Intelligent Agents

CSEN266

Artificial Intelligence

Outlines

- Agents and environments
- Rational Agent
- Environment types
- The structure of agents

Agents

- Agent: an entity that perceives its environment through sensors and acts upon that environment through actuators.
- Agents interact with environments through sensors and actuators

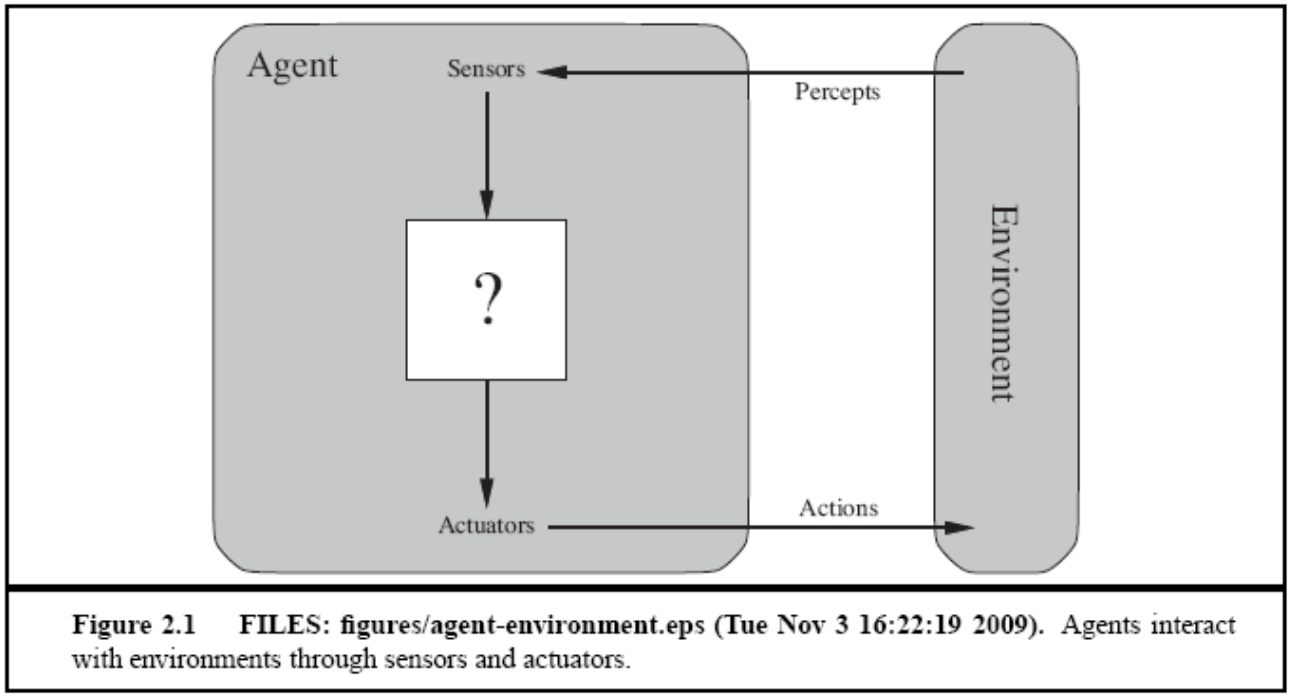


Figure 2.1 FILES: figures/agent-environment.eps (Tue Nov 3 16:22:19 2009). Agents interact with environments through sensors and actuators.

Agents

- Human agent
  - Sensors: eyes, ears, …
  - Actuators: hands, legs, …
- Robotic agent
  - Sensors: cameras, infrared range finders, …
  - Actuators: motors
- Software agent
  - Sensors:
    - Keyboard, mouse, touchscreen, voice
    - Receiving network packets
  - Actuators: Writing content to files, sending data to other computers, displaying information, and generating sounds, …

Agents

- Percept: the agent's perceptual inputs at any given instant
- Percept sequence: the complete history of everything the agent has ever perceived

- Agent function: maps any given percept sequence to an action

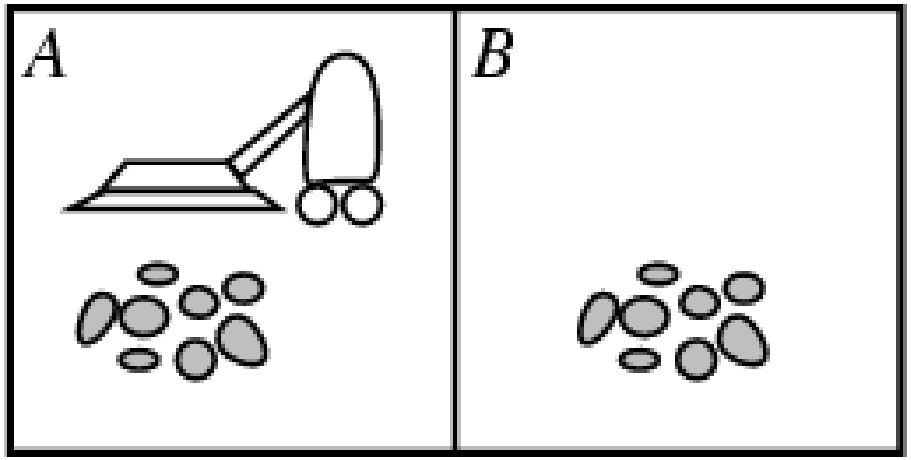
$$f: \text{percepts} \rightarrow \text{action}$$

  - An abstract mathematical description

Agents

- Agent program: implements the agent function
  - A concrete implementation, running with some physical system

Agent Function Example: Vacuum Cleaner



Percept sequence	Action
{A, Clean}	Right
{A, Dirty}	Suck
{B, Clean}	Left
{A, Clean},{A, Clean}	Right
{A, Clean},{A Dirty}	Suck
…	…

Rational Agent

- Whether an agent is rational depends on
  - Performance measure: an objective criterion to evaluate the success of an agent's behavior
    - e.g., vacuum-cleaner agent: the amount of dirt cleaned up, the amount of time taken, the amount of electricity consumed, etc.
  - Agent's prior (built-in) knowledge of the environment
  - What actions the agent can take
  - Agent's percept sequence to date

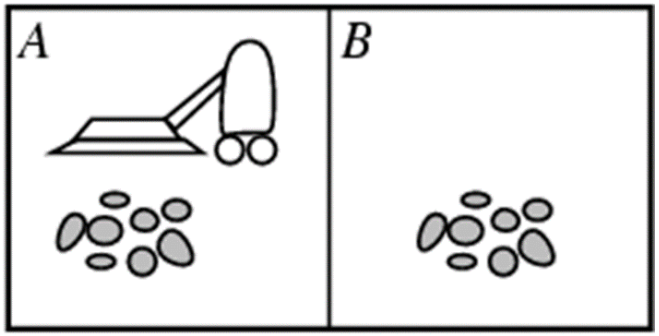
Rational Agent

- A **rational agent** is an agent that can select actions to maximize its performance measure, given the agent's capabilities, evidence provided by the percept sequence and whatever built-in knowledge the agent has.

- Rationality is distinct from omniscience (all-knowing with infinite knowledge).

Example: Vacuum Cleaner Agent

- A robot vacuum cleaner has a local sensor. It only perceives its current location and takes actions accordingly. It does not know whether the other location is clean or dirty.



- Statement: this vacuum cleaner agent cannot be rational.

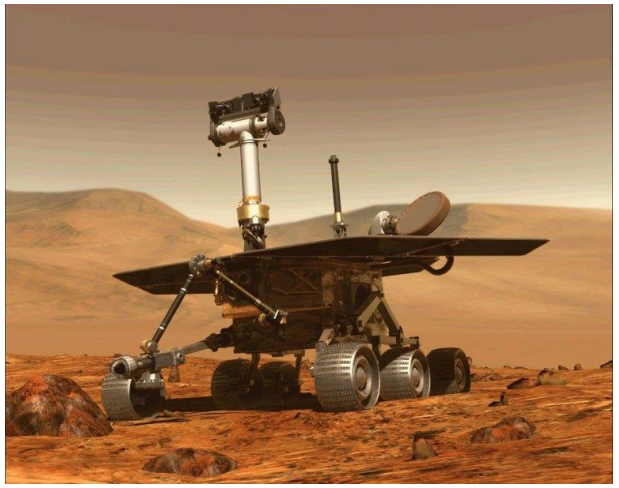
  a) True, b) False

- Answer:
- b) False. It is rational as long as it can do its best given the capability it has.

Example: Mars-rover

- A Mars-rover can observe the entire environment, but it does not have an agent program to plan its route. This Mars-rover is not rational.

  a) True, b) False



- Answer:
- a) True. Since we know there is a better program: one that includes route planning.

Task Environment

- To design a rational agent, we must specify its task environment
- **PEAS** description of the environment

  Performance measure

  Environment

  Actuators

  Sensors

PEAS Example

- **Agent = robotic taxi**
- **Performance measure:** safety, fast, legal, comfortable trip, maximize profits ...
- **Environment:** Roads, traffic, pedestrians, weather, ...
- **Actuators:** steering wheel, accelerator, brake, horn, signal, touch pad,…
- **Sensors:** camera, sonar, GPS, odometer, engine sensor, …

PEAS Example

- **Robotic Soccer Game**

Figure credit: slate.com

- **Performance measure:**
  - (a) Scores
- **Environment:**
  - Soccer field, players, judge, audiences

PEAS Example

- **Robotic Soccer Game**

Figure credit: slate.com

- **Actuators:**
  - Body parts (legs, arms, hands, feet, etc.), motors
- **Sensors:**
  - Cameras, other sensors

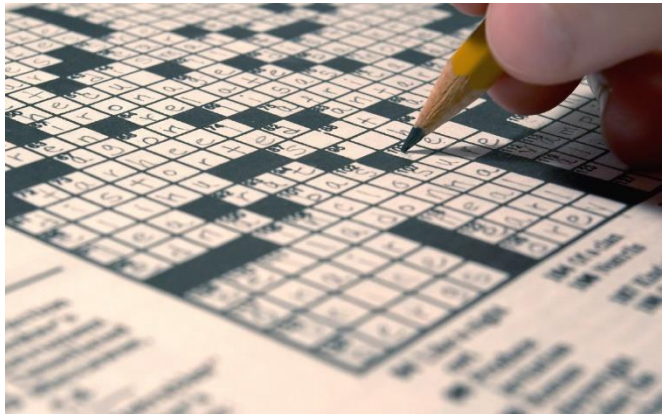
Environment Types (Fully/Partially Observable)

- **Fully observable**
  - If an agent's sensors give it access to the complete state of the environment at each point in time
- **Partially observable**
  - Noisy and inaccurate sensors, or
  - Parts of the state are missing from the sensor data
    - e.g. A vacuum cleaner agent with a local dirt sensor
- **Unobservable**
  - No sensors

Environment Types

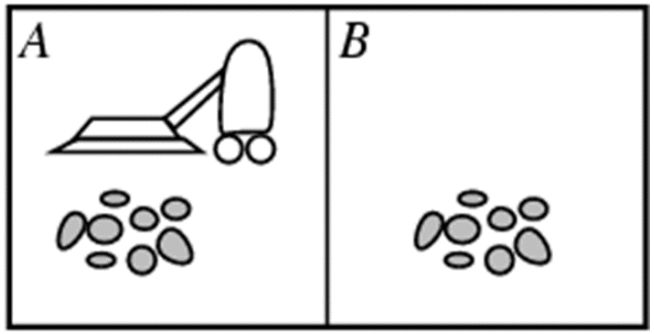
- **Deterministic (vs. stochastic):**
  - The next state of the environment is completely determined by the current state and the action executed by the agent.
  - An environment is stochastic if probability is involved

    e.g. Game with dice, such as Backgammon
  - If the environment is deterministic except for the actions of other agents, then the environment is strategic (such as playing chess)



Environment Types (Episodic vs. Sequential)

- **Episodic**
  - The agent's experience is divided into atomic "episodes"
  - In each episode: the agent receives a percept, and then performs a single action
  - The next episode does not depend on the actions taken in previous episodes
  - e.g. simple reflex vacuum cleaner, part-picking robot



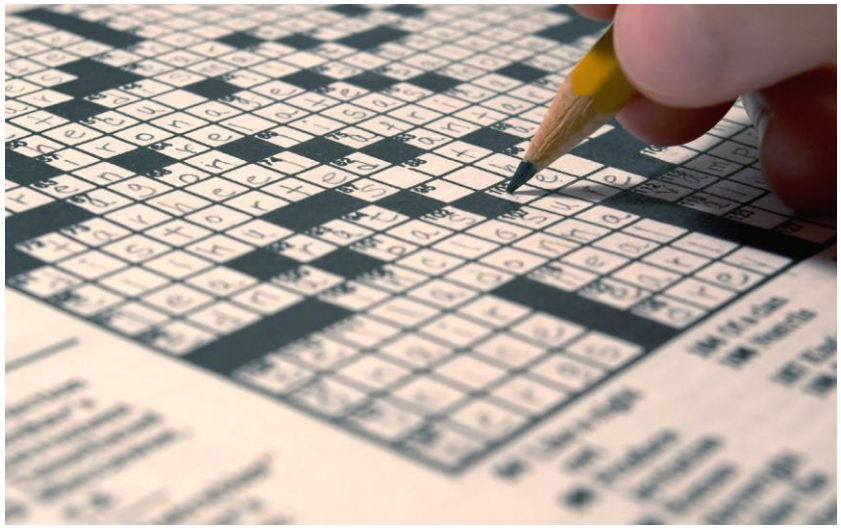
Environment Types (Episodic vs. Sequential)

- **Sequential**
  - The current decision could affect all future decisions
  - Chess and taxi driving

- Which is simpler, episodic or sequential?

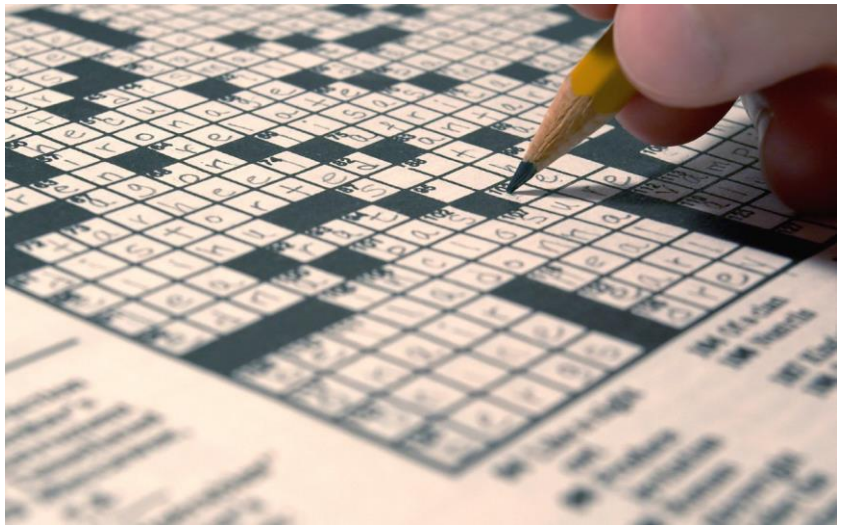
Environment Types

- **Single agent (vs. Multi-agent):**
  - An agent operating by itself in an environment.
  - Crossword puzzle vs. chess



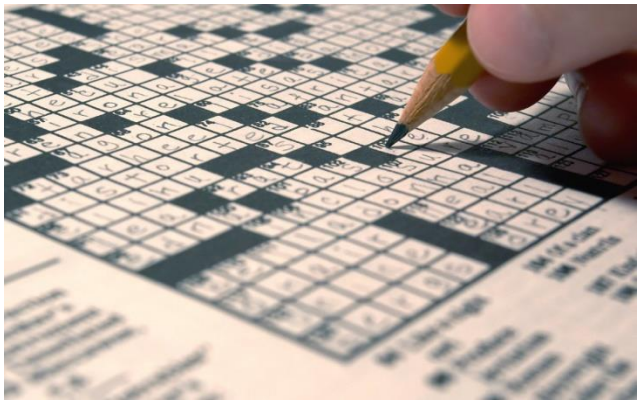
Environment Types

- **Single agent (vs. Multi-agent):**
  - Does the other agent interfere with my performance measure?
  - Examples?
  - Online bookshop, Auction



Environment Types (Static vs. Dynamic/Semidynamic)

- **Static**
  - The environment is unchanged with the passage of time while an agent is deliberating
- **Dynamic**
  - The environment changes with the passage of time



Crossword puzzles?

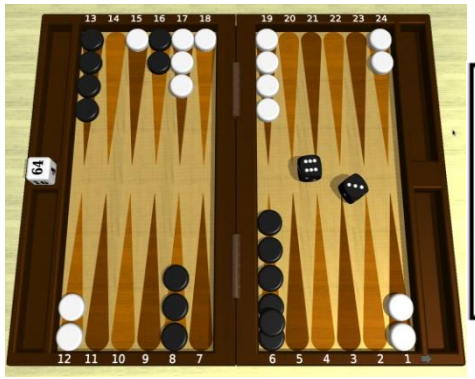
Taxi driving?

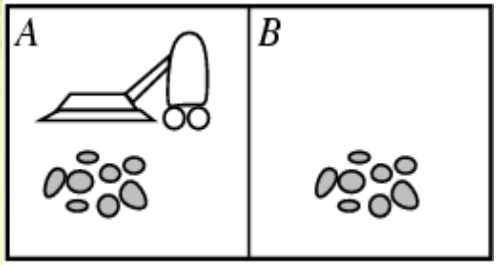
Environment Types (Static vs. Dynamic/Semidynamic)

- **Semidynamic**
  - The environment itself does not change with the passage of time but the agent's performance score does
  - Chess (when played with a clock)

Environment Types

- **Discrete (vs. continuous):**
  - States of the environment
  - Percepts and Actions of the agent
  - Limited number, distinct, clearly defined
  - Chess vs. taxi driving (infinite: speed and location are continuous values)





	Medical Diagnosis	Chess with a clock	Backgammon	Taxi driving	Vacuum Cleaner (no memory)
Observable?					
Deterministic?					
Episodic?					
Static?					
Discrete?					
Single-agent?					

Environment Types

- The simplest environment is
  - Fully observable, deterministic, episodic, static, discrete and single-agent.
- Most real situations are
  - partially observable, stochastic, sequential, dynamic, continuous, multi-agent.

The Structure of Agents

- *agent* = *architecture* + *program*
  - Architecture: computing devices with physical sensors and actuators
  - Agent program: implements the agent function
    - the mapping from percepts to actions

The Structure of Agents

- Relation between the architecture and the program
  - The architecture makes the percepts from the sensors available to the program and runs the program
  - The program output an action choice
  - The architecture feeds the program's action choice to the actuators

- The program has to be appropriate for the architecture
  - If the architecture does not have legs, then the program should not recommend actions like Walk

Example

- Every agent function is implementable by some architecture/program combination.

  a) True, b) False

  Answer: b) False. Consider

  - An agent who perceives a bit each turn, and
  - the agent function is to return an integer that matches the value of the entire bit string perceived so far.
  - The agent gains a point of reward if the integer returned is correct.

  Eventually, any agent program will fail because it will run out of memory.

Summary

- **Agent:** perceives and acts in an environment
- **Agent function**: maps percept sequence to actions
- **Agent program**: implements the agent function
- **Performance measure**: defines the criterion of success for an agent

Summary

- **Rational agent**: can select actions to maximize the performance measure, given the agent's capabilities, built-in (prior) knowledge about the environment, and percept sequence

- **Task environment specification** – **PEAS** **(P**erformance measure**, E**nvironment, **A**ctuators, **S**ensors**)**

- **Types of environment**

- **The structure of an agent:** architecture + program