Perceptron

Single Layer

Multi Layer

AND Gate

OR Gate

XOR Gate

Multi Layer more neurons

Single Layer

AND

x_1	x_2	Y
0	0	0
0	1	0
1	0	0
1	1	1

OR

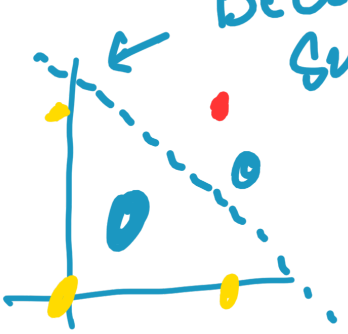
x_1	x_2	Y
0	0	0
0	1	1
1	0	1
1	1	1

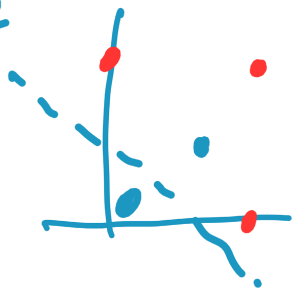
XOR

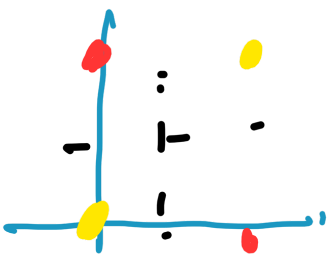
x_1	x_2	Y
0	0	0
0	1	1
1	0	1
1	1	0

$x_1\bar{x}_2 + \bar{x}_1 x_2$

Decision Surface







Linearly Seperable

?

Can we have a "linear" decision surface ?

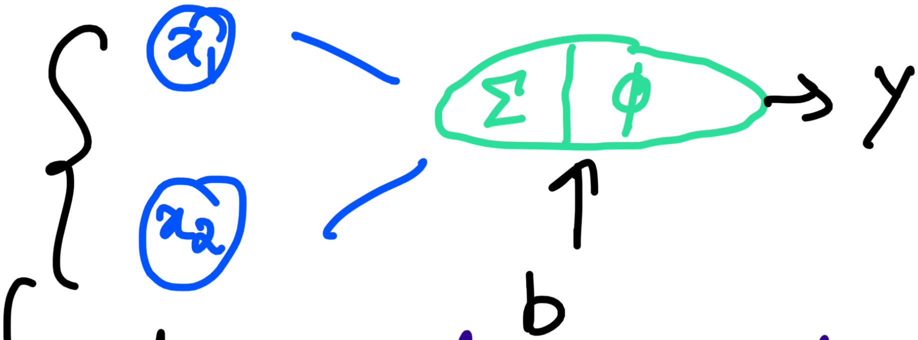
x

Linear Decision Surface

xor

class 1 | cl

Single Perceptron



i/p   Single Layer   o/p

i/p

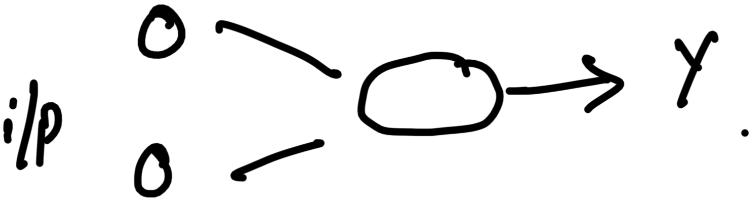
1 perceptron / 1 neuron

Σ → weighted summation

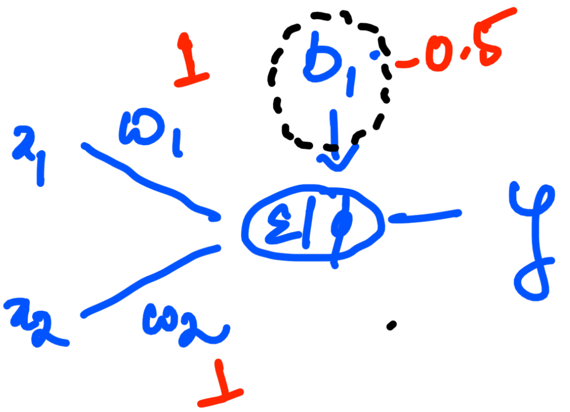
φ → transfer function

b → bias.

y → o/p



Perceptron OR gate



x_1	x_2	y
0	0	0
0	1	1
1	0	1
1	1	1

Supervised (Y)

4 samples

2 attributes/dimension

$$\Sigma = (x_1 w_1 + x_2 w_2 + b)$$

$$y = \phi(\Sigma)$$

$w_1 = 1$ $\quad b_1 = -0.5$

$w_2 = 1$

$x_1 = 0 \quad x_2 = 0$

$$x_1 \times w_1 + x_2 \times w_2 + b_1$$

$$0 \times 1 + 0 \times 1 + -0.5$$

$$= -0.5$$

$$y = \phi(-0.5)$$

$$= 0$$

ϕ transfer

$$y = \begin{cases} 0 & w.x + b < 0 \\ 1 & w.x + b \geq 0 \end{cases}$$

Threshold

$x_1 = 0 \quad x_2 = 1$

$$x_1 w_1 + x_2 w_2 + b_1$$

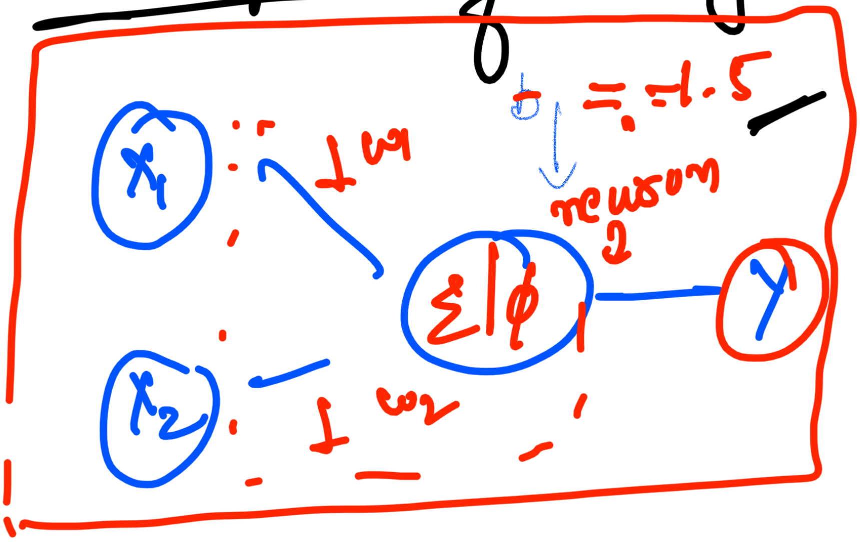
$$= 0 \times 1 + 1 \times 1 - 0.5$$

$$= 0.5$$

$$y = \phi(0.5)$$

$$= 1$$

Perceptron of AND gate



x_1	x_2	y
0	0	0
0	1	0
1	0	0
1	1	1

$w_1 = 1$ $\quad b_1 = -1.5$

$w_2 = 1$

$x_1 = 0 \quad x_2 = 0$

$x_1 w_1 + x_2 w_2 + b_1$

$0 \times 1 + 0 \times 1 + -1.5$

$= -1.5$

$y = \phi(-1.5)$

$= 0$

$x_1 = 1 \quad x_2 = 1$

$x_1 w_1 + x_2 w_2 + b_1$

$= 1 \times 1 + 1 \times 1 + (-1.5)$

$= 0.5$

$y = \phi(0.5)$

$= 1$

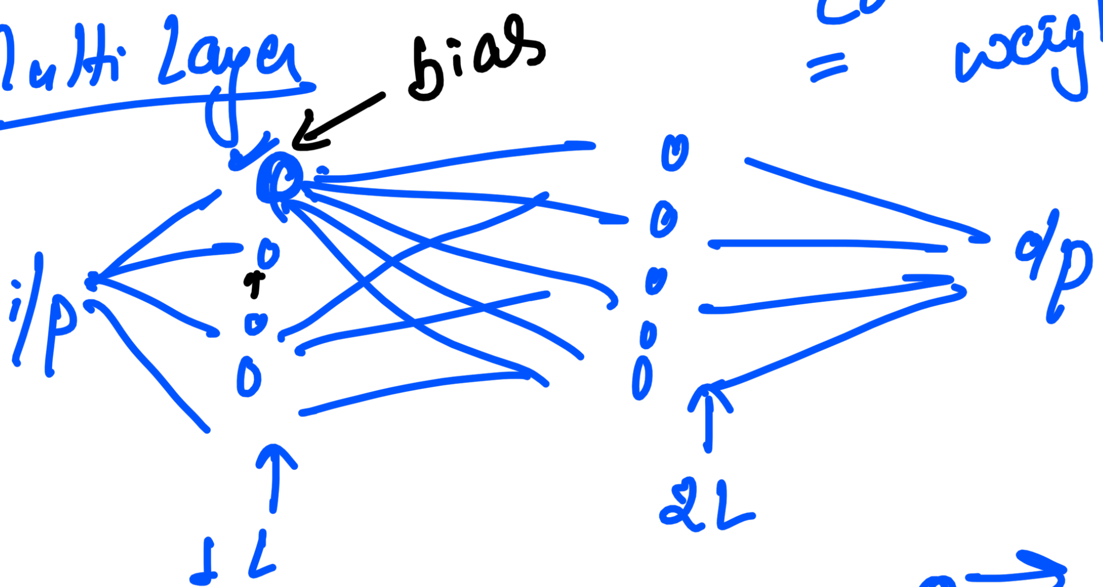
Single Layer

i/p   o/p

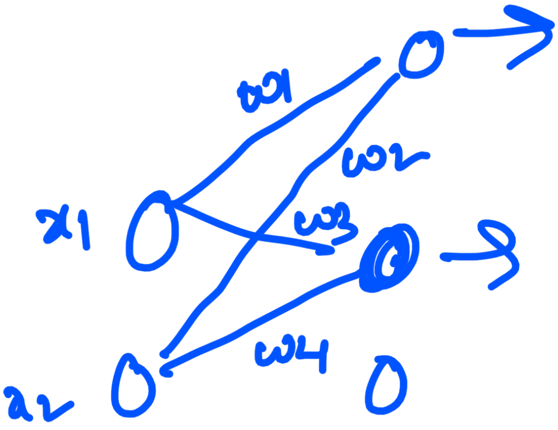
1 Layer
Hidden Layer

connection
= weights

Multi Layer



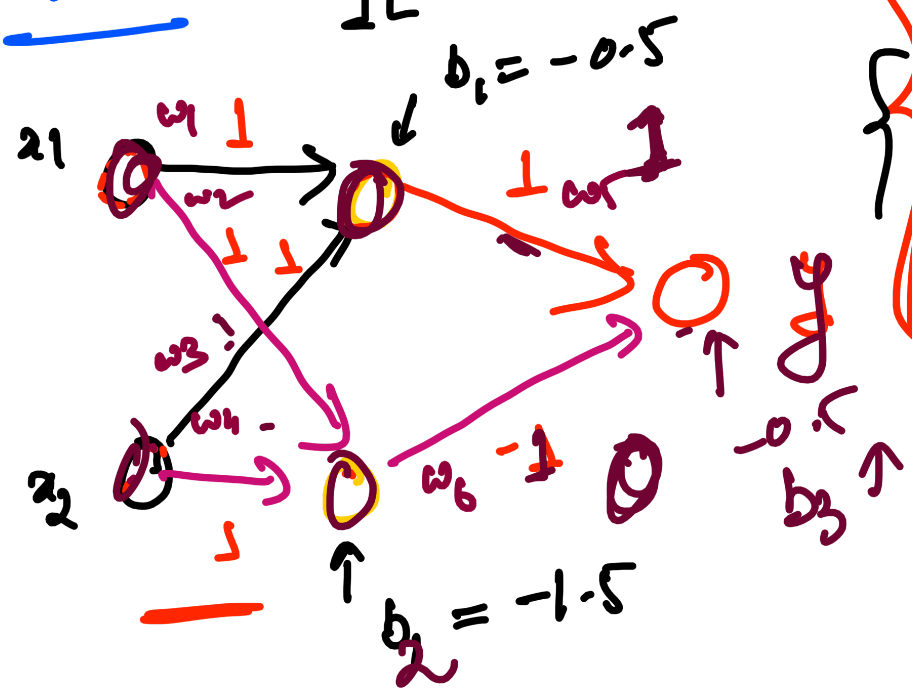
$\Sigma \mid \phi$



$$\phi(x_1 w_1 + x_2 w_2)$$

$$\phi(x_1 w_3 + x_2 w_4)$$

XOR



x_1	x_2	y
0	0	0
0	1	1
1	0	1
1	1	0

$\Sigma \mid \phi$

$$y = \begin{cases} 0 & w.x + b \leq 0 \\ 1 & w.x + b > 0 \end{cases}$$

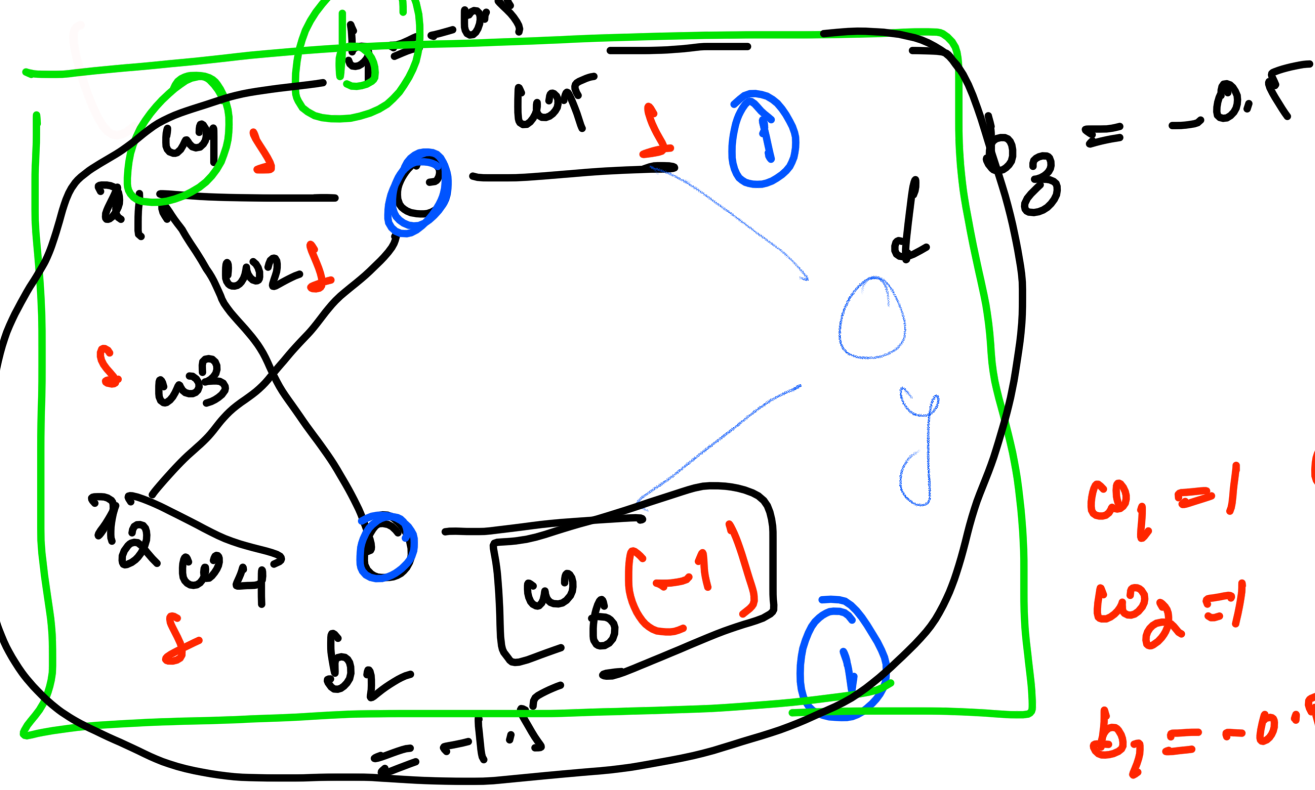
$x_1 = 0 \quad x_2 = 1$

$$\phi(x_1 w_1 + x_2 w_2 + b_1)$$
$$= \phi(0 \times 1 + 1 \times 1 + -0.5)$$
$$= \phi(0.5) = 1$$

$x_1 = 0 \quad x_2 = 1$

$$\phi(x_1 w_3 + x_2 w_4 + b_2)$$
$$= \phi(0 \times 1 + 1 \times 1 - 1.5)$$
$$= \phi(-0.5)$$
$$= 0$$

$$\phi\ 1 \times w_5 + 0 \times w_6 + -0.5$$
$$= 1 \times 1 + 0 \times (-1) + (-0.5)$$
$$= 1 - 0.5$$
$$\phi(0.5) = 1$$



$w_1 = 1$ $\quad w_3 = 1$

$w_2 = 1$ $\quad w_4 = 1$

$b_1 = -0.5$

$b_2 = -1.5$

$w_5 = 1$ $\quad b_3 = -0.5$

$w_6 = -1$

$x_1 = 1 \qquad x_2 = 1$

$$\phi(x_1 w_1 + x_2 w_2 + b_1)$$

$$\phi(1 \times 1 + 1 \times 1 + -0.5)$$

$$= \phi(1.5)$$

$$= 1$$

$$\phi(x_1 w_3 + x_2 w_4 + b_2)$$

$$= \phi(1 \times 1 + 1 \times 1 + -1.5)$$

$$= \phi(0.5)$$

$$= 1$$

$$\phi(1 \times w_5 + 1 \times w_6 + b_3)$$

$$= \phi(1 \times 1 + 1 \times (-1) + (-0.5))$$

$$=$$

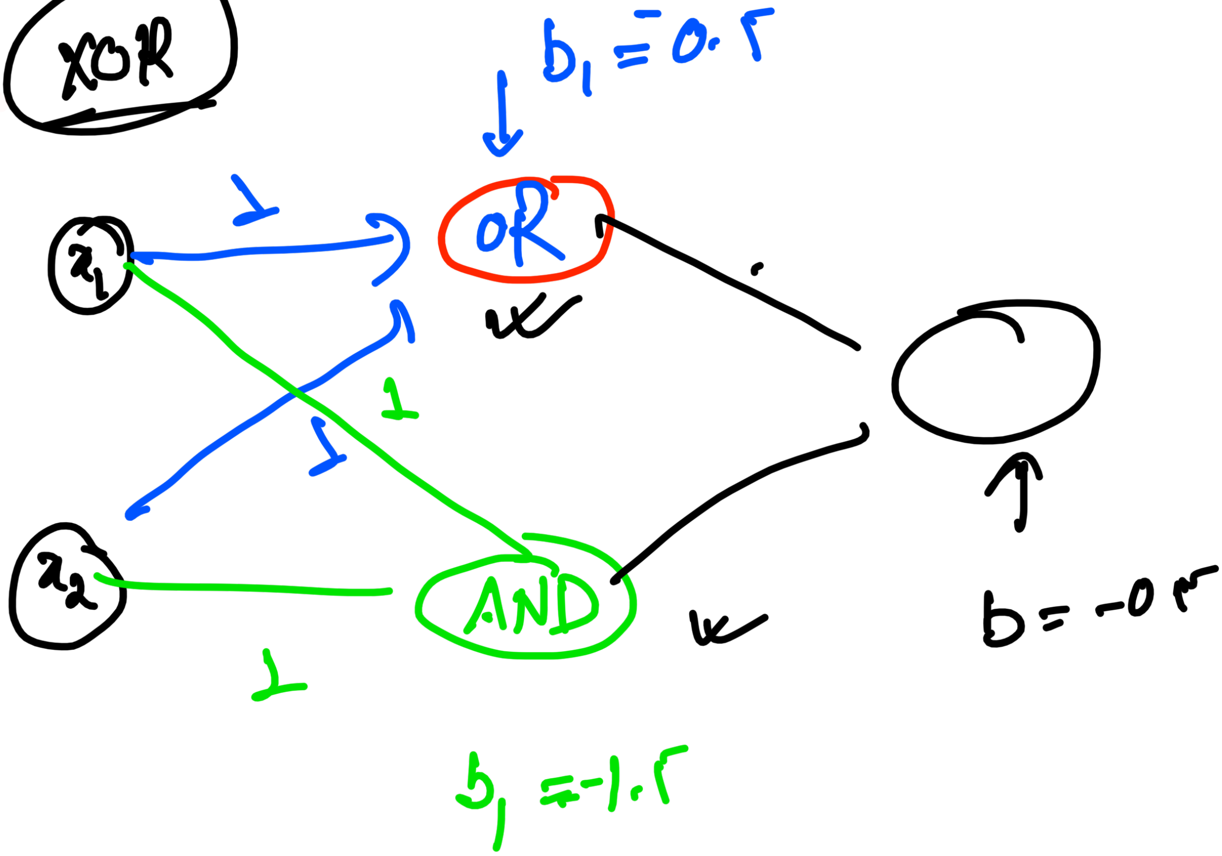
$= \phi(-0.1)$

$= 0$

weight = learnable parameter

random numbers

XOR



MNIST

cat dog