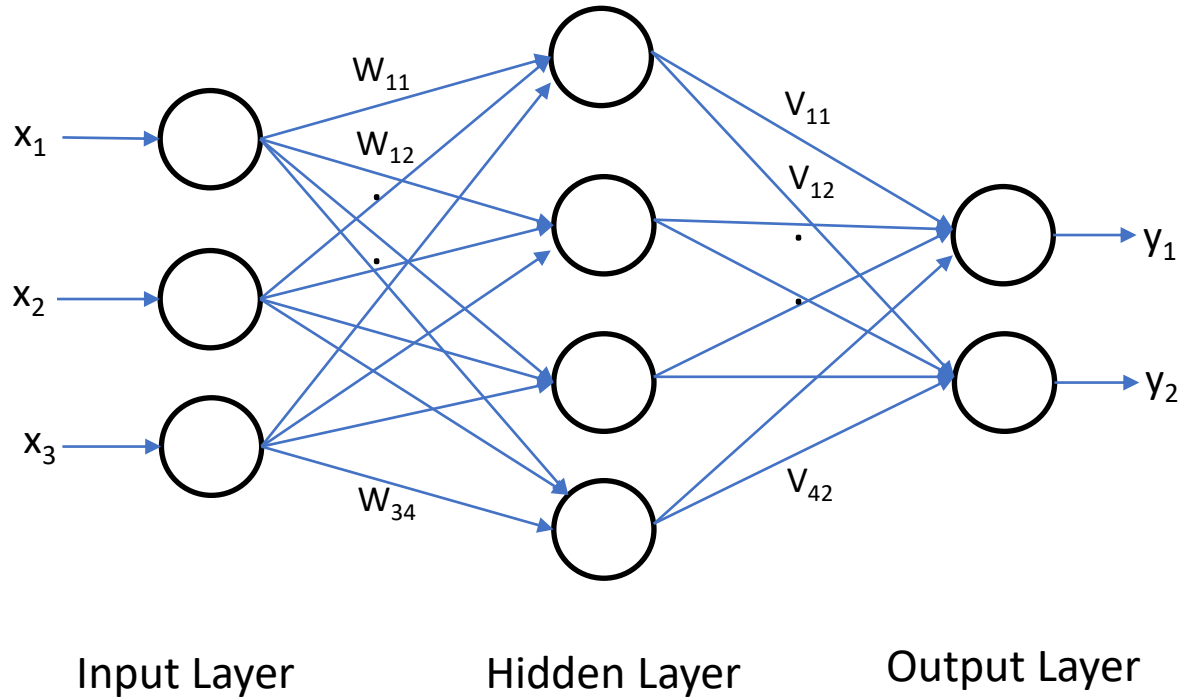
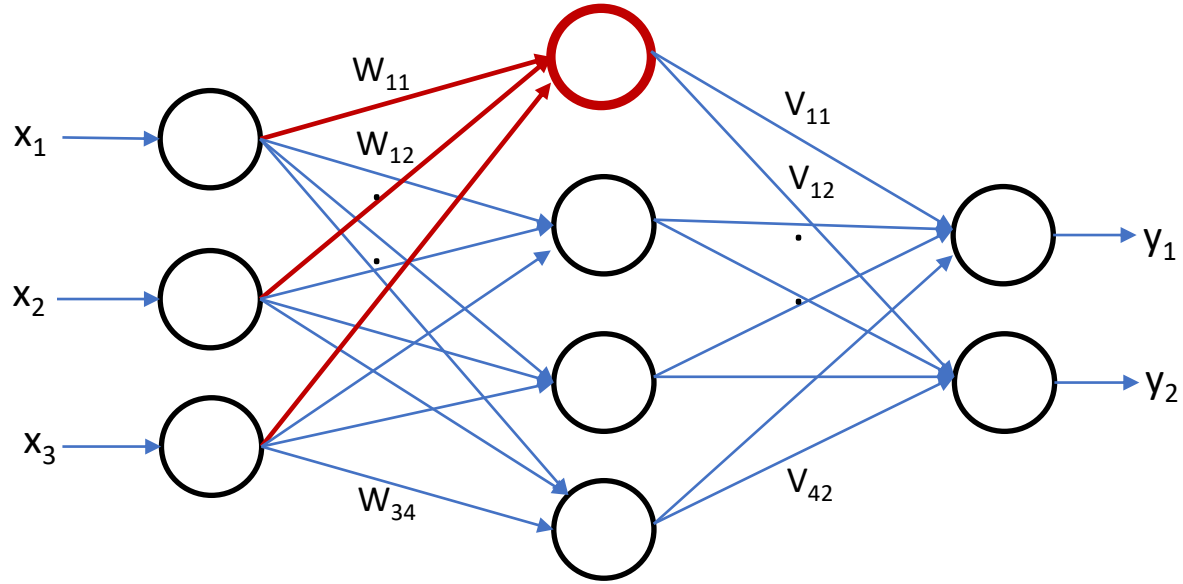
Lesson 9
Multilayer Perceptron

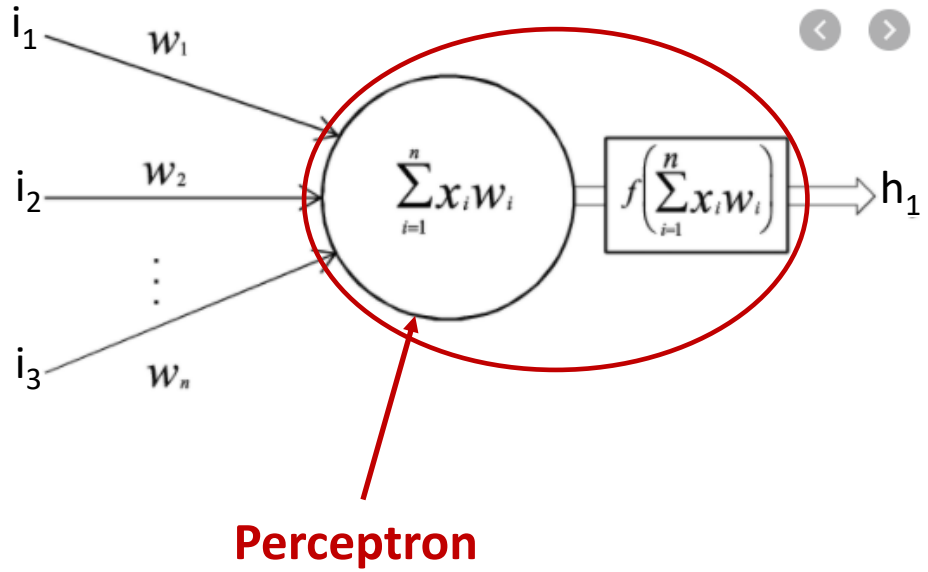
What is Multilayer Perceptron Neural Network?



Multilayer Perceptron



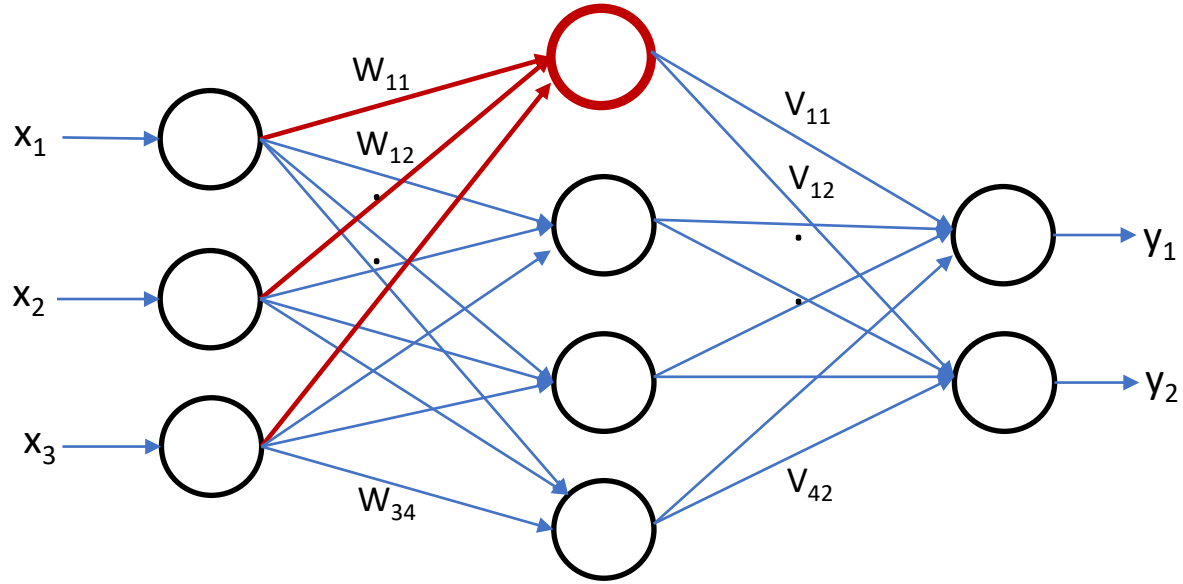
Input Layer Hidden Layer Output Layer



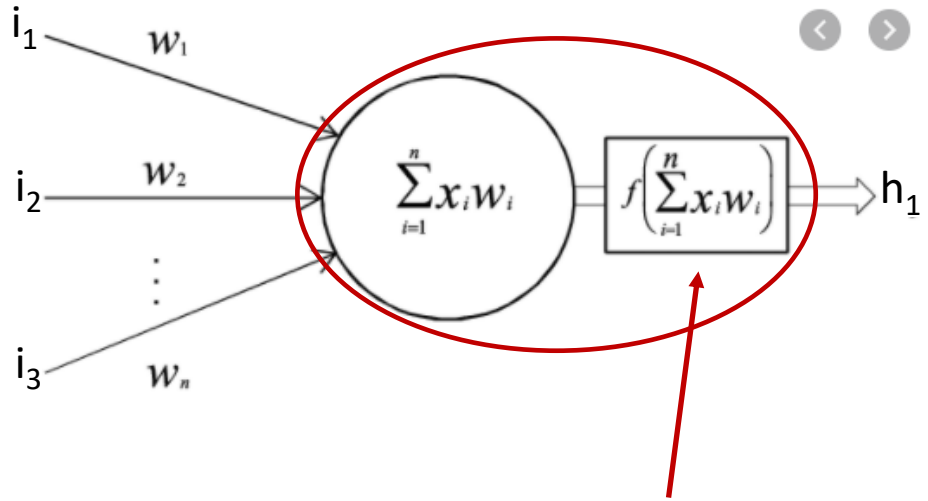
For a given node I, the perceptron is defined as weighted summation of the incoming data from the nodes of the previous layer.

$$p_i = x_0 w_{0i} + x_2 w_{2i} + \ldots + x_n w_{ni} = \sum_{j=1}^{n} x_j w_{ji}$$

Multilayer Perceptron

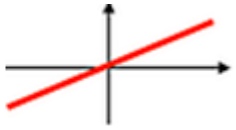


Input Layer Hidden Layer Output Layer



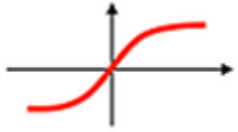
Activation Function

Linear $\phi(z) = z$

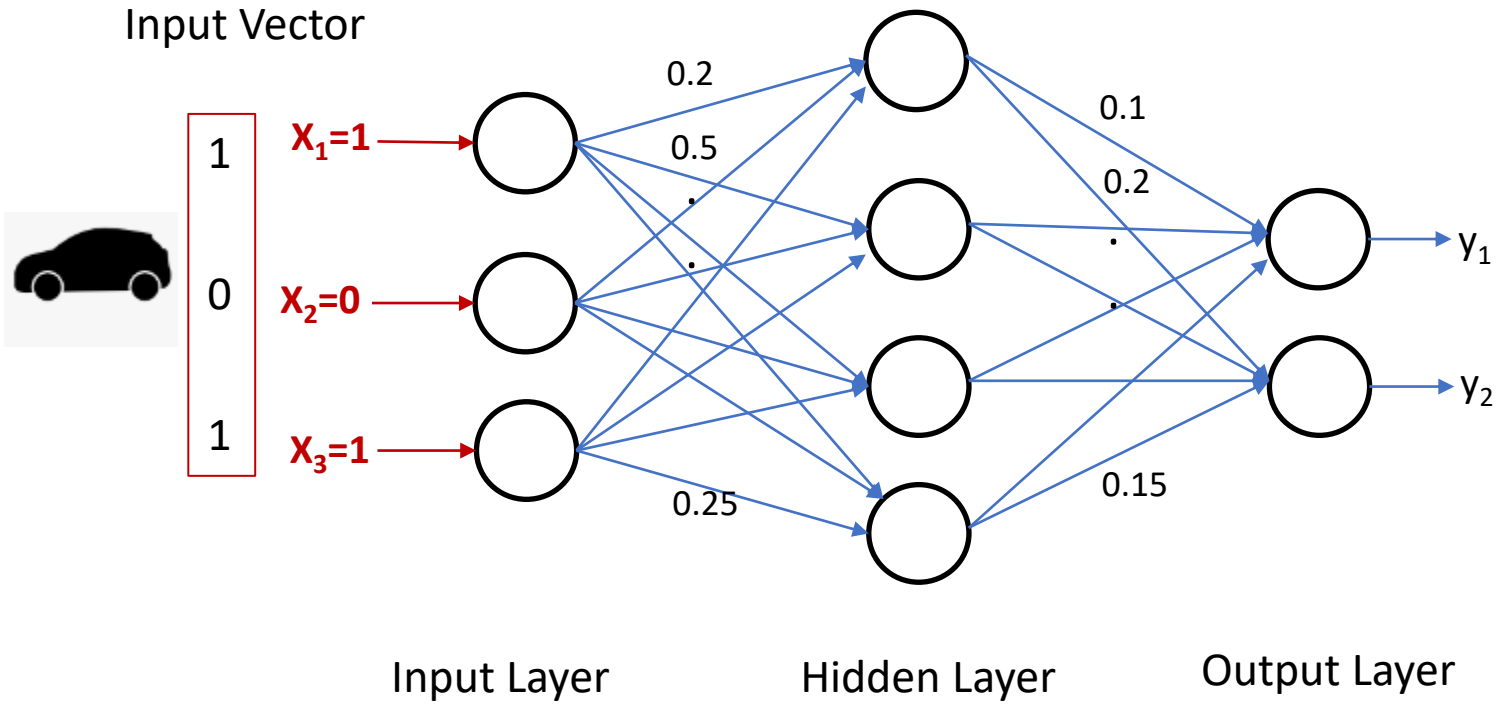


Logistic (sigmoid) $\phi(z) = \frac{1}{1+e^{-z}}$

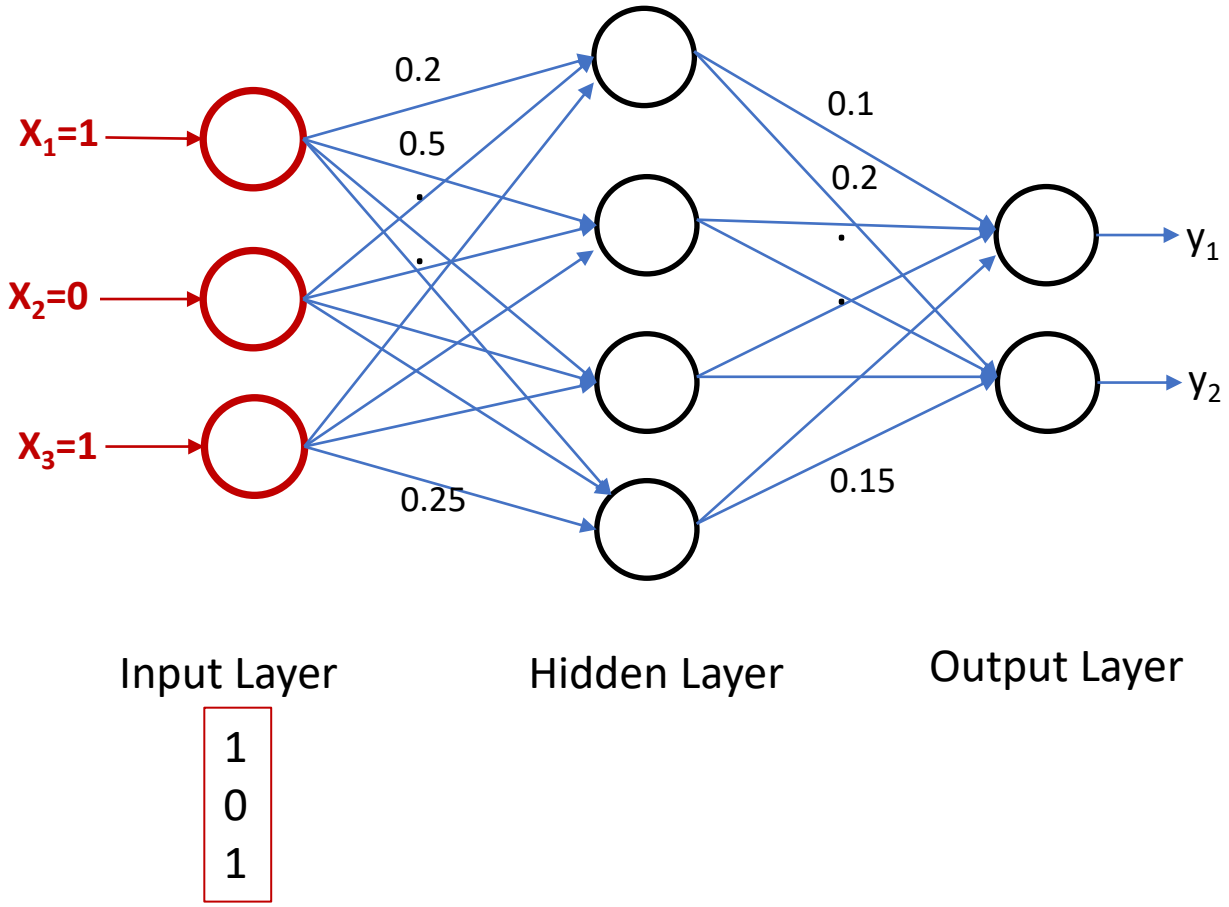
Hyperbolic tangent $\phi(z) = \frac{e^{z}-e^{-z}}{e^{z}+e^{-z}}$



Forward Pass



Forward Pass

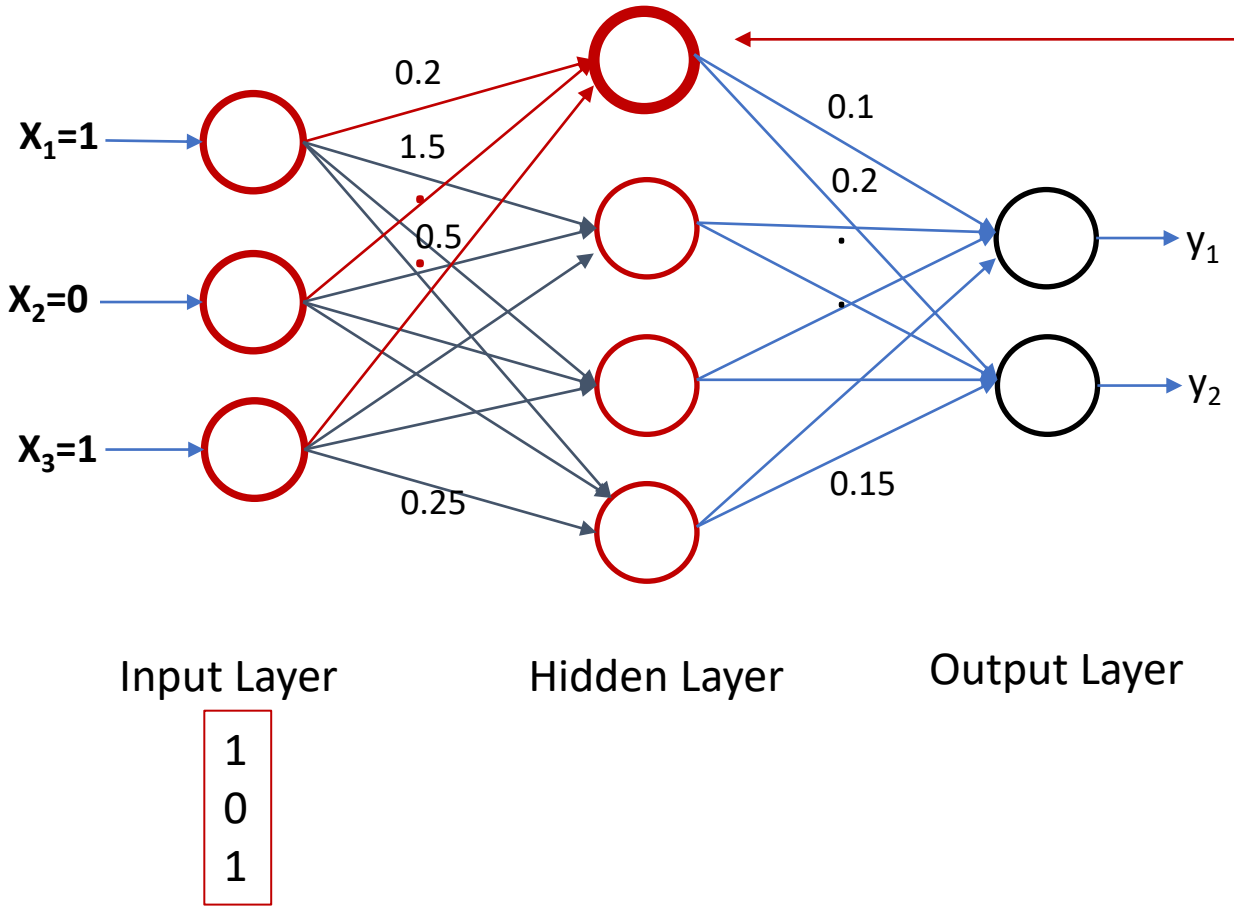


x=Perceptron(x)

Linear Activation function

x=f(x)

Forward Pass

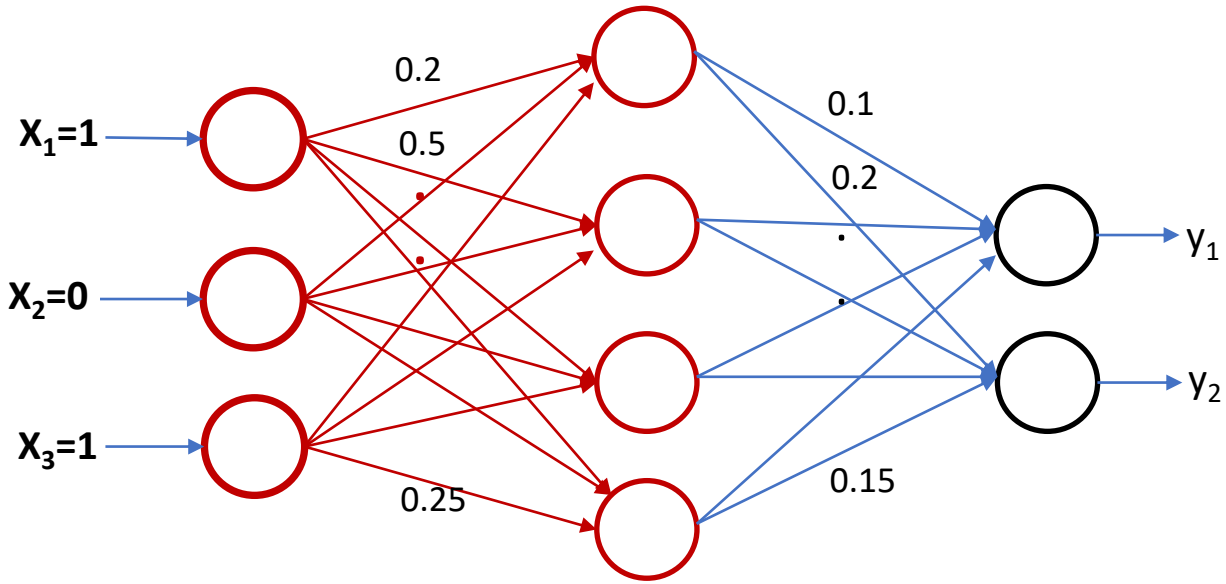


1x0.2 + 0x1.5 + 1x0.5= 0.7

Sigmoid Activation function

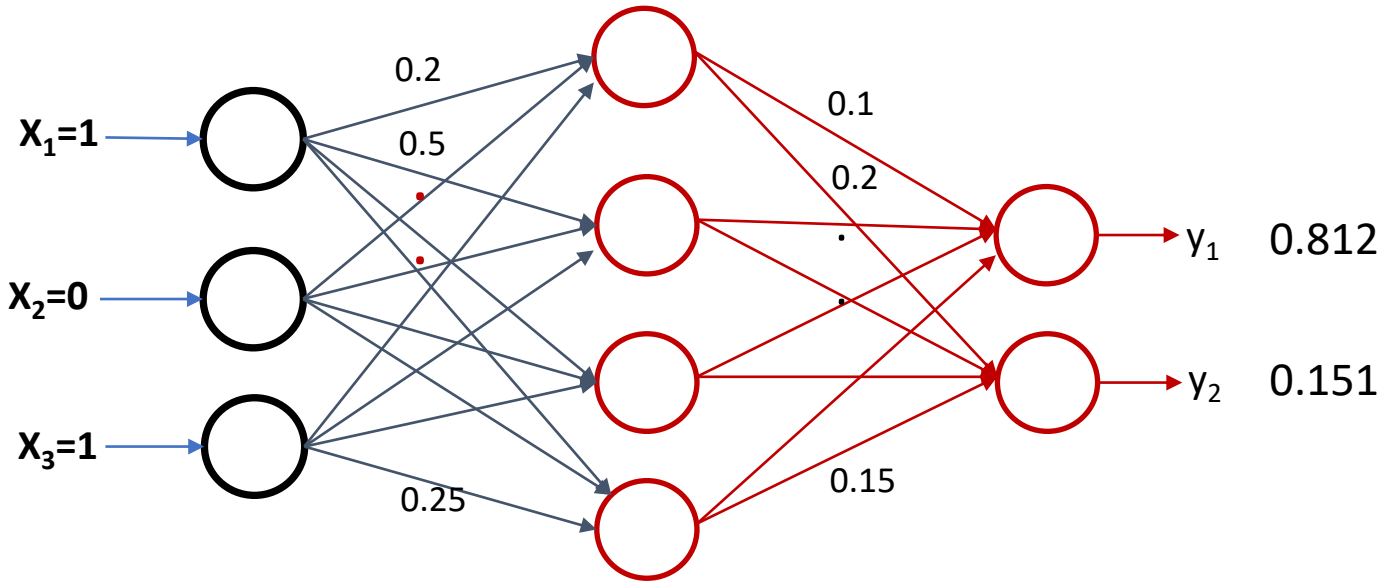
f(0.7)=0.668

Forward Pass



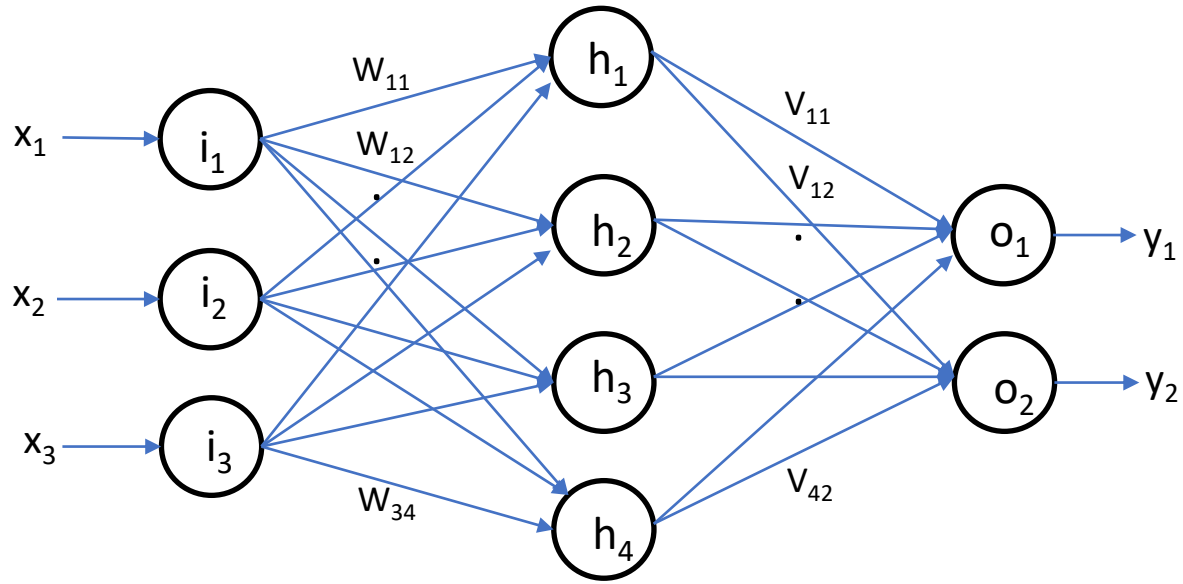
Input Layer	Hidden Layer	Output Layer
1	0.668	
0	0.912	
1	0.102	
	0.471	

Forward Pass



Input Layer	Hidden Layer	Output Layer
1	0.668	0.812
0	0.912	0.151
1	0.102	
	0.471	

Weight Matrix



	h_1	h_2	h_3	h_4
i_1	W_{11}	W_{12}	W_{13}	W_{14}
i_2	W_{21}	W_{22}	W_{23}	W_{24}
i_3	W_{31}	W_{32}	W_{33}	W_{34}

W

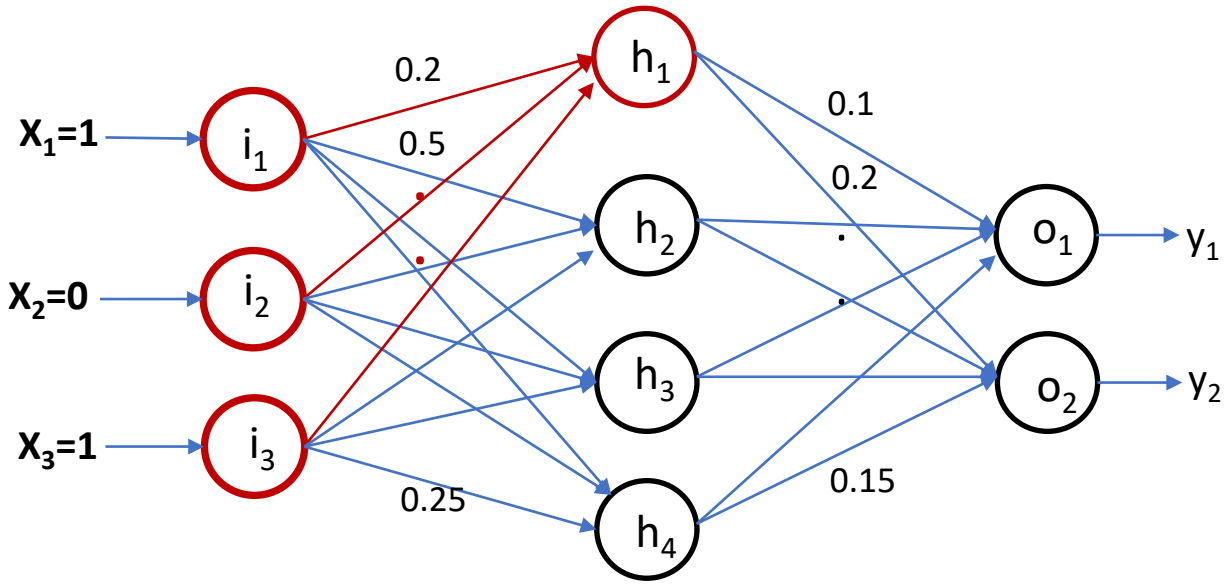
	o_1	o_2
h_1		
h_2		
h_3		
h_4		

V

Forward Pass

$$p_1 = x_1 W_{11} + x_2 W_{21} + x_3 W_{31}$$

$$h_1 = Sigmoid(p_1)$$

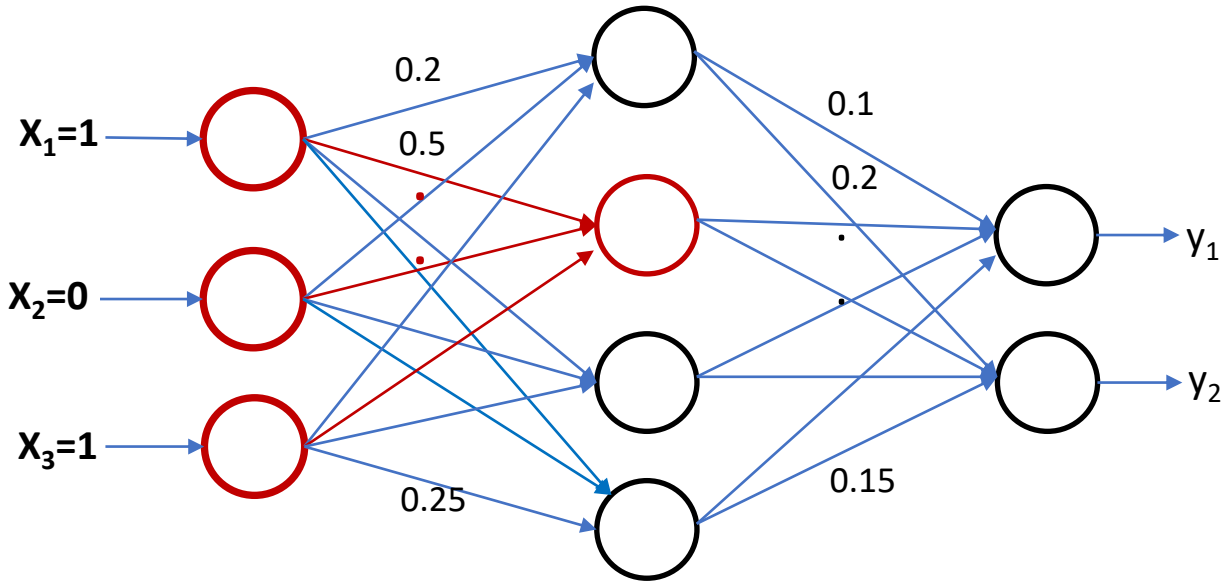


1 0 1	X	h_1 h_2 h_3 h_4 i_1 i_2 i_3 W	=	h_1 h_2 h_3 h_4 **0.668**

Forward Pass

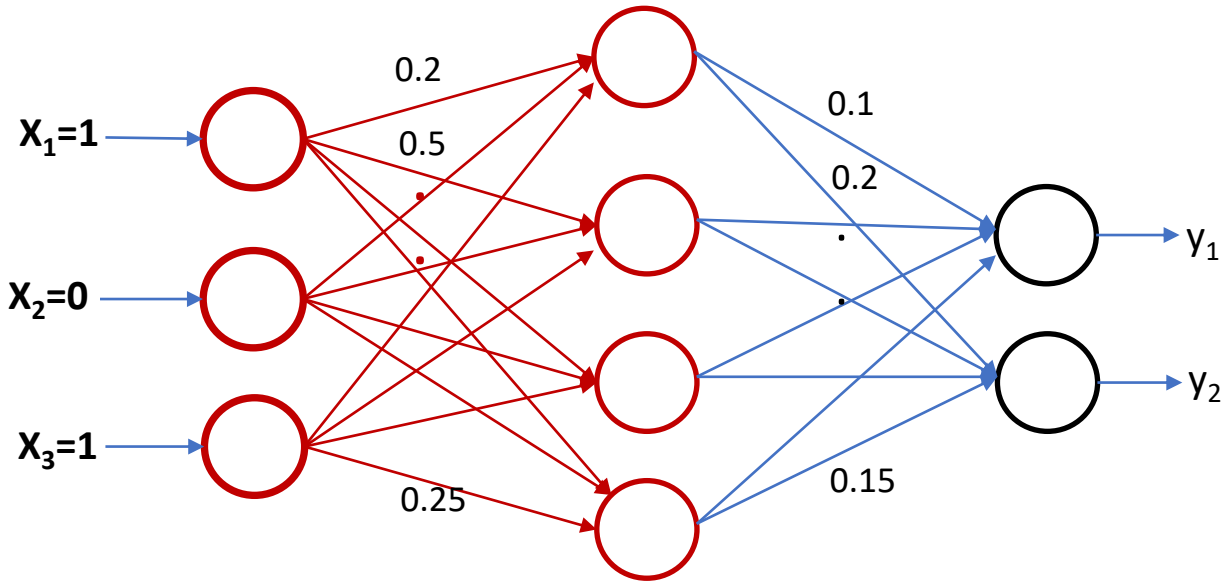
$$p_2 = x_1 W_{12} + x_2 W_{22} + x_3 W_{32}$$

$$h_2 = Sigmoid(p_2)$$



1 0 1	X	h_1 h_2 h_3 h_4 i_1 i_2 i_3 W	=	h_1 h_2 h_3 h_4 0.668 **0.912**

Forward Pass

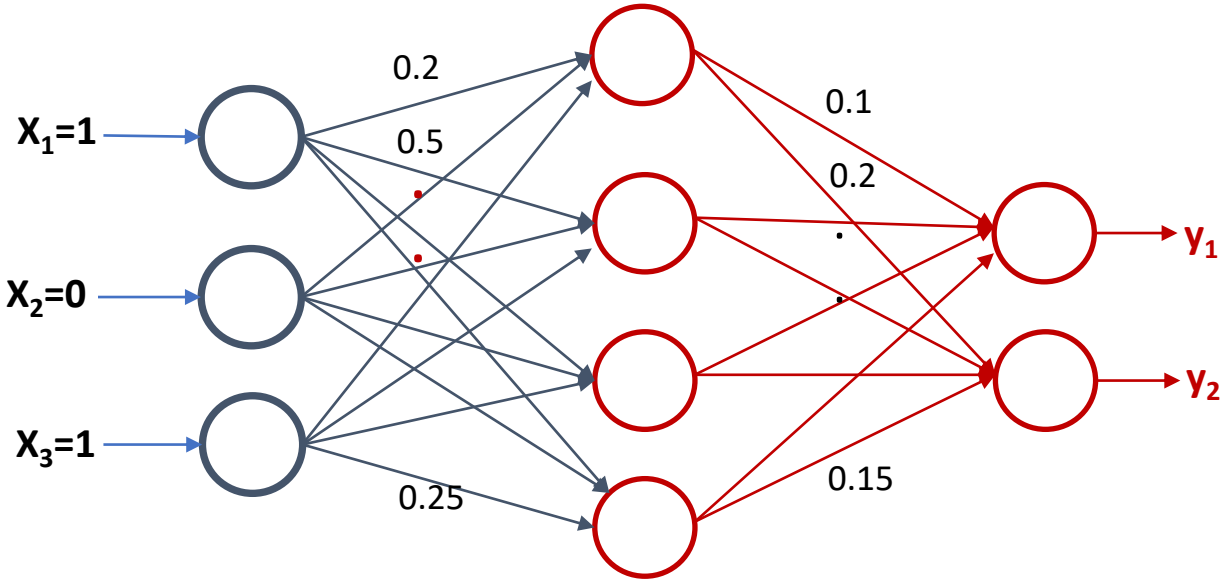


$$\bar{p}^T = \bar{x}^T . W$$

$$\bar{h}^T = Sigmoid(\bar{p}^T)$$

				h_1	h_2	h_3	h_4		h_1	h_2	h_3	h_4
1	0	1	X	i_1				=	0.668	0.912	0.102	0.471
				i_2								
				i_3								
$\bar{x}^T$				W					$\bar{h}^T$			

Forward Pass



$$\bar{p}^T = \bar{h}^T . V$$

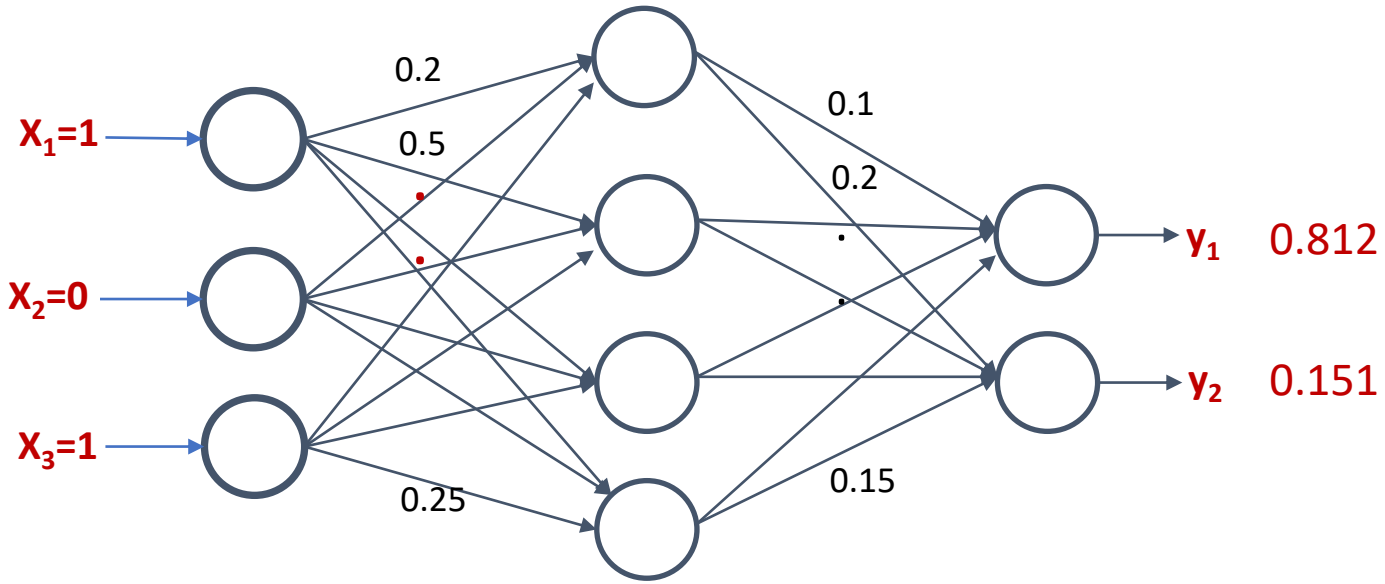
$$\bar{y}^T = Sigmoid(\bar{p}^T)$$

0.668	0.912	0.102	0.471	X		=	0.812 0.151
$\bar{h}^T$							$\bar{y}^T$

	o_1	o_2
h_1		
h_2		
h_3		
h_4		

V

Forward Pass



$$\bar{y}^T = Sigmoid(\, Sigmoid(\bar{x}^T W)\bar{\cdot} V\,)$$