UNIT-1

Introduction to Artificial Intelligence

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit I: Introduction to Artificial Intelligence	1a. Describe the interaction between the given agent and environment. 1b. Describe the salient features of a given agent. 1c. Explain performance measures used to evaluate a given agent. 1d. Explain the environment in artificial intelligence. 1e. Describe initial state and goal state for a given problem.	1.1 Introduction– Definition of AI. AI history. 1.2 Introduction to Agents-Define agent, agent performance,Agent faculties. Examples of agents-Robots. Softbots. Expert systems, autonomous spacecraft, intelligent buildings 1.3 Intelligent Agents. Rationality, Environment- Observability, Determinism. Episodicity. Dynamism and Continuity.(Only definitions) 1.4 State space search- Goal directed agent, State Space Search Notations-Initial state, action or an operator, plan, path cost.

1.1 Introduction-Definition of AI, AI history.

Definition of AI

Artificial Intelligence is concerned with the design of intelligence in an artificial device.
The term was coined by **McCarthy** in 1956.
There are two ideas in the definition.

1. Intelligence
2. artificial device

AI Definition:

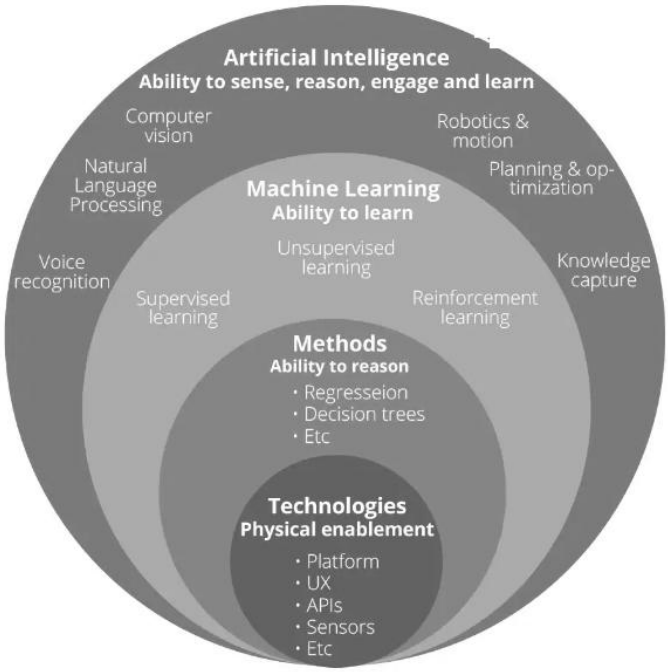
Artificial intelligence is **the simulation of human intelligence processes by machines, especially computer systems**.

OR

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions.

OR

Artificial intelligence (**AI**) is intelligence demonstrated by machines, as opposed to the **natural intelligence** displayed by animals including humans.



AI history:

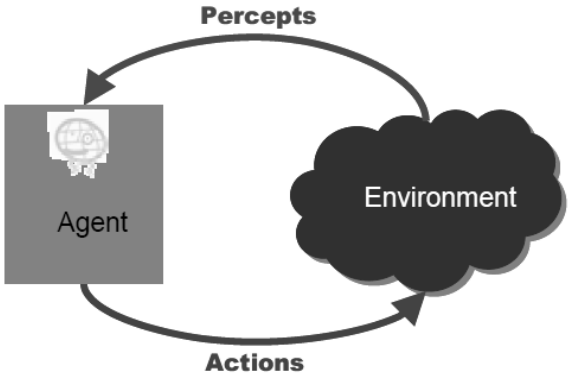
- Intellectual roots of AI date back to the early studies of the nature of knowledge and reasoning. The dream of making a computer imitate humans also has a very early history.
- The concept of intelligent machines is found in Greek mythology. Aristotle (384-322 BC) developed an informal system of syllogistic logic, which is the basis of the first formal deductive reasoning system.
- Pascal in 1642 made the first mechanical digital calculating machine.
- In the 19th century, George Boole developed a binary algebra representing (some) "laws of thought."
- In 1943 McCulloch & Pitts developed a Boolean circuit model of brain.

- The 1990's saw major advances in all areas of AI including the following:
  • machine learning, data mining
  • intelligent tutoring,
  • case-based reasoning,
  • multi-agent planning, scheduling,
  • uncertain reasoning,
  • natural language understanding and translation,
  • vision, virtual reality, games, and other topics.

- Interactive robot pets ("smart toys") become commercially available, realizing the vision of the 18th century novelty toy makers.
- In 2000, the Nomad robot explores remote regions of Antarctica looking for meteorite samples.

1.2 Introduction to agents:

An agent acts in an environment.



An agent perceives its environment through sensors. The complete set of inputs at a given time is called a percept. The current percept or a sequence of percepts can influence the actions of an agent. The agent can change the environment through actuators or effectors. An operation involving an effector is called an action. Actions can be grouped into action sequences. The agent can have goals which it tries to achieve.

Properties of Environment

The environment has multifold properties −

- **Discrete / Continuous** − If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete (For example, chess); otherwise it is continuous (For example, driving).
- **Observable / Partially Observable** − If it is possible to determine the complete state of the environment at each time point from the percepts it is observable; otherwise it is only partially observable.
- **Static / Dynamic** − If the environment does not change while an agent is acting, then it is static; otherwise it is dynamic.
- **Single agent / Multiple agents** − The environment may contain other agents which may be of the same or different kind as that of the agent.
- **Accessible / Inaccessible** − If the agent's sensory apparatus can have access to the complete state of the environment, then the environment is accessible to that agent.
- **Deterministic / Non-deterministic** − If the next state of the environment is completely determined by the current state and the actions of the agent, then the environment is deterministic; otherwise it is non-deterministic.

- **Episodic / Non-episodic** − In an episodic environment, each episode consists of the agent perceiving and then acting. The quality of its action depends just on the episode itself. Subsequent episodes do not depend on the actions in the previous episodes. Episodic environments are much simpler because the agent does not need to think ahead.

➢ Definition of Agent:

An agent is anything that can be viewed as perceiving its environment through sensors and executing actions using actuators.

OR

An agent is anything that can perceive its environment through sensors and acts upon that environment through effectors.

- A **human agent** has sensory organs such as eyes, ears, nose, tongue and skin parallel to the sensors, and other organs such as hands, legs, mouth, for effectors.
- A **robotic agent** replaces cameras and infrared range finders for the sensors, and various motors and actuators for effectors.
- A **software agent** has encoded bit strings as its programs and actions.

➢ Agent Performance

- An agent function implements a mapping from perception history to action. The behaviour and performance of intelligent agents have to be evaluated in terms of the agent function.
- The **ideal mapping** specifies which actions an agent ought to take at any point in time.
- The **performance measure** is a subjective measure to characterize how successful an agent is. The success can be measured in various ways. It can be measured in terms of speed or efficiency of the agent. It can be measured by the accuracy or the quality of the solutions achieved by the agent. It can also be measured by power usage, money, etc.

➢ Examples of Agents

- Humans can be looked upon as agents. They have eyes, ears, skin, taste buds, etc. for sensors; and hands, fingers, legs, mouth for effectors.
- Robots are agents. Robots may have camera, sonar, infrared, bumper, etc. for sensors. They can have grippers, wheels, lights, speakers, etc. for actuators. Some examples of robots are Xavier from CMU, COG from MIT, etc. we have the AIBO entertainment robot from SONY.
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- We also have software agents or softbots that have some functions as sensors and some functions as actuators. Askjeeves.com is an example of a softbot.

- Expert systems like the Cardiologist is an agent.
- Autonomous spacecrafts.
- Intelligent buildings.

➢ Agent Faculties

The fundamental faculties of intelligence are

- Acting
- Sensing
- Understanding, reasoning, learning

1.3 Intelligent Agents

An **Intelligent Agent** must sense, must act, must be autonomous (to some extent), It also must be rational.
AI is about building rational agents. An agent is something that perceives and acts.
A rational agent always does the right thing.

➢ Rationality

- Perfect Rationality assumes that the rational agent knows all and will take the action that maximizes her utility. Human beings do not satisfy this definition of rationality.
- **Rational Action** is the action that maximizes the expected value of the performance measure given the percept sequence to date.
- Rationality is concerned with expected actions and results depending upon what the agent has perceived. Performing actions with the aim of obtaining useful information is an important part of rationality.

➢ Agent Environment

Environments in which agents operate can be defined in different ways. It is helpful to view the following definitions as referring to the way the environment appears from the point of view of the agent itself.

Observability

- In terms of observability, an environment can be characterized as fully observable or partially observable.
- In a fully observable environment all of the environment relevant to the action being considered is observable. In such environments, the agent does not need to keep track of the changes in the environment. A chess playing system is an example of a system that operates in a fully observable environment.
- In a partially observable environment, the relevant features of the environment are only partially observable. A bridge playing program is an example of a system operating in a partially observable environment.

Determinism

- In deterministic environments, the next state of the environment is completely described by the current state and the agent's action. Image analysis systems are examples of this

kind of situation. The processed image is determined completely by the current image and the processing operations.

- If the environment state is wholly determined by the preceding state and the actions of *multiple* agents, then the environment is said to be strategic. Example: Chess. There are two agents, the players and the next state of the board is strategically determined by the players' actions.

Episodicity

- An **episodic** environment means that subsequent episodes do not depend on what actions occurred in previous episodes.

Dynamism

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Episodicity

- An episodic environment means that subsequent episodes do not depend on what actions occurred in previous episodes.
- In a sequential environment, the agent engages in a series of connected episodes.

Dynamism

- Static Environment: does not change from one state to the next while the agent is considering its course of action. The only changes to the environment are those caused by the agent itself.
    - A **static** environment does not change while the agent is thinking.
    - The passage of time as an agent deliberates is irrelevant.
    - The agent doesn't need to observe the world during deliberation.

- A Dynamic Environment changes over time independent of the actions of the agent -- and thus if an agent does not respond in a timely manner, this counts as a choice to do nothing

Continuity

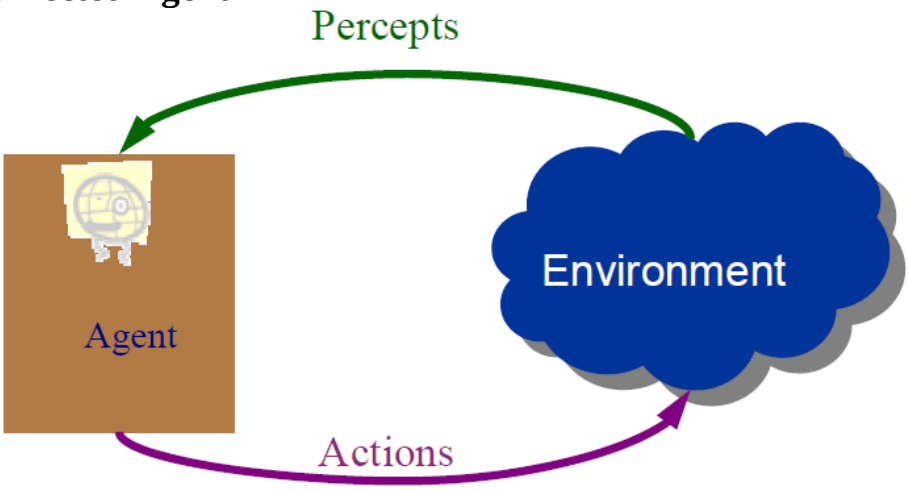
If the number of distinct percepts and actions is limited, the environment is **discrete**, otherwise it is **continuous**.

1.4 State space search

- Formulate a problem as a state space search by showing the legal problem states, the legal operators, and the initial and goal states .
- A state is defined by the specification of the values of all attributes of interest in the world
- An operator changes one state into the other; it has a precondition which is the value of certain attributes prior to the application of the operator, and a set of effects, which are the

attributes altered by the operator
• The initial state is where you start
• The goal state is the partial description of the solution

Goal Directed Agent



- A goal directed agent needs to achieve certain goals. Such an agent selects its actions based on the goal it has. Many problems can be represented as a set of states and a set of rules of how one state is transformed to another. Each state is an abstract representation of the agent's environment. It is an abstraction that denotes a configuration of the agent. Initial state : The description of the starting configuration of the agent
- An action/ operator takes the agent from one state to another state. A state can have a number of successor states.
- A plan is a sequence of actions.
- A goal is a description of a set of desirable states of the world. Goal states are often specified by a goal test which any goal state must satisfy.

State Space Search Notations

Let us begin by introducing certain terms.

- An initial state is the description of the starting configuration of the agent
- An action or an operator takes the agent from one state to another state which is called a successor state. A state can have a number of successor states.
- A plan is a sequence of actions.
- The cost of a plan is referred to as the path cost. The path cost is a positive number, and a common path cost may be the sum of the costs of the steps in the path.

2 MARKS QUESTIONS

1. **Define AI.**
2. **Define agent.**

3. **List agent performance.**
4. **List agent faculties.**
5. **List examples of agents.**
6. **Define Intelligent agent.**
7. **Define Rationality.**
8. **Define observability w.r.t environment.**
9. **Define Determinism w.r.t environment.**
10. **Define Episodicity w.r.t environment.**
11. **Define Dynamism w.r.t environment.**
12. **Define Continuity w.r.t environment.**
13. **Define goal directed agent.**
14. **Define initial state w.r.t state space search.**
15. **Define action w.r.t state space search.**
16. **Define plan and path cost w.r.t state space search.**

4 MARKS QUESTIONS

1. **Explain AI history.**
2. **Explain agent and its performance.**
3. **List properties of environment.**
4. **List any four characteristics of environment.**
5. **Explain state space search and goal directed agent.**
6. **Define initial state, action, plan and path cost w.r.t state space search.**