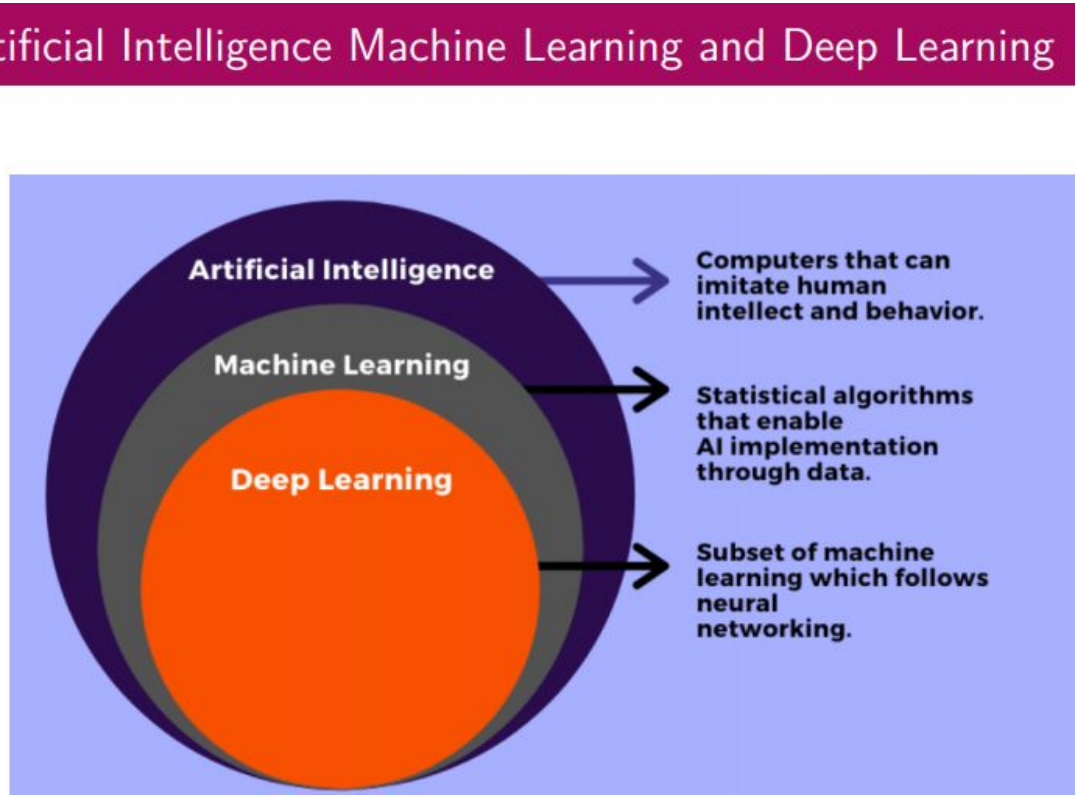
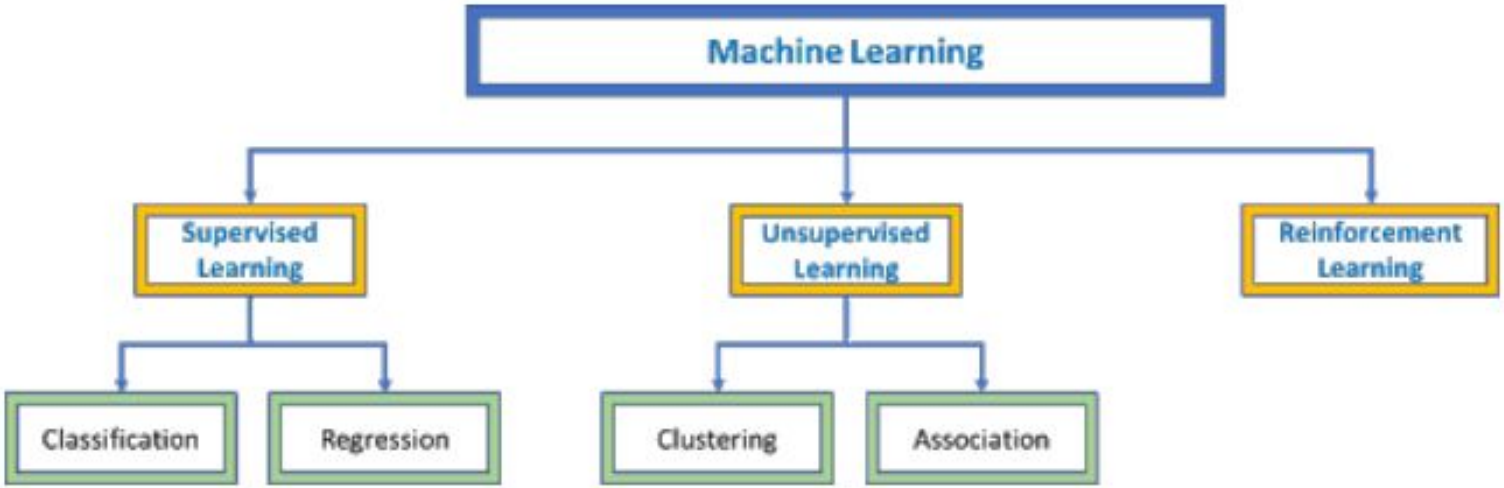
AI lab

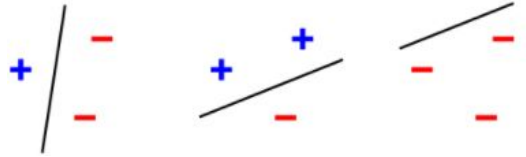

Artificial Intelligence Machine Learning and Deep Learning
Artificial Intelligence
Machine Learning
Deep Learning
Computers that can imitate human intellect and behavior.
Statistical algorithms that enable AI implementation through data.
Subset of machine learning which follows neural networking.

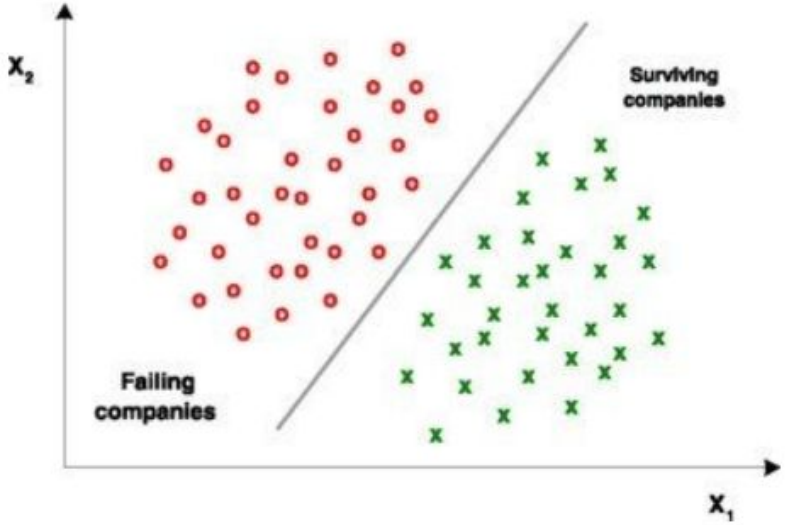
- Machine Learning is the field of study that gives computers the capability to learn without being explicitly programmed. The goal of Machine Learning is to understand the structure of data and fit that data into models that can be understood and utilized by people.
- Machine Learning can also defined as a set of methods that can automatically detect patterns in data and then use the uncovered patterns to predict future data or to perform other kinds of decision making under uncertainty.
- Machine Learning is concerned with the development of algorithms and techniques that allow computers to learn.

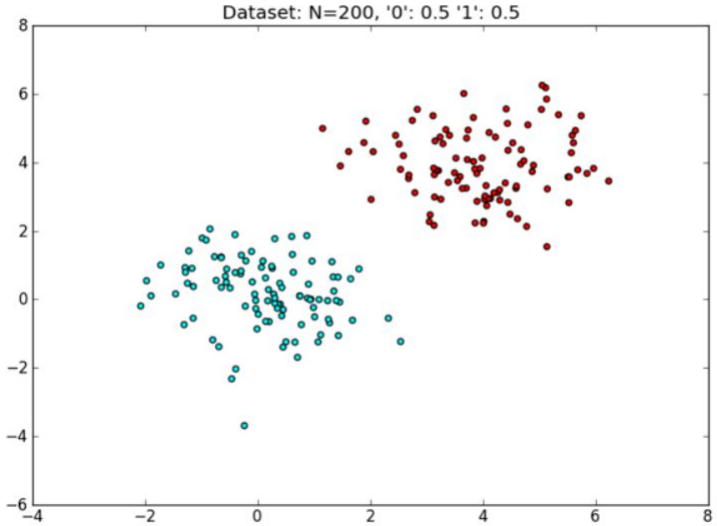
Types of Machine Learning



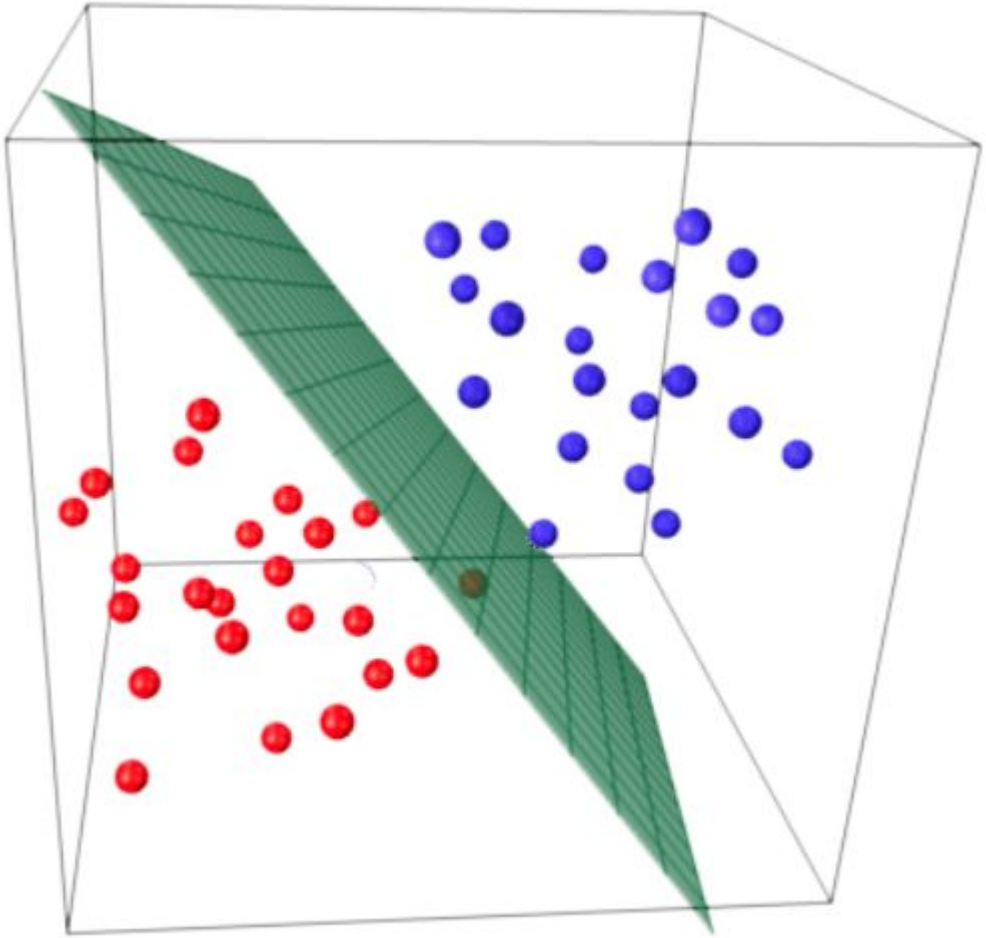
Examples of linearly separable data







A dataset is said to be linearly separable if it is possible to draw a line that can separate the red and green points from each other.



This concept can be extended to three or more dimensions as well. For example, this is an example of a three dimensional dataset that is linearly separable.

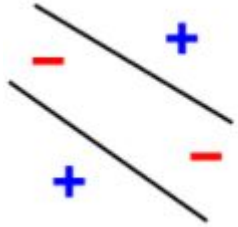
In n dimensions, the separator is a (n-1) dimensional hyperplane - although it is pretty much impossible to visualize for 4 or more dimensions.

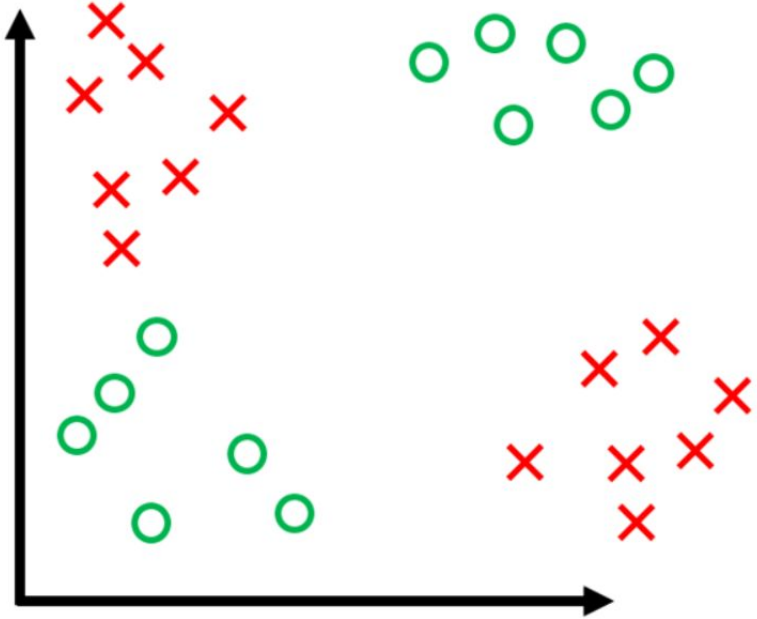
Algebraic definition:

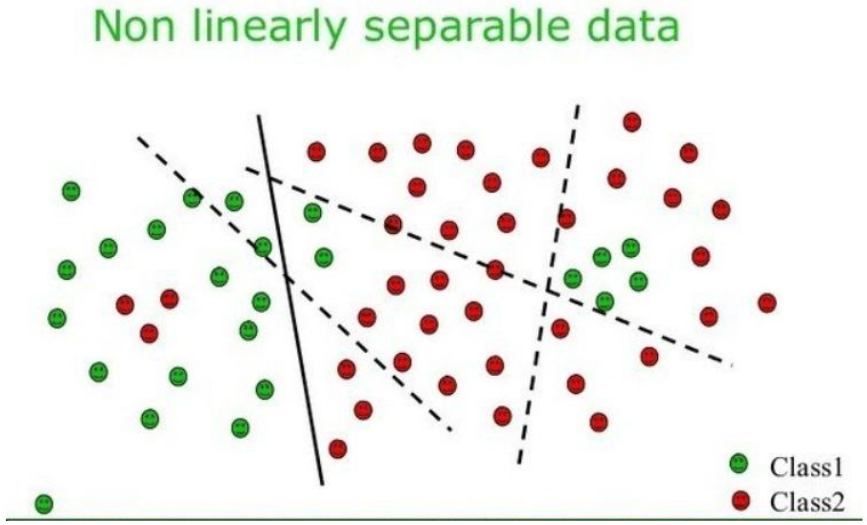
Algebraically, the separator is a linear function, i.e. if data point x is given by (x1, x2), when the separator is a function $f(x) = w1*x1 + w2*x2 + b$

All points for which $f(x) = 0$, are on the separator line. All points for which $f(x) > 0$ are on one side of the line, and all points for which $f(x) < 0$ are on the other side.

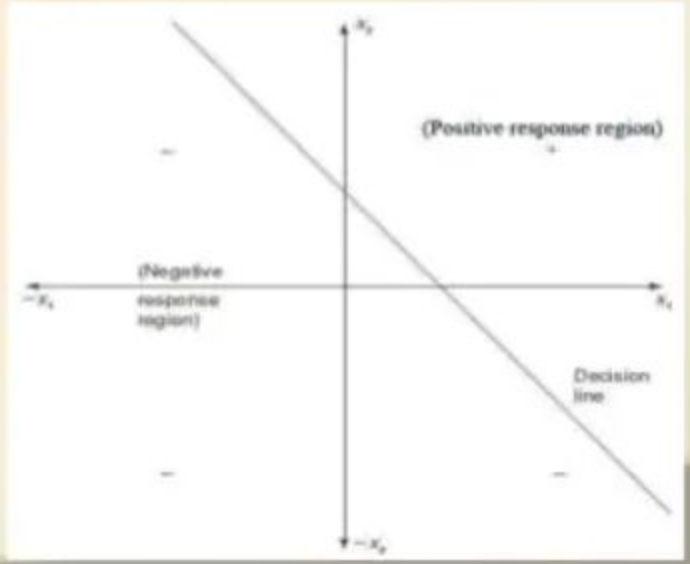
Examples of linearly non- separable data







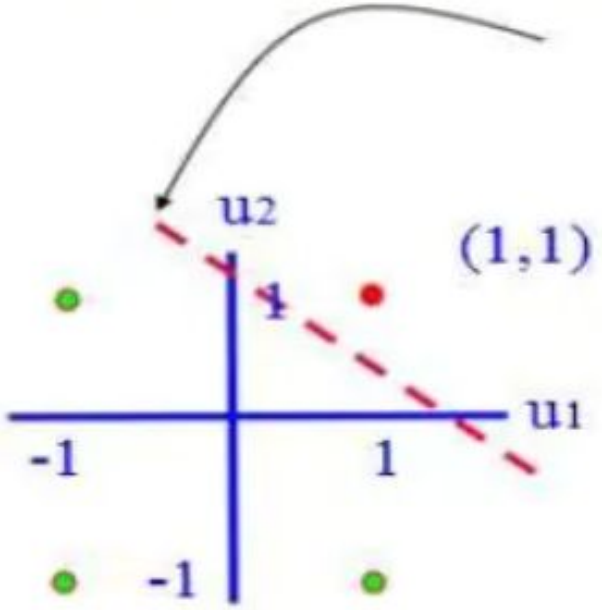
- Consider a network having positive response in the first quadrant and negative response in all other quadrants (AND function) with either binary or bipolar data, then the decision line is drawn separating the positive response region from the negative response region.

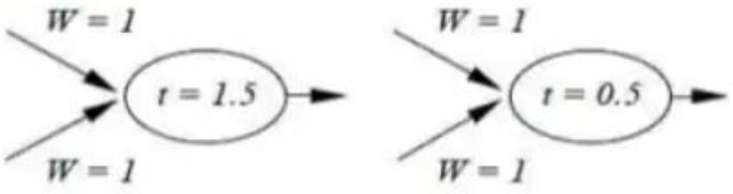


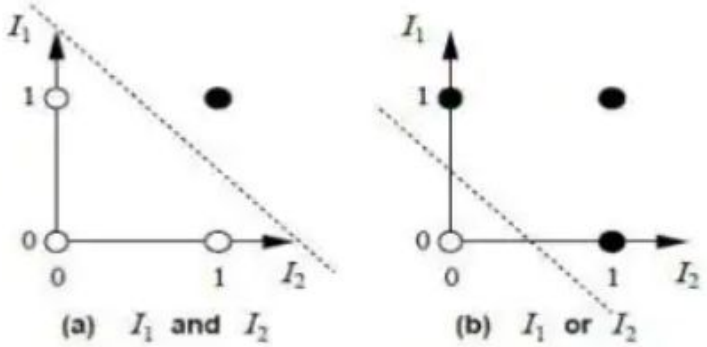
AND Gate is linearly Separable

:-

u1	u2	AND
-1	-1	-1
1	-1	-1
-1	1	-1
1	1	1







- The net input to the output Neuron is:

$$Y_{in} = w_0 + \Sigma_i x_i w_i$$

Where Y_{in} = The net inputs to the ouput neurons.
i = any integer
w_0 = initial weight

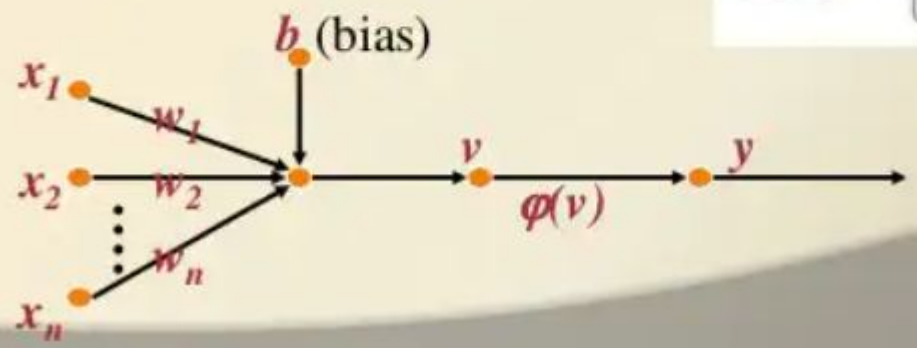
- The following relation gives the boundary region of net input.

$$b + \Sigma_i x_i w_i = 0$$

Intro to Perceptron

- The perceptron was first proposed by Rosenblatt (1958) is a simple neuron that is used to classify its input into one of two categories.
- A perceptron is a single processing unit of a neural network. A perceptron uses a **step function** that returns +1 if weighted sum of its input ≥ 0 and -1 otherwise.

$$\varphi(v) = \begin{cases} +1 \text{ if } v \geq 0 \\ -1 \text{ if } v < 0 \end{cases}$$



The perceptron consists of 4 parts.

1. Input values or One input layer
2. Weights and Bias
3. Net sum
4. Activation Function

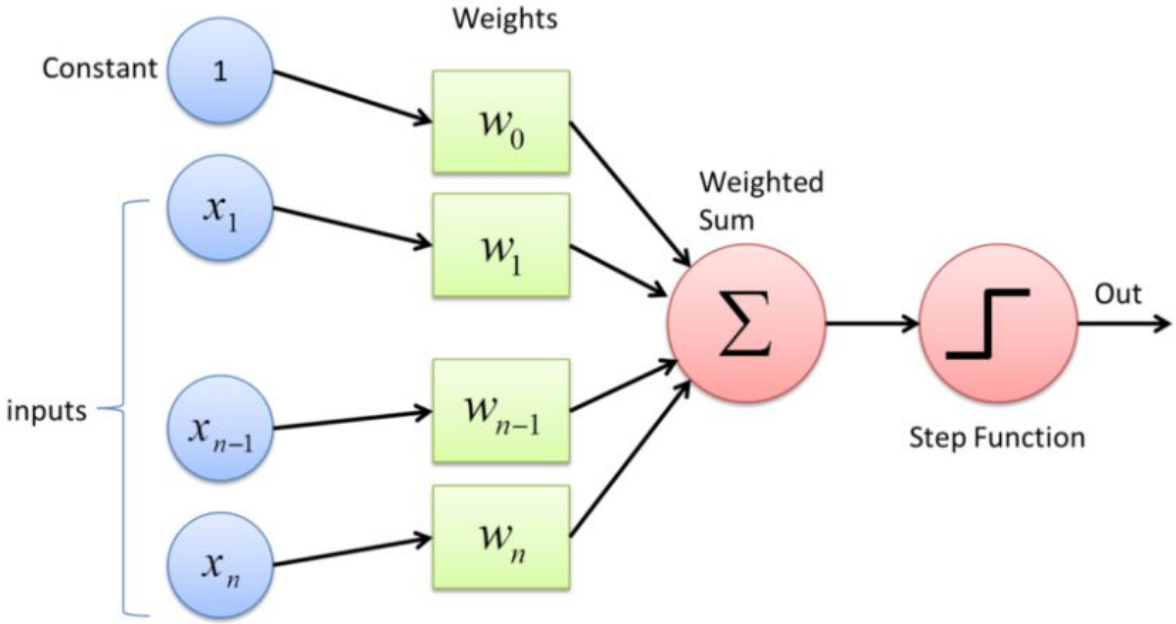


Fig : Perceptron

But how does it work?

The perceptron works on these simple steps

a. All the inputs x are multiplied with their weights w. Let's call it k.

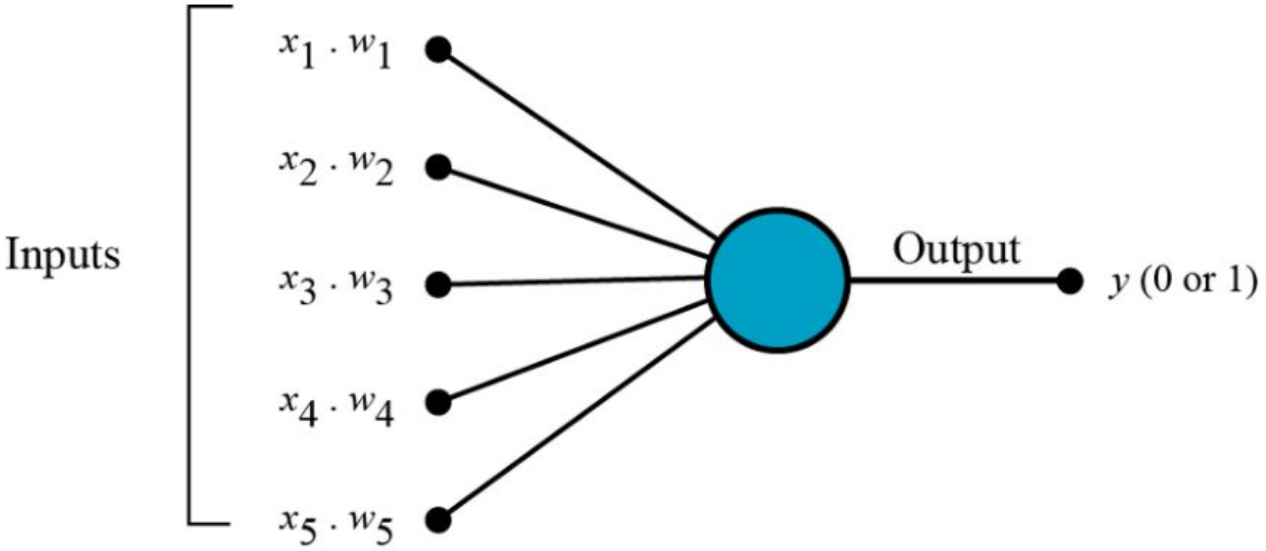


Fig: Multiplying inputs with weights for 5 inputs

b. ***Add*** all the multiplied values and call them ***Weighted Sum.***

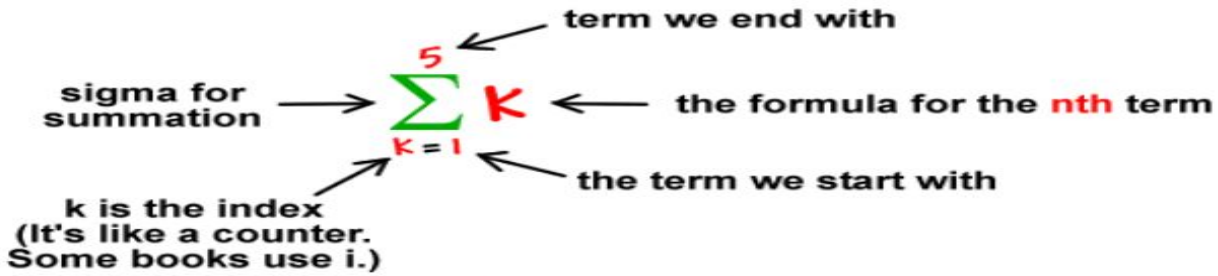


Fig: Adding with Summation

c. ***Apply*** that weighted sum to the correct ***Activation Function.***

For Example: Unit Step Activation Function.

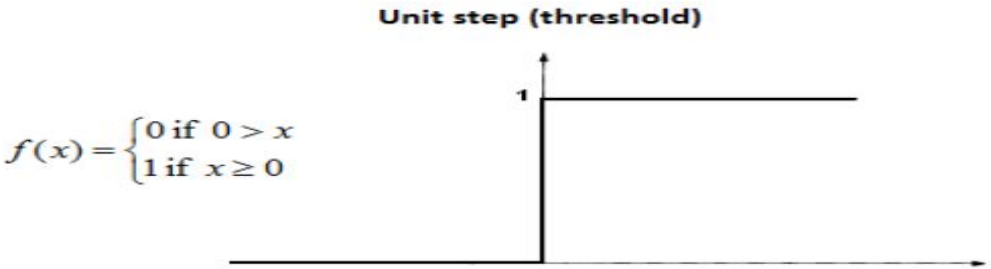
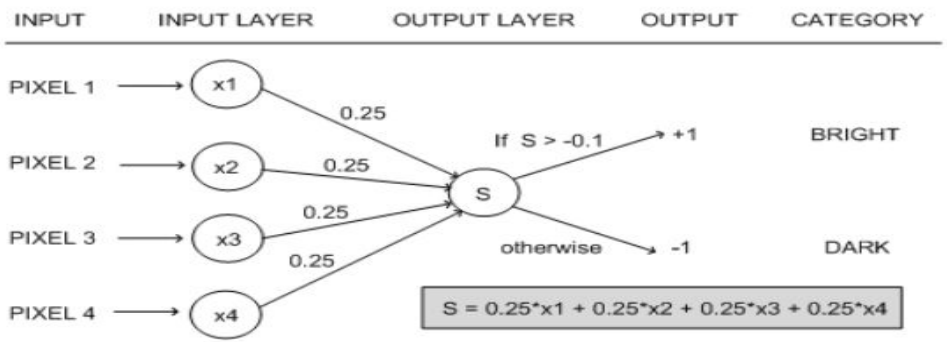


Fig: Unit Step Activation Function

Why do we need Weights and Bias?

Weights shows the strength of the particular node.

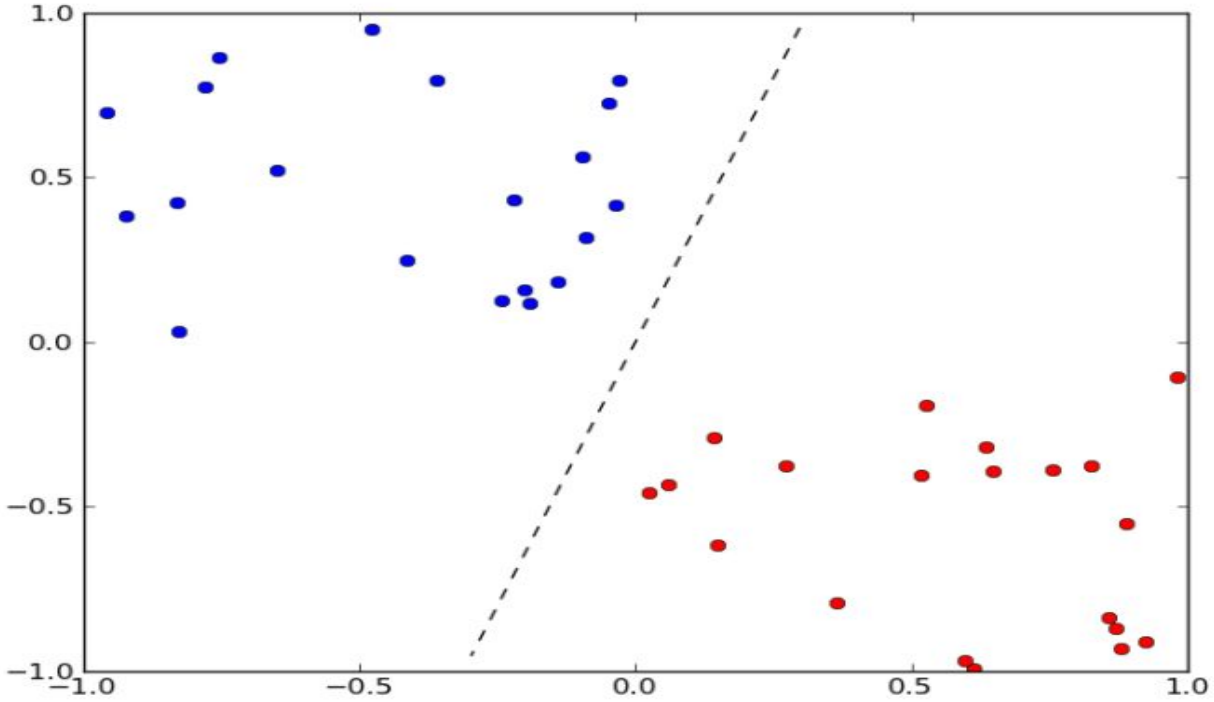
A bias value allows you to shift the activation function curve up or down.



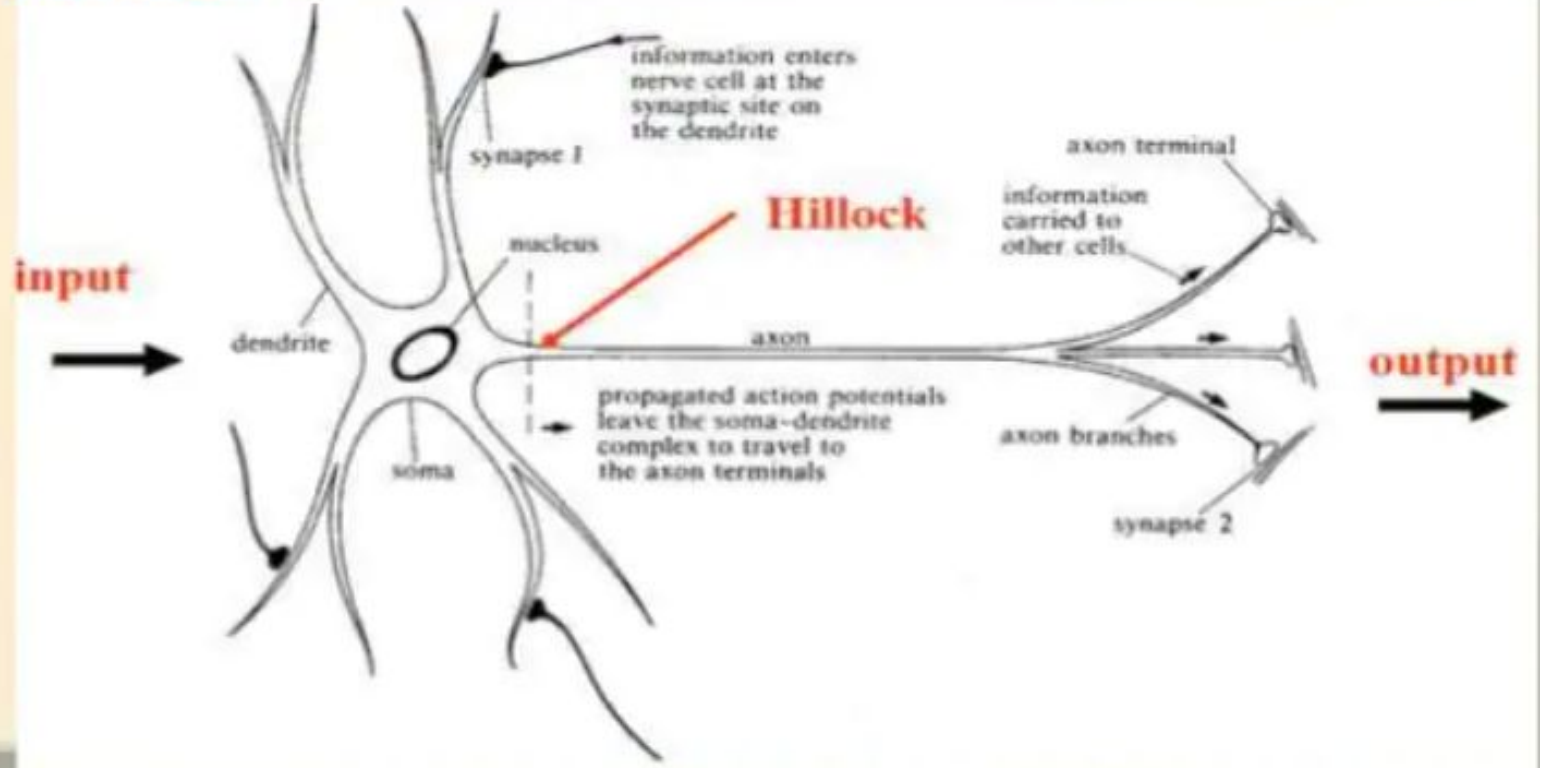
Why do we need Activation Function?

In short, the activation functions are used to map the input between the required values like (0, 1) or (-1, 1).

Perceptron is usually used to classify the data into two parts. Therefore, it is also known as a Linear Binary Classifier.



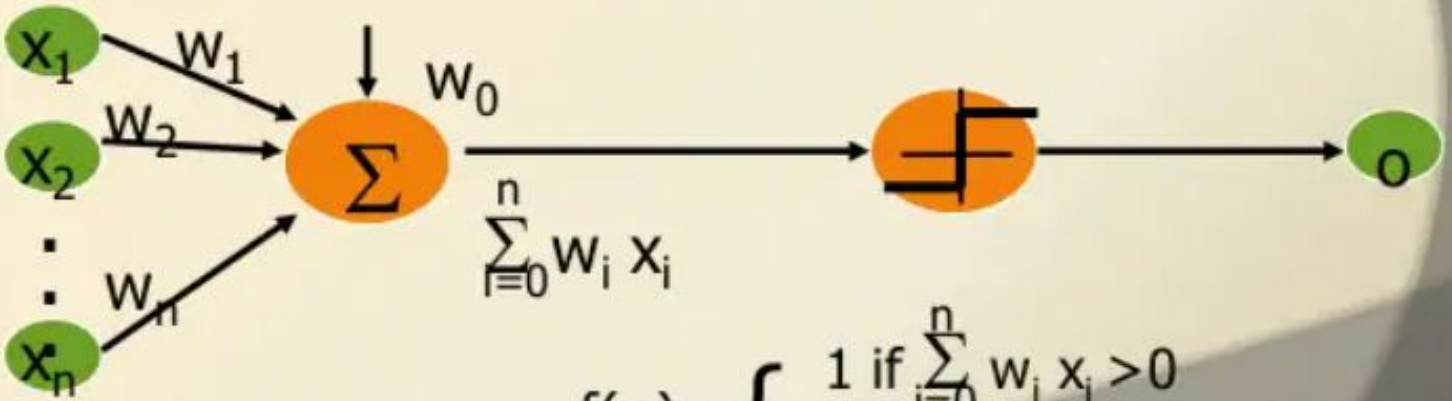
Perceptron in terms of a Biological Neuron



- While in actual neurons the dendrite receives electrical signals from the axons of other neurons, in the perceptron these electrical signals are represented as numerical values. At the synapses between the dendrite and axons, electrical signals are modulated in various amounts. This is also modeled in the perceptron by multiplying each input value by a value called the weight.
- An actual neuron fires an output signal only when the total strength of the input signals exceed a certain threshold. We model this phenomenon in a perceptron by calculating the weighted sum of the inputs to represent the total strength of the input signals, and applying a step function on the sum to determine its output. As in biological neural networks, this output is fed to other perceptrons.

Linear Threshold Unit (LTU)

- Perceptron can be defined as a single artificial neuron that computes its weighted input with the help of the threshold activation function or step function.
- It is also called as a TLU (Threshold Logical Unit).



What can a Perceptron do ?

- In machine learning, the **perceptron** is an algorithm for supervised classification of an input into one of several possible non-binary outputs.
- Perceptron can be defined as a single artificial neuron that computes its weighted input with the help of the threshold activation function or step function.
- The Perceptron is used for binary Classification.
- The Perceptron can only model linearly separable classes.
- First train a perceptron for a classification task.
  - Find suitable weights in such a way that the training examples are correctly classified.
  - Geometrically try to find a hyper-plane that separates the examples of the two classes.

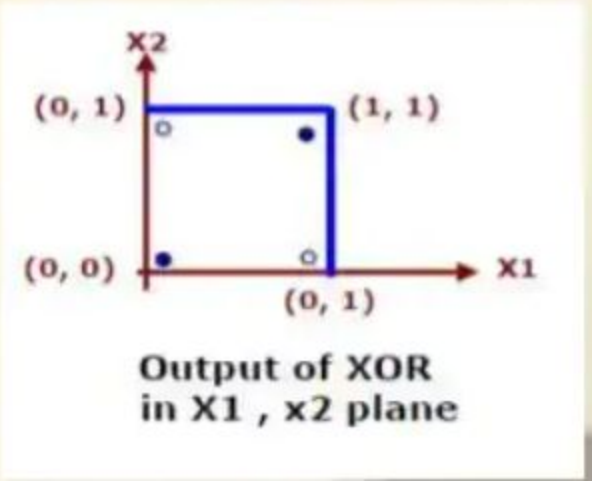
Exclusive OR (XOR) Problem :-

Input x1	Input x2	Output	
0	0	0	} Even parity •
1	1	0	
0	1	1	} Odd parity °
1	0	1	

XOR truth table

- Even parity means even number of 1 bits in the input
- Odd parity means odd number of 1 bits in the input

- There is no way to draw a single straight line so that the circles are on one side of the line and the dots on the other side.
- Perceptron is unable to find a line separating even parity input patterns from odd parity input patterns.



Limitation of Perceptron :-

- The perceptron can only model linearly separable functions,
  - those functions which can be drawn in 2-dim graph and single straight line separates values in two part.

  Boolean functions given below are linearly separable:
  - AND
  - OR
  - COMPLEMENT

  It cannot model XOR function as it is non linearly separable.
  - When the two classes are not linearly separable, it may be desirable to obtain a linear separator that minimizes the mean squared error.