

# Problema AND

$P_1$	$P_2$	$P_1 \text{ AND } P_2$
V	V	V
V	F	F
F	V	F
F	F	F

Representación con  $1 \times \emptyset$

$X_1$	$X_2$	y
1	1	1
1	0	0
0	1	0
0	0	0

$$V=1$$

$$F=\emptyset$$

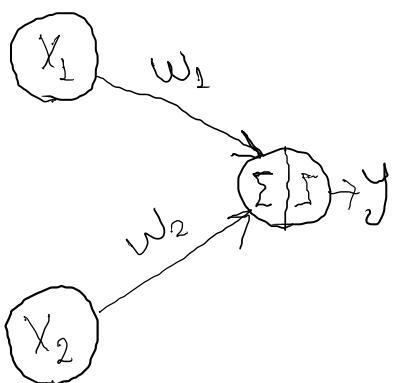
Representación con  $1 \times -1$

$X_1$	$X_2$	y
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

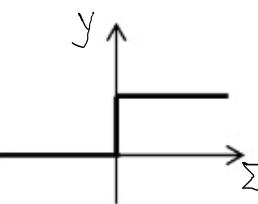
$$V=1$$

$$F=-1$$

Red Neuronal Simple

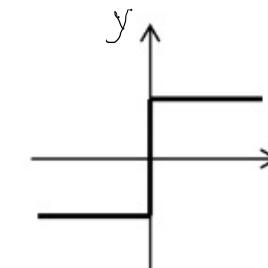


Función Paso



$$y = \begin{cases} 1 & \text{Si } \Sigma > 0 \\ 0 & \text{Si } \Sigma \leq 0 \end{cases}$$

Función Signo



$$y = \begin{cases} 1 & \text{Si } \Sigma > 0 \\ -1 & \text{Si } \Sigma \leq 0 \end{cases}$$

Las funciones en esta red se denominan, funciones de activación o de transferencia

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$X_1$	$X_2$	y
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0	1	0
0	0	0

$$V=1$$

$$F=\emptyset$$

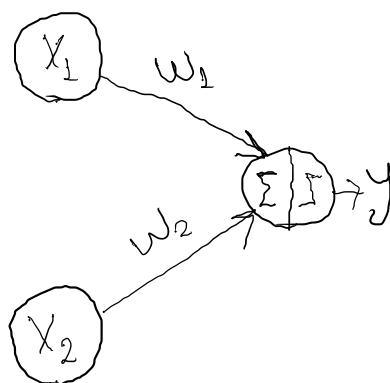
Representación con  $1 \times -1$

$X_1$	$X_2$	y
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

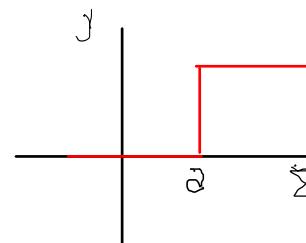
$$V=1$$

$$F=-1$$

Red Neuronal Simple

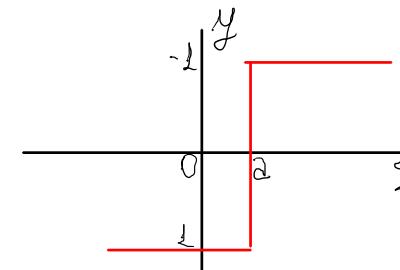


Función Paso



$$y = \begin{cases} 1 & \text{Si } \Sigma > a \\ 0 & \text{Si } \Sigma \leq a \end{cases}$$

Función Signo



$$y = \begin{cases} 1 & \text{Si } \Sigma > 0 \\ -1 & \text{Si } \Sigma \leq 0 \end{cases}$$

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V	F	F
F	V	F
F	F	F

Representación con  $1 \times \emptyset$

$X_1$	$X_2$	y
1	1	1
1	0	0
0	1	0
0	0	0

$$V=1$$

$$F=\emptyset$$

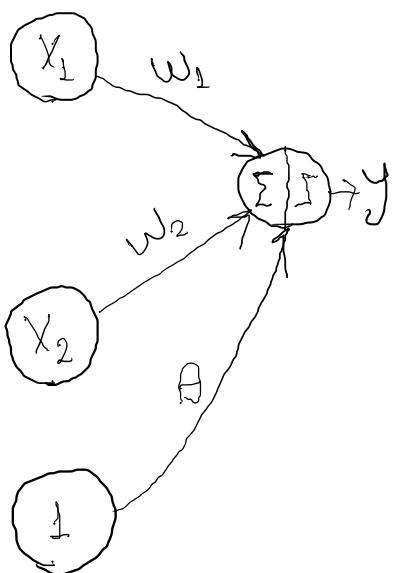
Representación con  $1 \times -1$

$X_1$	$X_2$	y
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

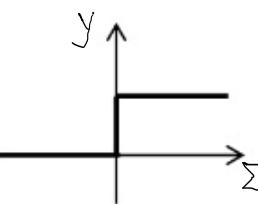
$$V=1$$

$$F=-1$$

Red Neuronal Simple

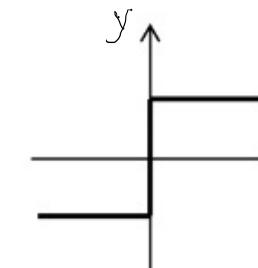


Función Paso



$$y = \begin{cases} 1 & \text{Si } \Sigma > 0 \\ 0 & \text{Si } \Sigma \leq 0 \end{cases}$$

Función Signo



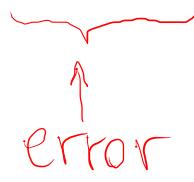
$$y = \begin{cases} 1 & \text{Si } \Sigma > 0 \\ -1 & \text{Si } \Sigma \leq 0 \end{cases}$$

Las funciones en esta red se denominan, funciones de activación o de transferencia

# Algoritmo de aprendizaje para la red neuronal simple

## "Perceptrón Simple"

$$\Delta w_j = \eta [z - y] x$$

 error

$\eta$  = tasa de aprendizaje

$z$  = valor deseado (salida verdadera)

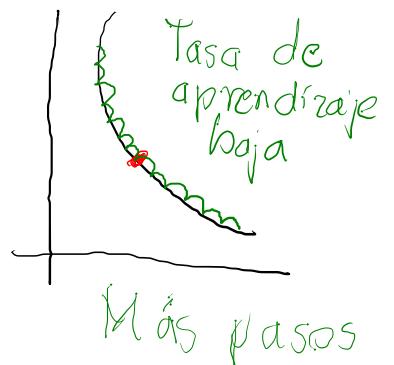
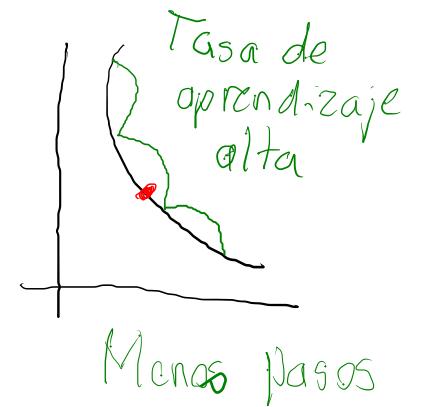
$y$  = valor obtenido

$x$  = entrada asociada al peso

$$\begin{cases} w_j = w_j + \Delta w_j \\ w_j = w_j + \eta [z - y] x \end{cases}$$

$\eta$  tiene un valor entre 0 y 1

error =  $z - y$



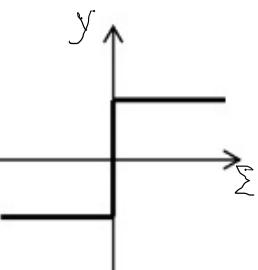
# Problema AND

Representación con  $\begin{pmatrix} 1 & -1 \end{pmatrix}$

$x_1$	$x_2$	$y$
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

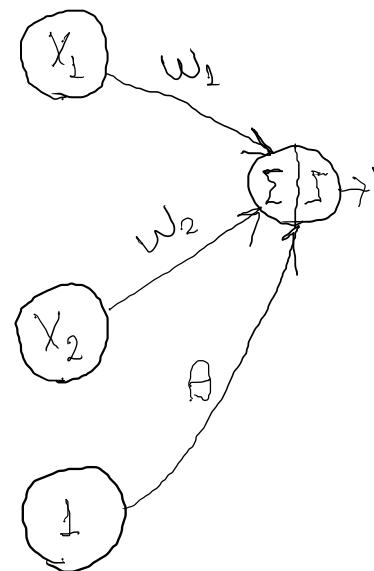
↑  
Conjunto de  
entrenamiento

Función Signo



$$y = \begin{cases} 1 & \text{Si } \Sigma > 0 \\ -1 & \text{Si } \Sigma \leq 0 \end{cases}$$

Red Neuronal Simple



Los pesos se  
inizializan  
aleatoriamente

Por ejemplo:

$$w_1 = 0.50$$

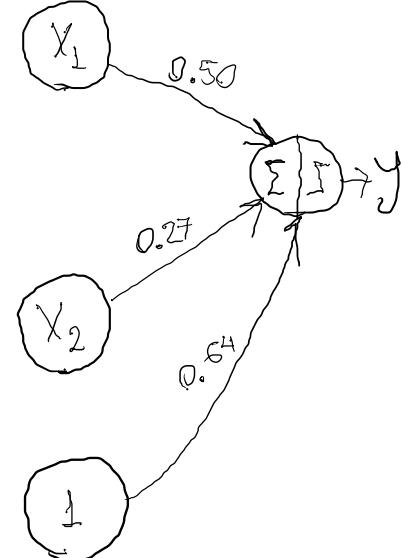
$$w_2 = 0.27$$

$$\theta = 0.64$$

$$w_1 = 0.4975365687586023$$

$$w_2 = 0.2661737230725406$$

$$\text{sesgo} = 0.6374111614436909$$

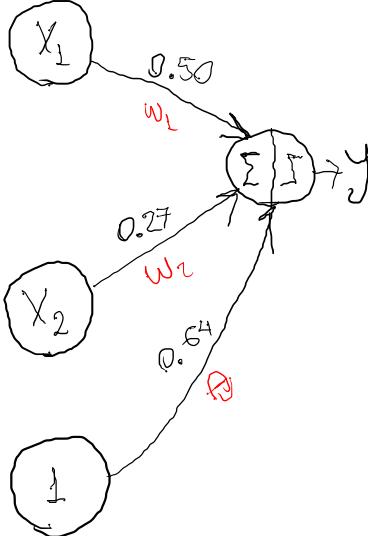


# Problema AND

$$V=1 \quad F=\neg$$

$X_1$	$X_2$	$y$
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

$$\eta = 0.50$$



$$w_1 = 0.4975365687586023 \\ w_2 = 0.2661737230725406 \\ \text{sesgo} = 0.6374111614436909$$

$f = \text{función}$   
 $\text{signo}$

## EPOCA 1

$$x_1 = 1 \quad x_2 = 1 \quad z = 1$$

$$y = f(1 \times 0.50 + 1 \times 0.27 + 1 \times 0.64)$$

$$y = f(1.40) = 1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 0.50 + 0.50[1 - 1]1 = 0.50$$

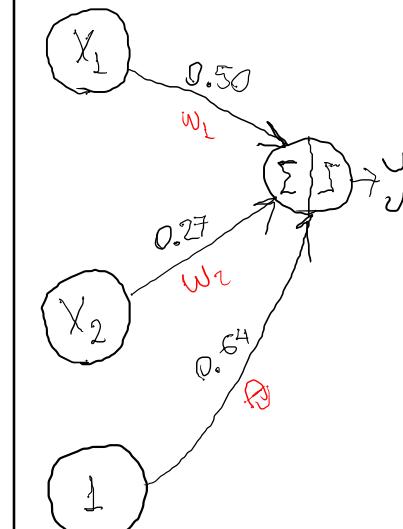
$$w_2 = 0.27 + 0.50[1 - 1]1 = 0.27$$

$$\theta = 0.64 + 0.50[1 - 1]1 = 0.64$$

$$w_1 = 0.50 + 0.50[1 - 1]1 = -0.50$$

$$w_2 = 0.27 + 0.50[1 - 1](-1) = 1.27$$

$$\theta = 0.64 + 0.50[1 - 1]1 = -0.36$$



$$x_1 = 1 \quad x_2 = -1 \quad z = -1$$

$$y = f(1 \times 0.50 - 1 \times 0.27 + 1 \times 0.64)$$

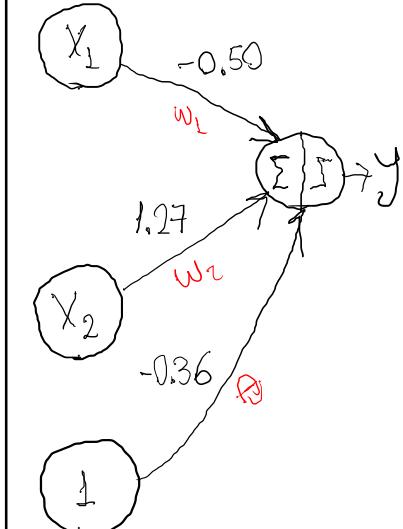
$$y = f(0.87) = 1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 0.50 + 0.50[1 - 1]1 = -0.50$$

$$w_2 = 0.27 + 0.50[1 - 1](-1) = 0.27$$

$$\theta = -0.36 + 0.50[1 - 1]1 = -0.36$$



$$x_1 = -1 \quad x_2 = 1 \quad z = -1$$

$$y = f((-1) \times 0.50 + 1 \times 0.27 + (-1) \times 0.64)$$

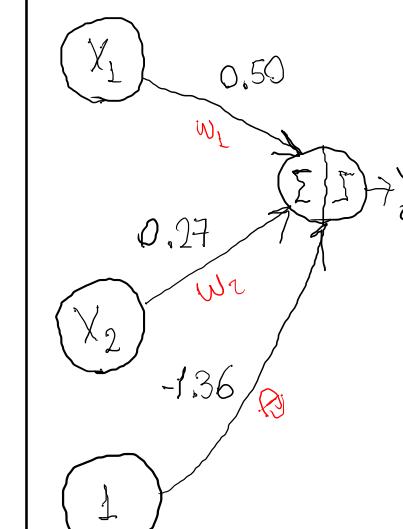
$$y = f(-0.36) = 1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = -0.50 + 0.50[-1 - 1](-1) = 0.50$$

$$w_2 = 0.27 + 0.50[-1 + 1](-1) = 0.27$$

$$\theta = -0.36 + 0.50[-1 + 1]1 = -0.36$$



$$x_1 = -1 \quad x_2 = -1 \quad z = -1$$

$$y = f(1 \times 0.50 - 1 \times 0.27 + (-1) \times 0.64)$$

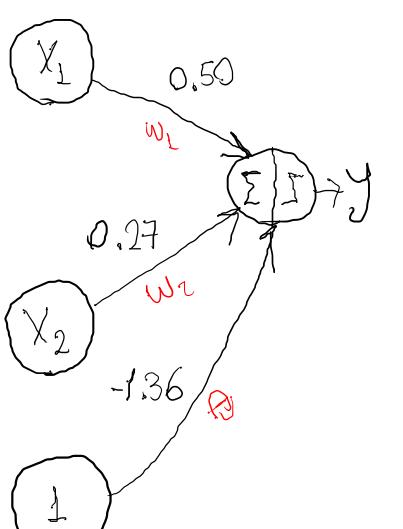
$$y = f(-1.36) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 0.50 + 0.50[1 + 1](-1) = 0.50$$

$$w_2 = 0.27 + 0.50[1 + 1](-1) = 0.27$$

$$\theta = -1.36 + 0.50[1 + 1]1 = -1.36$$

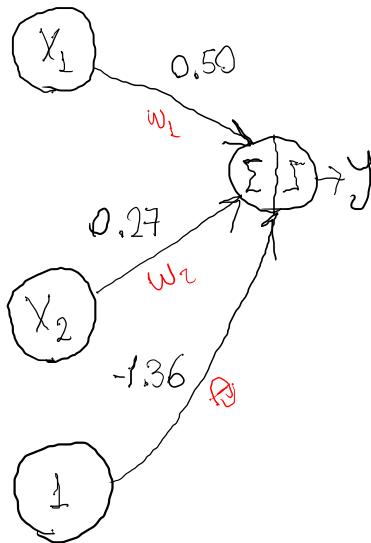


# Problema AND

$$V=1 \quad F=\neg 1$$

$X_1$	$X_2$	$y$
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

$$\eta = 0.50$$



$f =$  función  
signo

## ÉPOCA 2

$$x_1 = 1 \quad x_2 = 1 \quad z = 1$$

$$y = f(1 \times 0.50 + 1 \times 0.27 + 1 \times (-1.36))$$

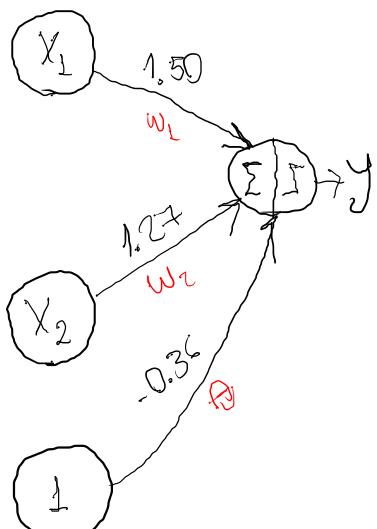
$$y = f(-0.60) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 0.50 + 0.50 [1 + 1] 1 = 1.50$$

$$w_2 = 0.27 + 0.50 [1 + 1] 1 = 1.27$$

$$\theta = -1.36 + 0.50 [1 + 1] 1 = -0.36$$



$$x_1 = 1 \quad x_2 = -1 \quad z = -1$$

$$y = f(1 \times 1.50 - 1 \times 1.27 + 1 \times (-0.36))$$

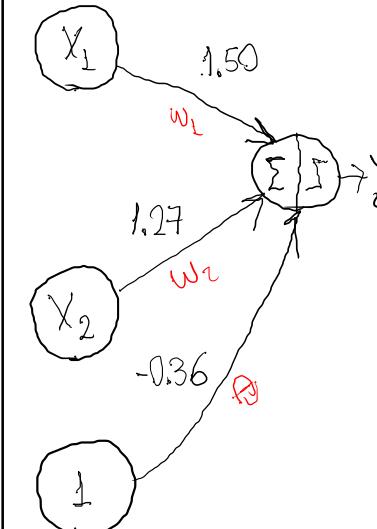
$$y = f(-0.13) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 + 1] 1 = 1.50$$

$$w_2 = 1.27 + 0.50 [1 + 1] (-1) = 1.27$$

$$\theta = -0.36 + 0.50 [1 + 1] 1 = -0.36$$



$$x_1 = -1 \quad x_2 = 1 \quad z = -1$$

$$y = f((-1)(1.50) + 1 \times 1.27 + (-1)(-0.36))$$

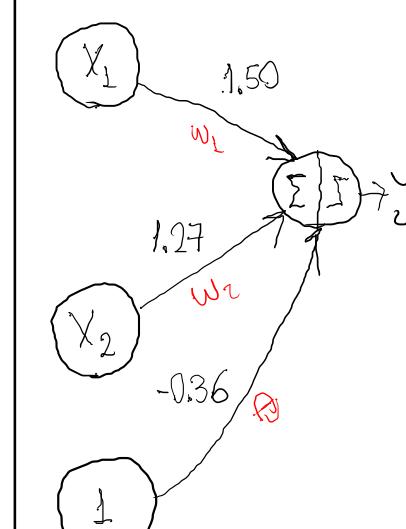
$$y = f(-0.59) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 + 1] (-1) = 1.50$$

$$w_2 = 1.27 + 0.50 [1 + 1] (1) = 1.27$$

$$\theta = -0.36 + 0.50 [1 + 1] 1 = -0.36$$



$$x_1 = -1 \quad x_2 = -1 \quad z = -1$$

$$y = f((-1)(1.50) - 1 \times 1.27 + (-1)(-0.36))$$

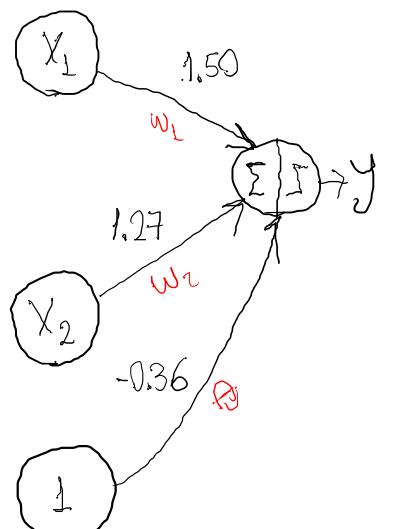
$$y = f(-3.13) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 + 1] (-1) = 1.50$$

$$w_2 = 1.27 + 0.50 [1 + 1] (-1) = 1.27$$

$$\theta = -0.36 + 0.50 [1 + 1] 1 = -0.36$$

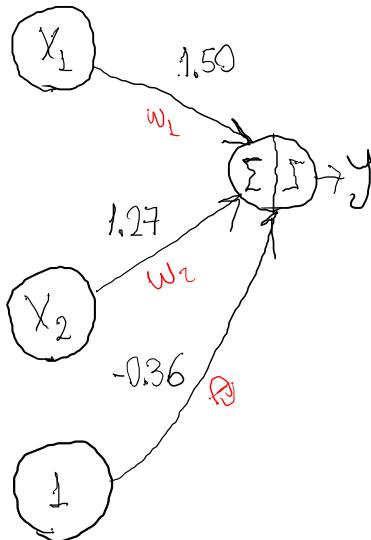


# Problema AND

$$V=1 \quad F=\neg 1$$

$X_1$	$X_2$	$y$
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

$$\eta = 0.50$$



ÉPOCA 3

$$x_1 = 1 \quad x_2 = 1 \quad z = 1$$

$$y = f(1 \times 0.50 + 1 \times 1.27 + 1(-0.36))$$

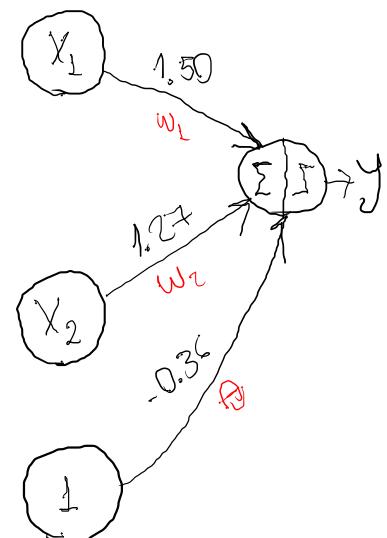
$$y = f(2.40) = 1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 - 1] 1 = 1.50$$

$$w_2 = 1.27 + 0.50 [1 - 1] 1 = 1.27$$

$$\theta = -0.36 + 0.50 [1 - 1] 1 = -0.36$$



En la época 3 los pesos no cambian.

$f$  = función signo

$$x_1 = 1 \quad x_2 = -1 \quad z = -1$$

$$y = f(1 \times 1.50 - 1 \times 1.27 + 1(-0.36))$$

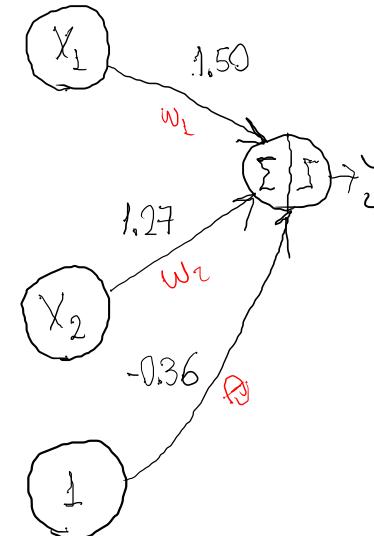
$$y = f(-0.13) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 - (-1)] 1 = 1.50$$

$$w_2 = 1.27 + 0.50 [1 - (-1)] 1 = 1.27$$

$$\theta = -0.36 + 0.50 [1 - (-1)] 1 = -0.36$$



$$x_1 = -1 \quad x_2 = 1 \quad z = -1$$

$$y = f((-1)(1.50) + 1 \times 1.27 + (-1)(-0.36))$$

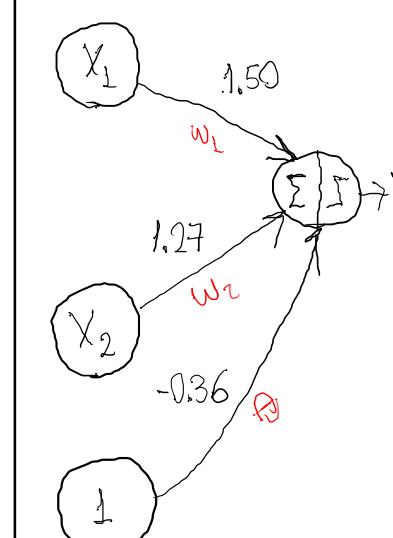
$$y = f(-0.59) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 - (-1)] (-1) = 1.50$$

$$w_2 = 1.27 + 0.50 [1 - (-1)] (-1) = 1.27$$

$$\theta = -0.36 + 0.50 [1 - (-1)] (-1) = -0.36$$



$$x_1 = -1 \quad x_2 = -1 \quad z = -1$$

$$y = f((-1)(1.50) - 1 \times 1.27 + (-1)(-0.36))$$

$$y = f(-3.13) = -1$$

$$w_i = w_i + \eta [z - y] x_i$$

$$w_1 = 1.50 + 0.50 [1 - (-1)] (-1) = 1.50$$

$$w_2 = 1.27 + 0.50 [1 - (-1)] (-1) = 1.27$$

$$\theta = -0.36 + 0.50 [1 - (-1)] (-1) = -0.36$$

