Intelligent Agents

Introduction to Intelligent Agents

- Agents are entities that perceive their environment through sensors and act upon it using actuators.
- The concept of rational agents is central to AI and focuses on *how well an agent can behave in its environment*.
- The design of an agent depends on the environment it operates in.

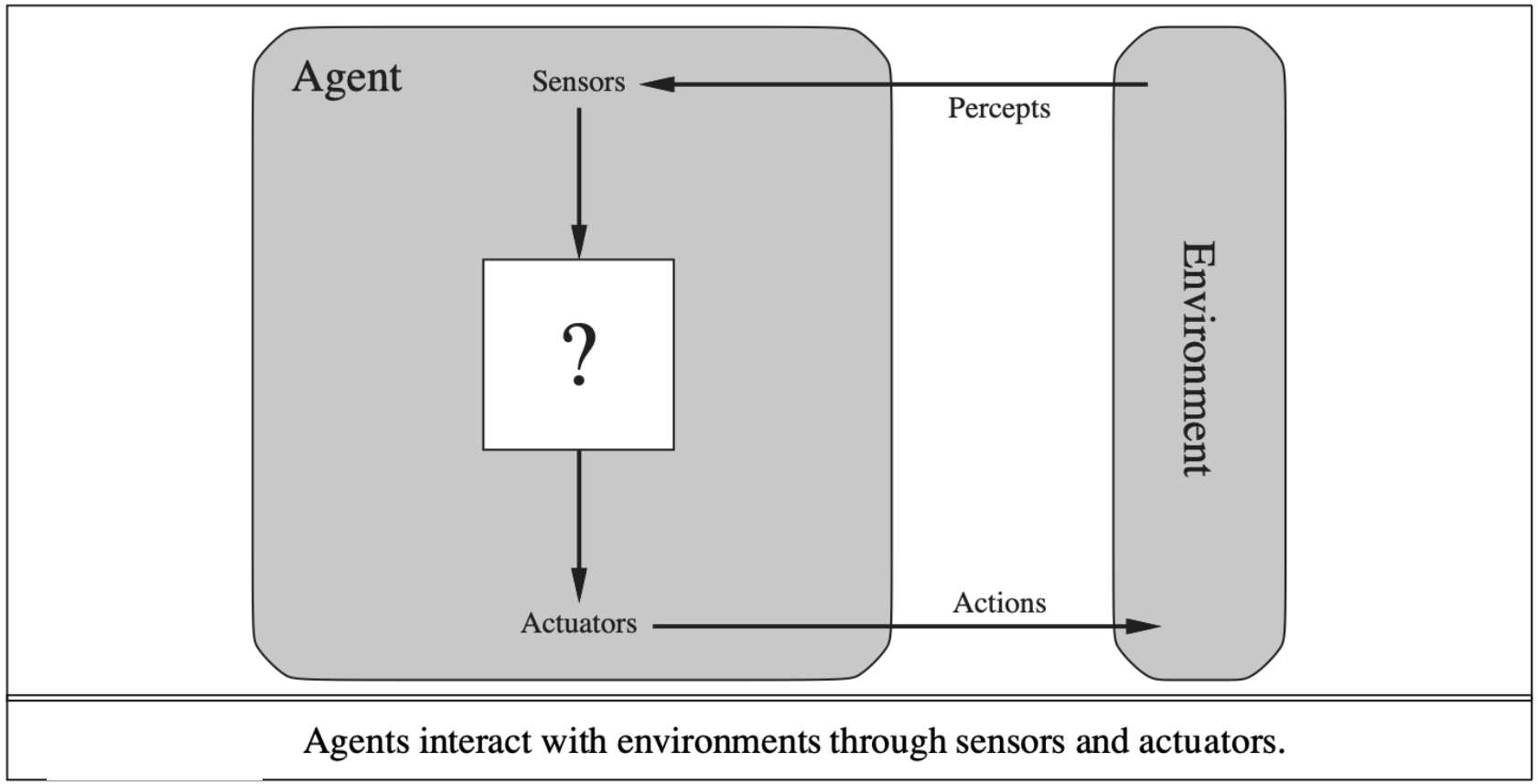
Agents and Their Environments (cont.)

- An agent is anything that perceives its environment and acts accordingly.
- Examples of Agents
  - Human Agent
    - Uses eyes, ears, and hands as sensors and actuators.
  - Robotic Agent
    - Uses cameras and infrared sensors for perception, motors for action.
  - Software Agent
    - Uses keystrokes, files, and network packets as inputs; responds via screen display and file modifications.

Agents and Their Environments

- Percepts and Percept Sequences
  - Percept
    - Agent’s sensory input at a given moment.
  - Percept Sequence
    - Complete history of everything an agent has perceived.

Agents and Their Environments



Agents interact with environments through sensors and actuators.

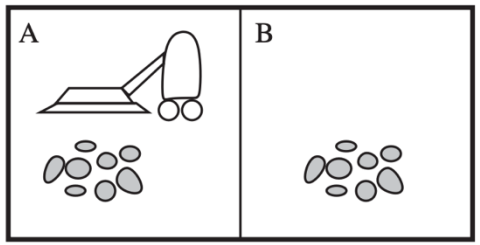
Agent Function and Agent Program

- Agent Function
  - A mathematical mapping from percept sequences to actions.
- Agent Program
  - The actual implementation of the agent function within a system.

Agent Function and Agent Program

- The Vacuum Cleaner Agent
  - Operates in a world with two locations: A and B.
  - Perceives its location and whether the location is dirty.
  - Actions: Move left, move right, suck dirt, or do nothing.
  - Simple Agent Function
    - If the square is dirty → Suck
    - If the square is clean → Move to the other square

Agent Function and Agent Program



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*
⋮	⋮

Partial tabulation of a simple agent function for the vacuum-cleaner world

Representation of an Agent

- Agent Function

$$f : P^* \rightarrow A$$

Where

- f is the agent function
- P^* represents the set of all percept sequences
- A is the set of actions

- The agent chooses actions based on past percepts to

What Makes an Agent Intelligent?

- The effectiveness of an agent depends on how well it interacts with its environment.
- AI focuses on designing agents that make non-trivial decisions using computational resources.
- The performance of an agent is evaluated based on its success in achieving its goals.

Good Behaviour – The Concept of Rationality

Introduction to Rationality

- Rationality is a fundamental concept in AI and intelligent agents.
- It determines how an agent makes decisions based on information and environment.
- Rational behaviour leads to optimal or satisfactory outcomes.

What is a Rational Agent?

- A rational agent selects the best possible action given available information.
- It considers:
  - Perception (what it observes)
  - Knowledge (what it knows)
  - Actions (what it can do)
  - Goals (what it wants to achieve)

Measuring Rationality

- Performance Measure
  - Evaluates how well the agent performs.
- Percept Sequence
  - History of all agent's perceptions.
- Knowledge Base
  - Information and prior experiences.
- Action Set
  - Available actions the agent can take.

Components of Rationality

- Utility-Based Rationality
  - Maximizes expected outcomes.
- Goal-Based Rationality
  - Takes actions leading to specific goals.
- Knowledge-Based Rationality
  - Uses prior knowledge to enhance decision-making.

Rational Agent in Action

- Example
  - A self-driving car
    - Uses sensors to perceive surroundings.
    - Analyzes traffic rules and road conditions.
    - Chooses the safest and fastest route.
    - Adjusts speed to optimize efficiency and safety.

Challenges in Achieving Rationality

- Incomplete or Uncertain Information
- Computational Complexity
- Dynamic and Unpredictable Environments
- Trade-offs Between Time and Accuracy

The Nature of Environments

The Nature of Environments

- Rational agents solve task environments.
- Task environments define the problems agents must solve.
- Agent design depends on the environment's characteristics.

Specifying the Task Environment (PEAS)

- Rational agents solve task environments.
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- Agent design depends on the environment's characteristics.

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

PEAS description of the task environment for an automated taxi.

Specifying the Task Environment (PEAS)

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

Examples of agent types and their PEAS descriptions.

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Examples of task environments and their characteristics.

Automated Taxi Driver Example (cont.)

- Rational agents solve task environments.
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Automated Taxi Driver Example (cont.)

- Performance Measure
  - Reaching the destination correctly.
  - Minimizing fuel and maintenance costs.
  - Ensuring safety, comfort, and legal compliance.
  - Maximizing profit.
- Environment
  - Roads, traffic, pedestrians, obstacles.
  - Different driving conditions (weather, location).
  - Passenger interactions.

Automated Taxi Driver Example

- Actuators
  - Steering, acceleration, braking.
  - Communication via screens/voice output.
- Sensors
  - Cameras, infrared, sonar.
  - Speedometer, GPS, accelerometer.
  - Engine and fuel monitoring systems.

Properties of Task Environments

- Observability
  - Fully Observable
    - Sensors detect all relevant aspects.
  - Partially Observable
    - Limited information (e.g., taxi can't see driver intentions).
  - Unobservable
    - No sensors available.

Number of Agents

- Single-Agent
  - One agent (e.g., solving a puzzle).
- Multi-Agent
  - Competitive
    - Agents work against each other (e.g., chess).
  - Cooperative
    - Agents collaborate (e.g., traffic coordination).
  - Mixed
  - Both cooperation and competition (e.g., taxi-driving).

Agents and Types of Agents

See Class Notes

Thanks!

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