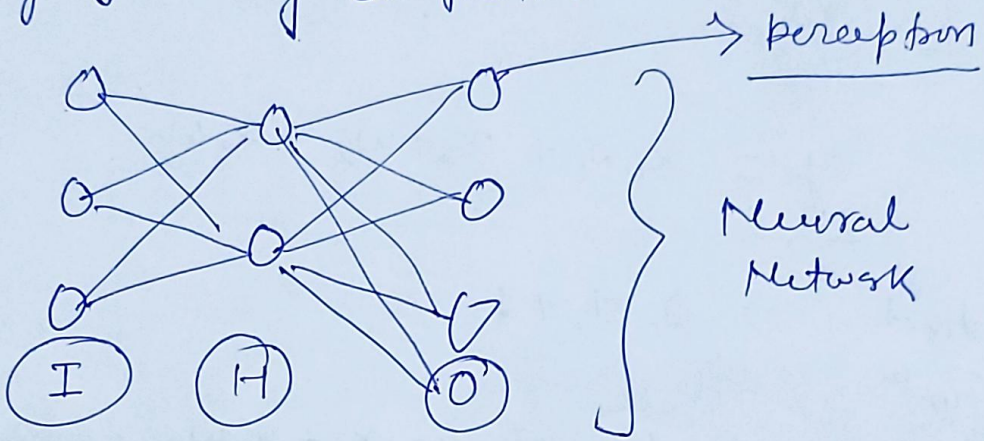
Perceptron / multi layer perceptron

→ Perceptron is the basic unit of a neural Network.

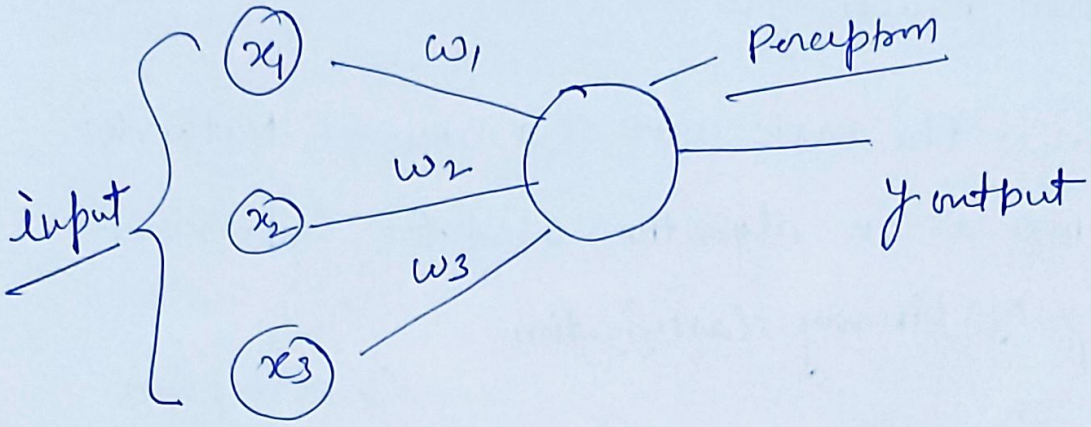
→ A perceptron is an algorithm used for Supervised learning of binary classification.



→ working / math / unit

→ In short a perceptron is a single neuron of a neural Network.

→ A perceptron takes a vector of real valued inputs. , Calculated a linear combination of these input then outputs a 1 if the result is greater than some threshold & -1 or 0 otherwise.



$$y = x_1 w_1 + x_2 w_2 + x_3 w_3$$ 0, -1, +1

Activation ⇒ 0, -1, +1

Fun^n.

$$\begin{cases} 1 & \text{if } w_1 x_1 + x_2 w_2 \dots w_n x_n > 0 \\ -1 & \text{otherwise} \end{cases}$$

Signed Activation Function

AND / OR

0	0	0
0	1	0
1	0	0
1	1	1

$$\begin{cases} 1 & \text{if } w_1 x_1 + x_2 w_2 \dots w_n x_n > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$w_i = w_i + \Delta w_i$$

$$\Delta w_i = \eta (t - o) x_i$$

t → Target, o → actual, η → learning rate, x_i → input

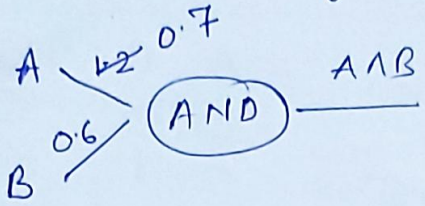
AND Gate using perceptron:

A	B	A∧B
0	0	0
0	1	0
1	0	0
1	1	1

Given $w_1 = 1.2$ $w_2 = 0.6$

Threshold = 1

learning rate : - 0.5



$\geq 1 = 1$

$< 1 = 0$

$w_1 x_1 + w_2 x_2 = w_i x_i$

1) $0 \times 1.2 + 0 \cdot 0.6 = \overline{0}$

2) $0 \times 1.2 + 1 \times 0.6 = 0.6 = \overline{0}$

3) $1 \times 1.2 + 0 = 1.2 \geq 1.2 = 1$ ×

$$w_i = w_i + \eta(t-o)x_i$$

$$w_i = 1.2 + 0.5(0-1)A$$

$$w_1 = 1.2 + 0.5(0-1)\cdot 1$$

$$= 0.7$$

$$w_2 = 0.6 + 0.5(0-1)0 = 0.6$$

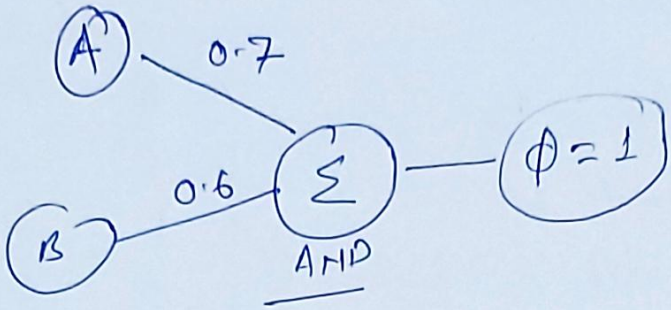
$w_1 = 0.7$ $w_2 = 0.6$

$0 + 0 = 0$

$0 + 0 = 0$

$0 + 0 = 0$

$0.7 + 0.6 = 1.3$



OR Gate Perceptron:-

$w_1 = 0.6 \quad w_2 = 0.6 \quad Th = 1 \quad \mu = 0.5$

A	B	A ∨ B
0	0	0
0	1	1
1	0	1
1	1	1

$0 + 0 = 0$

$0 + 0.6 = 0.6 = 0$ ✗

$w_1 = 0.6 + 0.5(1 - 0) \times 0$

$= 0.6$

$w_2 = 0.6 + 0.5(1 - 0) * 1$

$= 1.1$

$w_1 = 0.6 \quad w_2 = 1.1$

$0 + 0 = 0$

$0 + 1.1 = 1.1 = 1$

$0.6 + 0 = 0.6 = 0$ ✗

$w_1 = 1.1$

$w_2 = 1.1$

$0 + 0 = 0$

$0 + 1.1 = 1.1 = 1$ ✓

Question

0.5 | 0.5 | 0.5

$Th = 1$

1, 1, 0.5

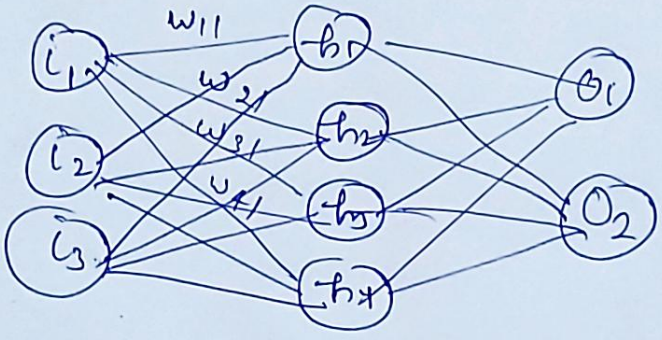
$Th = 1$

Multilayer perceptron (MLP)

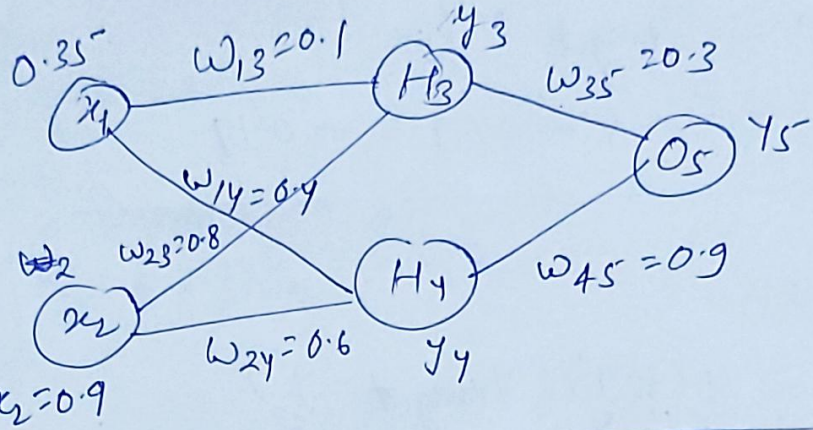
→ A- MLP is a class of feed-forward ANN.

→ In the multilayer perceptron, there can be more than one linear layer (combinations of neurons)

→ Three layer :- input, output, hidden layer (n number



XOR



Assume Sigmoid function perform fwd & Bck Pass on network with output 0.5 & LR = 1

Soln

$$a_J = \sum_J (w_{ij} \times x_i) \qquad y_J = \frac{1}{1+e^{-a_J}} = f(a_J)$$

$$a_1 = w_{13} \times x_1 + w_{23} \times x_2$$

$$= (0.1 \times 0.35) + (0.8 \times 0.9) = 0.755$$

$$y_3 = \frac{1}{1+e^{-0.755}} = 0.68$$

$$a_2 = w_{14} \times x_1 + w_{24} \times x_2$$

$$= (0.4 \times 0.35) + (0.6 \times 0.9) = 0.68$$

$$y_4 = f(a_2) = \frac{1}{1+e^{-0.68}} = 0.6637$$

$$a_3 = w_{35} \times y_3 + w_{45} \times y_4$$

$$= (0.3 \times 0.68) + (0.9 \times 0.6637) = 0.801$$

$$y_5 = f(a_3) = \frac{1}{1+e^{-0.801}} = 0.69$$

Error = $y_{target} - y_5$

$= 0.5 - 0.69 = -0.19$

Backward Pass =

For output $\delta_5 = y_5(1-y_5)(y_{target} - y_5)$

$= 0.69(1-0.69)(0.5-0.69) = -0.0406$

for hidden unit

$\delta_3 = y_3(1-y_3) w_{35} \times \delta_5$

$= 0.68(1-0.68) * (0.3 \times 0.0406) = -0.00265$

$\delta_4 = y_4(1-y_4) w_{45} \times \delta_5$

$= 0.6637(1-0.6637) \cdot (0.9 \times -0.0406)$

$= -0.0082$

$\Delta w_{45} = n \delta_5 y_4 = 1 \times -0.0406 \times 0.6637$

$= -0.0269$

$w_{45} = \Delta w_{45} + w_{45}(old) = -0.0269 + 0.9 = 0.8731$

$\Delta w_{14} = n \delta_4 x_4 = 1 * -0.0082 \times 0.35 = -0.00287$

$w_{14(new)} = \Delta w_{14} + w_{14}(old) = -0.00287 + 0.4$

$= 0.3971$

$w_{13} = 0.0991$ $w_{24} = 0.5926$

$w_{35} = 0.2724$ $w_{45} = 0.8731$

$w_{14} = 0.3971$

$w_{23} = 0.7976$

$t_{mr} = y_{target} - y_5 =$

$= 0.6820 - 0.5 = 0.5 - 0.6820$

$= -0.182$