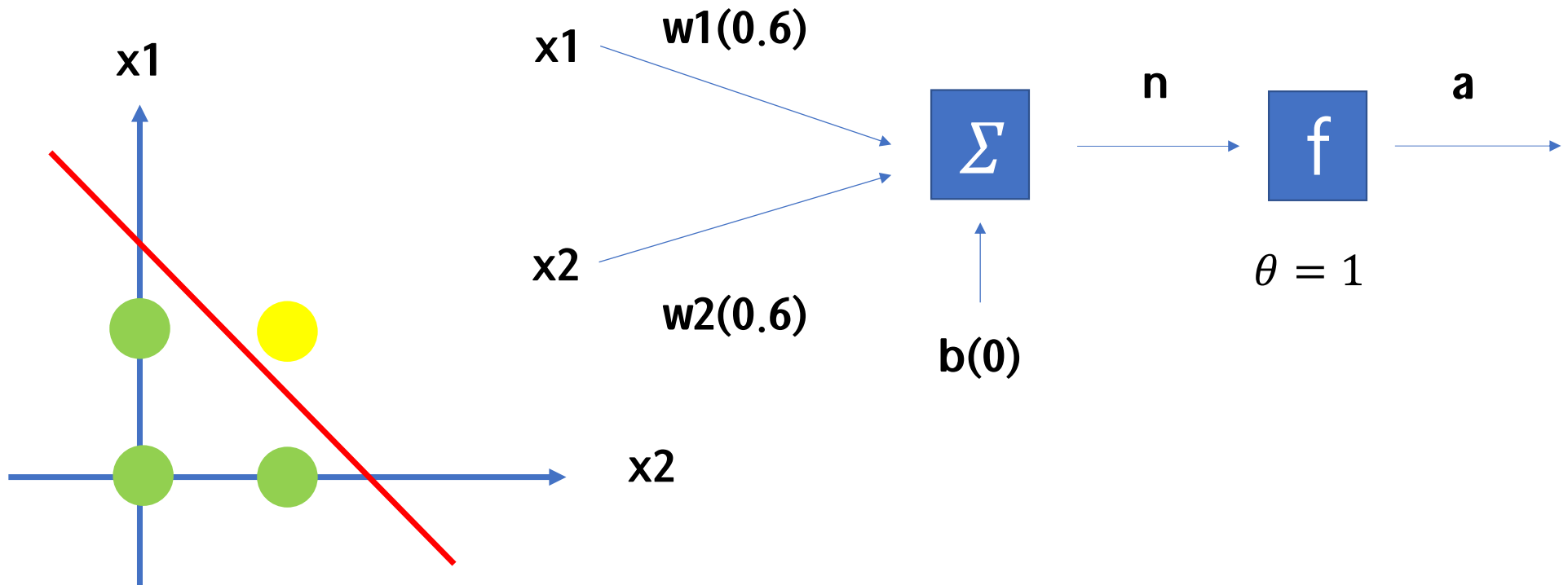
Even not so perfect, example works well



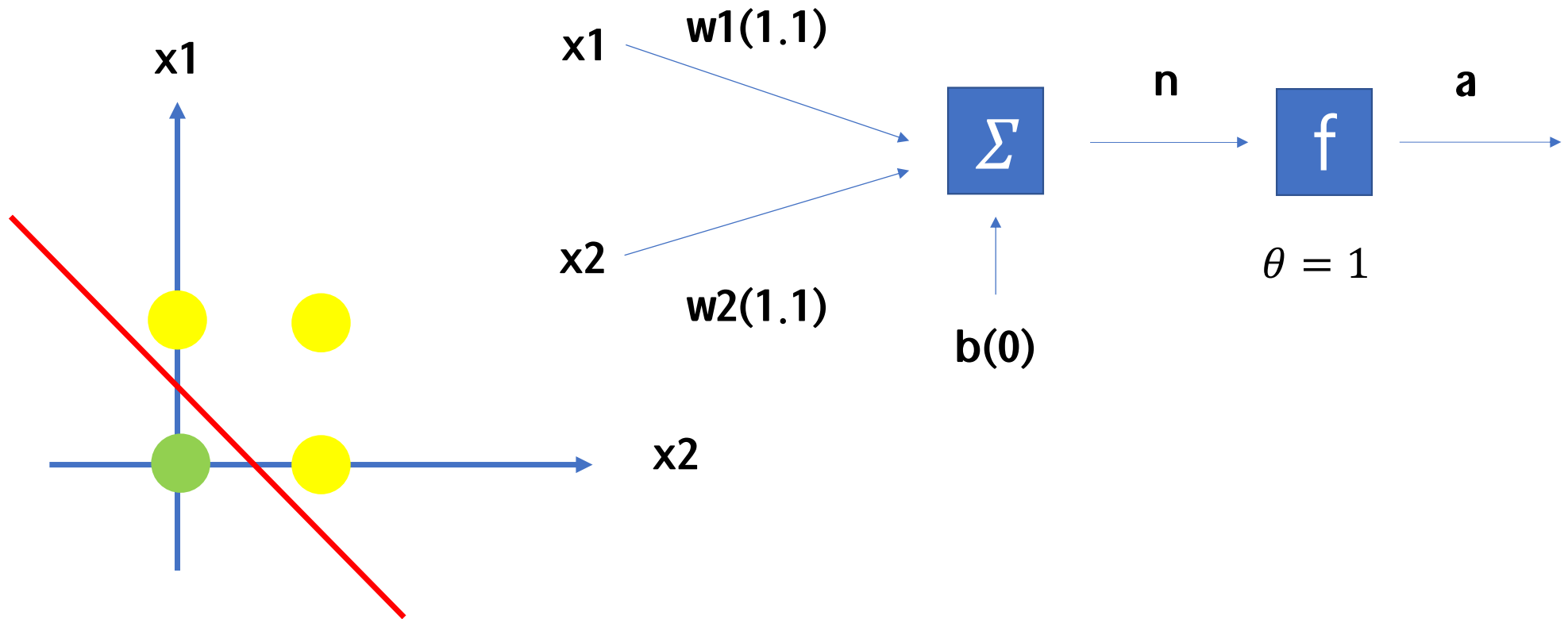
Perceptron only recognize linearly separable pattern



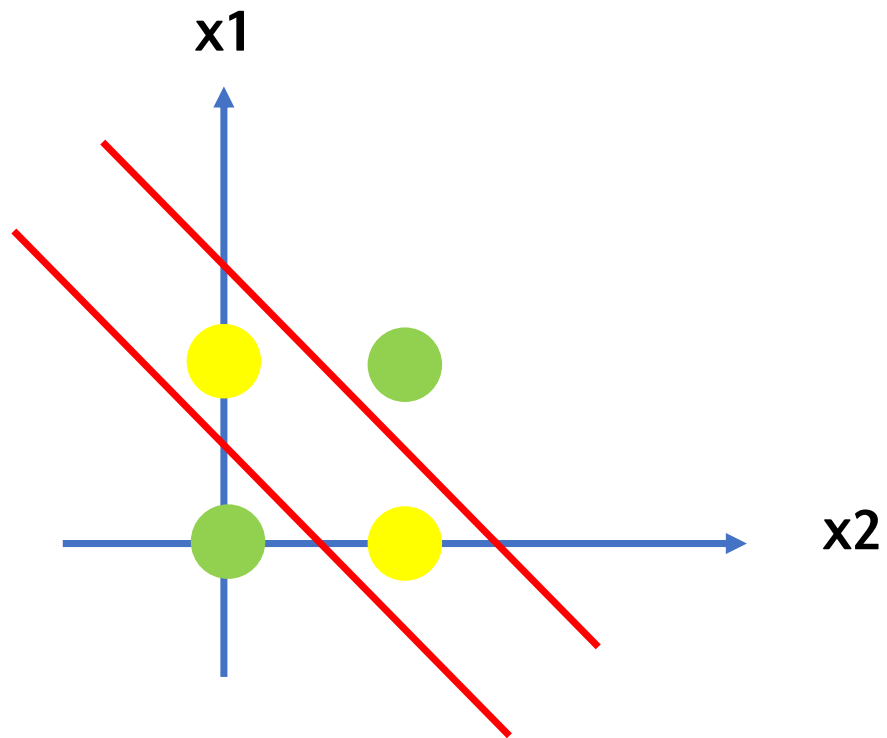
Perceptron works AND operation



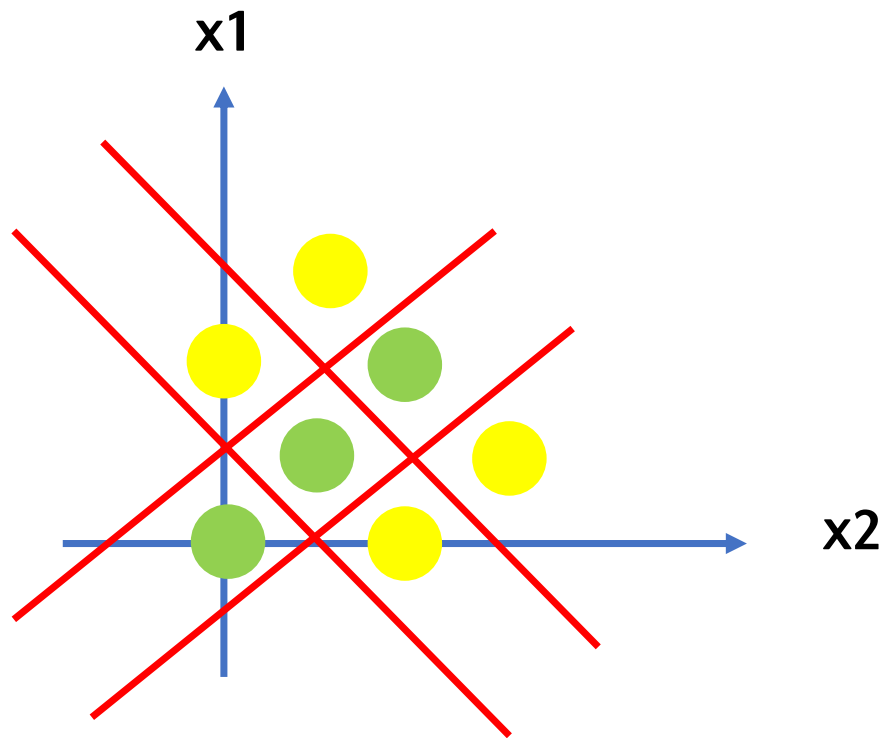
Perceptron works AND operation



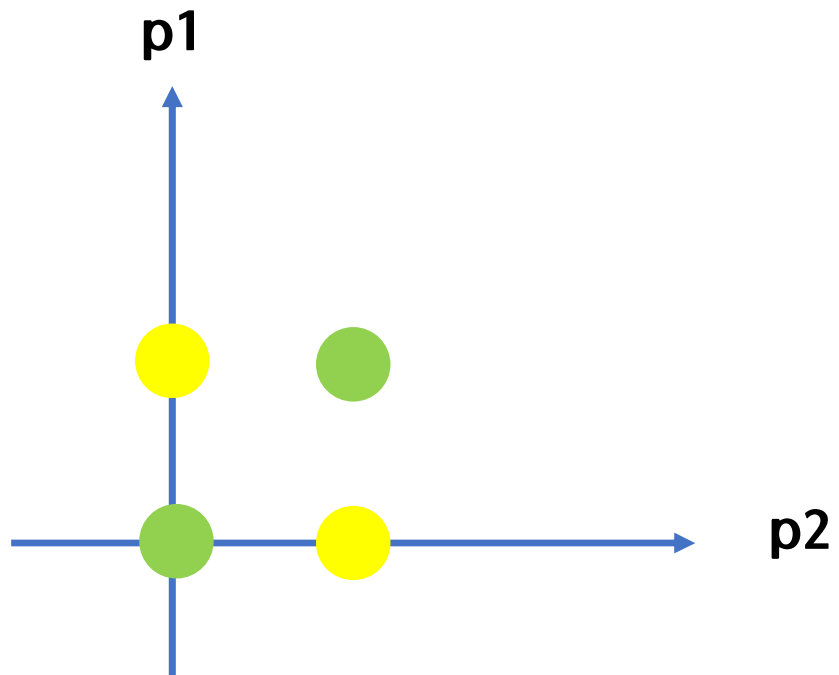
Perceptron NOT works XOR operation



Perceptron NOT works non-linear separable pattern

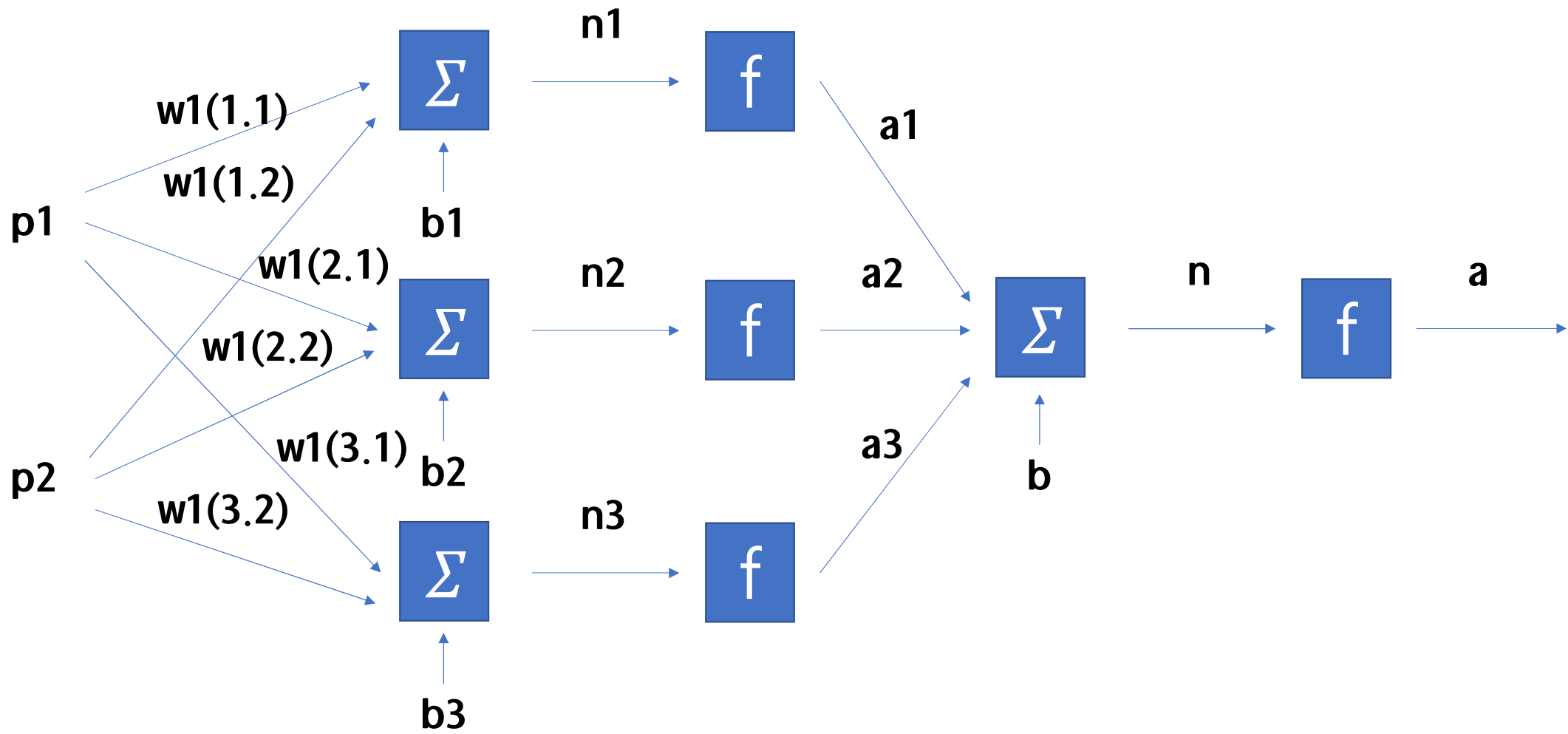


XOR operation

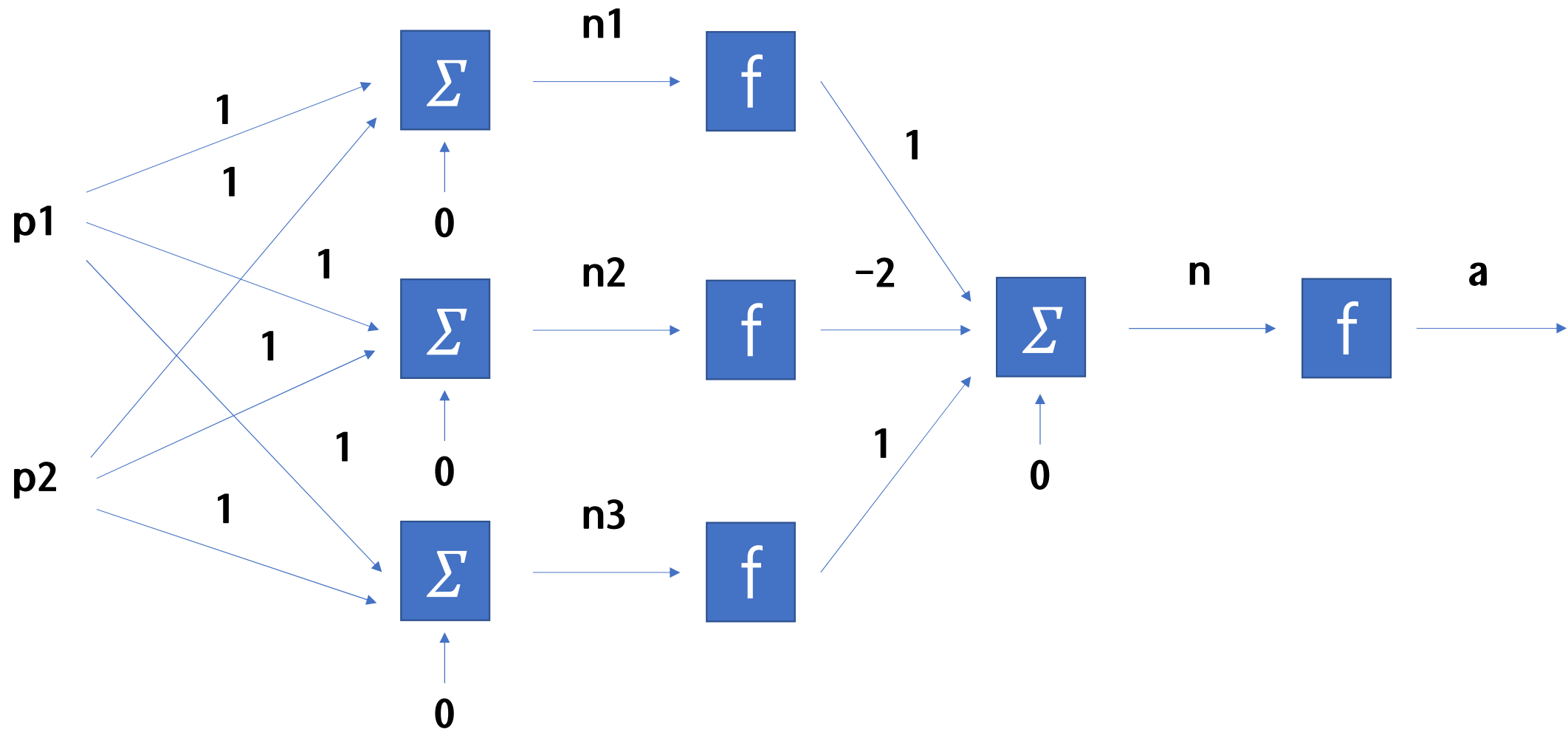


P1	P2	P1 XOR P2
0	0	0
0	1	1
1	0	1
1	1	0

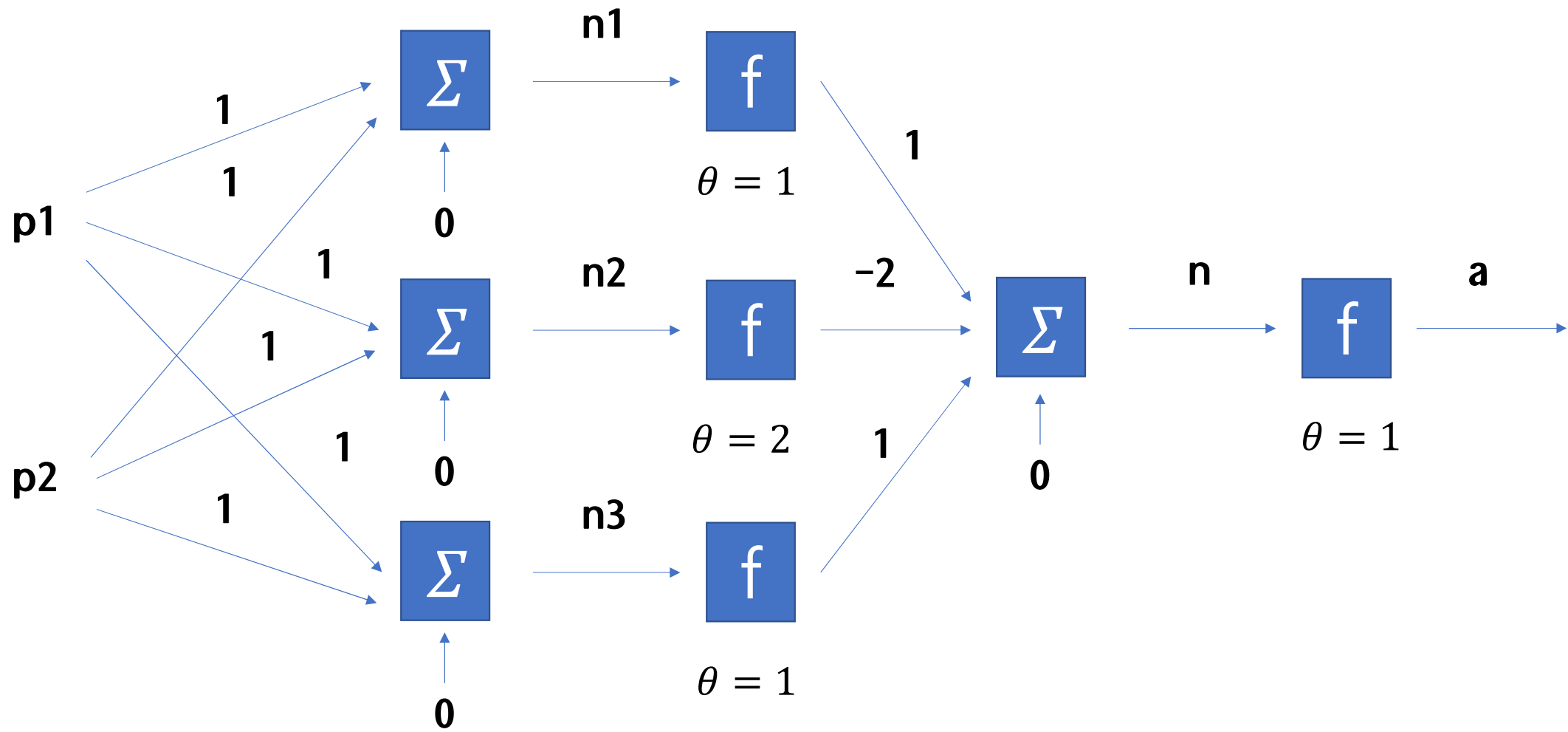
Activation goes next neuron



Assign value on weights

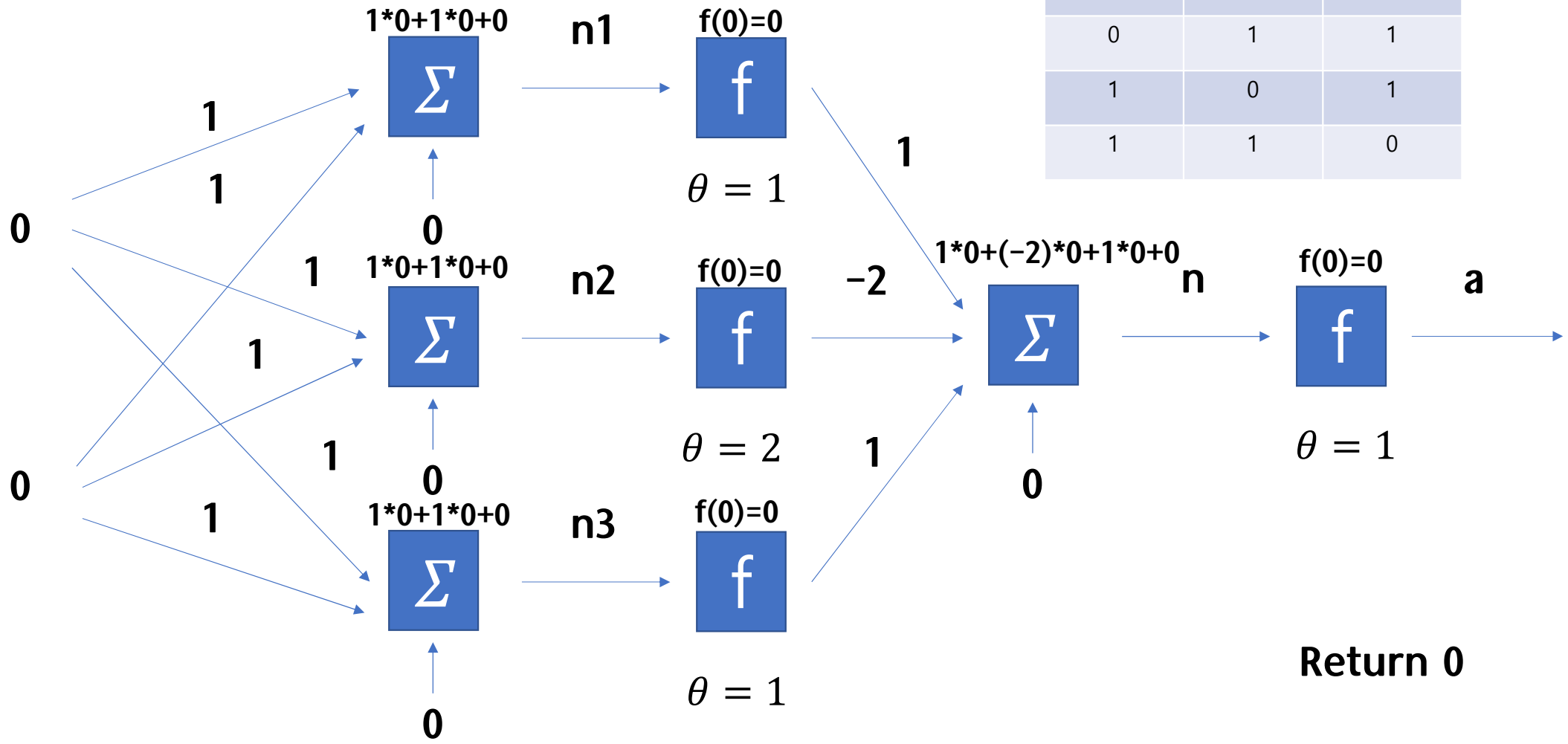


Assign threshold



XOR (0,0)

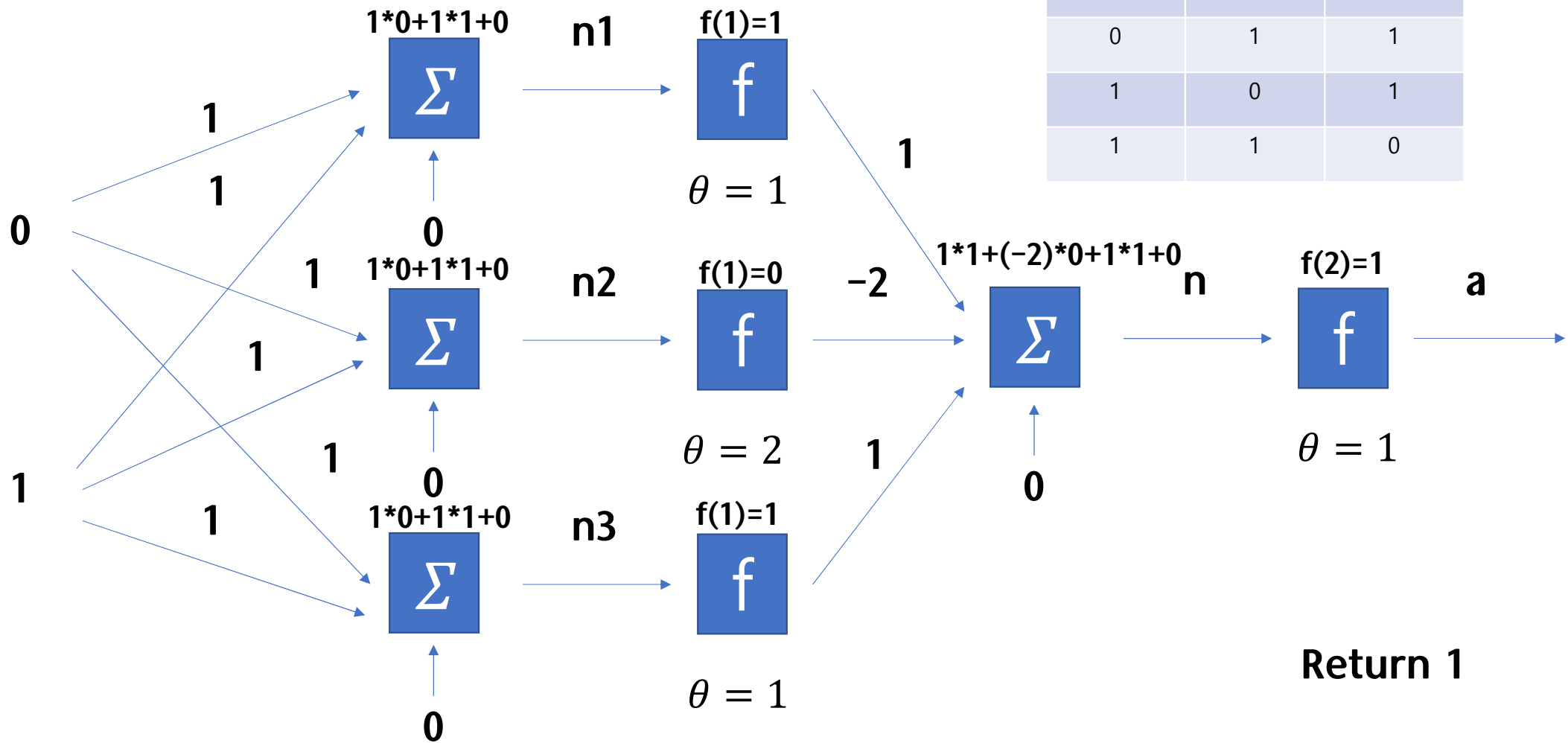
P1	P2	P1 XOR P2
0	0	0
0	1	1
1	0	1
1	1	0



Return 0

XOR (0,1)

P1	P2	P1 XOR P2
0	0	0
0	1	1
1	0	1
1	1	0



Input / Hidden / Output Layer

