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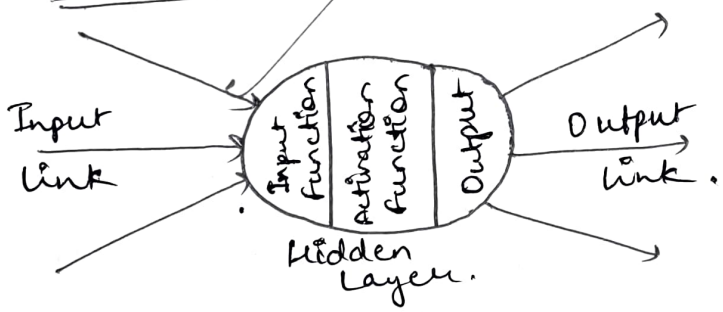
ARTIFICIAL INTELLIGENCE

ARTIFICIAL NEURAL NETWORK :

An Artificial Neural Network (ANN) in the field of Artificial Intelligence where it attempts to mimic a network of neurons that makes up a human Brain. In ANN, various neurons are interconnected to each other in layers of Network. These Neurons are called Nodes.

ANN Architecture :-



* Input function :-
It is the linear regression applied to the input data, weights and bias.
If = $\sum w_i x_i + b$

* Activation function :-
It is the function applied to the input to get desired output and hence defines the Model. Some of the Activation functions are sigmoid function, Relu, TanH, step function, sign function etc.

Advantage of ANN :-

1. Parallel Processing Capabilities.
2. Store data on the entire network.
3. Have capabilities to work with incomplete knowledge.
4. Have a memory distribution.
5. Have fault tolerance.

Disadvantage of ANN :-

1. Assurance of proper network structure.
2. Unrecognized behaviour of Network.
3. Hardware dependency.
4. Difficulty of showing the issue to the Network.
5. The duration of the network is unknown.

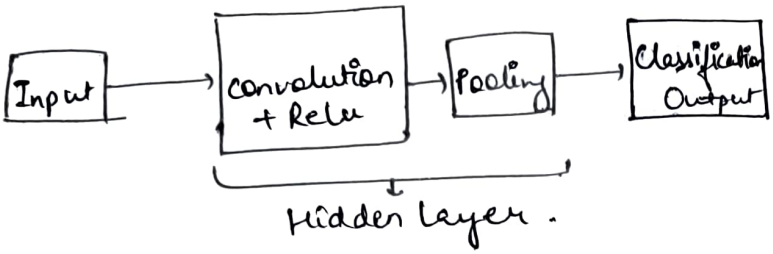
Type of ANN :-

1. Feedforward Neural Network.
2. Feedback Neural Network.
3. Recurrent Neural Network.
4. Convolutional Neural Network.

CONVOLUTIONAL NEURAL NETWORK :-

CNN is a type of Neural Network architecture used to understand and interpret Image and visual data.

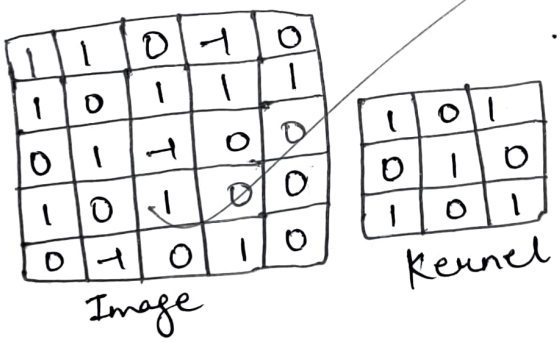
CNN Architecture :-

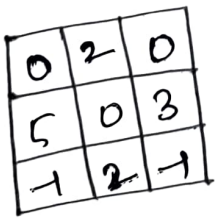


* Convolution Layer :-

This layer perform a dot product between a kernel and restricted portion of receptive field.

Eg :-





Activation Map.

Convolution is important : sparse interaction, parameter sharing, and equivariant representation

* Pooling Layer :-

Pooling replaces the output of the network at certain locations by deriving a summary statistic of Nearby output. This helps in reducing computation and weights.

Eg :-

1	2	4	5
7	8	6	3
14	2	12	10
9	4	2	6

max pool →

8	6
14	12

Application Of CNN :-

1. Object Detection.
2. Semantic Segmentation
3. Image Captioning.

Advantages of CNN :-

1. Good at detecting patterns and features in images, audios and videos.
2. Robust to translation, rotation and scaling invariance.
3. End-to-end training, no need for manual feature extraction
4. Can Handle large amounts of data and achieve high accuracy.

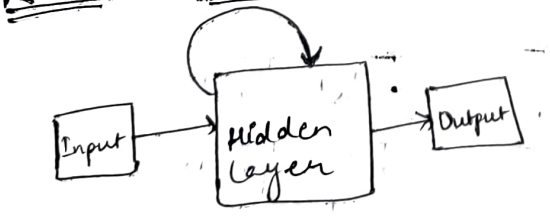
Disadvantages of CNN :-

1. Computationally expensive to train and require a lot of Memory.
2. Can be prone to overfitting if not enough data or proper regularization is used.
3. Requires large amounts of labelled data.
4. Interpretability is limited, it's hard to understand what the network has learned.

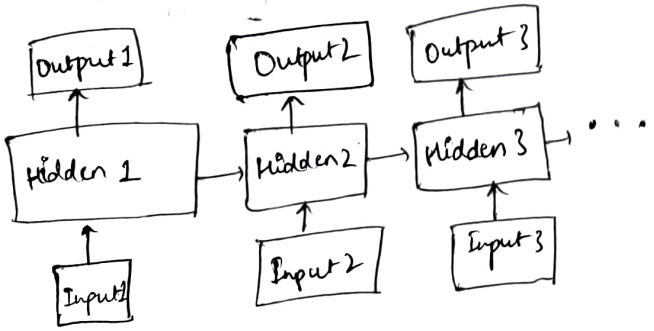
RECURRENT NEURAL NETWORK :-

Traditionally, The neural Networks were designed where input and output were independent of each other. Recurrent Neural Network is neural Network where output of previous step is fed as input to the current step.

RNN Architecture :-



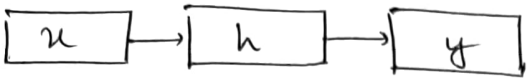
Rolled RNN



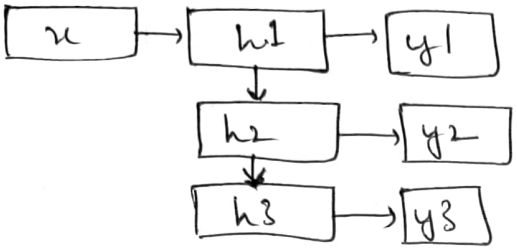
Unrolled RNN

Type of RNN :-

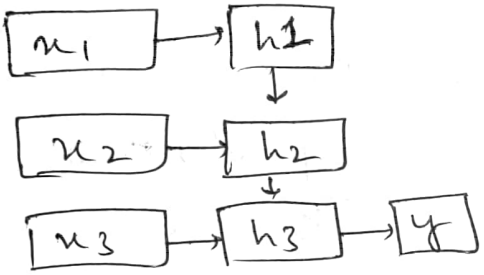
(1) One to One :- One output obtain for one input



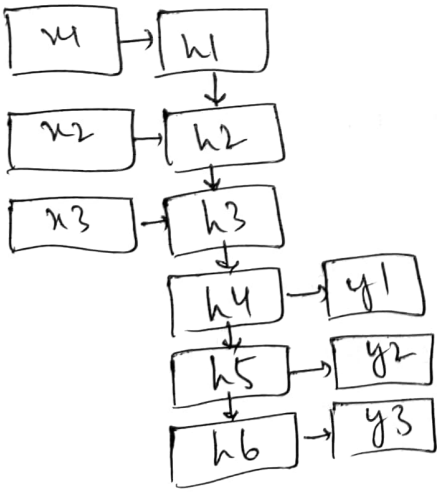
(2) One to Many :- Multiple outputs obtain for one input

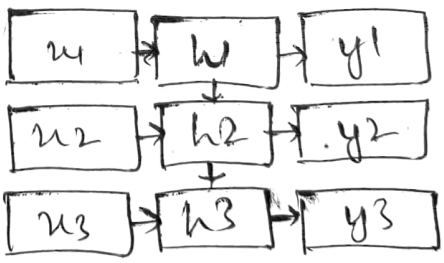


(3) Many to One :- One output obtain for multiple inputs



(4) Many to Many :- Multiple outputs obtain for multiple input





Application of RNN :-

1. Text Summarization
2. Text Recommendation
3. Image Recognition
4. Music Creneration

Advantages of RNN :-

1. Remembers each and every piece of information through time.
2. Used with convolutional layer to extend the effective pixel neighbourhood.

Disadvantages of RNN :-

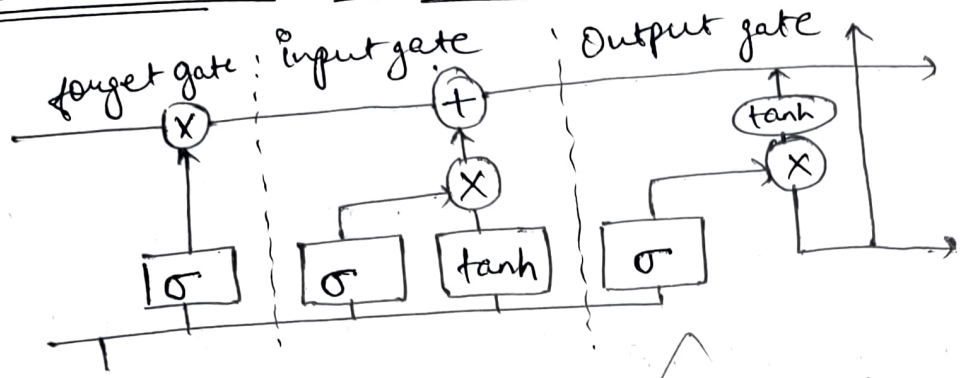
1. Gradient Vanishing and exploding problems.
2. Training RNN is difficult.
3. Cannot process very long sequences.

LONG-SHORT TERM MEMORY :

LSTM Network are a type of Recurrent Neural Network that tackles the long-term dependencies of RNN. LSTM is used for Processing, Predicting and Classifing on the basis of time-series data.

LSTM has a memory cell, which contain information for an extended period of time. Memory cell is controlled by input gate, forget gate and output gate.

Architecture of LSTM :-



* **forget gate :-**
  This information that is no longer in use is removed with the forget gate.
* **input gate :-**
  The information that is useful is added to the cell state by the input gate.
* **Output gate :-**
  The information is extracted from the current cell state and presented as the output by the output gate.

Application of LSTM :-

1. Language Modelling.
2. Speech Recognition
3. Time Series Forecasting.
4. Anomaly Detection.
5. Recommendation System.
6. Video Analysis.

Advantages of LSTM :-

1. Ability to learn long-term dependencies.
2. Capture complex pattern in sequential data.
3. Avoid gradient vanishing or exploding.
4. Handles noisy or missing data.

Disadvantages of LSTM :-

1. computationally Expensive.
2. Require more memory and time.
3. Prone to Overfitting.
4. Harder to interpret and explain.