INSTITUTE OF INFORMATION TECHNOLOGY

JAHANGIRNAGAR UNIVERSITY

Number of Assignment : 01

Submission Date : 08/04/2024

Course Tittle : Machine Learning

Course Code : ICT - 4261

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Roll – 2023

4th year 2nd Semester

IIT – JU

Ensemble Learning :-

Ensemble methods refer to the techniques used in ML to combine multiple base models to achieve better predictive performance. It's aim is to leverage the strength of multiple models to create a more accurate and robust predictor. This reduces the risk of overfitting.

Ensemble methods can be of 2 types:-

i) Homogenous ; ii) Heterogenous.

But, main types of ensemble method are of 4 types :-

i) Bagging
ii) Boosting
iii) Stacking
iv) Random forest.

Bagging :- Bagging is a machine learning ensemble technique to improve the accuracy and stability of a model. It generates multiple subsets of training data by random sampling with replacement & then training a model on each subset. The individual models are combined by taking their predictions average for regression or majority vote for classification

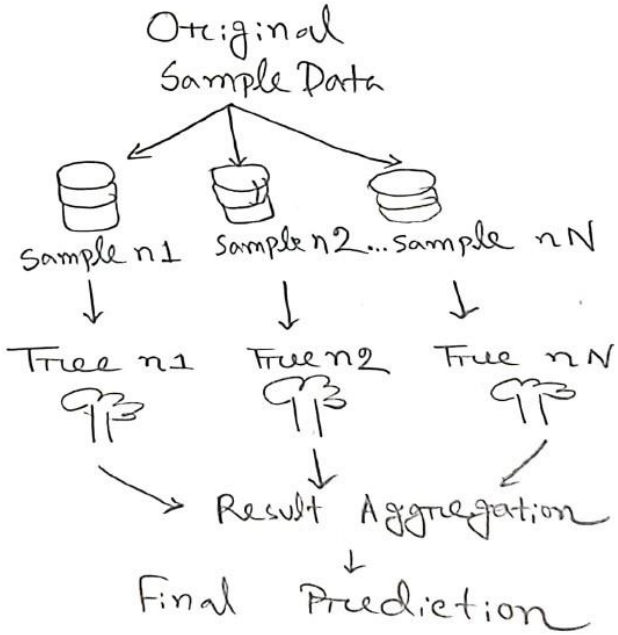


Fig:- Bagging.

Boosting :- Boosting adopts a sequential approach where the prediction of the current model is transferred to next one. Each model iteratively focuses attention on the observations that are misclassified by its predecessors.

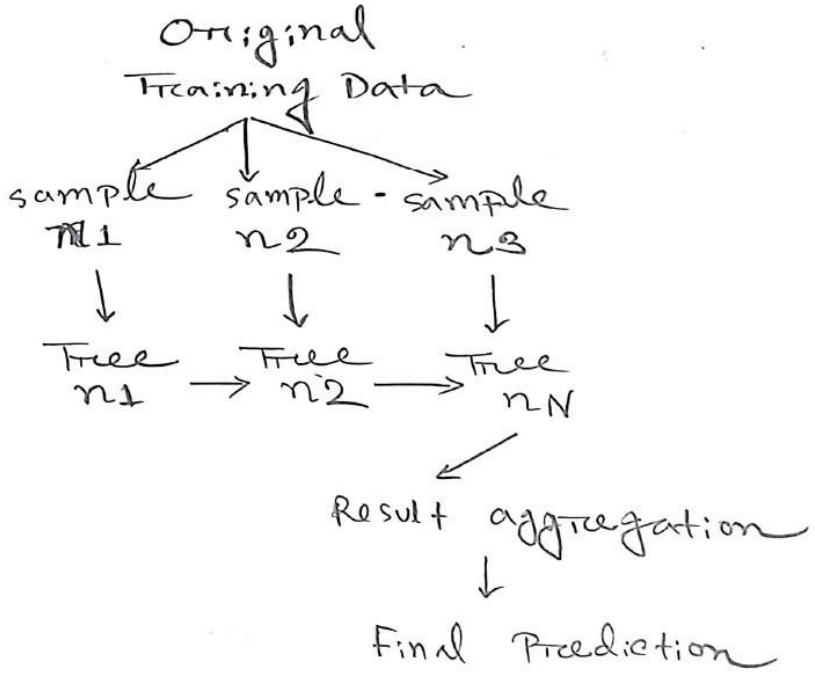


Fig :- Boosting

[4] Neural Network :- A network is a computational model inspired by the human brain. It consists of interconnected layers of computational units called neurons.

Key components :- i) input layer ; ii) hidden layer ; iii) output layer ; iv) neuron ; v) input ; vi) weight ; vii) Transfer function ; viii) Activation function ; ix) Bias.

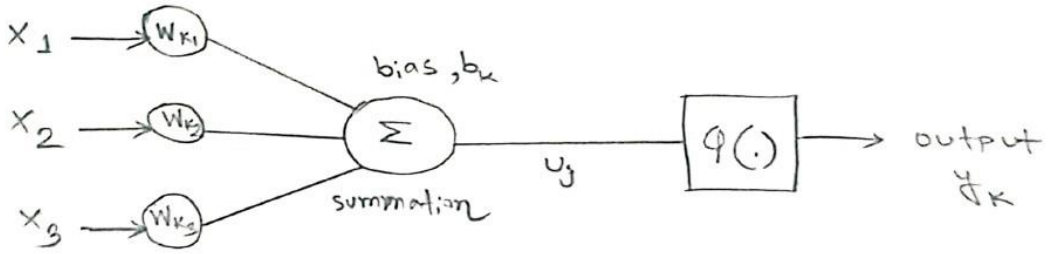
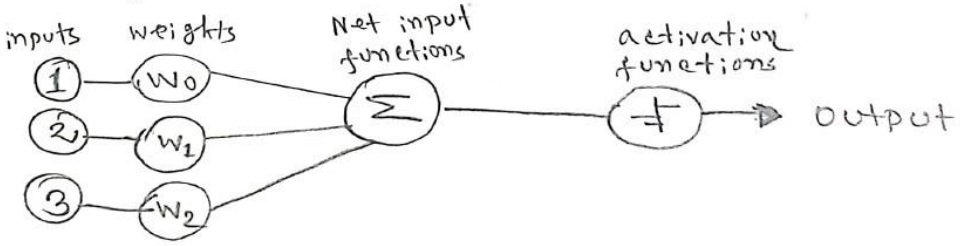


Fig :- Various components of a Neuron.

⊞ **Perceptron :-** Perceptron is a single layer neural network with 4 parameters- input values, weights & bias, net sum, activation function. It is the simplest neural network architecture.

⊞ **Standard Neural Network :-** It is a type of N.N. that takes a number of inputs, applies certain mathematical operations on these inputs and produces output. It takes a vector of real values inputs, performs linear combination of each attribute with corresponding assigned to each of them.



⊞ Mechanism of perceptron :-

Let, x be the input & w_k be the weight. Now, multiply them to find weighted sum.

$$\sum w_k * x_k = w_1 * x_1 + w_2 * x_2 + \ldots + w_k * x_k$$

Now, add bias ~~to~~ b to it.

$$\sum w_k * x_k + b$$

pass the value for activation function for output,

$$Y = f\left(\sum w_k * x_k + b\right)$$

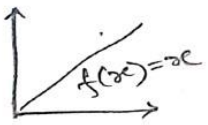
⊞ Multi-Layered Perceptron Model :-

The multi-layer perceptron model is known as back-propagation algorithm, which executes in two stages as follows:-

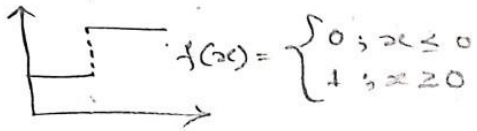
i) Forward stage :- Activation functions starts from the input layer in the forward stage & terminate on the output layer.

ii) Backward Stage :- The weight & bias values are modified as per the models requirement. The error between actual output & demanded originated backward on the output layer & ended on input layer.

Activation Function :- An activation function decides whether a neuron should be activated or not. This is of different types - Binary step Linear, Non - linear function.

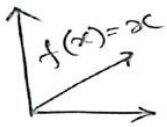


Linear

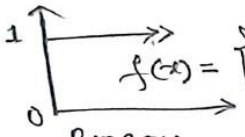


Binary step.

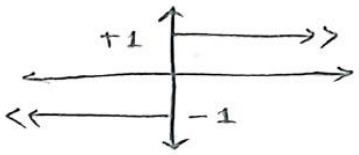
Non-linear activation functions are also of different types :-



Identity

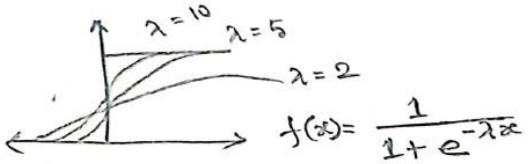


Binary step



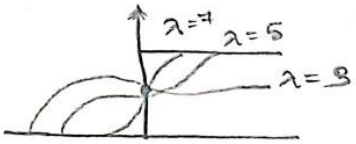
Bipolar step

$$f(x) = \begin{cases} 1 ; & x \geq 0 \\ -1 ; & x < 0 \end{cases}$$

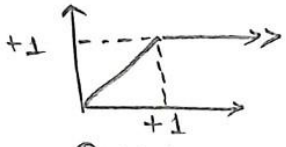


Binary Sigmoidal

$$f(x) = \frac{1 - e^{-2x}}{1 + e^{-2x}}$$



Bipolar Sigmoidal



Ramp.

$$f(x) = \begin{cases} 1 ; & x > 1 \\ x ; & 0 \leq x \leq 1 \\ 0 ; & x < 0 \end{cases}$$

Radial Basis Function :- RBF or Kernel function is applied to the distance to calculate every neuron's weight. Weight = RBF [Distance]. The greater the distance of a neuron from a point being evaluated, the less weight it has.

Math:-

$H(x) = e^{\frac{-(x-c)^2}{\sigma^2}}$; where, $(x-c)^2 = d^2 = (x_2-x_1)^2 + (y_2-y_1)^2$

For input pattern (0,0), the distance from (0,0), (0,1), (1,0), (1,1) are:-

$d_1^2 = 0$; $d_2^2 = 1$; $d_3^2 = 1$; $d_4^2 = 2$

$\therefore H_1(x) = 1$; $H_2(x) = 0.6$; $H_3(x) = 0.6$; $H_4(x) = 0.4$

$\therefore \sum W_K H_K(x) = (-0.8)(1) + (0.9)(0.6) + (0.9)(0.6) + (-0.8)(0.4) = -0.04$

Similarly, for input pattern (0,1), (1,0), (1,1)

$\sum W_K H_K(x) = 0.3$

$\sum W_K H_K(x) = 0.3$

$\sum W_K H_K(x) = -0.04$

forward Phase Calculation

Input	$H_1(x)$	$H_2(x)$	$H_3(x)$	$H_4(x)$	$\sum W_K H_K$	output
(0,0)	1	0.6	0.6	0.4	-0.04	0
(0,1)	0.6	1	0.4	0.6	0.3	1
(1,0)	0.6	0.4	1	0.6	0.3	1
(1,1)	0.4	0.6	0.6	1	-0.04	0

The End