

Assignment 2

1) Supervised and Unsupervised learning (FTS)

Supervised Learning

- Supervised learning algorithms, are trained using labelled data.
- Takes direct feedback to check if the model is predicted correct output.
- The goal is to train the model so that it can predict the output when it is given new data.
- Need supervision to train the model.
- Eg Linear Regression, Logistic Regression, Decision tree etc.

Unsupervised Learning

- Unsupervised learning algorithms are trained using unlabelled data.
- Does not take feedback.
- The goal is to find the hidden patterns and useful insights from the unknown dataset.
- Does not need any supervision to train the model.
- Eg Clustering, KNN and Apriori Algorithm.

2) Artificial Neural Network and its features -

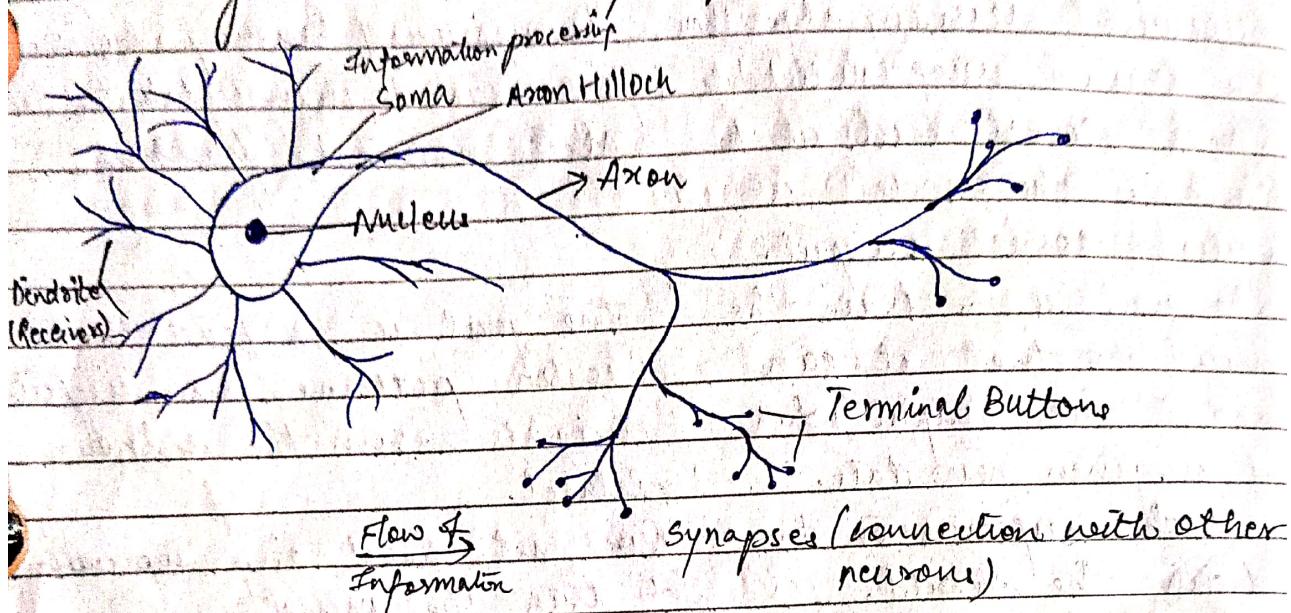
Artificial Neural Network refers to a biologically inspired sub-field of artificial intelligence modelled after the brain. ANN is based on biological neural networks that construct the brain structure. They also have neurons linked to each other in various layers of the network. These neurons are known as nodes.

The features of ANN are -

- They are extremely powerful computational devices.
- They have massive parallelism making them very efficient.
- Storage is fault tolerant.

4) They can interpolate and extrapolate from their stored information.

2) Draw and explain simple structure of biological neurons (perception model).



A typical biological neuron consists of -

- ① Soma - Collects signal coming through
- ② Dendrites - receive information from other neurons
they are connected through and distribute the signal further through
- ③ Axon - Cable through which neurons send information
- ④ Synapses (or Terminal Buttons) - Represent the main memory of the neurons

4) Explain various types of activation function
There are different types of activation function
some of them are -

- ① Identity Function:- Used for input layer. It is a linear function of the form
 $y_{out} = f(x) \approx x, \forall x$
output remains same as input.

② Threshold/Step Function - It gives 1 as output if the input is either 0 or positive. If the input is negative, it gives 0 as output.

$$y_{out} = f(\text{input}) = \begin{cases} 1, & x > 0 \\ 0, & x \leq 0 \end{cases}$$

③ Rectified Linear Unit Function - Used in the areas of convolutional neural networks and deep learning.

$$f(x) = \begin{cases} x, & x \geq 0 \\ 0, & x \leq 0 \end{cases}$$

④ Sigmoid Function - Differentiable and continuous activation function. There are two types:-

→ Binary Sigmoid Function

$$y_{out} = f(x) = \frac{1}{1 + e^{-kx}} \quad \text{where } k = \begin{matrix} \text{steepness} \\ \text{or slope} \\ \text{parameter} \end{matrix}$$

→ Bipolar Sigmoid Function

$$y_{out} = f(x) = \frac{1 - e^{-kx}}{1 + e^{-kx}}$$

5) What do you mean by Multilayer feed-forward neural network?

A multilayer feedforward neural network is an interconnection of perceptrons in which data and calculations flow in a single direction, from the input data to the outputs. The number of layers in a neural network is the number of layers of perceptrons. Through output assessment, network activity can be noticed based on group behaviour (Control).

of the associated neurons and output is decided. The primary advantage of this network is that it figures out how to evaluate and recognize input patterns.

- b) Limitations of Multilayer Perception
- Multilayer Perception with hidden layers have a non-convex loss function where there exists more than one local minimum. Therefore, different random weight initializations can lead to different validation accuracy.
 - MLP requires tuning a number of hyperparameters such as the number of hidden neurons, layer and iterations.
 - It is sensitive to feature scaling.

- c) Explain and derive the concept of Back Propagation Learning Algorithm.
- Back Propagation algorithm, the most fundamental building block in a neural network, is used to effectively train a neural network through a method called chain rule. In simple terms, after each forward pass through a network, backpropagation performs a backward pass while adjusting the model's parameters (weights and biases). Back propagation algorithm performs gradient descent to try to minimize the sum square error between the network's output values and the given target values.

- Applications of Perception
- ① Only works with linearly separable classes

Perception

- An ANN unit - that helps to detect certain input data computations in business intelligence
- Single layer neural network with 4 parts - input values, weights and bias, net sum and an activation func.

Perception Model

- ① Input nodes/ layers: - Accepts initial data into the system for further processing

- ② Weights & Bias: - weight parameter represents strength of the connection b/w units
Bias → like of intercept in linear eqn

- ③ Activation func - Used to take a subjective decision based on various pre statements and form desired outputs

Working

- ② Perception model begins with multiplication of all input values and their weights, then adds these values together to create the weighted sum.

Weighted sum applied to activation function
activation func ensures that output is mapped b/w required values {0,1} or {-1,1}.

Limitations of Perception Model

- ① Output can only be a binary no (0 or 1) due to hard limit transfer func
- ② Only be used to classify the linearly separable sets of input vectors.

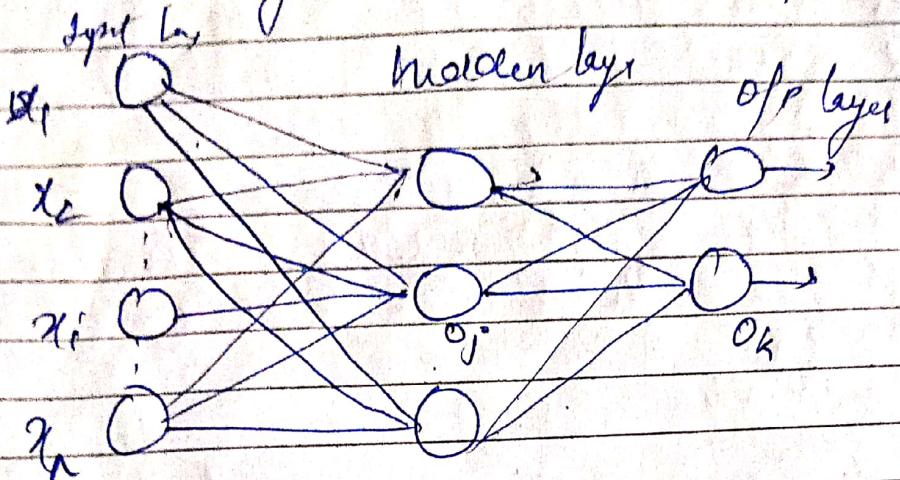
Backpropagation

- multilayered, feedforward neural network
- One of the simplest and most general methods used for supervised learning of multilayered neural networks
- Works by approximating the non-linear relationship b/w the input and the output by adjusting the weight values internally
- Operations of BP(NA) can be divided into -
 - ① Feedforward
 - ② Backpropagation

- ① In feedforward step, an input pattern is applied to the input layer and the effect propagates layer by layer through the network until an output is produced.
- ② The network's actual output is compared to the expected output, and an error signal is computed for each output node.
- ③ The output error signals are transmitted backwards from output layer to each node in the hidden layer that immediately contributed to the output layer.
- ④ The process is then repeated, layer by layer, until each node in the network has received an error signal that describes its relative contribution to the overall error.
- ⑤ The BP algo looks for the min value of the error function in weight space using a technique called gradient descent.
- ⑥ The weights that minimize the error function is then considered to be a sol' of the learning problem.

Multilayer Feedforward NN

Consists of one input layer, one or more hidden layers and an output layer.



→ Try to model the class prediction as a non linear combination of inputs.

