

# **Introduction**

**Unit No 1**

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# Intelligent Agents

- **Intelligent agents** are the cornerstone of artificial intelligence. They are autonomous entities that perceive their environment through sensors and act upon it using actuators to achieve specific goals. These agents can be anything from simple software programs to complex robots.

# Core Components of an Intelligent Agent

- **Perception:** The agent's ability to gather information from its environment through sensors.
- **Decision Making:** The process of selecting the best action based on the perceived information and the agent's goals.
- **Action:** The execution of the chosen action through actuators.

# Types of Intelligent Agents

- 1.Simple Reflex Agents:** These agents act based on the current perception, without considering the history of the environment. Examples include thermostats and traffic lights.
- 2.Model-Based Reflex Agents:** These agents maintain an internal state representing the world, allowing them to make decisions based on both the current perception and the remembered state.
- 3.Goal-Based Agents:** These agents have a specific goal in mind and choose actions that maximize the likelihood of achieving that goal.

4. **Utility-Based Agents:** These agents consider multiple possible outcomes and assign values (utilities) to them, selecting the action that maximizes the expected utility.
5. **Learning Agents:** These agents can improve their performance over time through learning from experience.

# Examples of Intelligent Agents

- **Virtual Assistants:** Siri, Alexa, and Google Assistant are intelligent agents that interact with users to perform tasks.
- **Self-driving Cars:** These vehicles are complex intelligent agents that perceive their surroundings, make decisions about steering, acceleration, and braking, and execute those actions.
- **Recommendation Systems:** These systems suggest products or content based on user preferences and behavior.
- **Game-Playing Agents:** Chess and Go champions like AlphaGo are intelligent agents that excel at strategic thinking and decision-making.

# Challenges and Future Directions

While intelligent agents have made significant strides, several challenges remain:

- **Uncertainty and Noise:** Dealing with incomplete or inaccurate information.
- **Learning from Complex Environments:** Acquiring knowledge efficiently in dynamic and complex scenarios.
- **Ethical Considerations:** Ensuring that intelligent agents align with human values and avoid harmful biases.

- The future of intelligent agents holds immense potential. Advancements in machine learning, natural language processing, and robotics will enable the creation of even more sophisticated and capable agents. We can expect to see intelligent agents playing a crucial role in various fields, including healthcare, finance, and transportation.



# Agents and Environments Good Behavior

- The interaction between an agent and its environment is fundamental to AI. It's the dynamic interplay that shapes an agent's behavior and determines its success.

## Understanding the Relationship

- **Agent:** An autonomous entity that perceives its environment through sensors and acts upon it through actuators to achieve specific goals.
- **Environment:** The external world in which the agent operates. It can be static, dynamic, discrete, continuous, deterministic, stochastic, and more.

# Good Behavior: The Goal

A well-behaved agent is one that:

- **Achieves its goals efficiently:** It selects actions that maximize its chances of success.
- **Adapts to the environment:** It can learn and adjust its behavior based on changes in the environment.
- **Is safe and ethical:** It avoids causing harm and respects moral principles.
- **Collaborates effectively:** It can work cooperatively with other agents if necessary.

# Factors Influencing Good Behavior

- **Performance Measure:** Defines the criteria for success.
- **Percepts:** The agent's sensory inputs from the environment.
- **Actions:** The agent's possible outputs to the environment.
- **Environment Properties:** Characteristics of the environment, such as static vs. dynamic, discrete vs. continuous, deterministic vs. stochastic.
- **Agent Architecture:** The internal structure of the agent, including its knowledge representation, learning mechanisms, and decision-making processes.

# Challenges and Considerations

- **Uncertainty:** Environments often contain noise and unpredictability, requiring robust agents.
- **Partial Observability:** Agents may not have complete information about the environment.
- **Multiple Agents:** Interactions between agents can lead to complex behaviors and challenges.
- **Ethical Implications:** Agents must be designed to align with human values and avoid harm.

# Examples of Good Behavior

- **Self-driving cars:** Safely navigating complex environments, avoiding accidents, and optimizing routes.
- **Medical diagnosis systems:** Accurately identifying diseases, recommending appropriate treatments, and respecting patient privacy.
- **Virtual assistants:** Understanding user needs, providing helpful information, and protecting user data.

# The Concept of Rationality

- Rationality in AI refers to an agent's ability to make decisions that maximize its performance based on the information it has and the goals it seeks to achieve. Essentially, a rational AI agent is one that always chooses the best possible action from a set of alternatives to reach a specific objective.

# Key Components of Rationality

- Performance Measure: Defines the criteria for success. This is crucial as it determines what constitutes a "good" or "bad" outcome.
- Knowledge Base: The agent's understanding of the world, including facts, rules, and theories.
- Perception: The ability to gather information from the environment.
- Action: The ability to execute actions within the environment.

# Types of Rationality

- Perfect Rationality: Assumes an agent has complete information, infinite computational power, and unlimited time to make decisions. While this is a theoretical ideal, it's often unrealistic in real-world scenarios.
- Bounded Rationality: Recognizes the limitations of real-world agents, including limited information, computational resources, and time. This is a more practical approach to rationality.



# Challenges in Achieving Rationality

- **Uncertainty:** Real-world environments are often filled with uncertainty, making it difficult to predict outcomes accurately.
- **Computational Complexity:** Many problems require extensive computational resources, making optimal decision-making challenging.
- **Dynamic Environments:** Environments can change rapidly, requiring agents to adapt their decisions accordingly.

# Example of Rationality

- A self-driving car is a prime example of a rational agent. Its goal is to reach the destination safely and efficiently.
- It uses sensors (perception) to gather information about the road, traffic, and other vehicles.
- It then makes decisions (action) based on its knowledge of traffic rules, road conditions, and the desired route.
- While perfect rationality is impossible due to unforeseen events like pedestrians or road hazards, the car aims to be as rational as possible within its constraints.

# Rationality and Ethics

- It's essential to note that rationality does not inherently equate to morality. A rational agent could make decisions that are harmful if its performance measure is not aligned with ethical values. Therefore, ensuring that AI systems are not only rational but also ethical is a crucial challenge.

# The Nature of Environments

- An environment in AI is the surrounding context in which an agent operates. It provides the input data to the agent, which the agent processes to produce actions that influence the environment.

# Environments can be classified based on several dimensions

## Observability

- **Fully Observable:** The agent has complete and accurate information about the environment's state at all times.
  - Example: Chess
- **Partially Observable:** The agent has limited or noisy information about the environment.
  - Example: Self-driving car

- **Determinism**
- **Deterministic:** The next state of the environment is completely determined by the current state and the agent's action.
  - Example: Chess (without random elements like dice)
- **Stochastic:** The next state of the environment is influenced by random factors.
  - Example: Weather prediction

## Static vs. Dynamic

- **Static:** The environment does not change while the agent is deliberating.
  - Example: Solving a puzzle
- **Dynamic:** The environment can change while the agent is deliberating, requiring real-time responses.
  - Example: Self-driving car

## Discrete vs. Continuous

- **Discrete:** The environment has a finite number of states and actions.
  - Example: Tic-tac-toe
- **Continuous:** The environment has an infinite number of states and actions.
  - Example: Robot navigation



## Single-agent vs. Multi-agent

- **Single-agent:** Only one agent interacts with the environment.
  - Example: Chess
- **Multi-agent:** Multiple agents interact with each other and the environment.
  - Example: Football

## Episodic vs. Sequential

- **Episodic:** Each episode is independent of the others.
  - Example: Image classification
- **Sequential:** The current decision can affect future outcomes.
  - Example: Chess

## Known vs. Unknown

- **Known:** The agent has complete knowledge of the environment's dynamics and structure.
  - Example: Mathematical proofs
- **Unknown:** The agent must learn about the environment through experience.
  - Example: Reinforcement learning

# Interaction between Agent and Environment

- **Perception:** The agent receives sensory input from the environment.
- **Action:** The agent performs actions based on its perception and goals.
- **Feedback:** The environment provides feedback to the agent in the form of rewards or new states.

# Challenges in Environment Design

- **Real-world complexity:** Real-world environments are often highly complex, dynamic, and uncertain.
- **Simulation vs. reality gap:** Simulators may not accurately represent real-world conditions.
- **Ethical considerations:** AI agents operating in real-world environments raise ethical concerns.

# The Structure of AI Agents

- An AI agent is essentially a system that perceives its environment through sensors, processes information, and acts upon that environment through actuators

# Core Components of an AI Agent

## **Core Components of an AI Agent**

- Architecture: The physical platform on which the agent operates.
- Includes hardware (sensors, actuators, processors) and software (operating system, programming language).
- Examples: a robot, a software application, or a combination of both.

## **Agent Program:**

- The software component that implements the agent function.
- Maps percepts (sensory inputs) to actions.
- Can be implemented using various techniques like rule-based systems, decision trees, neural networks, or reinforcement learning.



## **Agent Function:**

- The mathematical representation of the agent's behavior.
- Maps a history of percepts to an action.
- $f: P^* \rightarrow A$ , where  $P^*$  is the set of all possible percept sequences and  $A$  is the set of possible actions.
- Types of AI AgentsBased on their capabilities, AI agents can be categorized into:

# Types of AI Agents

Based on their capabilities, AI agents can be categorized into:

## **Simple Reflex Agents:**

- Act based on the current percept, ignoring the history.
- Suitable for simple environments with immediate rewards.

## **Model-Based Reflex Agents:**

- Maintain an internal state to represent the world.
- Can handle partially observable environments.

### **Goal-Based Agents:**

- Have explicit goals and consider future actions to achieve them.
- Use search and planning techniques to find optimal paths.

### **Utility-Based Agents:**

- Consider multiple goals and trade-offs between them.

Maximize expected utility.

### **Learning Agents:**

- Improve their performance over time through learning.
- Combine other agent types with learning capabilities.