Introduction To Artificial Intelligence

Unit - 01

Introduction :- Concept of AI, history, current status, scope, agents, environments, Problem formulations, Review of tree and graph structures, state space representation, search graph and search tree.

Concept of AI

Definition and Objective

Artificial Intelligence (AI) is the branch of computer science that aims to build machines and systems capable of performing tasks that typically require human intelligence. These tasks include learning from experience, reasoning, problem-solving, understanding language, and perception. The term was first coined by John McCarthy in 1956, who defined AI as "The science and engineering of making intelligent machines."

Types and Techniques

AI is broadly classified into three categories :-

Narrow AI
General AI
Super Intelligent AI

Narrow AI is task-specific and currently the most common type - like voice Assistants or recommendation systems.

General AI, still theoritical, would perform any intellectual task a human can do.

Superintelligent AI, a futuristic idea, would surpass human intelligence.

To built intelligent behaviour, AI systems use techniques like

Machine learning (ML)
Deep Learning (DL),
Natural language Processing (NLP),

ML enables machines to learn from data without explicit programming.

DL uses neural networks that mimic the human brain.

NLP allows machines to understand, interpret, and respond to human languages, essential for applications like chatbots and Translators.

Applications, benefits, and challenges.

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AI is widely used in sectors like healthcare, finance, education, transportation, and entertainment. It powers applications such as disease predection, fraud detection, autonomous vehicles, smart assistants (eg., Alexa, Siri), facial recognition, and real-time language translation.

The benefits of AI include increased efficiency, automation of repetitive tasks, data-driven decision-making, and enhanced user experiences. However, challenges include ethical concerns like job loss, decision-making bias, lack of transperency in some models, and data privacy issues. AI development also requires vast amounts of data and high computational power.

History of AI

Early foundations and Beginnings

The concept of Artificial Intelligence began long before computers existed. Ancient myths and philosophical debates imagined intelligent machines. However, the formal foundation of AI was laid in the mid-20th century. In 1950, Alan Turing proposed the idea of machine intelligence in his famous paper "Computing Machinery and Intelligence" introducing the Turing test to evaluate machine intellegence.

The field officially began in 1956 at the Dartmouth Conference, organized by John McCarthy, who is considered the father of AI. He, along with Marvin Minsky, Claude Shannon, and others, proposed that "every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."

Development phases and milestones

- 1950s – 60s : AI programs showed early success in solving algebra, proving theorems, and playing games like chess. languages like LISP (developed by McCarthy) became popular in AI development.
- 1970s :- The first AI winter began due to unmet expectations and reduced funding. Systems lacked real-world performance and adaptability.
- 1980s :- The rise of Expert Systems (e.g. MYCIN, DEDRAL) brought commercial interest back. There were ~~rule~~ rule-based systems solving specific tasks using knowledge bases.
- 1990s :- Focus shifted to machine learning and statistical models. In 1997, IBM's Deep Blue defeated world chess champion Garry Kasparov, a landmark in AI history.
- 2000s – 2010s :- The AI boom was driven by big data and improved hardware (GPUs). Deep learning, based on neural networks, gained popularity. Technologies like speech recognition, image classification, and

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natural language processing saw massive improvement.

- Recent Years :- AI now powers applications like autonomous vehicles, virtual assistants (Siri, Alexa), language models (like ChatGPT), and medical diagnostics. Research continues toward ethical AI, General AI, and explainable AI.

Current status.

Artificial Intelligence has moved from being a theoretical concept to a powerful, real-world technology. In the current era, AI is widely deployed accross various industries and integrated into everyday life. Technologies like Machine learning, Deep learning, Natural Language Processing, computer vision, and ~~Robotics~~. Robotics have reached advanced stages of development.

Modern AI systems are capable of:-

- Recognizing speech and images with high accuracy
- Generating human-like text (e.g., Chatgpt)
- Driving autonomous vehicles
- Detecting fraud in financial systems.
- Assisting in medicall diagnostics
- Recommending content based on user behaviour

Major Companiens like Google, Microsoft, Amazon, IBM, and Tesla are investing heavily in AI research and deployment.

Scope of AI

The scope of AI is vast and continuously expanding. It includes the ability to perform cognitive functions such as learning, reasoning, planning, problem-solving, perception, and language understanding. AI is transforming domains like:-

Field	Scope of AI use
Healthcare	Diagnosis, surgery assistance, drug design, patient monitoring.
Education	Smart tutoring systems, performance analysis, content delivery.
Finance	Risk management, fraud detection, investment prediction.
Transportation	Self-driving cars, smart traffic systems, logistic optimization.
Agriculture	Precision farming, weather forecasting, yield estimation.
Retail	Customer insights, chatbots, dynamic pricing
Defense	Survillance, autonomous drones, cybersecurity tools.
Home Automation	Smart assistants (e.g. Alexa, Siri), smart homes, IOT integration.

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Agents.

An agent in Artificial Intelligence is anything that can perceive its environment through sensors and act upon that environment through actuators to acheive a goal.

AI agents are designed to make decisions, learn from experiences, and adapt to changes in the environment.

Ex: A self driving car is an intelligent agent. It preceives traffic, pedestrians, and road signs (sensors), and acts by steering, accelerating, or braking (actuators).

Agent structure.

Every agent consist of :

Sensors :- To preceive the environment.

Actuators :- To perform actions.

Perception :- Input received from the environment.

Agent function :- Maps percepts to actions.

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Types of Agents.

Simple Reflex Agent : Acts only on current percept; no memory

Eg Thermostat

Model-based Reflex Agent :- Maintains internal state to handle partially observable environments.

Goal-based Agent :- Takes actions to acheive a goal; considers future outcomes

Utility-Based Agent :- Chooses actions based on preference (utility) to maximize satisfaction.

Learning Agent :- Improves performance over time through learning from environment feedback.

Diagram :- Agent Structure.

Environment

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Sensors

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Agent Program (Perceive → Decide → Act)

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Actuators

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Environment

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Environment

In Artificial Intelligence, the environment is the external context in which an agent operates. It is the world with which the agent interacts through its sensors and actuators. The agent perceives the environment, processes the percept, and performs actions that may change the environment.

Ex:- For a robot vaccum cleaner, the environment includes the floor layout, walls, furniture, and obstacles.

Properties of environments

observable vs Partially observable : fully observable: agent has complete access to state of environment (e.g. chess).
Partially : limited info (e.g. diving in fog).

Deterministic vs Stochastic :- Deterministic : outcome of action is predictable.
Stochastic : Includes randomness (e.g., stock market)

episodic vs Sequentially :- Episodic : decisions are independent of past (e.g. image classification). sequentially : Past actions affect future (e.g. chess).

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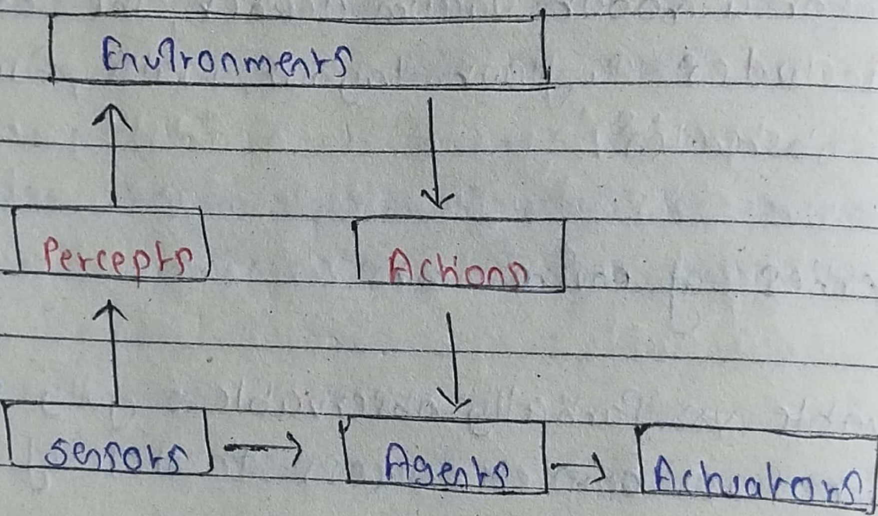
Static vs Dynamic :- static :- environment doesn't change while agent is deciding (eg. crossword puzzle). Dynamic :- Environment changes (e.g. self-driving).

Discrete vs Continuous :- Discrete :- limited states (e.g, chess board). Continuous :- Infinite states (eg, autonomous car).

Single-Agent vs Multi-Agent :- Single :- one agent (e.g. calculator). Multi :- Multiple agents (eg. multiplayer games, traffic systems).



Problem Formulations

1. Concept of Problem Formulation in AI:

Problem formulation is the process of defining an AI problem so that it can be processed and solved systematically by an intelligent agent. It involves converting real-world problems into a structured representation using mathematical and logical models that an AI system can understand.

A well-formulated problem ensures that agent can explore all possible solutions efficiently and choose the most optimal one.

2. Components of a Well-formulated Problem.

A problem in AI is typically represented as a 5-tuple (S, A, y, S_0, G):-

Component	Description
Initial state (S_0)	The starting point of the agent.
State space (S)	All possible states reachable from the initial state
Actions (A)	All possible actions the agent can perform.
Transition function (y)	Describes what action leads from one state to another.
Goal test (G)	checks whether a given state is a goal state
Path cost	Numeric cost associated with the path taken (for optimization)

3. Example of Problem formulation : 8-Puzzle

• Initial State :- A 3x3 grid with tiles in random positions.

- State space :- All possible configurations of the grid.
- Actions :- Move the blank tile up, down, left, or right.
- Transition function :- Defines how a move changes the grid
- Goal Test :- Checks if the tiles are in a specific ordered arrangements.
- Path Cost :- Usually each move has a cost of 1.

Review of Tree and Graph structures.

1. Role of Tree and Graph structures in AI

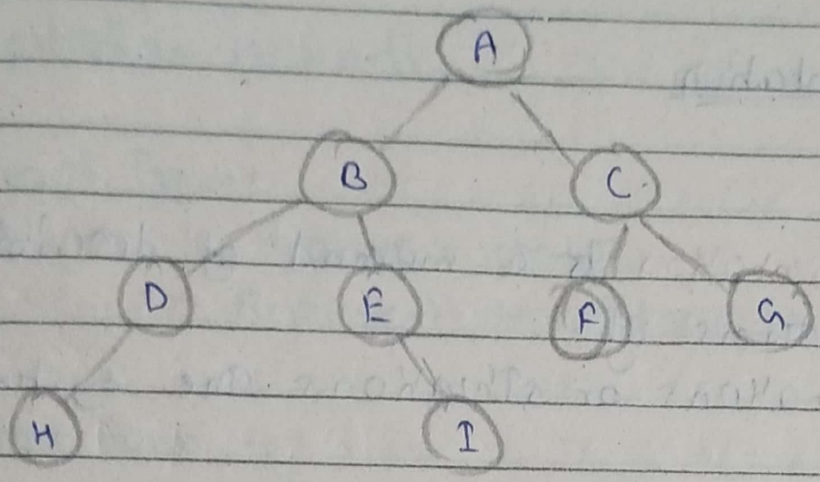
Tree and graph structures are fundamental data structures used in problem-solving and search algorithms within AI. They help represent states, transitions, and relationships between entities, enabling AI systems to efficiently search reason, and make decisions.

- Tree :- A connected ~~acyclic~~ acyclic graph with a root node. Commonly used in search ~~algorithm~~ problems.
- Graph :- A general structure with nodes (vertices) and edges that may be directed or undirected, cyclic or acyclic.

2. Tree Structures in AI

Used mainly in search algorithms like :-

- State-space trees :- Represent possible actions from the initial state
- Game trees :- Used in AI for games (e.g. Minimax).
- Decision trees :- Used for classification in Machine learning.



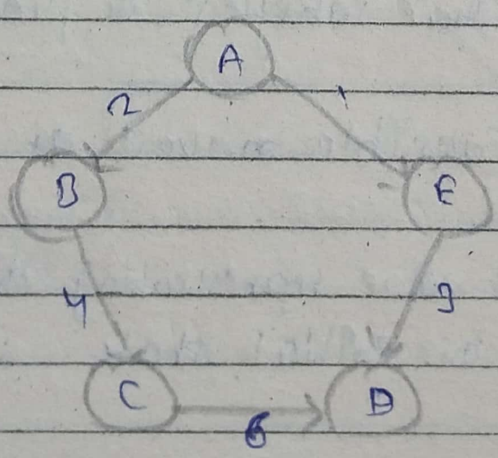
3. Graph Structures in AI

Used for :-

- Search problems :- Representing all possible states and transitions (e.g. pathfinding).
- Knowledge representation :- Semantic networks and concept graphs.
- Constraint Satisfaction Problems (CSPs): Nodes as variables, edges as constraints.

Types :-

- Directed vs Undirected.
- Weighted vs Unweighted.
- Cyclic vs Acyclic.



State space Representation

Definition

State space representation is a method of describing a problem in terms of:-

States:- Configurations or situations the system can be in

Initial state:- The starting configuration

Goal state(s):- The desired configuration(s) to be achieved.

Operators/Actions:- Rules that define how to move from one state to another.

It is widely used in Problem-solving, search algorithms, and planning in AI.

Components of state space

State:- A snapshot of the environment at a certain point in time.

Initial state:- The starting point of the search.

Goal state:- A state that satisfies the problem's success criteria.

Actions/Operators:- Possible moves or transitions between states.

Path cost:- Numerical value representing the cost to reach a state from the initial state.

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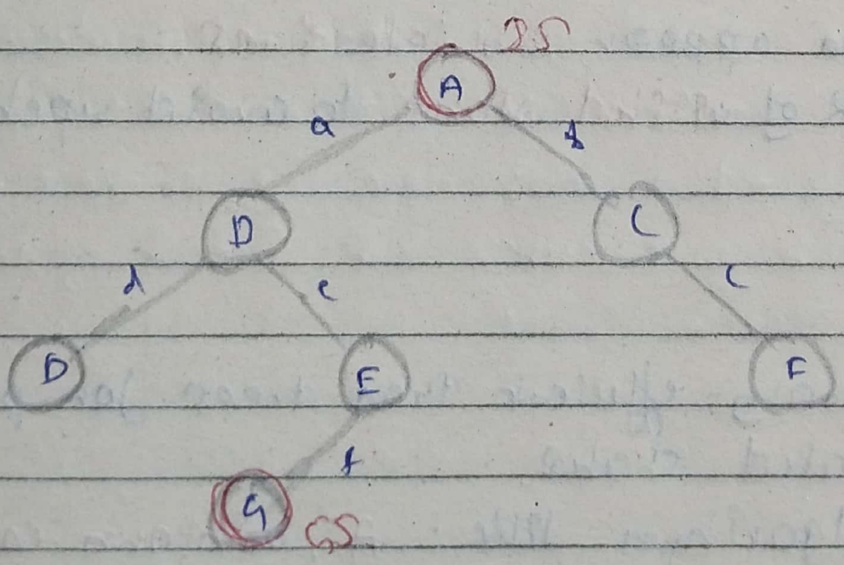
Representation Methods.

1 Graph Form:
Nodes :- Represent states.
Edges :- Represent transitions (actions).

2. Tree Form :-
· used when exploring all possible paths from the root (initial state) without considering repeated states.

Ex :- 8-puzzle Problem
state :- Arrangement of tiles
Initial state :- Given scrambled arrangement.
Goal state :- ordered arrangement (1-8 tiles + blank space).
operators :- Move blank tile up, down, left, right.
state space :- All possible tile arrangements reachable from the initial state



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Search graph & search Tree

Search Tree

Definition :- A Tree structure generated during the search process where:
- Nodes → Represent states
- Edges → Represent actions leading to new states.

Characteristics :-
- No repeated states (assumes each state is unique).
- Used mainly for uninformed search without memory of visited nodes.

Example :- Tree expansion in depth first search.

Search Graph

Definition :- A graph structure generated during the search where :-
- states can appear multiple times.
- Keeps track of visited states to avoid repetition and loops.

Characteristics :-
- More memory-efficient than trees for problems with repeated states.
- Used in algorithm like : A*, uniform cost search

Comparision Table

Feature	Search Tree	Search Graph
Structure	Tree	Graph
Repetition	No check for repeated states	Avoids repeated states using visited list
Memory	Can be large due to duplicates	More compact
Usage	Simple search, uninformed exploration.	Complex search, optimal path finding.