SCOA Assignment 4

Roll No: 41163

Title: Implement basic logic gates using McCulloch-Pitts or Hebb net neural networks.

Problem Statement: Implement basic logic gates using McCulloch-Pitts or Hebb net neural networks.

Objective:

- To understand the concept of an artificial neuron.
- To implement McCulloch-Pitts network.

Outcome:

- Understood and implemented McCulloch-Pitts network.

Software Requirements :

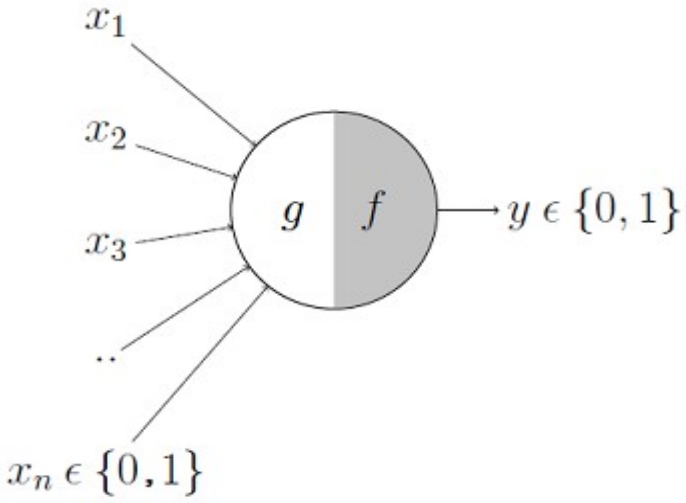
1. Jupyter Notebook
2. Python 3.8.5
3. 64 bit OS

Hardware Requirements :

- Machine with 64 bit processor

Theory:

The first computational model of a neuron was proposed by Warren McCulloch (neuroscientist) and Walter Pitts (logician) in 1943.



The neuron is divided into two parts. The first part, g takes an input and performs an aggregation and based on the aggregated value the second part, f makes a decision.

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

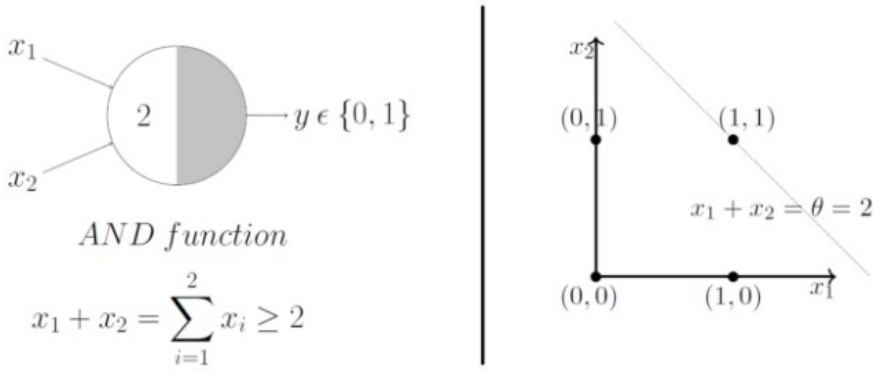
$$\begin{aligned} y = f(g(\mathbf{x})) &= 1 \quad if \quad g(\mathbf{x}) \geq \theta \\ &= 0 \quad if \quad g(\mathbf{x}) < \theta \end{aligned}$$

Boolean Functions using M-P neuron:

For Boolean functions structure M-P neurons is simple. Aggregate function calculates sum of all inputs, if sum is more than threshold, the neuron fires.

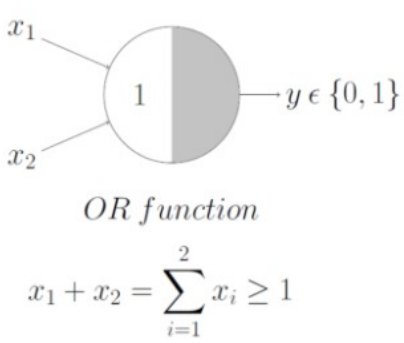
1. AND Function:

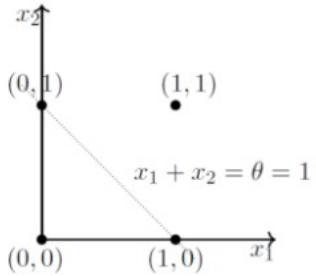
An AND function neuron would only fire when all the inputs are ON i.e., g(x) ≥ number of input features.



2. OR Function:

An OR function neuron would only fire when any of the inputs is ON i.e., g(x) ≥ 1.





3. NOT Function:

A NOT function neuron would only fire when input is OFF i.e., g(x) = 0.

4. NOR Function:

A NOR function neuron would only fire when all the inputs are OFF i.e., g(x) = 0.

Test Cases:

Operations	**Input**	**Expected O/P**	**Actual O/P**	**Result**
AND	0,0,0 0,0,1 1,1,0 1,1,1	0 0 0 1	0 0 0 1	Successful
OR	0,0 0,1 1,0 1,1	0 1 1 1	0 1 1 1	Successful
NOT	0 1	1 0	1 0	Successful
NOR	0,0 0,1 1,0 1,1	1 0 0 0	1 0 0 0	Successful

Conclusion:

Therefore, successfully implemented basic logic gates using McCulloch-Pitts neural network.