Intelligent Agents

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Announcements

- Read Chapter 3 in *AI: A Modern Approach* for next time
- Feel free to interrupt with questions!
- Office hours are posted on the website, and lecture slides will be added each day after class (PDF format)

What is an Agent?

An intelligent agent perceives its environment with *sensors* and acts rationally upon that environment with its *effectors*.

- Agents perform the reasoning (or *thinking*) task in our AI framework from last time… it consists of:
  - Percepts (input from sensors)
  - Actions (output with effectors)
  - Goals
  - Environment

Examples of Intelligent Agents

<table>
<thead>
<tr>
<th>Agent</th>
<th>Percepts</th>
<th>Actions</th>
<th>Goals</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALVINN</td>
<td>Images, Position</td>
<td>Steering, Control speed</td>
<td>Drive from A to B</td>
<td>Roads, Vehicles, Hazards</td>
</tr>
<tr>
<td>Google engine</td>
<td>Web pages, Search queries</td>
<td>Navigate web, Gather info</td>
<td>Find best search matches</td>
<td>Internet</td>
</tr>
<tr>
<td>Deep Blue</td>
<td>Current board state</td>
<td>Choose next move</td>
<td>Win the game?</td>
<td>Opponent, Game board</td>
</tr>
<tr>
<td>Financial Forecaster</td>
<td>Stock market data</td>
<td>Pick stocks to buy &amp; sell</td>
<td>Maximize investments</td>
<td>Stock market, company reports</td>
</tr>
<tr>
<td>Medical Diagnostic</td>
<td>Symptoms, Test results</td>
<td>Tests, Treatments</td>
<td>Healthy patient</td>
<td>Patient, Hospital</td>
</tr>
</tbody>
</table>

Agent Architecture

Well, maybe!
Agent Program

*Agents map percepts to actions*

- Basic cycle
  - Perceive
  - Reason, decide, or think
  - Act
  - Repeat

Another Definition

- An agent is a computer software system whose main characteristics are:
  - Situatedness
  - Autonomy
  - Adaptivity
  - Sociability

Features of Agents

- Situatedness
  - Emphasizes the agent’s direct connection to its environment through some set of sensors (percepts) and effectors (actions)

Features of Agents

- Autonomy
  - The agent acts without direct intervention by humans or other agents; it has control over its own actions and internal state
  - Some aspect of the current situation must trigger a response (preprogramming to know when and how to respond doesn’t count)

Features of Agents

- Adaptivity
  - React flexibly to changes in its environment
  - Take goal-directed initiatives
  - Learn from its own experience, its environment, and its interactions with others (be they people or other agents)

Features of Agents

- Sociability
  - The agent is capable of interacting in a peer-to-peer manner with humans or other agents
How should an Agent Act?

★ A rational agent does the right thing!

■ A performance measure is needed say how successful a task has been achieved

■ Rational agents try to maximize success

How should an Agent Act?

■ An ideal rational agent should, for each possible sequence of perceptions, do whatever action(s) will maximize its performance measure based on:
  – The percepts
  – Its built knowledge
  – Acquired knowledge

Types of Agent Programs

■ There are several kinds of agent programs which try to meet these conditions:
  – Lookup table
  – Simple reflex agent
  – Model-based reflex agent
  – Goal-based agent
  – Utility-based agent

Lookup Table

■ Map percepts to actions \textit{explicitly}
  – For interesting problems, the table would be too big to generate and store
  – Not adaptive to changes in the environment; \textit{entire} table must be updated
  – Matches only the current percept… doesn’t track its history

Simple Reflex Agent

■ Use \textit{if-then rules} to match certain percepts to an action
  – No need to consider all percepts
  – Can generalize percepts by mapping them to the same action
  – Can adapt to changes in the environment by adding new rules
  – Reacts only the current percept… \textit{still} doesn’t track its history

Model-Based Reflex Agent

■ Internally encode state (maintain a model) of the world based on past percepts and prior knowledge
  – Actions can be based on a sequence of percepts; knowledge of non-perceptual world state
  – Must be able to represent change in the world; could represent just current state but this limits reasoning ability
Goal-Based Agent

- Actions chosen to reach a *desired goal*
  - Goals help decide which actions are good
  - Proactive rather than reactive
  - May have to consider long sequences of possible actions before deciding if goal is achieved: “what will happen if I do this…?”
  - Doesn’t allow for *degrees of goodness*

Utility-Based Agent

- Choose which alternative is *best*
  - Utility function gives a measure of success or goodness for a given state
  - Allows decisions comparing choice between conflicting goals, and choice between likelihood of success and importance of goal (if achievement is uncertain)

Agent Architecture Example

- Real World
  - Sensors
  - Effectors
- Agent
  - Model of World (being updated)
  - Prior Knowledge
  - Reasoning
  - Possible Actions
  - Goals/Utility

Features of Environments

- Is the world fully or partially observable?
- An environment is fully observable if the agent is provided with full knowledge about the state of the world

Features of Environments

- Is the world deterministic or stochastic?
- An environment is deterministic if the next state of the world is completely determined by the current state and the agent’s actions
- Randomness and chance cause stochastic environments

Features of Environments

- Is the world episodic or sequential?
- An environment is episodic if each percept-action episode does not depend on the actions in prior episodes
  - e.g. Picking defective parts off an assembly line
- Driving a car or playing a game are sequential: short-term actions have long-term consequences
Features of Environments

- Is the world static or dynamic?
- An environment is static if it doesn’t change between the time of perceiving and acting
- Time is an important factor in dynamic environments, since percepts are time-sensitive and can become obsolete

Features of Environments

- Is the world discrete or continuous?
- An environment is discrete if there are a limited number of distinct, clearly-defined percepts and actions

Features of Environments

- Is the world single agent or multi-agent?
- Solving a crossword puzzle is clearly a single agent environment
- Playing chess, driving a car, working with other robots to assemble a product are all multi-agent
  - Some competitive and some cooperative multi-agent environments

Features of Environments

- Let’s think about the features for these environments:
  1. Chess
  2. Poker
  3. Driving a taxi
  4. Classifying web pages
  5. Reading addresses on mail envelopes

Environments

- In practice there is often uncertainty due to partially observable, stochastic, and dynamic environments
- In AI, we commonly use *toy environments*, which approximate the world but with simpler states and actions

Summary

- An agent perceives and acts in an environment to achieve specific goals.
- Types of agents
  - Lookup table
  - Simple reflex agent
  - Model-based reflex agent
  - Goal-based
  - Utility-based
Summary

- Features of Environments
  - Fully vs. partially observable
  - Deterministic vs. stochastic
  - Episodic vs. sequential
  - Static vs. dynamic
  - Discrete vs. continuous
  - Single vs. multi-agent