Unit-02

Neuro computing:-

* Neuro computing refers to the utilization of computer simulation technology to explore complex mathematical neural models, allowing for empirical evaluation of neuro computers from a behaviour perspective

* Neuro computing is a branch of computing that uses artificial neural networks to perform tasks such as pattern recognition, classification, prediction and optimization. It works like how biological neurons in the brain process and transmit information.

* Neuro computing is inspired by the working of the human brain and nervous system.

Key features of Neuro computing :-

* It works like human brain neurons with weights, activations, and learning.
* Many simple processing units (neurons) work together in parallel.
* Systems adapt automatically by adjusting weights during training.
* once trained, networks can predict unseen data

Nervous System :-

* In NIC, the Nervous system is studied as an inspirational model because it shows how the human brain and nerves cordinate complex tasks like learning, memory, decision-making and fast information transfer.
* In NIC, the nervous system acts as the biological blue print that motivates the creation of ANN and other intelligent models to Solve real-world problems.

Role of Nervous System in NIC :-

Nervous system is made up of billions of neurons that work together to process information, learn from experience, and respond to the Environment

* This natural Mechanism inspires how we build artificial systems.

* Nervous system helps in information processing by processing inputs from environment to give meaningful outputs.

* Nervous system also helps in parallel computing where many small processing units work together to solve complex problems faster.

* Even if some neurons are damaged, the nervous system still functions, this motivates NIC systems to be robust and continue working even with noisy or incomplete data.

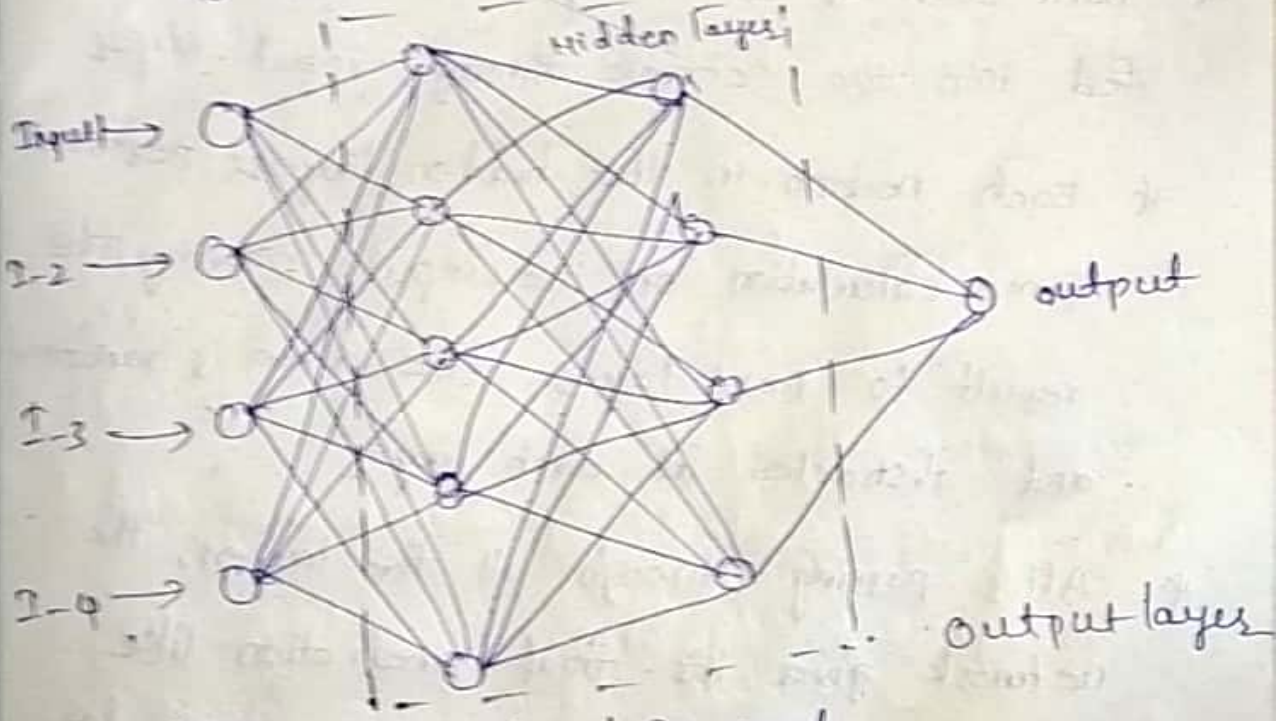
* Nervous system in NIC can adapt their parameters through training data to perform better over time.

Artificial Neural networks :-

Artificial Neural networks are computer systems designed to mimic how the human brain process information.

* Just like the brain uses neurons to process data and make decisions, ANN's use artificial neurons to analyze data, identify patterns and make predictions.

* ANN networks consits of layers of interconnected neurons that work together to solve complex problems.



Working of ANN :-

ANN's work by learning patterns in data through a process called training.

During training, the network adjusts itself to improve its accuracy by comparing its predictions with the actual results.

* The Neuron is the basic building block of Artificial neural networks. It receives input signals, processes them and produces an output signal.
* Data such as an image, text or number is fed into the network through input layer.
* Each neuron in the hidden layers performs some calculation on the input, passing the result to next layer. The data is transformed and abstracted at each layer.
* After passing through all the layers, the network gives its final prediction like classifying an image as a cat or dog.

* The process of Back propagation is used to adjust the weights between neurons when the network makes a mistake, the weights are updated to reduce the error and improve the next prediction.

Typical ANN's and Learning Algorithms:-

In NIC, the most common neural network models are:

(1) Perception (Single-layer Neural network)

* It is the simplest Artifical neural network model.
* It consists of input nodes connected directly to output nodes.
* It works only for linearly seperable problems
* It uses perceptron rule.

2) Feedforward Neural network (FNN)

* In FNN the information flows in one direction i.e from input → hidden layers → output
* In FNN there is no feed back loops.
* It is suitable for classification and regression tasks.

3) Mult

3) Multi-layer perceptron :—

* It is an Extension of FNN with one or more hidden layers
* It uses non-linear activation functions like sigmoid, tanh etc..
* It can be used to ~~mode~~ solve complex and non-linear problems.
* It Uses Back propagation learning algorithm with gradient descent
* It is widely used in applications like OCR, Speech recognition and medical diagnosis

4) Recurrent Neural networks (RNN) :—

* In RNN's we have feedback connections
* Here the past outputs are fed back into the network to the memory of part state
* RNN's are suitable for sequential data

5) Convolution Neural network (CNN) :—

* works especially well with image and spatial data.
* uses convolution layers, pooling layers and fully connected layers.
* Applications :- face recognition, medical image analysis object detection

Learning Algorithms :-

ANNs can learn from data through various learning paradigms :-

1) Supervised Learning
2) Unsupervised learning
3) Reinforcement Learning

From Natural to Artificial Neural networks :-

Artificial neural networks are the mathematical and computational imitation of natural neural networks (brain). They take inspiration from how biological neurons receive, process and transmit information and use this idea to design intelligent algorithms for problem solving

* Scientists wanted to mimic the brain's learning ability using machines.
* The biological neuron became the model for Artificial neuron
* The connections (synapses) were represented as weights in ANN.
* The process of signal transmission was represented by Mathematical functions.

* Artificial neuron also called as perceptron has inputs, weights, summation function, Activation function and output.

* This artificial neurons allow machines to learn adapt and recognize patterns.

Scope of neuro computing:-

Neuro computing is based on Artificial Neural networks.

* It is one of the most important areas in NIC.

* Its scope is very wide because it combines biology, CS and Mathematics to solve real world problems

* In academic and research domain neuro computing provides a foundation for understanding how the brain processes information and how this can be replicated in machines.

* In Technical perspective, neuro computing has vast application in solving real-world problems. It can be used for pattern recognition tasks like handwriting, speech and face recognition.

* In industries, neuro computing has already shown its value -

In healthcare, it is used for disease detection drug discovery and personalized treatment.

* In finance, it helps in fraud detection, risk analysis and automated trading etc...

* In future, the scope of neuro computing is expanding even further, with the rise of deep learning, it forms the backbone of advanced artificial intelligence.