DEEP LEARNING

- Deep learning models are based on ANNs, which are inspired by the structure and function of the human brain. These networks consist of layers of interconnected nodes (neurons) that process data.
- The term "deep" refers to the use of multiple layers in the neural network.
- Each layer in the network transforms the input data into more abstract and composite representation, allowing the model to recognize complex patterns.
- Effective for tasks involving unstructured data such as images, text and audio.

ML vs DL

Aspect	Machine Learning (ML)	Deep Learning (DL)
Definition	Subset of AI focusing on learning from data	Subset of ML using neural networks with multiple layers
Data Requirements	Smaller datasets, structured data	Large datasets, unstructured data
Feature Engineering	Manual feature extraction	Automatic feature extraction
Computational Power	Less computational power, can use CPUs	High computational power, requires GPUs/TPUs
Model Complexity	Simpler, more interpretable models	Complex, less interpretable models
Training Time	Shorter training times (seconds to hours)	Longer training times (hours to weeks)

NEED:

- Understand Complex Data
- Automatic Feature Extraction: Traditional ML models struggles with unstructured data like images, text and audio.
- Better Accuracy
- Availability of Big Data
- Advent of GPU

BIOLOGICAL NEURON:

- Neuron in human body are connected to each other.
- Neuron produce short impulses known as action potential.
- Action Potential travels through axon synapses which release neurotransmitters.
- Synapses is junction b/w axon of one neuron to dendrite of another.
- When another neuron receives sufficient neuro-transmitters, it fires its own action potential.

FIRST ARTIFICIAL NEURON:

- In 1943, introduced by Warren McColluch and Walter Pits.
- Basic Mathematical representation of Biological Neuron.

- Operates on following principles:
- i) Binary Inputs and Output
- ii) Threshold Logic

- Logic operation used:

AND GATE:

- Both inputs should be True to get output value as True.
- If any input is False, output value will also be False.

OR GATE:

- Any one input should be True to get True output.

NOT GATE:

- Simple reverses the value of input.

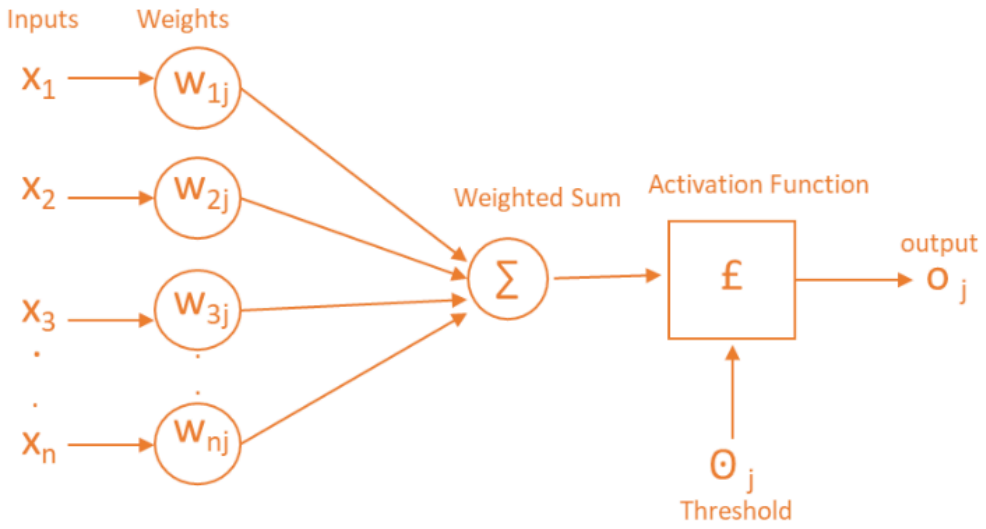
ARTIFICIAL NEURAL NETWORK:

- ANN are a type of Neural Network which are inspired by the human brain.

- Data is passed from one layer to the another.
- Data doesn't travel from 1 layer twice
- Consists of :
- i) Input Layer
- ii) Hidden Layers
- iii) Output Layer

- Each of these connections have weights that determine the influence of one unit or another unit.

PERCEPTRON:



- Simples ANN Architecture.
- Invented by Frank Rosenblatt.
- Perceptrons are Binary Classifiers. Just used to classify data with only 2 possible outcomes.
- Examples: Email Spam Detection

- Consists of :
  i) 1 input layer
  ii) 1 output layer (output node)
  iii) No hidden layers
  iv) Weights
  v) Bias
  vi) Summation Function
  vii) Activation Function

- Uses Threshold Logic Unit (TLU)
- Every input is associated with a weight.

- TLU compares the weighted sum of the inputs, compares this to the threshold.
- Outputs 1 if threshold is exceeded else 0.
- Activation Function Decides the value of each node.

PERCEPTRON LEARNING RULE:

Step 1 : Initialise Weights: Weights are randomly initialised by Perceptron.

Step 2 : Compute the Weighted Sum: Summation Function calculated sum of all the inputs with respect to weight.
Weighted sum calculation:
$Z = wnxn + b$

Where wnxn is the total sum of each input in multiplication to its weight, and b is bias.

Step 3 : Apply Activation Function: Activation function will consider threshold and weighted sum. It will further decide the value of a node. In this case, the output node's value is being decided.

Step 4 : Update Weights: If predicted output does not reach a certain threshold, and predicted output does not match the actual output, Backpropagation is performed. In Backpropagation, weights will update, and bias would also update accordingly.

WHY WEIGHTS?

- Weights determine the importance of each input in the decision-making process.
- Each input is multiplied by its corresponding weight, which scales input contributions to the final output.
- During backpropagation, perceptron adjusts the weights to minimise the error