Intelligent Agents

Chapter 2

Reminders

Assignment 0 (lisp refresher) due 1/28
Lisp/emacs/AIMA tutorial: 11-1 today and Monday, 271 Soda

Outline

Agents and environments
Rationality
PEAS (Performance measure, Environment, Actuators, Sensors)
Environment types
Agent types

Agents and environments

Agents include humans, robots, softbots, thermostats, etc.
The agent function maps from percept histories to actions:
\( f : \mathcal{P}^x \rightarrow A \)
The agent program runs on the physical architecture to produce \( f \)

Vacuum-cleaner world

Percepts: location and contents, e.g., \([A, Dirty]\)
Actions: Left, Right, Suck, NoOp

A vacuum-cleaner agent

<table>
<thead>
<tr>
<th>Percept sequence</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>([A, Clean])</td>
<td>Right</td>
</tr>
<tr>
<td>([A, Dirty])</td>
<td>Suck</td>
</tr>
<tr>
<td>([B, Clean])</td>
<td>Left</td>
</tr>
<tr>
<td>([B, Dirty])</td>
<td>Suck</td>
</tr>
<tr>
<td>([A, Clean], [A, Clean])</td>
<td>Right</td>
</tr>
<tr>
<td>([A, Clean], [A, Dirty])</td>
<td>Suck</td>
</tr>
<tr>
<td>|</td>
<td></td>
</tr>
</tbody>
</table>

function \textsc{reflex-vacuum-agent}(\text{location, status}) returns an action

\begin{align*}
\text{if } \text{status} = \text{Dirty} \text{ then return } & \text{Suck} \\
\text{else if } \text{location} = A \text{ then return } & \text{Right} \\
\text{else if } \text{location} = B \text{ then return } & \text{Left}
\end{align*}

What is the right function?
Can it be implemented in a small agent program?
Rationality

Fixed performance measure evaluates the environment sequence
- one point per square cleaned up in time $T$?
- one point per clean square per time step, minus one per move?
- penalize for $> k$ dirty squares?

A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date

Rational $\neq$ omniscient
- percepts may not supply all relevant information
Rational $\neq$ clairvoyant
- action outcomes may not be as expected
Hence, rational $\neq$ successful
Rational $\Rightarrow$ exploration, learning, autonomy

Internet shopping agent

Performance measure??
Environment??
Actuators??
Sensors??

PEAS

To design a rational agent, we must specify the task environment
Consider, e.g., the task of designing an automated taxi:

Performance measure??
Environment??
Actuators??
Sensors??

Environment types

<table>
<thead>
<tr>
<th>Observable??</th>
<th>Solitaire</th>
<th>Backgammon</th>
<th>Internet shopping</th>
<th>Taxi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic??</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Episodic??</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static??</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discrete??</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-agent??</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Internet shopping agent

Performance measure?? price, quality, appropriateness, efficiency
Environment?? current and future WWW sites, vendors, shippers
Actuators?? display to user, follow URL, fill in form
Sensors?? HTML pages (text, graphics, scripts)

PEAS

To design a rational agent, we must specify the task environment
Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .
Environment?? US streets/freeways, traffic, pedestrians, weather, . . .
Actuators?? steering, accelerator, brake, horn, speaker/display, . . .
Sensors?? video, accelerometers, gauges, engine sensors, keyboard, GPS, . . .
The environment type largely determines the agent design.

The real world is (of course) partially observable, stochastic, sequential, dynamic, continuous, multi-agent.
Agent types

Four basic types in order of increasing generality:
- simple reflex agents
- reflex agents with state
- goal-based agents
- utility-based agents

All these can be turned into learning agents
Utility-based agents

Agent

- State
- What the world evolves
- What my actions do
- Utility

Environment

- What the world is like now
- What it will be like if I do action A
- How happy I will be in such a state
- What action I should do now

Actuators

Learning agents

Agent

- Critic
- Problem generator

Environment

- Performance standard
- Sensors

Actuators

Summary

Agents interact with environments through actuators and sensors
The agent function describes what the agent does in all circumstances
The performance measure evaluates the environment sequence
A perfectly rational agent maximizes expected performance
Agent programs implement (some) agent functions
PEAS descriptions define task environments
Environments are categorized along several dimensions:
Several basic agent architectures exist:
  reflex, reflex with state, goal-based, utility-based