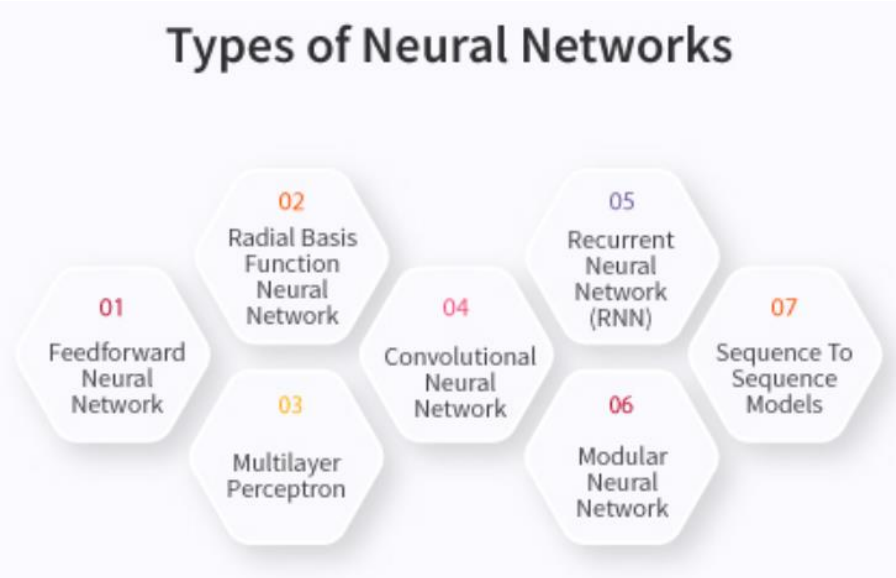
Neural Network

- It is inspired by the brain's processing, mimicking its information handling.
- It comprises interconnected nodes with associated weights in the links.
- During the learning process, weights undergo iterative updates based on input data.
- The final weights and the network's architecture form the trained neural network.
- The process of iteratively adjusting weights based on input data is known as the training process.
- Trained neural networks are adept at solving specific problems defined in the given task.
- They can be applied to various tasks, including classification, pattern matching, and data clustering.
- Neural networks demonstrate efficient and adaptive learning from the provided data.
- Once trained, they can provide fast and accurate solutions to specific problems.
- Their overall importance lies in their adaptive learning and efficient problem-solving capabilities.

Neural Networks Used For

- Vision & Speech: Identifying objects, faces, understanding spoken language (self-driving cars, voice assistants)
- Language Understanding: Sentiment analysis, chatbots, translation, text generation
- Healthcare: Diagnosing diseases, predicting patient outcomes, drug discovery
- Finance: Predicting stock prices, credit risk assessment, fraud detection, algorithmic trading
- Personalization: Content & recommendations (e-commerce, streaming, social media)
- Robotics & Vehicles: Processing sensor data, real-time decisions (robots, autonomous cars)
- Gaming & Entertainment: Game AI, realistic graphics, virtual environments
- Manufacturing: Monitoring processes, predictive maintenance, quality control
- Research & Science: Analyzing complex data, simulating phenomena, aiding research
- Creativity: Generating music, art, and other creative content



Types of Neural Network

(i) ANN

- ANN is also known as an artificial neural network.
- It is a feed-forward neural network because the inputs are sent in the forward direction.
- It can also contain hidden layers which can make the model even denser.
- They have a fixed length as specified by the programmer.
- It is used for Textual Data or Tabular Data. A widely used real-life application is Facial Recognition.
- It is comparatively less powerful than CNN and RNN.

(ii) CNN

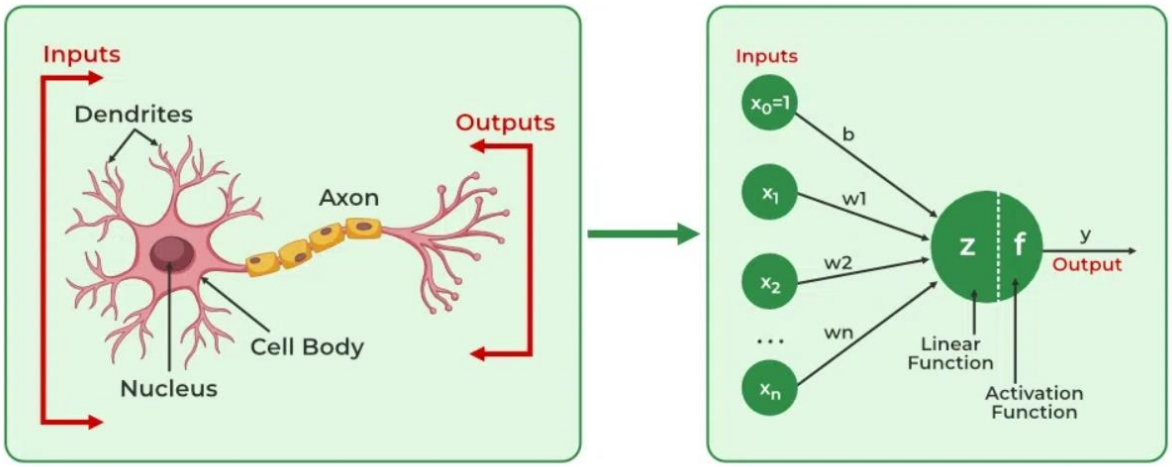
- Convolutional Neural Networks is mainly used for Image Data.
- It is used for Computer Vision. Some of the real-life applications are object detection in autonomous vehicles.
- It contains a combination of convolutional layers and neurons.
- It is more powerful than both ANN and RNN.

(iii) RNN

- It is also known as Recurrent Neural Networks.
- It is used to process and interpret time series data.
- In this type of model, the output from a processing node is fed back into nodes in the same or previous layers.
- The most known types of RNN are **LSTM** (Long Short Term Memory) Networks

What is Artificial Neural Network?

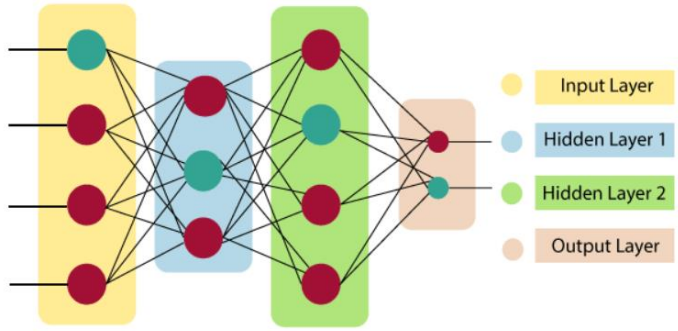
- It is inspired by brain's neurons.
- It has interconnected nodes/neurons, just like the brain.
- Neurons are organized in layers for information processing, similar to the brain.
- Nodes pass information through connections, echoing the communication between brain neurons.
- ANN neurons are simpler than brain neurons, lacking the complexity of their biological counterparts.
- Both can learn and adapt, but the brain is more dynamic due to its ongoing development and flexible synapses.



Biological Neural Network	Artificial Neural Network
Dendrites	Inputs
Cell nucleus	Nodes
Synapse	Weights
Axon	Output

Architecture of an artificial neural network

Artificial Neural Network primarily consists of three layers:



Input Layer:

As the name suggests, it accepts inputs in several different formats provided by the programmer.

Hidden Layer:

The hidden layer presents in-between input and output layers. It performs all the calculations to find hidden features and patterns.

Output Layer:

The input goes through a series of transformations using the hidden layer, which finally results in output that is conveyed using this layer.

The artificial neural network takes input and computes the weighted sum of the inputs and includes a bias. This computation is represented in the form of a transfer function.

$$\sum_{i=1}^{n} Wi * Xi + b$$

5.ADVANTAGES:

- Adapt to unknown situation.
- Autonomous learning & generalization.
- Robustness: fault tolerance due to network redundancy.
- Noise tolerance
- Ease of maintenance

6.DISADVANTAGES:

- No exact.
- Large complexity of the network structure.
- NN needs training to operate.
- Requires high processing time for large NN.
- NN sometimes become unstable.

Deep Learning vs Machine Learning: Neural Networks

Aspect	Machine Learning	Deep Learning
Hierarchy of Layers	Typically shallow architectures	Deep architectures with many layers
Feature Extraction	Manual feature engineering needed	Automatic feature extraction and representation learning
Feature Learning	Limited ability to learn complex features	Can learn intricate hierarchical features
Performance	May have limitations on complex tasks	Excels in complex tasks, especially with big data
Data Requirements	Requires carefully curated features	Can work with raw, unprocessed data
Training Complexity	Relatively simpler to train	Requires substantial computation power
Domain Specificity	May need domain-specific tuning	Can generalize across domains
Applications	Effective for smaller datasets	Particularly effective with large datasets
Representations	Relies on handcrafted feature representations	Learns hierarchical representations
Interpretability	Offers better interpretability	Often seen as a “black box”
Algorithm Diversity	Utilizes various algorithms like SVM, Random Forest	Mostly relies on neural networks
Computational Demand	Lighter computational requirements	Heavy computational demand
Scalability	May have limitations in scaling up	Scales well with increased data and resources