Chapter 2: Intelligent Agents

Artificial Intelligence:

Concepts of Agents and Types of Agents

An agent is anything that can be viewed as perceiving its ENVIRONMENT through SENSORS and acting upon that environment through ACTUATORS.

Rational Agent

A rational agent is one that does the right thing - ie when given certain precepts it generates the desired output

01

Percepts

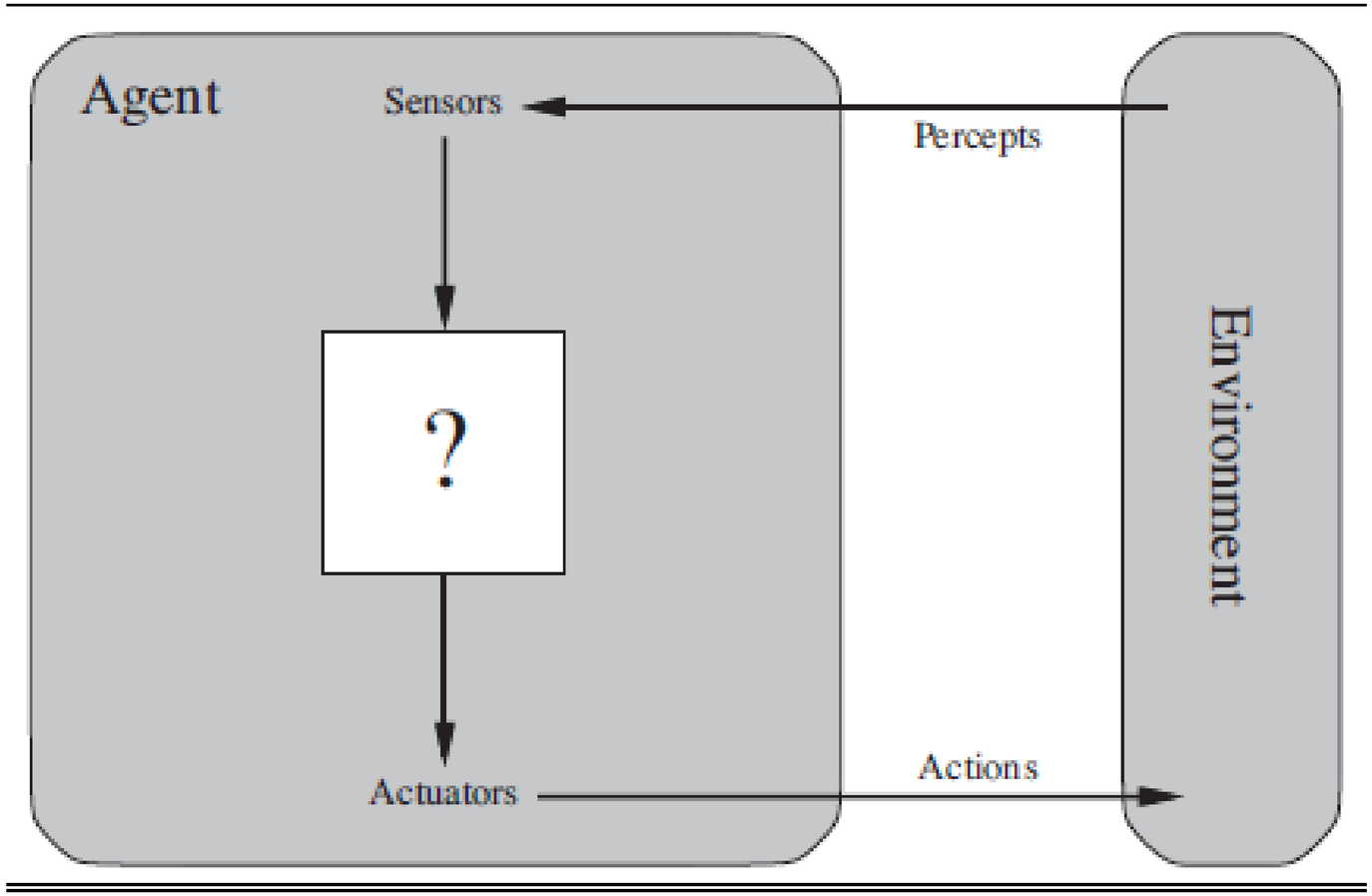
This refers to an agents perceptual inputs at a given time

02

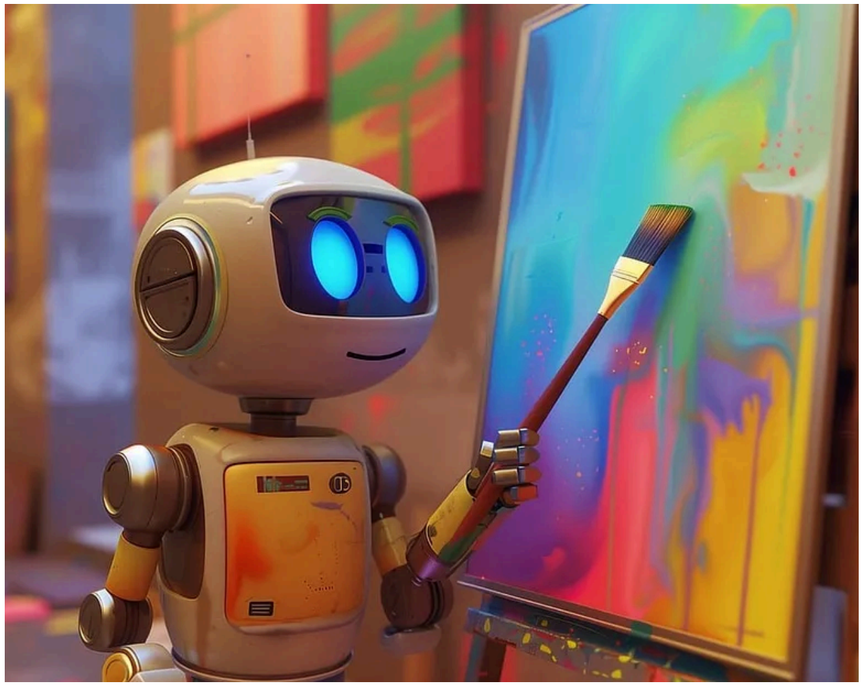
Percept Sequence

It is the complete history of everything the agent has ever perceived

An agent’s choice of action at any given instant can depend on the entire percept sequence observed to date, but not on anything it hasn’t perceived.



Agent Function



Definition:

The agent function is a mathematical function that maps percept sequences (inputs) to actions (outputs).

It represents the behavior of an agent in response to its environment.

Key Point

Input: Percept sequence (what the agent perceives over time).

Output: Action (what the agent decides to do).

Mathematical Representation: f: P* → A, where P* is the set of all possible percept sequences, and A is the set of possible actions.

Example:

A self-driving car perceives road conditions (percepts) and decides to brake or accelerate (actions).

A thermostat senses temperature (percept) and turns the heater on or off (action).

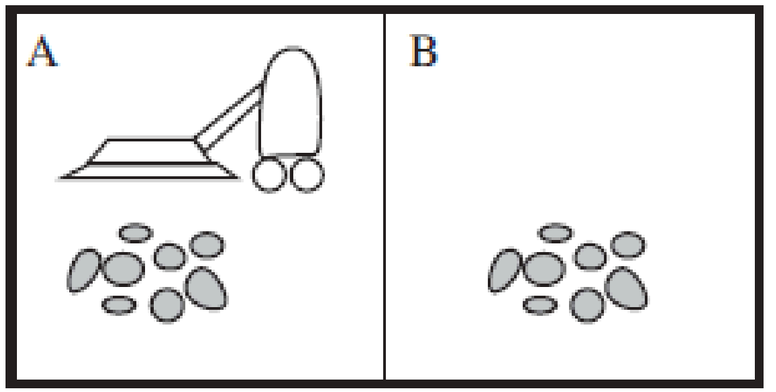


Figure 2.2 A vacuum-cleaner world with just two locations.

Percept sequence	Action
$[A, Clean]$	$Right$
$[A, Dirty]$	$Suck$
$[B, Clean]$	$Left$
$[B, Dirty]$	$Suck$
$[A, Clean], [A, Clean]$	$Right$
$[A, Clean], [A, Dirty]$	$Suck$
⋮	⋮
$[A, Clean], [A, Clean], [A, Clean]$	$Right$
$[A, Clean], [A, Clean], [A, Dirty]$	$Suck$
⋮	⋮

Figure 2.3 Partial tabulation of a simple agent function for the vacuum-cleaner world shown in Figure 2.2.

Agent Program

Definition:

The agent program is the implementation of the agent function. It runs on the agent's architecture to produce actions based on percepts.

Key Points

Relationship to Agent Function: The agent program is the code or logic that realizes the agent function.

Components:

Sensors: Collect percepts from the environment.

Actuators: Execute actions.

Decision-making Logic: The core program that processes percepts and decides actions

Example:

- A vacuum cleaner robot:
  - Sensors detect dirt (percept).
  - Agent program processes the data and decides to move forward or stop.
  - Actuators execute the movement

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Example 2:

A self-driving car:

- Sensors: Cameras, LIDAR, GPS.
- Agent Program: AI algorithms for navigation.
- Actuators: Steering wheel, brakes, accelerator.

Performance Measure

Definition:A performance measure evaluates how well an agent is achieving its goals in a given environment.

- **Key Points:**
  - **Purpose:**

    To quantify the success of an agent's behavior.

    To guide improvements in the agent's design.

Examples:

For a vacuum cleaner agent:

- Cleanliness of the floor (primary metric).
- Energy efficiency (secondary metric).
- Time taken to clean (tertiary metric).

For a chess-playing agent:

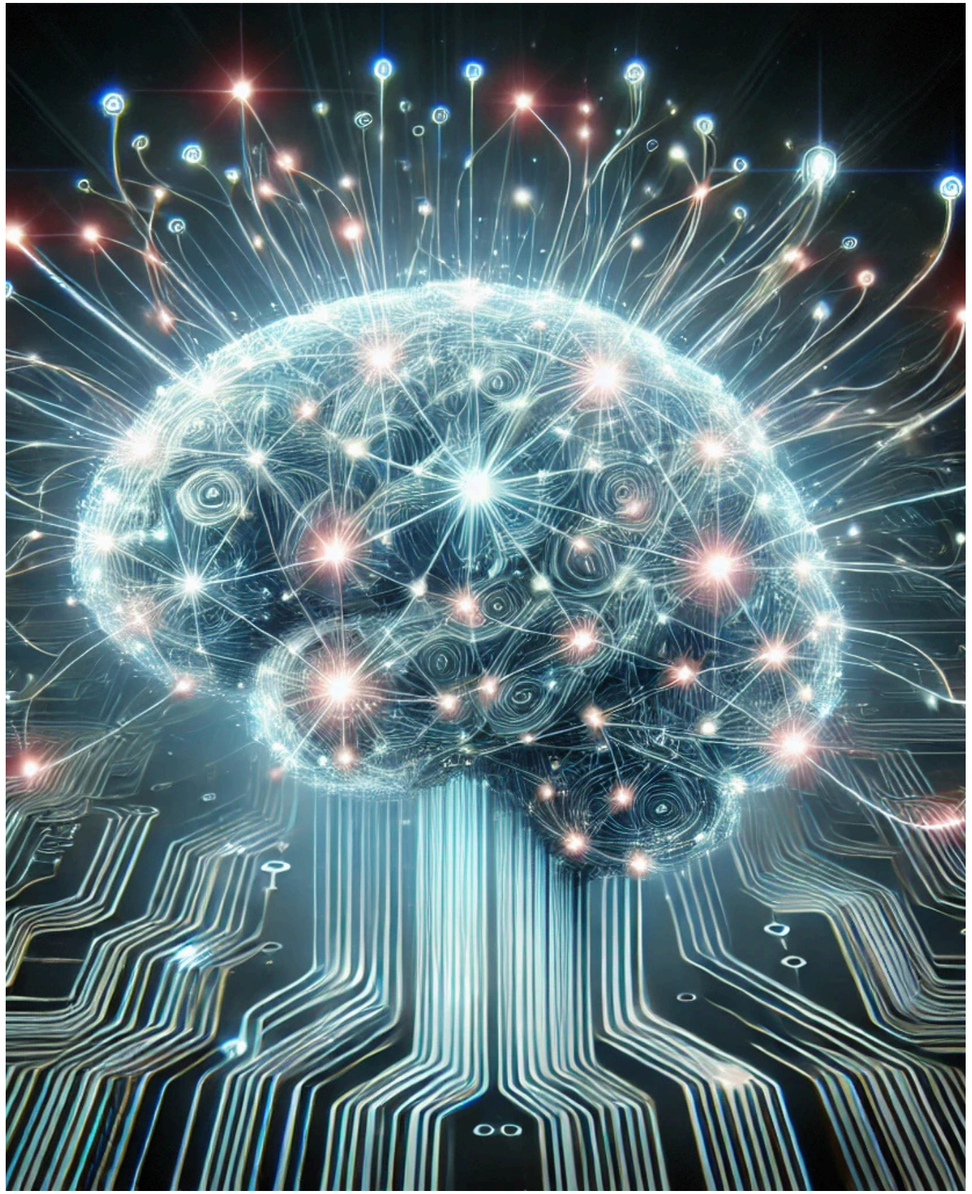
- Number of games won.
- Number of moves made.
- Time taken to make decisions.
-

Subjectivity:

Performance measures are context-dependent and vary based on the agent's purpose.

Example: A self-driving car's performance measure might prioritize safety over speed.

Omniscience, learning, and autonomy



Omniscient Agent

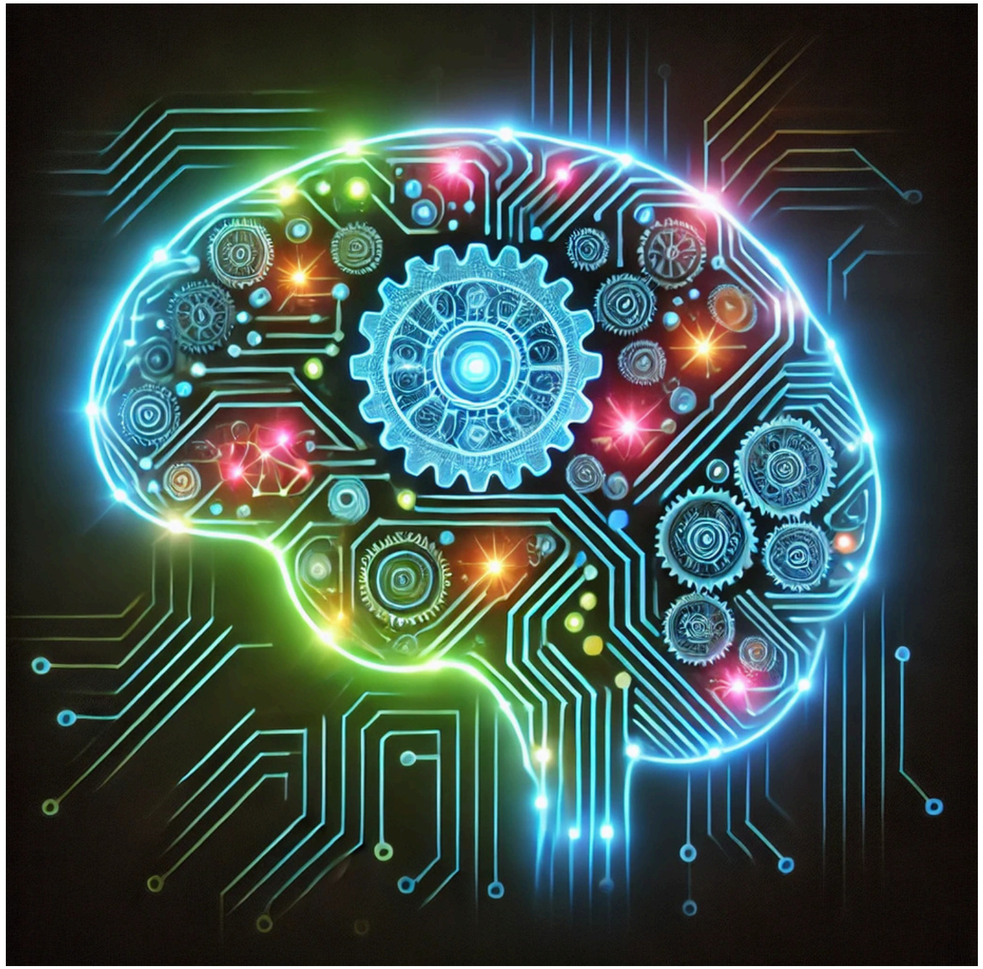
- **Definition:** Knows everything—actual outcome of its actions and can act accordingly
- **Reality:** Impossible; real agents only have partial observations.
- Rationality maximizes expected performance, while perfection maximizes actual performance.

Omniscience, learning, and autonomy

Information Gathering

- **Definition:** Doing actions in order to modify future percepts
- Taking actions to acquire more data.
- **Why It Matters:** Better decisions need better information.
- **Example:** A robot scanning an unknown room before moving.

Omniscience, learning, and autonomy



Learning

- **Definition:** Adapting and improving based on experience.

- **Key Process:** Modify internal components to align with feedback.
- There are extreme cases in which the environment is completely known a *priori*

- **Example:** A chess AI learning from past games to improve moves.

Omniscience, learning, and autonomy

Autonomy

- **Definition:** Relying on percepts and experience instead of pre-programmed knowledge.
- Should learn what it can to compensate for partial or incorrect prior knowledge.
- **Goal:** Reduce dependence, increase self-reliance.
- **Example:** A Mars Rover Operating Independently

Types of Agents

A. Simple Reflex Agents

These agents respond to the current perceived state without considering the history of past actions or states.

Characteristics:

- Reacts to specific stimuli in the environment.
- Does not have memory or the ability to learn from past experiences.

Example: A thermostat that turns on heating when the temperature drops below a set point.

Limitations: Cannot handle partially observable environments or plan for the future as they lack memory of past states.

B.Model-Based Reflex Agents:

These agents maintain an internal state based on the history of their past observations, allowing them to handle more complex environments.

Characteristics:

- Uses a model of the world to keep track of the state.
- Can make decisions based on both current percepts and the internal state.
- Capable of handling a broader range of situations than simple reflex agents.

Example: A robot vacuum that remembers areas it has cleaned and adjusts its path accordingly.

GOAL-BASED AGENTS.

What is a Goal-Based Agent?

A goal-based agent is an agent that:

- Has a specific goal or set of goals to achieve.
- Uses planning and reasoning to determine the best sequence of actions to reach the goal.
- Considers the future consequences of its actions, rather than just reacting to the current state of the environment.

Example

- A navigation app that finds the shortest route to a destination.

C. Utility-Based Agents

These agents aim to maximize a utility function,which is choosing the best option by evaluating the potential outcomes of each option.

Characteristics:

- Evaluates multiple possible actions based on their expected utility.
- Makes decisions that lead to the best possible outcome according to the utility function.
- More flexible and capable of handling uncertainty than the previous types

Example: An investment algorithm that evaluates various investment options based on predicted returns and risks to maximize profits.

LEARNING AGENTS

Learning agents are a type of intelligent agent that improve their performance over time by learning from their experiences.

HOW LEARNING AGENTS WORK

Learning Process

Perceive: The agent observes the environment through its sensors.

Act: The performance element selects an action based on the current knowledge.

Receive Feedback: The critic evaluates the outcome of the action and provides feedback.

Learn: The learning element updates the agent's knowledge or behavior based on the feedback.

Explore: The problem generator suggests new actions to improve learning.

Example

A recommendation system that improves suggestions based on user feedback, e.g. Netflix.

AN EXAMPLE USE CASE

THE VACUUM CLEANER AGENT.

The robot has:

- **Sensors:** To detect whether the current location is dirty or clean.
- **Actuators:** To move left, move right, or suck dirt.

Percepts

- (Location A, Dirty)
- (Location B, Clean)

Agent Function

- The agent function maps percept sequences to actions.
  - If the current location is dirty, the robot should suck.

Rationality in the Vacuum Cleaner Agent

. Rationality depends on:

- **Performance Measure**: Clean both locations with minimal time and energy.
- **Percept Sequence**: The history of what the robot has observed.
- **Prior Knowledge**: The robot knows the layout of the room.
- **Actions**: The robot can suck, move left, or move right.