Assignment No.4

Title: Mc-Culloch Pitts Neuron

Problem Statement:

Implement basic logic gates using Mc-Culoch-Pitts Neuron

Objectives:

- The student will be able to obtain the fundamentals and different architecture of neural networks.
- The student will have a broad knowledge in developing the different algorithms for neural networks.

Outcomes:

The students will be able to,

- Describe the relation between real brains and simple artificial neural network models.
- Understand the role of neural networks in engineering.
- Apply the knowledge of computing and engineering concept to this discipline.

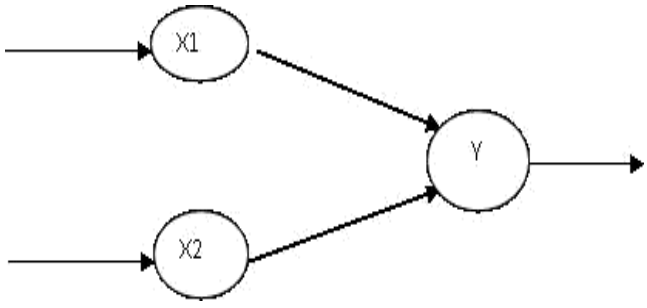
Theory:

Neural network was inspired by the design and functioning of human brain and components.

Definition:

Information processing model that is inspired by the way biological nervous system (i.e the brain) process information, is called Neural Network. Neural Network has the ability to learn by examples. It is not designed to perform fix/specific task, rather task which need thinking (e.g. Predictions). ANN is composed of large number of highly interconnected processing elements (neurons) working in unison to solve problems. It mimics human brain. It is configured for special application such as pattern recognition and data classification through a learning process. ANN is 85-90% accurate.

Basic Operation of a Neural Network:



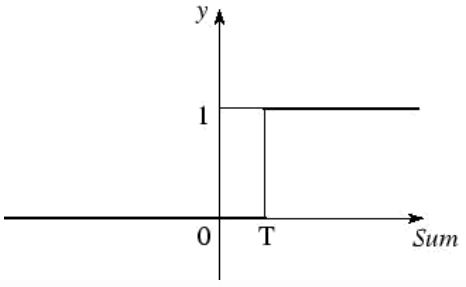
X1 and X2 - input neurons.
Y- output neuron
Weighted interconnection links- W1 and W2.
Net input calculation is :
Yin= x1w1+x2w2
Output is :
y=f(Yin)
Output= function

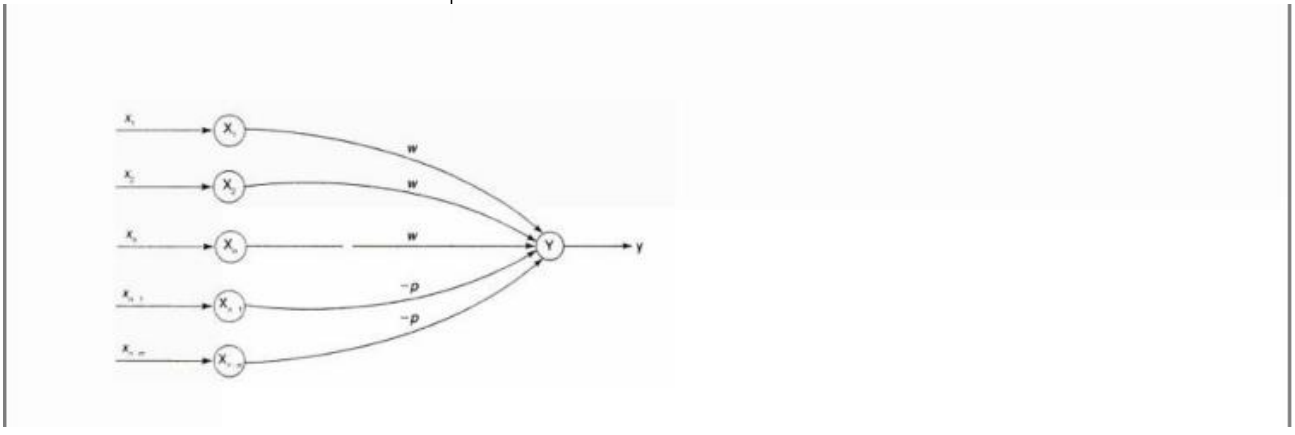
The McCulloch-Pitts Model of Neuron:

The early model of an artificial neuron is introduced by Warren McCulloch and Walter Pitts in 1943. The McCulloch-Pitts neural model is also known as linear threshold gate. It is a neuron of a set of inputs I1,I2,I3 …Im and one output y . The linear threshold gate simply classifies the set of inputs into
two different classes. Thus the output y is binary. Such a function can be described mathematically using these equations:

$$Sum = \sum_{i=1}^{N} I_i W_i, \qquad y = f(Sum).$$

W1,W2…Wm are weight values normalized in the range of either (0,1) or (-1,1) and associated with each input line, Sum is the weighted sum, and T is a threshold constant. The function f is a linear step function at threshold T as shown in figure





A simple M-P neuron is shown in the figure.

It is excitatory with weight (w>0) / inhibitory with weight −p (p<0).

In the Fig., inputs from x1 to xn possess excitatory weighted connection and Xn+1 to xn+m has inhibitory weighted interconnections.

Since the firing of neuron is based on threshold, activation function is defined as

$$f(y_{in}) = \begin{cases} 1 & if\ y_{in} \geq \theta \\ 0 & if\ y_{in} < \theta \end{cases}$$

For inhibition to be absolute, the threshold with the activation function should satisfy the following condition:

$$\theta > nw - p$$

Output will fire if it receives $-k$ or more excitatory inputs but

no inhibitory inputs where $kw \geqslant \theta > (k-1)\ w$

-The M-P neuron has no particular training algorithm.

- An analysis is performed to determine the weights and the threshold.
- It is used as a building block where any function or phenomenon is modelled based on a logic function.

Value of thresholding function is varied to implement various boolean functions.

For AND O=N

For OR O=1

where N is the number of inputs.

McCulloch - Pitts Neuron works only for boolean values.

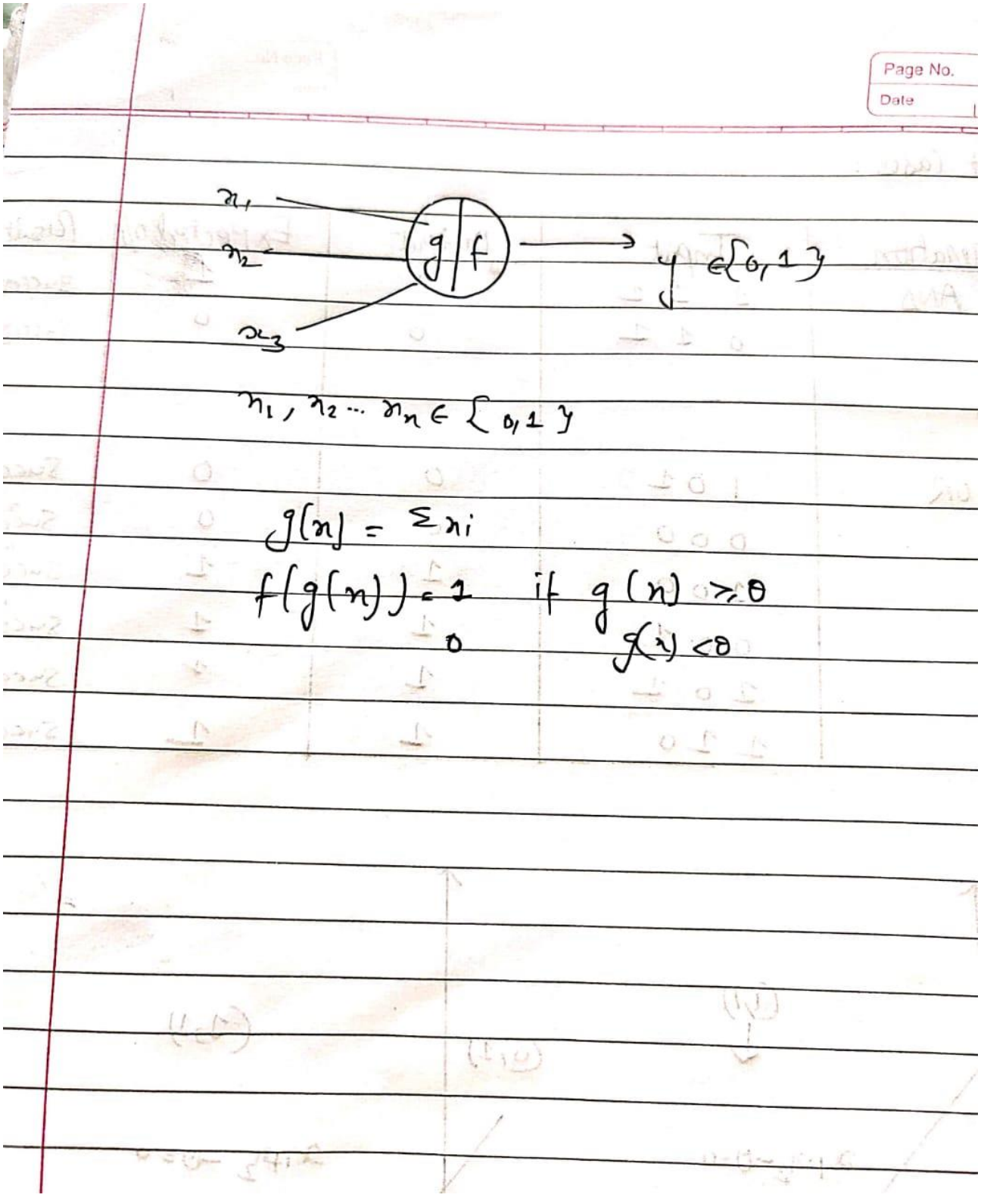
Geometrically, McCulloch - Pitts can suitably represent boolean functions. in which all positive (y = 1) lie on one side and all negative (y=0) lie on the other side of a linear decision boundary

Algorithm:

1. Initialize input array x from user
2. Calculate summation of input values.
3. Initialize threshold value Theta = no. of inputs on I for AND and OR respectively.
4. Calculate Y

Conclusion:

Successfully understood and implemented basic logic gates using Mc Culloch-Pitts neuron.



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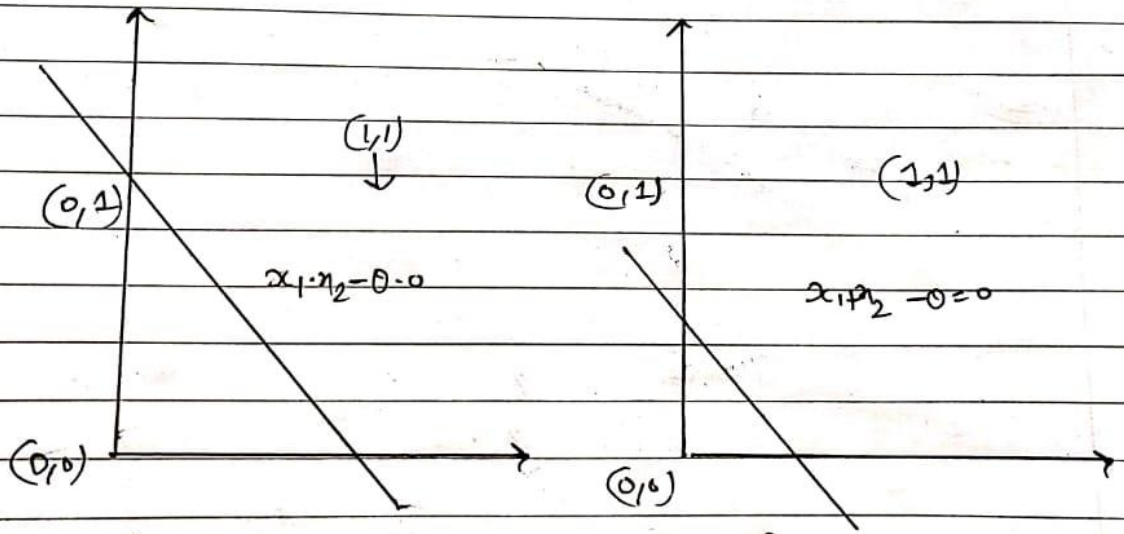
Test cases :

	Operation	Input	Output	Expected o/p	Result
①	AND	1 1 1	1	1	success
		0 1 1	0	0	success
②	OR	1 0 1	0	0	success
		0 0 0	0	0	success
		1 0 0	1	1	success
		0 0 1	1	1	success
		1 0 1	1	1	success
		1 1 0	1	1	success



AND operation

OR operation