

Deep Learning - IIT Ropar

Abhishek Thakur
Prime Minister Research Fellow (IIT Hyderabad)

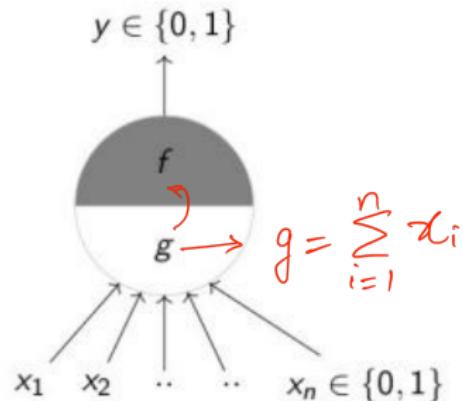
Prof. Mitesh M. Khapra, IIT Madras
Prof. Sudarshan Iyengar, IIT Ropar

Week 1
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McCulloch Pitts Neuron

Q1: Given the following representation of an MP neuron, What is the role of function 'g' ?



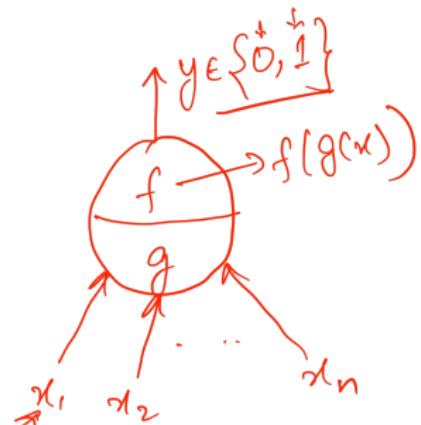
- (A) collect inputs
- (B) aggregate inputs
- (C) takes decision based on inputs
- (D) check validity of inputs

- g aggregates the input

- f takes a decision

- $g(x_1, x_2, x_3, \dots, x_n) = g(x) = \sum_{i=1}^n x_i$

$$y = f(g(x))$$

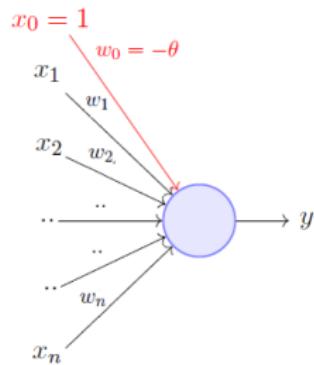


$$g(x) = \sum_{i=1}^n x_i$$

Perceptron

Q2: What are the advantages of Single Perceptron learning over the MP Neuron

- (A) Real Inputs ✓
- (B) Weights for each inputs ✓
- (C) hand coding the threshold is not required
- (D) All of the above



A more accepted convention,

$$y = 1 \quad \text{if} \sum_{i=0}^n w_i * x_i \geq 0$$

$$= 0 \quad \text{if} \sum_{i=0}^n w_i * x_i < 0$$

where, $x_0 = 1$ and $w_0 = -\theta$

McCulloch Pitts Neuron vs Perceptron

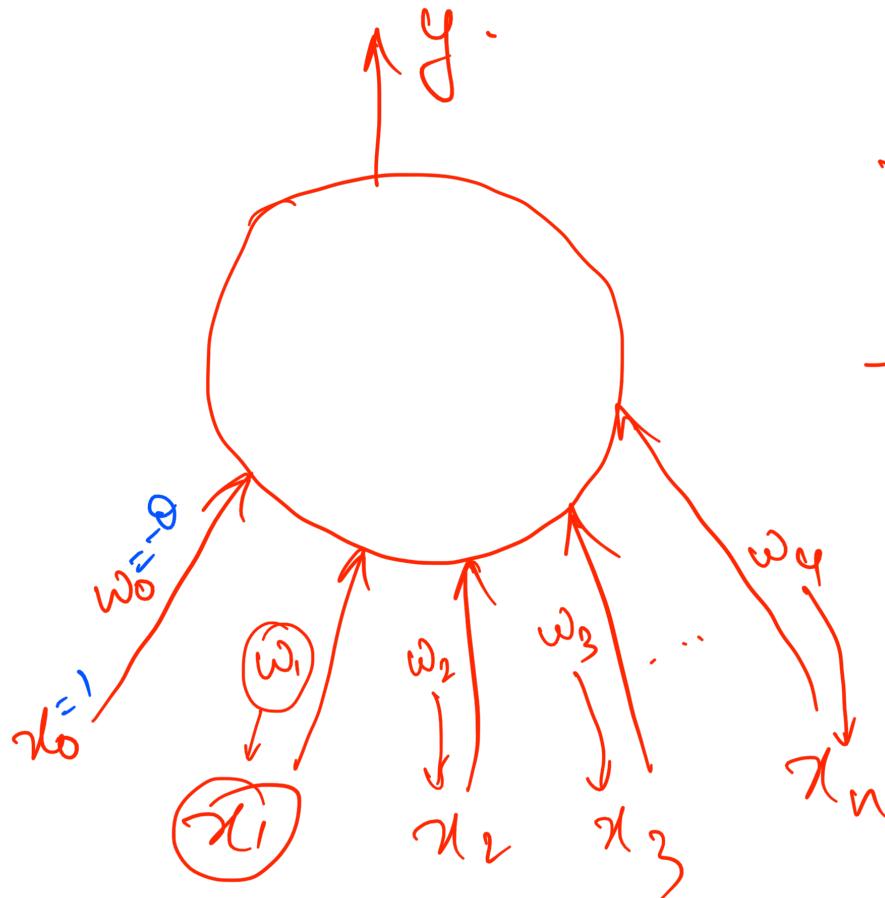
McCulloch Pitts Neuron (assuming no inhibitory inputs)

$$\begin{aligned}
 y &= 1 & \text{if } \sum_{i=0}^n x_i \geq 0 \\
 &= 0 & \text{if } \sum_{i=0}^n x_i < 0
 \end{aligned}$$

Perceptron

$$\left\{
 \begin{aligned}
 y &= 1 & \text{if } \sum_{i=0}^n w_i * x_i \geq 0 \\
 &= 0 & \text{if } \sum_{i=0}^n w_i * x_i < 0
 \end{aligned}
 \right.$$





- weight is assigned to each input
- Output is taken based on the priority of inputs.

$$y = 1, \text{ if } \sum_{i=1}^n w_i * x_i \geq \theta$$

$$y = 0, \text{ if } \sum_{i=1}^n w_i * x_i < \theta \rightarrow \text{Threshold.}$$

Rewrite;

$$y = 1, \text{ if } \sum_{i=1}^n w_i * x_i - \theta \geq 0$$

$$= 0, \text{ if } \sum_{i=1}^n w_i * x_i - \underline{\theta} < 0 \Rightarrow$$

$$y = 1, \text{ if } \sum_{i=0}^n w_i * x_i \geq \theta$$

Perceptron

Q3: A perceptron has inputs $W_1 = -2.5$, $W_2 = 1.5$ with threshold value $T = 0.3$, what output does it give for the input $x_1 = 0.5$ and $x_2 = 2.5$. Here W_1 is the weight assigned to x_1 and W_2 is the weight assigned to x_2 .

- (A) 0
- (B) 1
- (C) 2.5
- (D) 2.2

$$w_1 = -2.5 \quad ; \quad x_1 = 0.5$$

$$w_2 = 1.5 \quad ; \quad x_2 = 2.5$$

$$\sum_{i=1}^2 w_i x_i = w_1 x_1 + w_2 x_2 = -2.5 \times 0.5 + 1.5 \times 2.5 \\ = -1.25 + 3.75 \\ = 2.5 > T = 0.3 \\ T = 0.3 = \boxed{w_0 x_0}$$

McCulloch Pitts Neuron

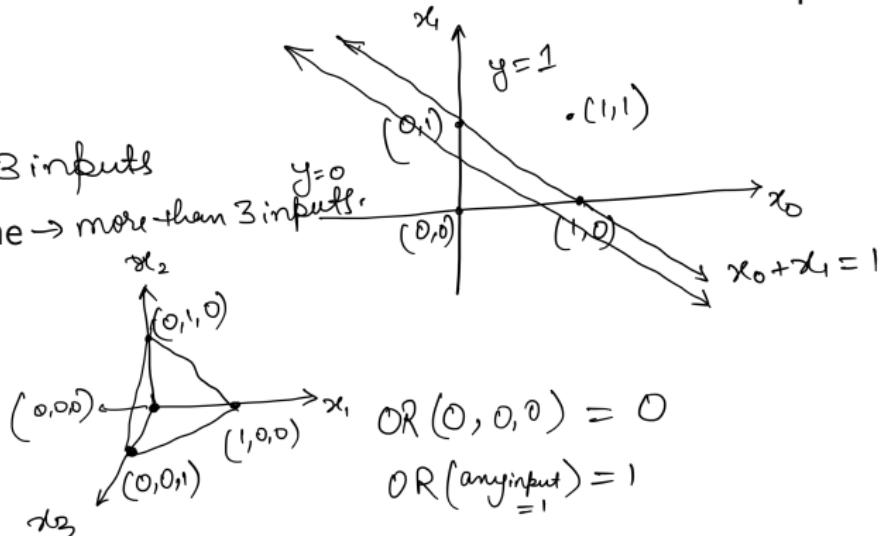
Q4: Pick out the one which best describes the decision boundary that a McCulloch Pitt Neuron model learns when the number of inputs is two.

(A) Point

(B) Line

(C) Plane \rightarrow 3 inputs

(D) Hyperplane \rightarrow more than 3 inputs



McCulloch Pitts Neuron

Q5 Consider an OR function MP neuron with three inputs x_1, x_2, x_3 . The number of input points can be 8. And the MP neuron tries to learn a decision boundary that is a plane. How many points out of this 8 input points lie below the plane?

(A) 1 $(0, 0, 0)$

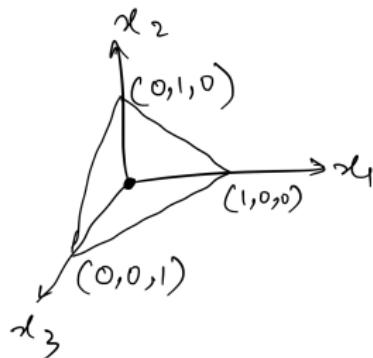
$x_1 \quad x_2 \quad x_3$

(B) 2

(C) 3

(D) 0

$$\text{Eqn of the plane } x_1 + x_2 + x_3 = 1$$

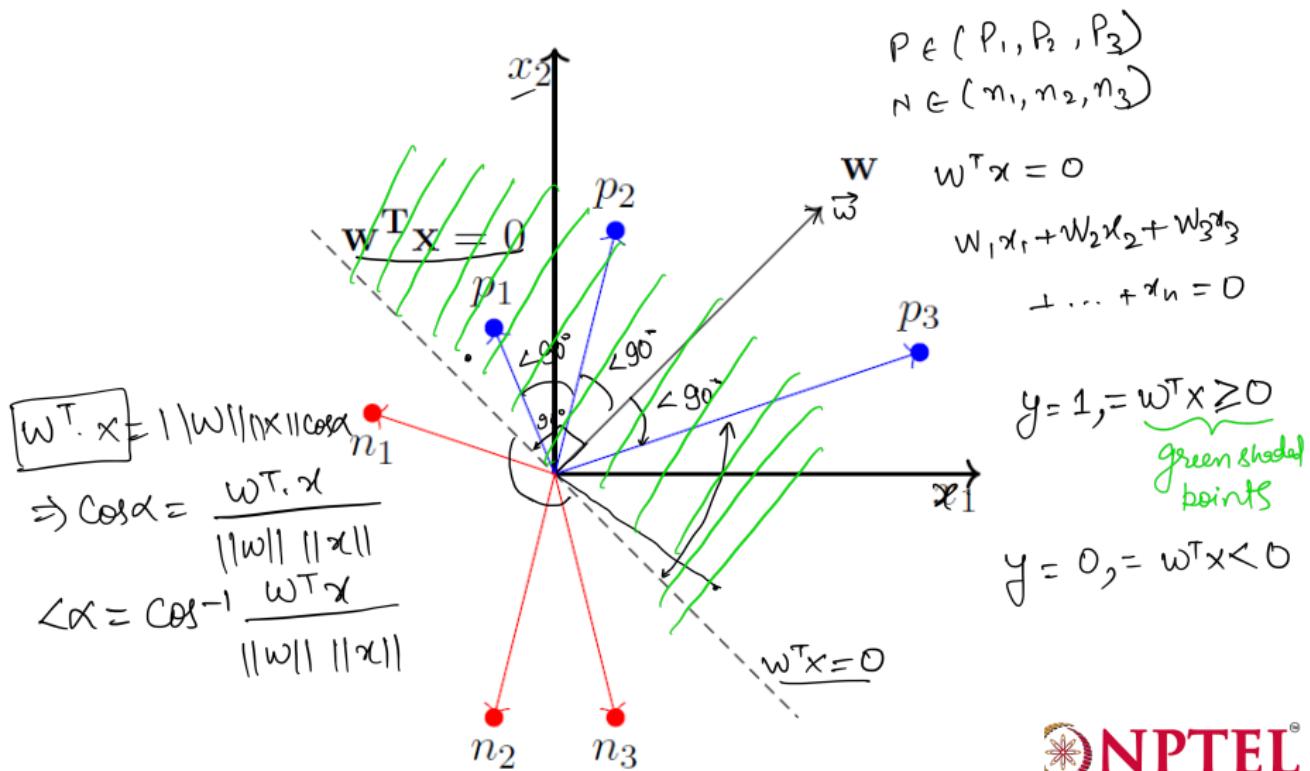


Perceptron

Q6: In the Perceptron learning algorithm, the positive points are those that are labelled 1 and negative points are those that are labelled 0. Now, what is the angle that any positive point(vector) makes with the 'w'?

- (A) $> 90^\circ \rightarrow$ greater than 90°
- (B) $< 90^\circ \rightarrow$ for positive points
- (C) $= 90^\circ$
- (D) cannot be inferred

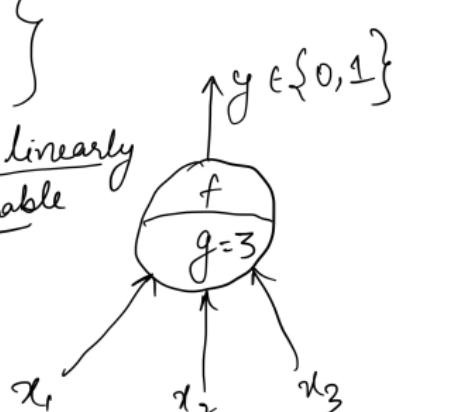
Perceptron



McCulloch Pitts Neuron

Q7: For which of the following gates, the threshold value is 3 for three inputs?

- (A) AND $\xrightarrow{f \geq 3}$
- (B) OR $\xrightarrow{f \geq 1}$
- (C) NOR $\xrightarrow{f \leq 0}$
- (D) XOR $\xrightarrow{\text{not linearly separable}}$



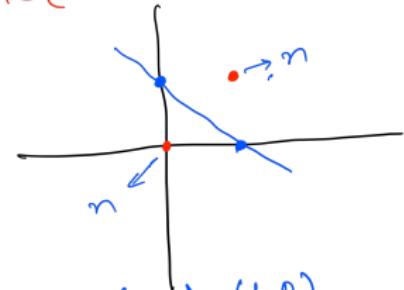
$$g = \sum x_i = x_1 + x_2 + x_3 = 3 \geq 3$$

-	·	AND	NOR	
x_1	x_2	x_3	y	y_{nors}
0	0	0	0	1
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	0

XOR

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

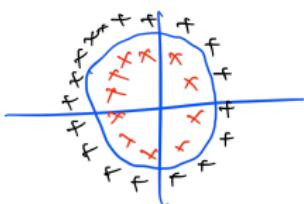
$$n \in \{(0,0), (1,1)\}$$



$$P \in \{0,1\}, \{1,0\}$$

when no. of input = 1 is odd then output = 1
 = 1 is even then output = 0

no, decision line can separate the negative & positive class

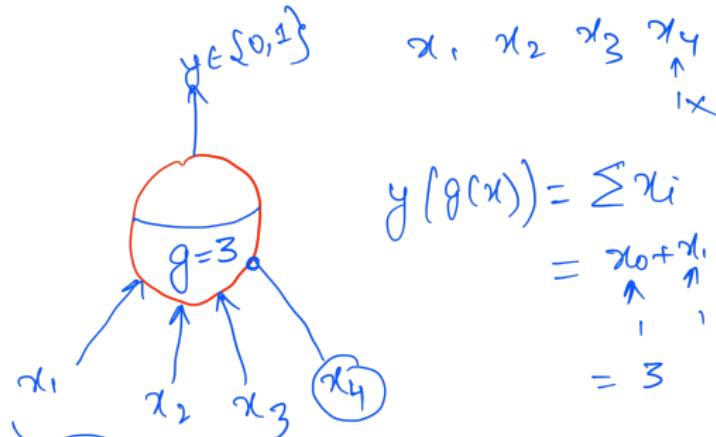


McCulloch Pitts Neuron

Q8: What is the thresholding parameter for the MP neuron for the given boolean function,? $(x_1 \text{AND} x_2) \text{AND} (x_3 \text{AND} !x_4)$

- (A) 4
- (B) 3
- (C) 2
- (D) 1

$$(x_1 \text{ AND } x_2) \text{ AND } (x_3 \text{ And } !x_4)$$



Non Linear Separable logic gate

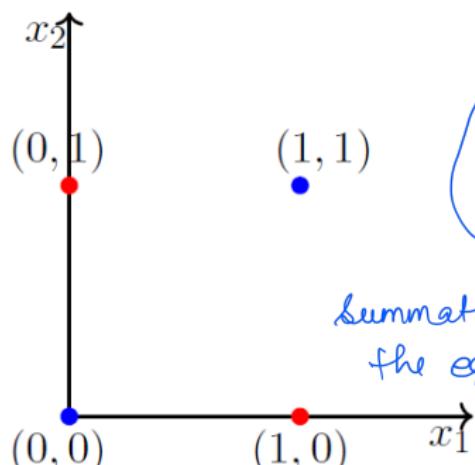
Q9: Which of the following gate is not linear separable?

- (A) AND
- (B) OR
- (C) NOR
- (D) XOR

→ not linearly → MLP (multi layer perceptron)

XOR

x_1	x_2	XOR	
0	0	0	$w_0 + \sum_{i=1}^2 w_i x_i < 0 \Rightarrow w_0 + 0 < 0$
1	0	1	$w_0 + \sum_{i=1}^2 w_i x_i \geq 0 \Rightarrow w_0 + w_1 \geq 0 \text{ (ii)}$
0	1	1	$w_0 + \sum_{i=1}^2 w_i x_i \geq 0 \Rightarrow w_0 + w_2 \geq 0 \text{ (iii)}$
1	1	0	$w_0 + \sum_{i=1}^2 w_i x_i \leq 0 \Rightarrow w_0 + w_1 + w_2 < 0 \text{ (iv)}$



$$\begin{aligned} w_1 &\geq -w_0 \\ w_2 &\geq -w_0 \\ w_1 + w_2 &\geq -2w_0 \\ w_1 + w_2 &\geq -w_0 \\ w_1 + w_2 &< -w_0 \end{aligned}$$

Summation of eqn (ii) & (iii) contradicts the eqn no. (4)



THANK YOU

