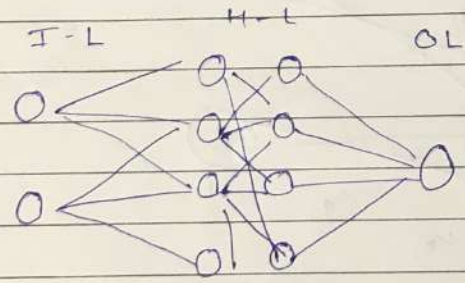
SOFT COMPUTING TQ. - UNIT 2

Q. Neural Networks & It's Characteristics.

Ans: Neural networks are computational systems inspired by the human brain's structre and function. They consist of interconnected nodes or "neurons" organized in layers. These network processes information by passing it through each layer, adjusting connection based on algorithms to improve performance. Neural networks are particularly adapt at recognizing patterns, making them valuable for tasks like image and speech recognition, as well as predective analysis.

Ex: A neural network can be used in email filtering to distinguish between spam and non-spam emails. By analyzing a large dataset of emails and learning from their content and characteristics, the network can accurately predict whether new emails are spam, helping keep your inbox clean.



CHARACTERISTICS

(i) Neuron layers are organized into input, hidden & output layer. Information flows from input to output through hidden layers.

(ii) It is a marthematical model consists of computational elements implemented neurally

(iii) Large number of highly interconnected processing elements known as neurons are prominent in NN.

(iii) The interconnections with their weights are associated with neurons

(iv) The input signals arrive at the processing elements through connection and weights.

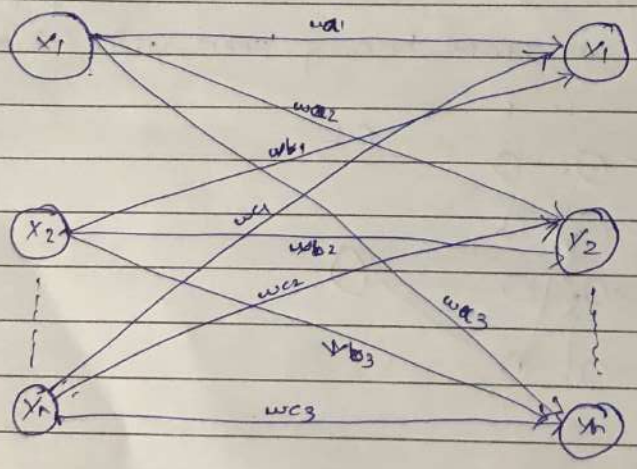
(v) A single neuron carries no specific information.

Q. Neuron Architecture

Ans. There are 5 basic neuron Architecture.

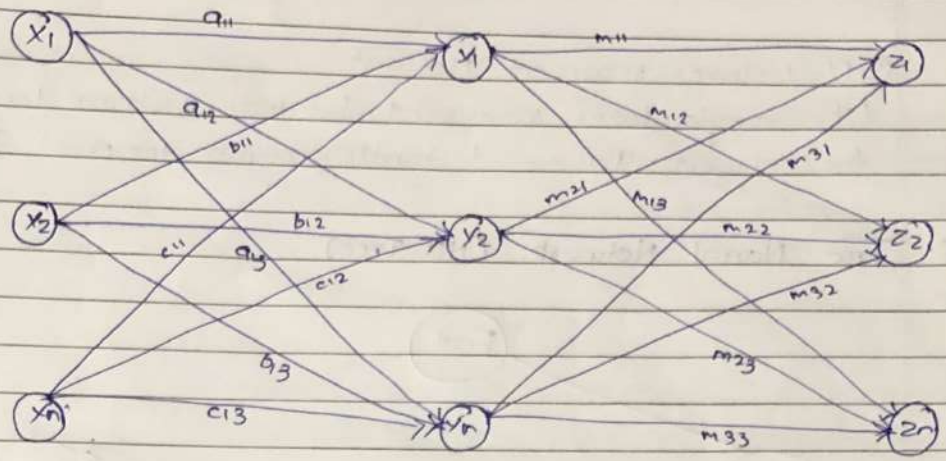
(i) Single Layer Feed-forward Network

Information moves in one direction, from input to output there are No loops.



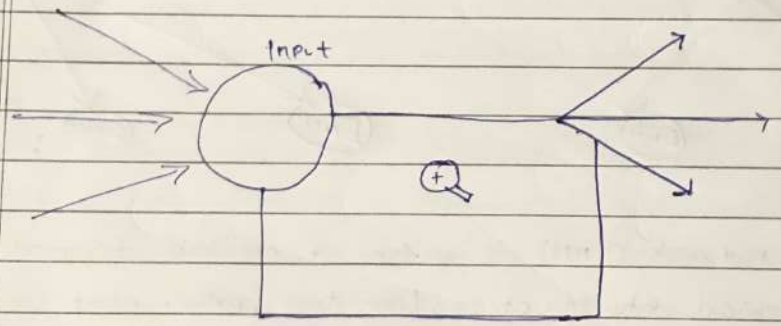
(ii) Multilayer feed-forward Network

Similar to single-layer but with more hidden layers between input and output for deeper learning

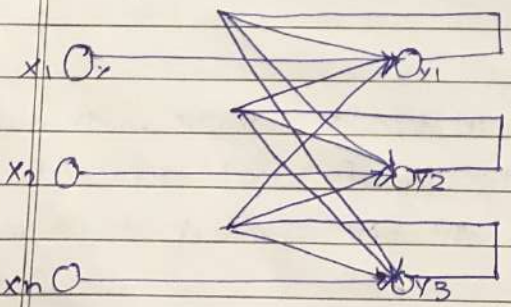


(iii) Single Node with it's own feedback

A single neuron can send output back to itself, allowing it to learn from its own past output.



(iv) Single layer recurrent network

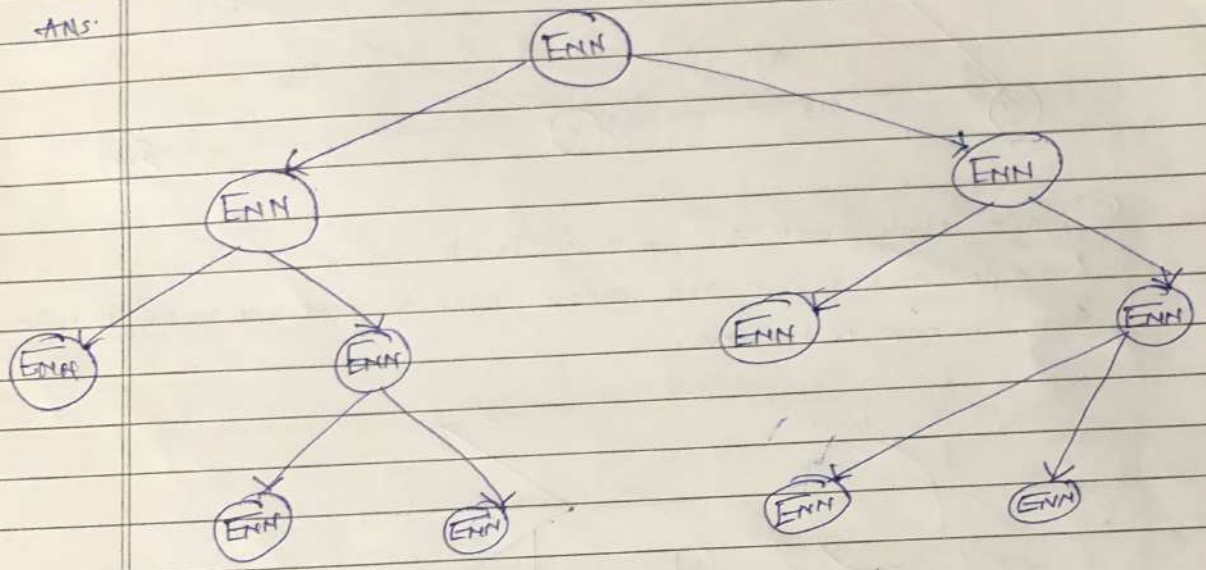


Neurons in one layer send feedback to each other, creating a network than can process sequences of data.

(v) Multi-layer recurrent Network
Like single layer recurrent but with multiple layers, enhancing the network ability to handle complex temporal tasks.

Q. Tree Neural Network. (TNN Tree)

ANS.



Tree Neural Network (TNN) is a type of network designed to handle hierarchical data structres, like tree, rather than usual flat vector structre. It's particularly used in natural language processing.

WORKING:

(i) TREE STRUCTRE

TNN's operate on data organized in tree-like structre, with nodes connected in an parent child relationship. Each node represents a piece of data and connection represent the hierarchical relationships between them.

(ii) Recursive Units.
Instead of traditional layers. TNN's uses recursive units to process nodes. Each recursive units can be thought as a mini neural network that processes information from it's child nodes and passes the result up to its parent node.

(iii) Forward Propagation
Starting from leaf nodes (nodes with no children), data is propagated upwards through the tree. Each recursive unit combines the input from its child nodes using a set of learned weight

(iv) Combination Of nodes
At each internal node, the input from the child nodes are combined from a new representation This process continues until the ~~root~~ root node is reached, which contains the final output.

(v) Backpropagation
During training errors are propagated back down the tree from the root to leaf nodes. Weights are adjusted to minimize the error, similar to traditional neural networks.

Ex: Imagine you want to evaluate sentiment of a sentence, like "I absolutely love this book".
(i) Leaf nodes: Each word in sentence ("I", "love", "this", "book") represe es a leaf nodes with it's own data.
(ii) Combining: The TNN Combines the word nodes into small phrases node Nodes eg: "I absolutely" & "love this book".
(iii) Higher: These phrases are futher combined to form a Sngle node (v) Combinti representing entire sentence

Final Output : The root node of tree gives the final sentiment score, indicating whether overall sentiment is positive, negative or neutral

TNN processes hirearchical structre of sentence step by step, allowing it to understand the context and overall meaning more effectively.

Q. Mc-Culloh Pits Neuron. (MP Neuron)

ANS. MP Neuron Model was the earliest neural network model discovered by Warren Mc Culloch and Walter Pits in 1943. It is also known as threshold Logic Unit.
The M-P Neurons are connected by directed weighted paths.
The activation of this model is binary. The weight associated with the communication links may be exitatory (w is positive) or inhibitory (w is negative).

Key Features :

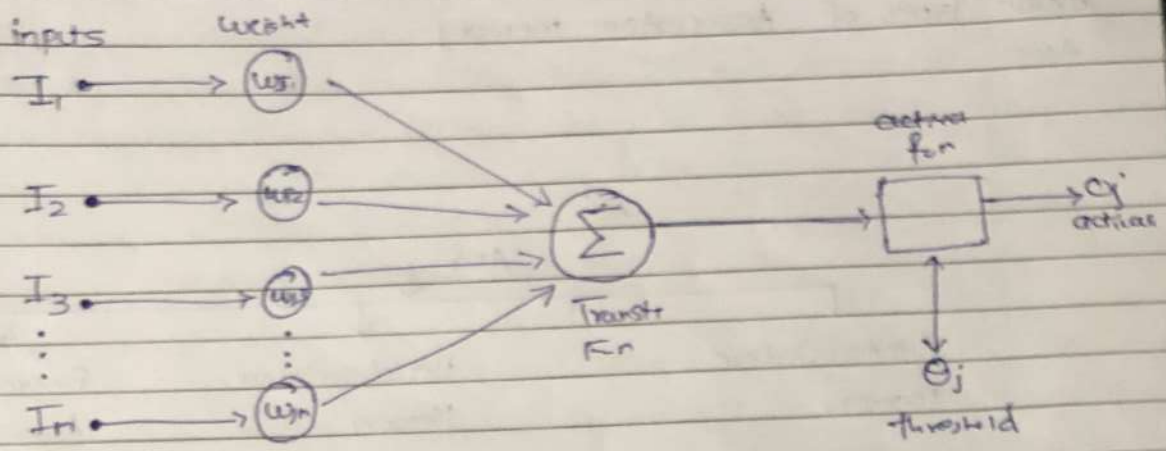
(i) Binary INputs : The neuron recieves multiple binary output (0 or 1).

(ii) Weighted Sum : Each input is multiplied by a weight and the result are summed up.

(iii) Threshold : The sum is compared to a threshold value.

(iv) Binary Output : If the wieghted sum meets ~~the~~ or exceeds the threshold, the neuron output 1 (fires) otherwise, it's output 0 (does not fires)

Understanding MP neuron model using binary data



Imagine you have a neuron with three binary inputs:
$I_1 = 1$, $I_2 = 0$, & $I_3 = 1$ and weights $w_{j1} = 0.5$, $w_{j2} = 0.3$ & $w_{j3} = 0.2$
The Threshold is set to 0.6.
The steps will be followed as

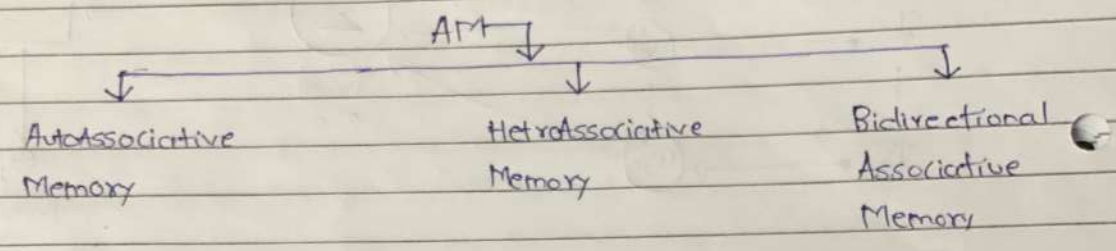
(i) calculate the weighted sum
$(1 \times 0.5) + (0 \times 0.3) + (1 \times 0.2) = 0.7$

(ii) Compare the weighted sum to threshold
$0.7 \geq 0.6$

(iii) Since the weighted sum is greater than equal to the threshold, the neuron output 1.
Therefor it will Fire.

Q. Types of Associative memory

Ans



① AutoAssociative Memory:

AutoAssociative memory is a type of memory system designed to recall an entire memory based on a partial input. It's particularly usefull for pattern recognition, error correction and noise reduction. The core idea is that the system can complete missing parts of information by recognizing and reconstructing the whole from its fragments.

Ex:

① Consider a scenario where you have set of images, each represented by a grid of pixels. If you store these images in an autoassociative memory system, you can later recall a full image even if you only provide a portion of it

② Imagine you have a mental image of your childhood home. You might only need to see a part of familiar wall or a piece of furniture to vividly recall the entire process. This mental process is similar to how associative memory works. Even with incomplete info, your brain can reconstruct full scene based on past experience.

(2) HETROASSOCIATIVE MEMORY

Hetroassociative memory is a type of memory system that links two or different sets of data. Given an input from one set, it retrieves the corresponding item from another set. This is particularly usefull for tasks like translation, data retrieval accross different modalities.

Ex:

(i) Consider a billngual dictionary where each word in one language is paired with its equivalent in other language. If you have the word "dog" in English, heteroassociative memory can retrieve "perro" in Spanish.

(ii) Imagine you see an image of a cat. Your brain instantly retrieves the word "cat" without you having to think about it consciously. This process of visual input triggering a verbal output is a simple example of heteroassociative memory at work. Your brain has work/learned to associate visual apperance of animal with the word "cat" allowing you to recall it effortlessly.

(3) BIDIRECTIONAL ASSOCIATIVE MEMORY (BAM)

Bidirectional Associative memory (BAM) is a type of neural network that stores pairs of patterns and allows retrieval in both directions between two sets. This means that if you input one element, you can retrieve its associated pair vice versa. BAM is particularly useful for tasks that require bidirectional recall, like language, translation and pattern association.

Ex:

(i) ~~Consider~~ a Languge Translation
You can input/store pair of words from two languages, such as English and French. You input "apple" in English, BAM retrieves "pomme" in French and vice versa.

(ii) Image & Label-~~Association~~
Imagine you have a dataset of images paired with labels. Inputting an image of cat retrieves the label "cat", and entering the word "cat" retrieves the image.

Q. ~~Adaline Neural Training Algorithm~~ Adaptive.

ANS: It is an network with a single linear unit. The linear activation functions are called linear units. In this, the input-output relationship is linear. Adaline networks are trained using delta rule.
Ataline. is a single neuron unit, which recieves input from several units and also from one unit, called bias. An Adeline's model consists of trainable weights. The input are of two values (+1 or -1) and weights have sign ("+" or "-")
The Adaline.

Q. ADALINE.

ANS: ADALINE Stands for Adaptive Linear Neuron.
It is an early Neural network model, developed by Bernard Widrow and Ted Hoff in 1960. It is designed for supervised learning and is used to approximate linear functions. It is used for Supervised learning and aims to predict continous values.

HOW IT WORKS:

- It takes inputs and assigns them weight
- These weighted input are summed up
- The sum is compared to the target value
- The difference (error) is used to adjust the weight
- This pruess repeats until the error is minimized.

WORKING: (TRAINING ALGO)

Ex: Predicting House Price. Imagine you want to predict the price of house ~~using~~ based on its size.

(i) Start with initial weight (w) & bias (b), say, w = 0.1 & b = 0.5

(ii) You have house that's 1000 square feet

(iii) Calculate weighted sum: y = (w x size) + b

$y = (0.1 \times 1000) + 0.5 = 100.5$

(iv) Error Calc: If actual price is 150, the error e = actual - y

$= 150 - 100.5 = 49.5$

(v) Weight: Update weight using learning rate (n) say n = 0.01

Update

(vi) Repeat these steps for more houses until the prediction is accurate.

Testing Algo.

Ex: Let's test the trained Adaline model with a new house size say 1500 sq.ft

(i) Weight Sum Calculation

$y = (w \times size) + b$

$= (-194014.95 \times 1500) + (-96.015)$

$= -291022523.515$

(ii) Activation Fun

Output is directly weighted sum

$y = -291022523.515$

(iii) Prediction

Compare this output with actual price to assess accuracy.