Introduction to Deep Learning

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* Definition :-

Deep Learning is the specialized field within Artificial Intelligence (AI) and Machine Learning (ML) which is designed to mimic the structure and function of human brain.

* Difference between ML and DL :-

(i) The traditional or classical ML completely depends on the statistical techniques to determine relationship between input and output variables.

(ii) Deep Learning uses the logical structure known as a Neural Network the achieve the relationship between input and output variables.

The Foundation of deep learning is the Artificial Naural Network (ANN) which attempts to draw conclusions similar to how human do.

The key Mechanism used in deep learning is 'Representation Learning'.

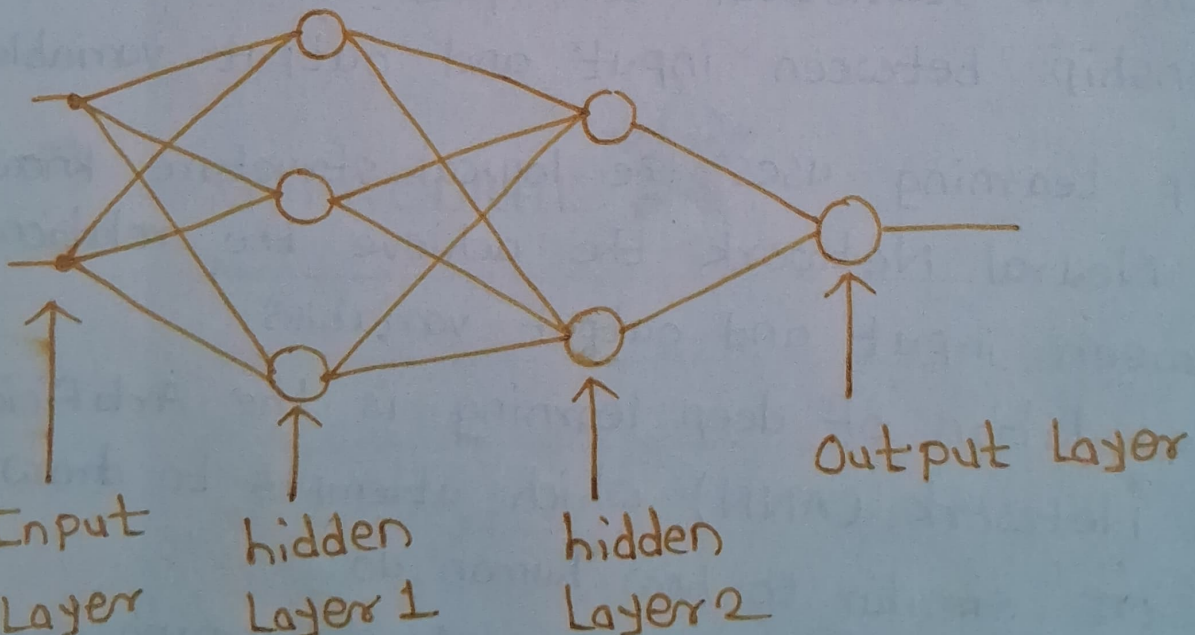
* Representation Learning :-

In Representation Learning you don't define any rules, you just feed the data into network and say,

"Figure out what cat makes cat"

The network transforms the data through multiple layers, until it finds the representation (a compact summary) of data that makes the answer obious.

* Neural Network Workflow :-



The No. of input Features (x) in input Layer, No. of hidden layers and No. of classes (y_i) in output Layer varies according to problem statement.

* Types of Neural Networks :-

① Multilayer Perceptron (MLP) :- It is also refered as ANN in basic contexts. This is the most fundamental type of deep learning.

Structure - It consists of Input Layer (recieving data) one or more hidden layers (processing the data) and output Layer (Producing the result)

Function - It is versatile and used for standard ML tasks like Regression & Classification.

Use case - MLP is typically used for tabular data rather than unstructured data like image or text.

② Convolutional Neural Network (CNN) :- CNNs are the specially designed networks for working with the grid like structured data, like images.

Structure - It consist of Input Layer, One or More Convalution Layers, One or More Hidden Layers and output Layer.

Use Case - They are widely used in Image processing and Video processing applications.

③ Recurrent Neural Network (RNN) :- RNNs are designed to handle sequential data where the order of information matters.

Structure - Unlike standard networks that feed information forward, RNNs possess a feedback loop.

The output from a layer is fed back to the input of the same or previous layer, allowing the network to retain a memory of previous inputs.

The "Memory" allows them to process sequences of information rather than just individual data points.

Variants - LSTM (Long Short-Term Memory) is used to handle longer sequences of data more effectively.

Use case - Textual Data, Speech recognition and Time series Analysis.

④ Auto Encoders :- It is the specific type of ANN used for unsupervised learning tasks involving data transformation.

Function - They work by compressing input data into a smaller representation (encoding) and restructuring the input from that compressed versions (decoding).

Use case - The primary applications include data compression and removing noise from data to improve quality.

⑤ Generative Adversarial Networks (GANs) :-
GANs are a more recent and advanced inovation designed to create new data rather than just analyzing existing data.

GAN structure - It consists of two neural networks competing against each other.

(i) The Generator - Creates fake data (generate fake image of a face)

(ii) The Discriminator - Acts like a detective trying to distinguish between real data and fake data created by the generator.

Function - Through this competition the generator gets better at creating realistic data until

the Discriminator can no longer tell the difference.

Use case - GANs are used for image generation and generating creative content.