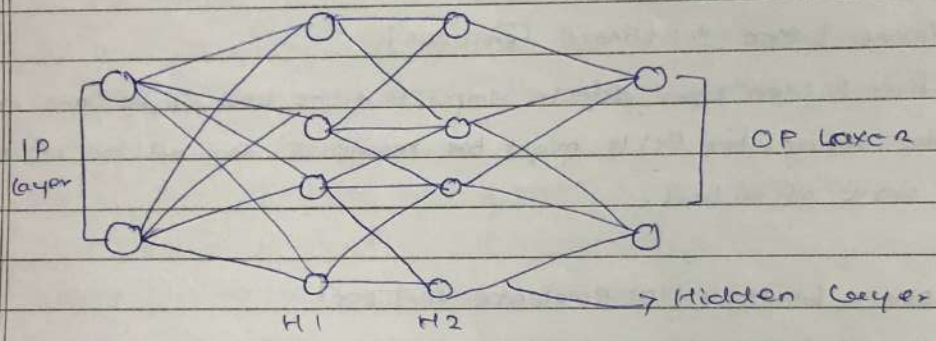
25/08/2025

# UNIT - 2

# ADVANCED ARTIFICIAL INTELLIGENCE

Q. Explain Concept of Deep Learing & It's Advantages.

Ans. Deep Learning is an branch of AI & ML that uses artificial neural networks with many layers that are hidden, which are used to learn patterns from large amount of data.
It automatically extracts features from raw input and can solve problems like Image recognition, speech recognition and natural language understanding




In traditional machine learning, a programmer has to manually select the important features from data, Eg: Edges, colors or shapes etc). But in Deep Learning, the system itself learns these features automatically. Each layer of neural network extract information at different levels.

Ex: Image Recognition

i) The first layer may detect Edges
ii) The second layer may detect Shapes like circles & squares
iii) Higher layers combine these features to improve/recognise complex object such as cats and dogs

Using An Example, we will Understand How the Deep learning Model works..

Deep Learning - Image Recognition Differentiating Btwn Cat & Dog.

(i) INPUT LAYER [RAW DATA]
The system recieves thousands of images of cats and dogs. Each image is converted into single numbers (pixels), which are given to the input layer of the neural network.

(ii) HIDDEN LAYER 1 : [BASIC FEATURES]
The first hidden layer detects simple features like edges, lines or corners in the image. For Ex: It might recognize the outline of ears or the curve of a tail.

(iii) HIDDEN LAYER 2 : [INTERMEDIATE FEATURES]
The second hidden layer combines edges and shapes to identify patterns like eyes, nose or features like fur texture, or overall body shape.

(iv) OUTPUT LAYER : [PREDICTION]
Finally the output layer predicts whether the image is a "Cat" or "Dog", often with probabilities
Ex: Cat = 0.95, Dog = 0.05 → The system predicts it's an Cat.

These models are trained on to an large dataset and an process called back propagation, where the network adjusts weights based on errors until it learns correctly. Deep Learning is used in many real-world applications Dute to its multiple Advantages, which li makes it reliable.

ADVANTAGES OF DL'

(i) Automatic Feature Extraction

(ii) Scalability & versatality

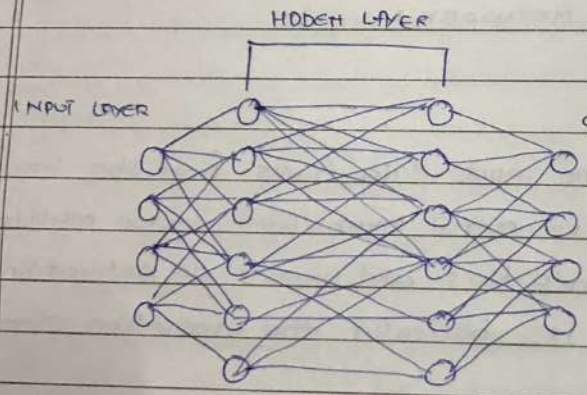
(iii) Trained Data.

Q. Explain Neural Network & it's Types.

Ans: A Neural Network is an computing model inspired by the structure of the human brain. It consists of interconnected units called as neurons arranged in layers. Each neuron recieves input, applies weights passes the result through activation mode / function and produces an output.

Neural Networks are widely used in pattern recognition, classificat, NLP, image recognition & Forecasting.

LAYERS IN NEURAL NETWORK ARCHITECTURE




(i) INPUT LAYER: This is where the network recieves the input data. Each input neuron in the layer ~~demands~~ corresponds to feature in input data

(ii) HIDDEN LAYER: These layers perform most of computational heavy lifting. A neural network can have on or multiple hidden layers. Each layer consist of units (neurons) that transform the input into something that output layer can use.

(iii) OUTPUT LAYER : The final layer that produces the output of an model. The format of these output varies depending on the speifric task like classification, regression.

Neural networks are capable of learning and identifying patterns directly from data without pre-defined rules. These networks are built from components like.

(i) Neurons : Basic units that recieves input, each threshold is governed by an threshold and an activation function

(ii) Connections : Links between neuron that carry information, regulated by weights and biases.

(iii) Wieght & Biases : These parameter defines /determines the strength and influence of connection

WORKING OF NEURAL NETWORK :

(i) FORWARD PROPOGATION

This is the process where input data flows from the input layer to hidden layer and then output layer. Each neuron multiplies it's ~~weight~~ inputs by weights, add bias and applies an activation function to produce the output. It's basically the prediction step of the network.

(ii) BACK PROPOGATION

After prediction, the network checks how far the output is from the actual answer using a loss function it then calculates how much each weight contributed to the error and updates them using methods like gradient discent. This steps allows to learn from the mistakes.

(III) ITTERATION

This process follows of forward propogation → error calculation → backpropogation → weight adjustments is repeated many times. With cycle, the network improves and makes more accurate predictions.

EX: PREDICTING IF A STUDENT PASSES OR FAILS

(I) Input Layers:

Two Inputs → Hours studied And Attendance

(II) Forward Propagation

The network multiplies these inputs with weights (imp of factors) and adds an bias.

Ex: $Z = (0.6 \times \text{Hours Studied}) + (0.4 \times \text{Attendance}) + b$

Then it applies an activation function (like sigmoid) to deide output

(III) Output layer:

The network predicts → "Pass" (1) or "Fail" (0)

(IV) Backpropagation

If the actual result is different (eg: network predicted Fai but student actually passed), the network calculates the errors and adjusts the weights.

(V) Iteration

This process is repeated for many students data until the network learns the correct relationships.

Q. Discuss AI Application in Healthcare, Finance & Robotics

Ans: AI is transforming healthcare, finance and robotics by making systems more accurate, efficient and intelligent. It reduces human effort while improving speed, safety and decision making. Understanding How AI contributes in different sectors.

(i) Healthcare:

AI in healthcare means using intelligent computer systems to help doctors and hospitals in diagosing diseases, suggesting treatem and improving patient care. It makes medical services faster and more accurate.

Ex: Medical Imaging

AI is widely used in analyzing scans like X-rays, MRI-s and CT Scans. It can detect early signs of lung cancer or fractures that may not be easily visible to doctors. The system highlights the suspicious area, helping doctors confirm the diagnosis quickly. This reduces human errors and speeds up the treatment.

Hospitals also uses AI to compare patient data with thousands of past records to recommend the ~~best~~ best possible care. As a Result, patients gets faster and more reliable medical support.

(ii) Finance:

AI in finance is the use of intelligent systems to manage money, detect risks, and improve decision-making in banks and financial companies. It ensures safer and faster financial services.

Ex: Fraud Detection

Bank uses AI to monitor millions of daily transaction. If a custm Card is suddenly used for a big purchase in another country while

also being used at home, AI immediately flags it as suspicious. It can block the transaction or send an alert to the customer for safety. This prevents theft and protects user from loosing money. Overtime, the system learns new fraud tricks, so it becomes smarter and more reliable.

(iii) Robotics

AI in robotics allow machines and robots to act intelligently by sensing the environment, making decision and performing tasks that usually need human effort

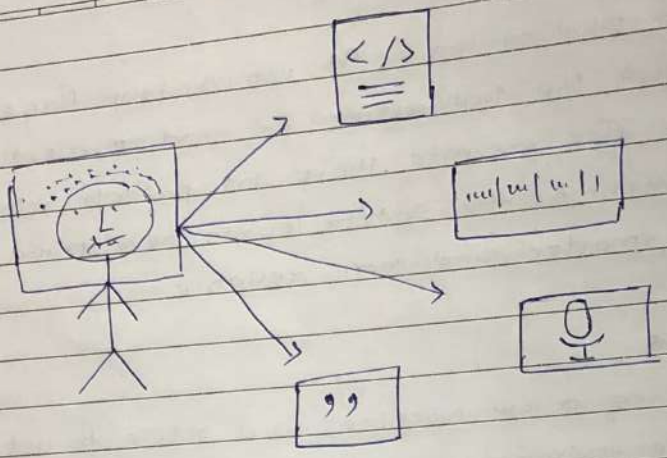
Ex: Self Driving Cars.

Self-Driving cars uses AI along with cameras and sensors to move without an driver. This system recognizes traffic lights, pedestrians and other vehicle in real-time.

For an instance if a person suddenly crosses the road, AI instantly applies the brakes to avoid an accident. It also decides when to change lanes or take turns safely. These cars react faster than humans and reduce accidents caused by human mistakes.

Q. Natural Language Processing and It's Role in AI

Ans. Natural language Processing (NLP) is an field that combines computers science, artificial intelligence and language studies. People usually communicate using words, sentences and their emotions, while computers only understand numbers and codes. NLP acts like an bridge between humans and machines by teaching computers how to read, listen and respond in human language.



NLP has an important role in AI because it makes interactions with machines more natural and useful. With the help of NLP, AI systems can understand, analyze written text, understand spoken words, and even reply in a meaningfull way. This allows AI to be used in real-life such as chatbots for customer support, voice assistants like Siri & Alexa, language translators, Spam email filter and social-media sentiment Analysis.
NLP gives the power to communicate like humands and provide smarter services.

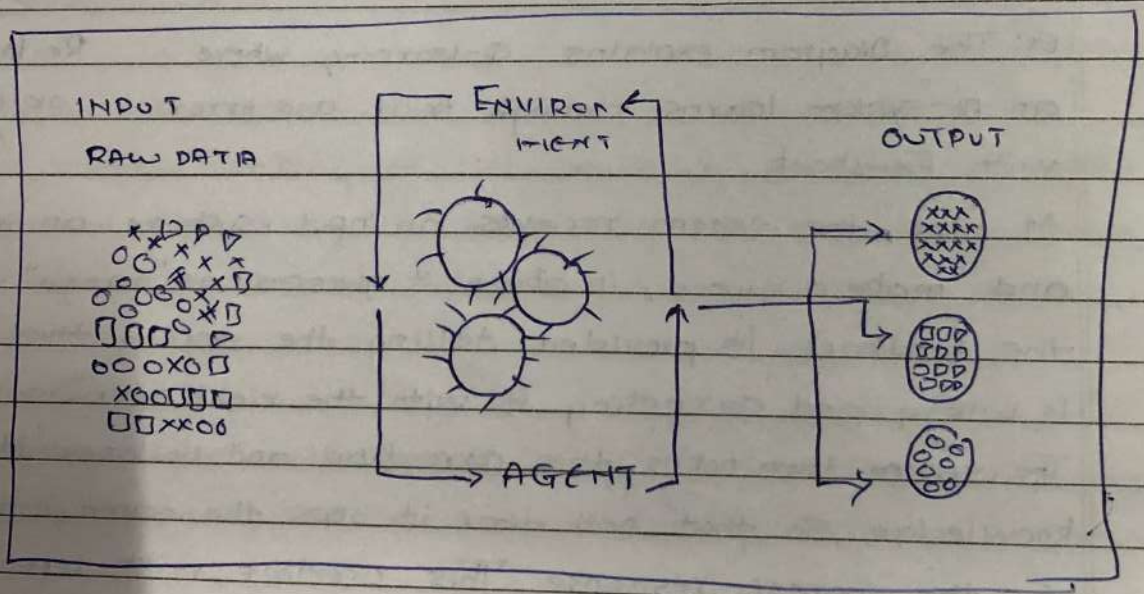
Ex: An Accurate Example of NLP is Google Translate.
When you type a sentence in English and want it in Hindi, the system uses NLP to understand the meaning of english sentence and then translate it to Hindi, and then display it in proper grammar.
Another Example is Siri or Alexa - When you say "play music" or "set an Alarm" NLP understands your speech, processes the request and gives right response

Q. Explain Re-Inforcement Learning & Q-Learning

ANS. Re-Inforcement Learning is an type of machine learning where an agent learns by interacting with an environment. The agent takes action, ~~based on~~ and based on those actions, it reieves a reward (positive/negative). Overtime, the agent tries to maximize rewards by learning which actions are the best

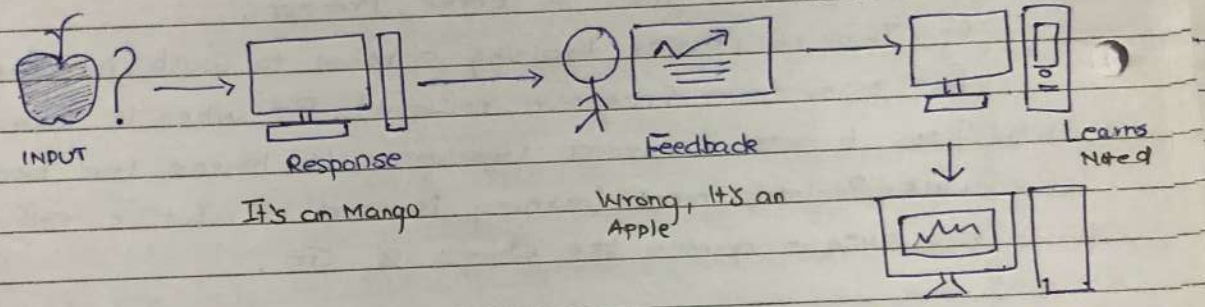
It works like Trial & Error Process.

Ex: Think of it like training a robot to walk, At first it may fall many times (negative reward). But when it takes correct steps, it gets rewarded. Gradually, it learns the best way to walk. Re-Inforcement Learning is used in robotics, self driving cars, and even in games like Chess & Go.




Re-Inforcement Learning revolves around the idea that an agent (the learner or decision maker) interacts with an agent perform) actions and recieves feedback to optimize its decision-making over time.

Q-learning is an popular Reinforncement Learing Algorith that helps an agent learn how to make the best decision by interacting with its environment. Instead of needing a model of the environments the agent learns purely from experience by trying different actions and seeing their results.




Ex: The Diagram explains Q-learning where an AI-system learns through trial and error with Feedback.

At first, the system recieves an input, such as an image of apple and make a guess, in above it guesses as "mango". Then the feedback is provided, telling the system that it's answer is wrong and correcting it with the right response "It's an Apple". The system then notes this correction and updates it's internal knowledge so that next time it sees the same input, it can give the correct response. This overtime, with repeated practices and corrections, the AI becomes better at choosing right actions, eventually giving correct answers constantly.

Q. Limitation & Challanges in Deep Learning Model

Ans. There are some weakness or drawbacks of DL model that restrict their performance. The limitation of the model are as followed:

(i) DATA DEPENDENCY.

Deep Learning model requires huge amount of labelled data to learn properly. If data is limited or of poor quality, the model performs badly.

(ii) HIGH COST

Training deep learning models needs expensive GPU's, large storage and long processing time, which makes them costly for many users.

(iii) BLACK-BOX NATURE

The internal working of deep learning models is difficult to interpret. We know the input and output, but not clearly how the decision was made.

(iv) OVERFITTING

Sometimes the model learns only from the training data and fails to generalize to new data, reducing accuracy in real-world use

(v) ENERGY CONSUMPTION

Large deep learning models consume a lot of electricity during training and deployement leading to high costs and enviromental concerns.

Deeplearing Faces Practical Difficulties and challanges in applying learning models in real-world situation. challanges are as followed:

① DATA DEPENDENCY

Deep learning models acquire huge amounts of labelled data to learn properly. If data is limit

① LACK OF EXPLAINABILITY

Deep learning model often cannot explain why they gave a certain results. In areas like healthcare or finance, this reduces trust.

(ii) GENERALIZATION ISSUES

Model may work well in controlled tests but struggle with realword situations that are slightly different from trained data.

(iii) DATA PRIVACY CONCERNS

Deep Learning needs sensitive personal data (medical fin.) handling such data raises security and privacy tasks.

(iv) PARAMETER TUNING

Finding the best model setting (like learning rate, batch size or no. of layers) is very complex and requires expertise

(v) DEPLOYMENT DIFFICULTIES

It is challenging to deploy large models on small devices like mobiles or IOT sensors because they lack enough memory and processing power.