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DETAILED LECTURE NOTES

Unit 5 :- Recommended System :→

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- ① Collaborative filtering
- ② Content-based filtering
- ③ Artificial Neural Network
- ④ Multilayer Network
- ⑤ Backpropagation
- ⑥ Introduction to Deep learning

Q: What is a Recommendation System :→

- Recommendation engines are a subclass of machine learning which generally deal with ranking or rating products/users.
- A recommender system is a system which predicts rating a user might give to a specific item.
- They are used by various large name companies like Google, Instagram, Spotify, Amazon, Netflix.

eg:- Spotify would recommend songs similar to the ones you have repeatedly listened to or liked.

eg:- Amazon

- Recommender system are often seen as a 'black box'.
- There are many different ways to build recommender system, some use → algorithmic
 - ↳ formulaic approaches

What defines a Good Recommendation?

- The method of evaluation of a recommendation is solely dependent on the dataset and approach used to generate the recommendation.
- Common statistical accuracy measures to evaluate accuracy of a recommender are

RMSD (Root Mean Square Deviation)

MAE (Mean Absolute Error)

k-fold cross validation



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Collaborative filtering systems: →

- Collaborative filtering is the process of predicting the interests of a user by identifying preferences and info from many users;

or

It finds similar users and recommend what similar users like.

- If users A & B have similar taste in a product, then A & B are likely to have similar taste in other products as well.

- There are two common type of approaches in collaborative filtering

memory based

model based.

- ① Memory based:— Neighbourhood Collaborative filtering

- This can be further split into user based

Collaborative f and item based CF.

- User based → minded users are going to yield strong and similar recommendation

item based - item based on the similarity b/w items calculated using user rating of those items.

② Model based approaches: →

→ It is associated with features of dataset that are parameterized as inputs of the model to find optimized solution.

- It include decision tree, rule based approaches etc

Advantages: —

- It is simple.
- It capture suitable characteris only.

Disadvantage: →

- Not friendly

eg: → ① YouTube: —

② Coursera: —



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Content Based Systems: →

- It generates recommendations based on the user's preferences and profile.
- Content based models focus on the rating provided by the target user themselves.
- It requires following data sources

- ① Item level: - Requires attributes of the item.
- ② User level data: - User feedback based on the item you're providing recommendation.

Advantage: →

- Good if rated by more users.

Disadvantage: -

- ① Never recommends uninteractive item.
- ② Ineffective for new users.

Example: -

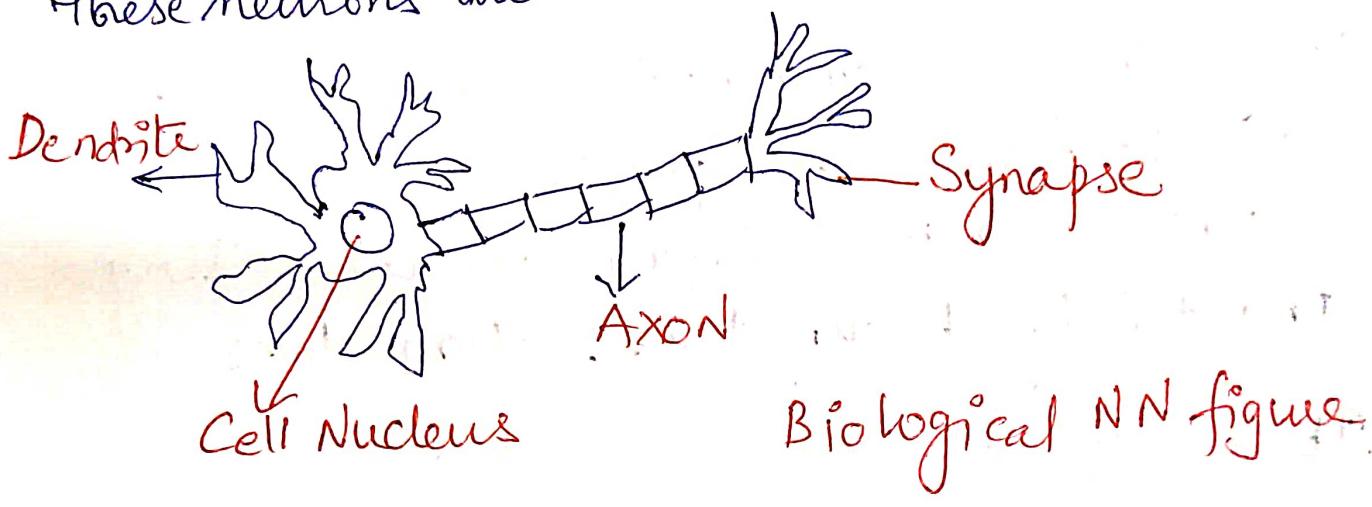
- ① Amazon product feed

- ② Spotify music recommendations

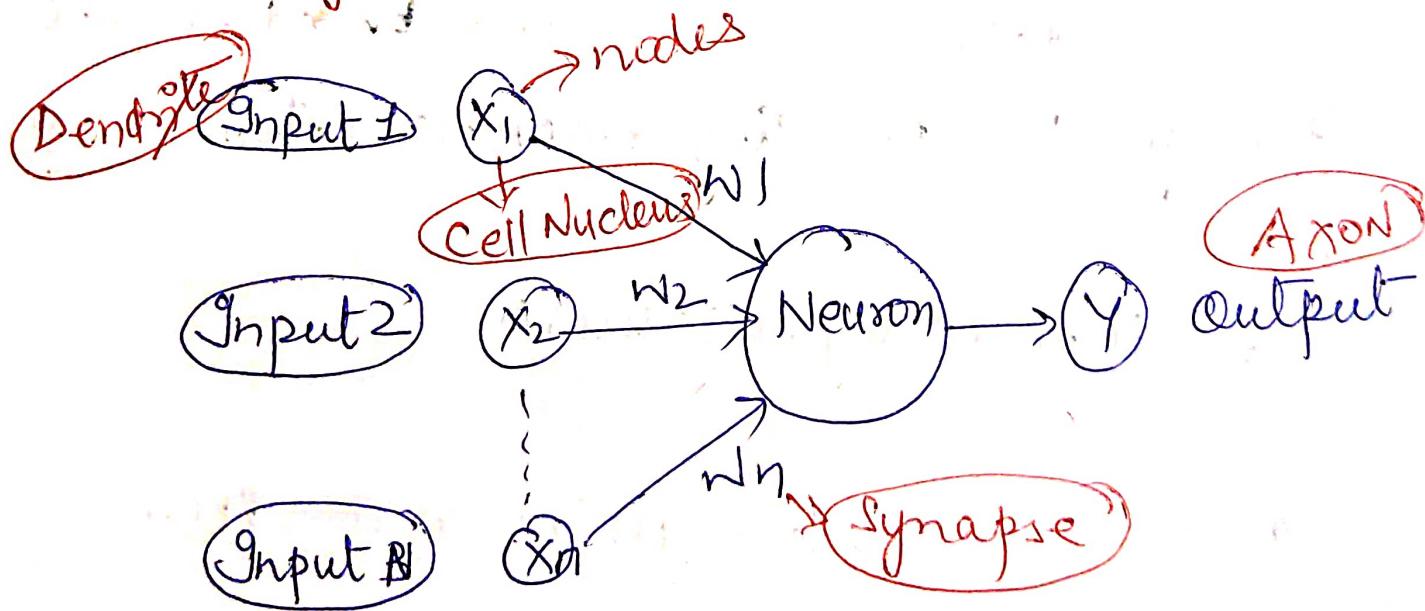
Artificial Neural Network →

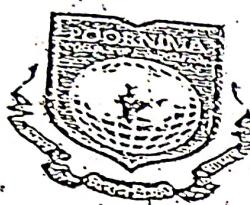
Artificial Neural Network (ANN) is derived from Artificial Neural Network (ANN) that develop the structure of biological neural n/w that develop the structure of a human brain.

In brain neurons are interconnected same in ANNs.
These neurons are known as nodes.



ANN figure →





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Artificial Neural Network primarily consists of three layers:

① Input layer:

It accept inputs in several different formats provided by the programmer

② Hidden layer: →

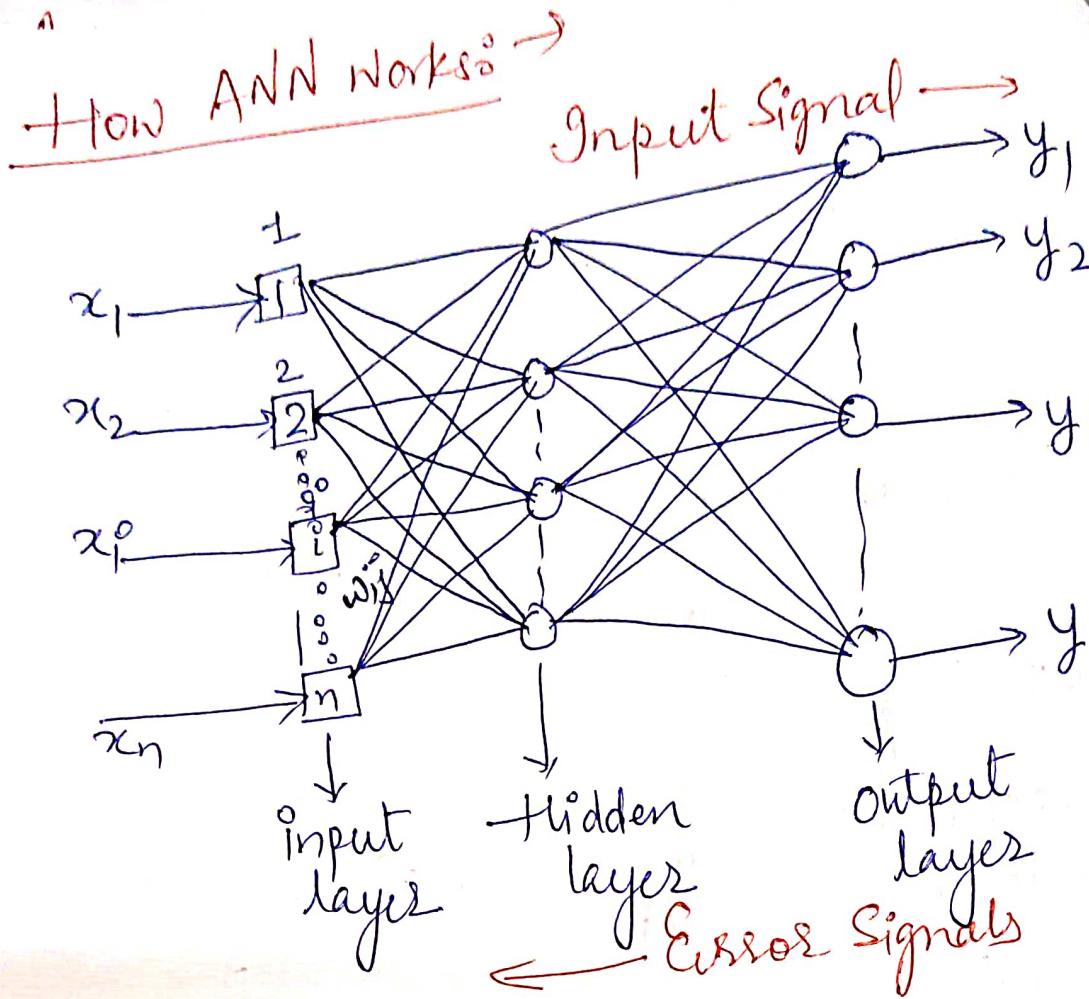
The hidden layer presents in b/w input and output layers. It performs all the calculation to find hidden features and patterns.

③ Output layer: →

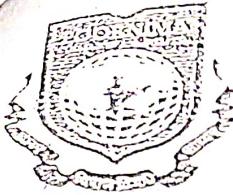
Input goes through a series of transformations using the hidden layer, which finally result in output.

- Computation of ANN

$$\sum_{i=1}^n X_i \cdot w_i + b$$



- first inputs are given and multiplied by their corresponding weights.
- Weighted input are summarized inside the competing unit.
if weighted sum = 0
bias is added ^{to} make the output non-zero
- Compare the output with the desired output.
We change the value of weights and passes through the activation fun.
- Activation func refers to set of transfer func used to achieve the desired off.
- There is a different kind of activation func.
- Some of the commonly used sets of activation func's are binary, linear & hyperbolic sigmoidal.



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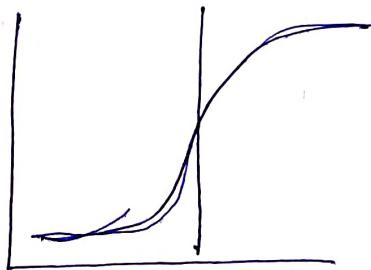
① Binary :-

- Output either 1 or 0.
- Set threshold value
- If weighted sum $> 1 \rightarrow$ set 1 output
if $< 1 \rightarrow$ set 0 output

② Sigmoidal

$$f(x) = (1 / (1 + e^{-x}))$$

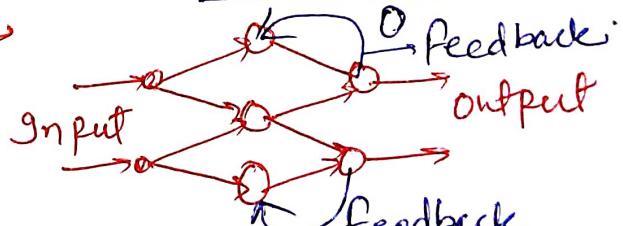
- it's in S shape



Types of Neural Network :-

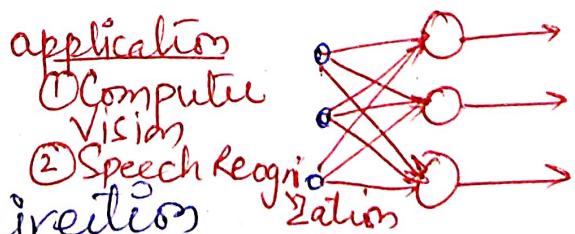
① feedback ANN :-

Output returns into the n/w to get best-evolved result



② Feed Forward ANN :-

- Simplest form of ANN
- Data travel in one direction
- This NN may not or may have hidden layers
- Simply we can say that it has a front propagated wave and no backpropagation.



Advantages of ANN →

- ① Parallel processing capability.
- ② Storing data on the entire n/w.
- ③ Capability to work with incomplete knowledge
- ④ Having a memory distribution

Disadvantages of ANN :-

- ① Assurance of proper n/w structure
- ② Unrecognized behavior of the n/w
- ③ Hardware dependence
- ④ Difficulty of showing the issue to the n/w.
- ⑤ The duration of the n/w is unknown;



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Perception:-

- Perception is most commonly used in ML & AI.
- Perception is a building block of a ANN. Perception is a linear m/c learning algo used for supervised learning for various binary classifiers.

Definition:- Perception is also as an Artificial Neural Network or neural network unit that helps to detect certain input data computations in business intelligence.

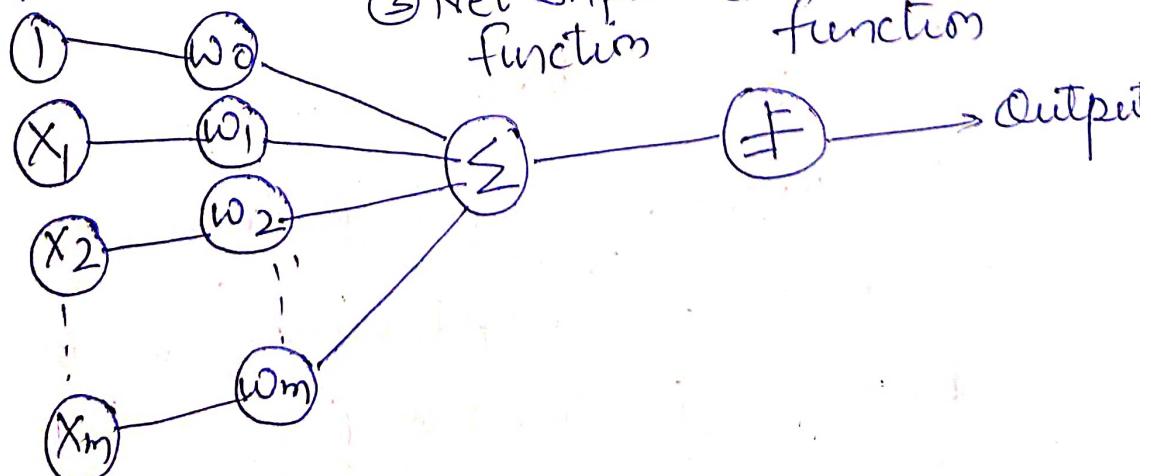
- It is basically used for the binary classification.

Basic Components of Perception

① Inputs ② Weights

③ Net Input function

④ Activation function



① Input Nodes/layer →

It is the primary component of perception and give value for further processing.

② Weight & Bias:-

Weight → represent the strength of connection b/w or and directly proportional to the strength of associated input neuron in deciding the op.

- Bias is a line of intercept in a linear eq.

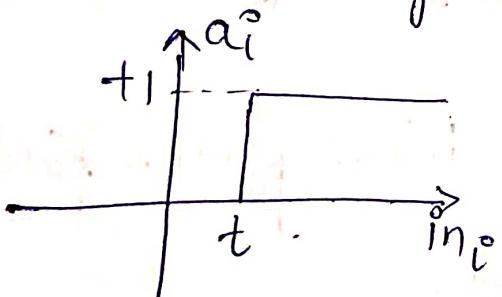
③ Activation func:-

- Important component that help to determine whether the neuron will fire or not.
- Types of Activation func

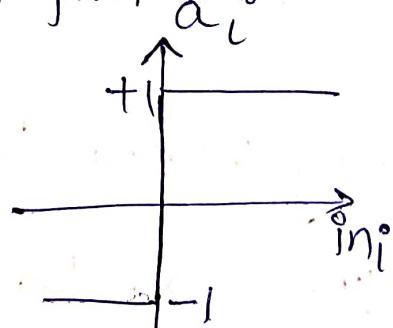
① Sign func

② Step func

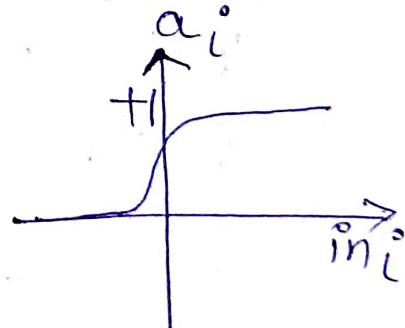
③ Sigmoid func



Step



Sign

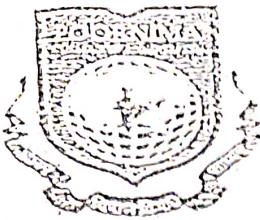


Sigmoid

Working of Perception:-

In ML perception is a single-layer neural n/w parameters that consist of four input values ④ weights & Bias

- ③ net sum
- ④ activation func.



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- first all input values & weights are multiplied and add them to create the weighted sum.
- This weighted sum is applied to activation func to obtain the desired op.

Step1

$$\sum w_i \times x_i = x_1 * w_1 + x_2 * w_2 + \dots + x_n * w_n$$

- Add special term bias to sum to improve the model's performance

$$\sum w_i \times x_i + b$$

Step2: Apply activation func to sum

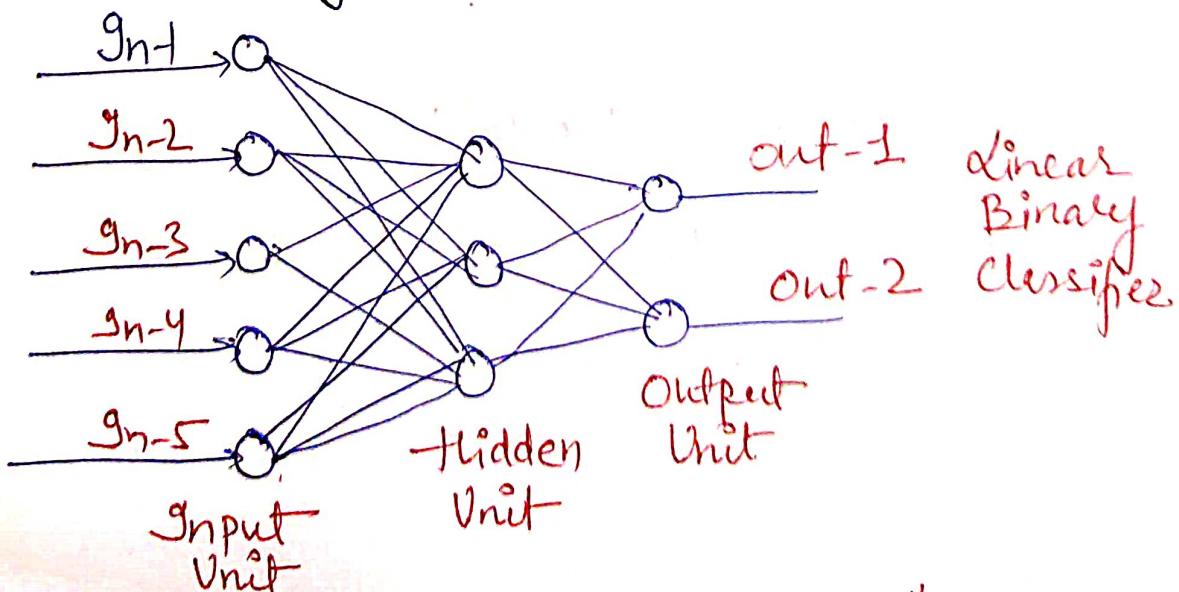
$$y = f(\sum w_i \times x_i + b)$$

Types of Perception Model: →

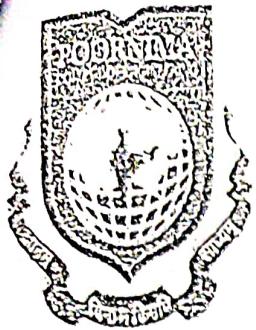
- ① Single-layer
- ② Multi-layer

Single layer Perception Model :-

- Easiest ANN
- S-LPM consist of feed forward n/w and also includes a threshold transfer func inside the model.
- Main objective of SLPM is to analyze the linearly separable objects with binary outcomes.
- In this model, they don't have recorded data. Instantly inputs for weights are allocated.
- If total sum of all input is more than a pre-determined value, the activated model get active and show the op. value as +1.
- But If the output is same as pre-determined or threshold value, then the performance of this model is stated as satisfied and weight does not change.



- Best example of Single-layer perception is "logistic regression"



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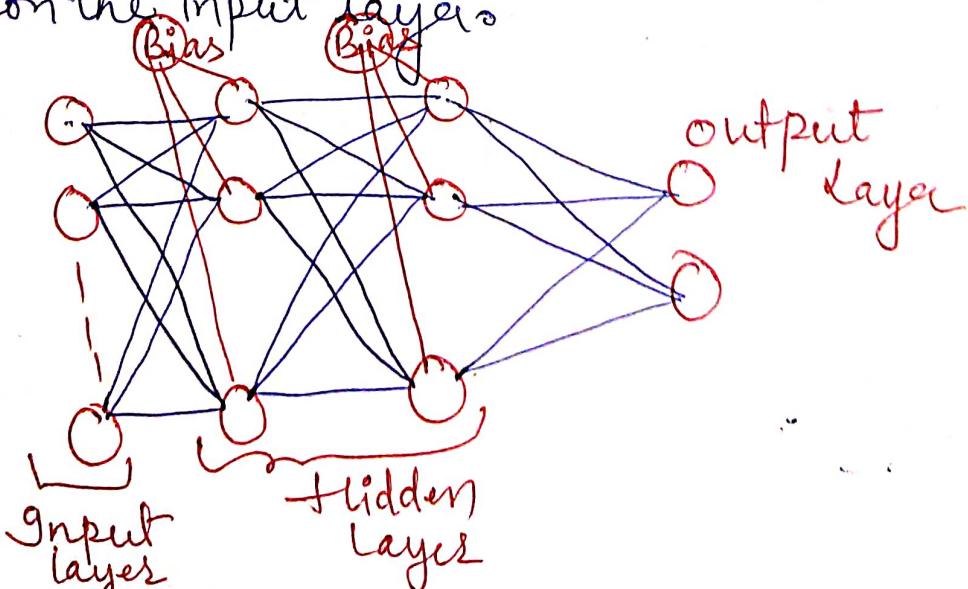
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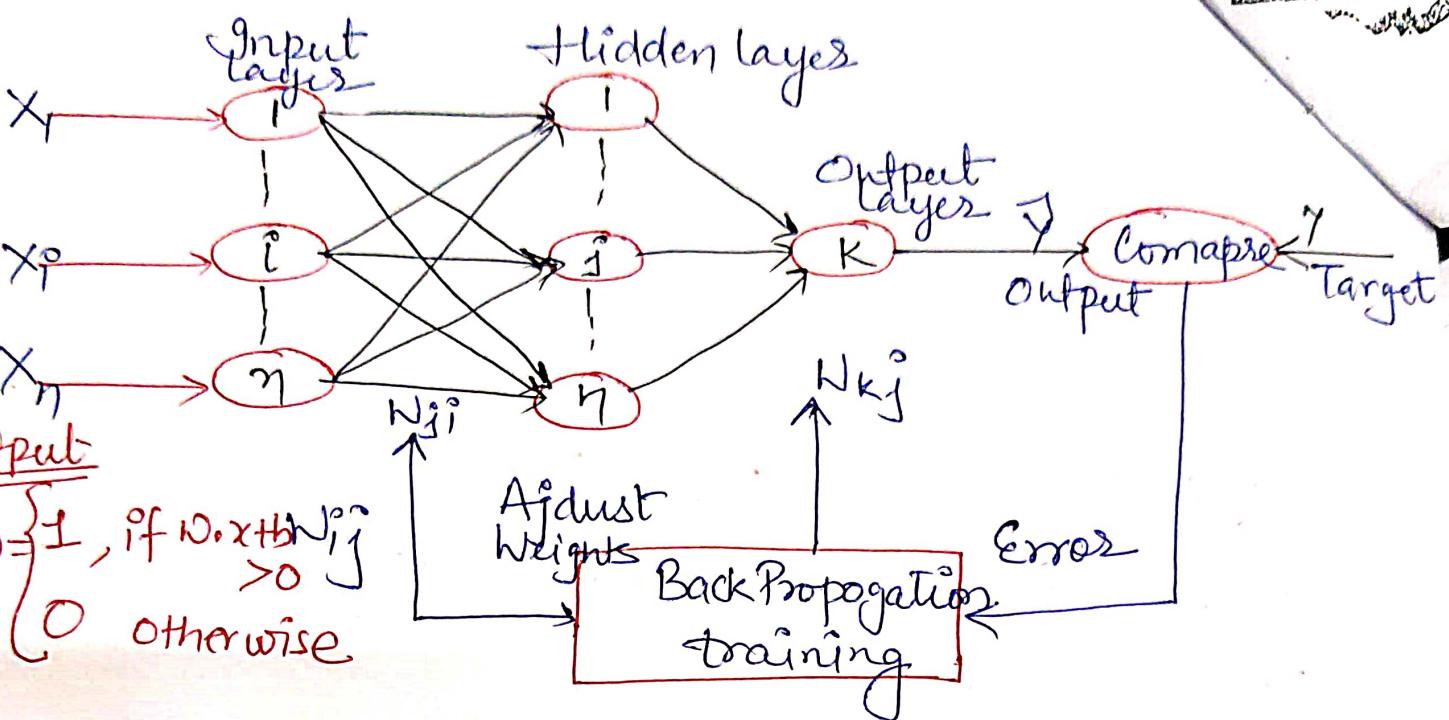
Multi-layered Perception Model:

- It has greater no. of hidden layer in comparison to single layer
- It is known as Back propagation algo which execute in two stages
 - (1) Forward Stage → Activation start from input layer in fwd stage and terminate on off layer.
 - (2) Backward Stage →

In backward stage, weight & bias values are modified as per the model's requirement.

find error b/w actual output and demanded originated backward on the output layer and ended on the input layers

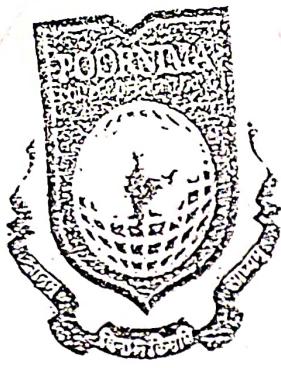




A multi-layer perceptron model has greater processing power and can process linear and non-linear patterns. It can also implement logic gates such as AND, OR, XOR, NAND, NOT, XNOR, NOR.

Advantages of Multi-layers Perception

- ① Used to solve complex non-linear problems.
- ② Well work with small and large input data.
- ③ Accuracy is good for both small and large input data.
- ④ Obtain quick predictions after the training.



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Disadvantages of MLP:-

- ① Computation are difficult and time-consuming
- ② It is difficult to predict how much the dependent variable effects each independent variable
- ③ Model func depends on the quality of Training.



Characteristic of Perceptron:-

- ① Perceptron is a ML algo for supervised learning of binary classifiers.
- ② Weight coefficient automatically learned.
- ③ Activation func applies a step rule to check whether the weighed func is greater than zero.

~~(2)~~

$$f(x) = \begin{cases} 1 & \text{if } \sum w_i x_i + b > 0 \\ 0 & \text{otherwise} \end{cases}$$

Limitations of Perceptron Model:-

- ① O/P of perceptron can only be binary no(0 or 1) due to hard limit transfer func.
- ② Perceptron are used to classify the linearly separable sets of input vectors only. If input vectors are non-linear, it is not easy to classify them properly.

①

Deep Learning :-

- DL is a part of ML which is based on neural n/w.
- In DL, there is no need of explicit program.
- Basically, it is ML class that makes use of numerous non-linear processing units, so it performs feature extraction as well as transformation.
- In DL output from each preceding layer is taken as input by each one of the successive layers.
- DL & ML are subset of AI.

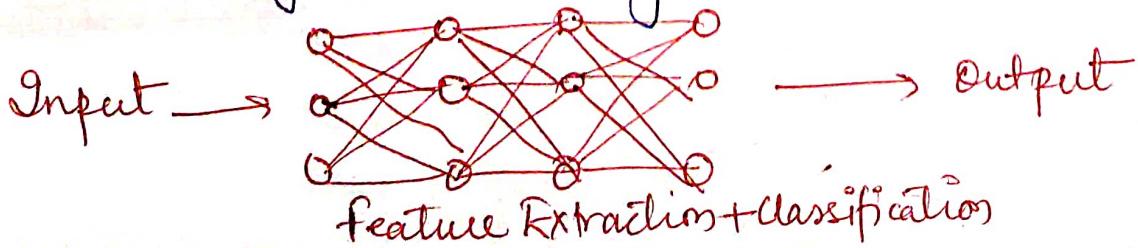
"The idea of DL to build such algorithm that can mimic the brain."

→ "Deep Learning is a collection of statistical techniques of machine learning for learning feature hierarchies that are actually based on artificial neural n/w!"

Architecture of Dl :-

① Deep Neural Network :-

- It is a neural n/w with a certain level of complexity (having multiple hidden layers in b/w input & op layers). They are capable of modeling and processing non-linear relationship

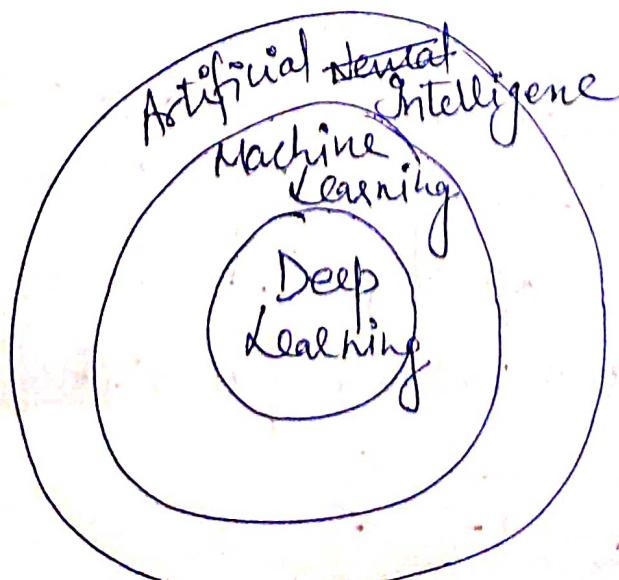


② Deep Belief N/W (DBN):-

- It is a class of Deep neural n/w.
- It is multi-layer belief n/w.
- Steps of DBN
 - ① Learn a layer of features from visible units using Contrastive Divergence algorithm.
 - ② Treat activations formerly trained features as visible units, which perform learning of features.
 - ③ When the learning of hidden layer done, then whole DBN is trained.

③ Recurrent Neural Network (RNN):→

- It allows for parallel and sequential computation.
- Due to large feedback n/w of connected neurons, they remember important things about the input they received and enable them to be more precise.



Feed forward Neural Network:-

- In this nodes don't form a cycle.
- Also known as Artificial Neural network.
- Hidden layer connected with the previous and next layer only and are fully connected.
- Don't have visible or invisible connection b/w the nodes in same layer.
- Don't have back-loops.

Application:-

- Data compression
- Computer Vision
- Handwritten character Recognition

② Convolutional Neural Network:-

- Special kind of neural n/w
- mainly used for image classification

Application:-

- Image Recognition
- Drug discovery
- Identify faces, street signs

④ Restricted Boltzmann Machine:-

- In this neurons present in the input layer and the hidden layer encompasses symmetric connections.
- No internal associations within the respective layer.

Application:-

- Filtering
- Risk Detection

Difference b/w ML and DL

Machine Learning	Deep Learning
① Work on less small amount of Dataset	① Works on large amt. of dataset for feature extraction
② Depend on low-end m/c	② Depend on high-end m/c.
③ Divide the tasks into sub-tasks, solve them individually and finally combine the results.	③ Solve problem end to end.
④ Training time is less	④ Training time is large
⑤ Testing time increase	⑤ Testing time decrease

Types of Deep Learning networks :-

① RNN (Recurrent Neural Network) :- Another version of feed-fwdn/w

- In RNN, hidden layer neurons receive input from the previous layer with a specific delay in time
- Due to this it has slow computational speed as well as it does not contemplate any future input for the current state.

Application

① Music composition

② Speech Recognition

③ Robot Control

④ Time-Series Prediction

Deep learning Application:-

- ① Self-driving cars
- ② Voice-controlled Assistance
- ③ Automatic Image Caption Generation
- ④ Automatic Machine Translation

Limitations:-

- ① Only learn through observation
- ② Comprises of biases issues.

Advantage of DL:-

- Easily identifies difficult defects
- Eliminates unnecessary costs
- Reduced cost for feature engineering

Disadvantages of DL:-

- Required large amt. of data
- Computationally expensive to train
- No strong theoretical foundation