Rational Agents (Chapter 2)
Outline

• Agent function and agent program
• Rationality
• PEAS (Performance measure, Environment, Actuators, Sensors)
• Environment types
• Agent types
Agents

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.
Agent function

• The agent function maps from percept histories to actions

• The agent program runs on the physical architecture to produce the agent function

• agent = architecture + program
Vacuum-cleaner world

- **Percepts:**
  Location and status,
  e.g., [A,Dirty]

- **Actions:**
  Left, Right, Suck, NoOp

Example vacuum agent program:

```python
function Vacuum-Agent([[location, status]]) returns an action

• if status = Dirty then return Suck
• else if location = A then return Right
• else if location = B then return Left
```
Rational agents

• For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and the agent’s built-in knowledge.

• Performance measure (utility function): An objective criterion for success of an agent's behavior.

• Can a rational agent make mistakes?
Back to vacuum-cleaner world

- **Percepts:**
  - Location and status,
  - e.g., [A, Dirty]

- **Actions:**
  - Left, Right, Suck, NoOp

**function Vacuum-Agent**([location, status]) returns an action

- *if* status = Dirty *then* return Suck
- *else if* location = A *then* return Right
- *else if* location = B *then* return Left

- Is this agent rational?
  - Depends on performance measure, environment properties
Specifying the task environment

- Problem specification: **Performance measure, Environment, Actuators, Sensors (PEAS)**

- **Example: automated taxi driver**
  - **Performance measure**
    - Safe, fast, legal, comfortable trip, maximize profits
  - **Environment**
    - Roads, other traffic, pedestrians, customers
  - **Actuators**
    - Steering wheel, accelerator, brake, signal, horn
  - **Sensors**
    - Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard
Agent: Spam filter

• Performance measure
  – Minimizing false positives, false negatives

• Environment
  – A user’s email account, email server

• Actuators
  – Mark as spam, delete, etc.

• Sensors
  – Incoming messages, other information about user’s account
Environment types

• **Fully observable (vs. partially observable):** The agent's sensors give it access to the complete state of the environment at each point in time

• **Deterministic (vs. stochastic):** The next state of the environment is completely determined by the current state and the agent’s action
  – **Strategic:** the environment is deterministic except for the actions of other agents

• **Episodic (vs. sequential):** The agent's experience is divided into atomic “episodes,” and the choice of action in each episode depends only on the episode itself
Environment types

• **Static (vs. dynamic):** The environment is unchanged while an agent is deliberating
  – **Semidynamic:** the environment does not change with the passage of time, but the agent's performance score does

• **Discrete (vs. continuous):** The environment provides a fixed number of distinct percepts, actions, and environment states
  – Time can also evolve in a discrete or continuous fashion

• **Single agent (vs. multi-agent):** An agent operating by itself in an environment

• **Known (vs. unknown):** The agent knows the rules of the environment
### Examples of different environments

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<th>Observable</th>
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<th>Episodic</th>
<th>Static</th>
<th>Discrete</th>
<th>Single agent</th>
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- **Word jumble solver**
- **Chess with a clock**
- **Scrabble**
- **Taxi driving**
Hierarchy of agent types

- Simple reflex agents
- Model-based reflex agents
- Goal-based agents
- Utility-based agents
Simple reflex agent

• Select action on the basis of current percept, ignoring all past percepts
Model-based reflex agent

- Maintains internal state that keeps track of aspects of the environment that cannot be currently observed
Goal-based agent

- The agent uses goal information to select between possible actions in the current state
Utility-based agent

- The agent uses a utility function to evaluate the desirability of states that could result from each possible action.
Where does learning come in?