Intelligent Agents

Chapter 2
ICS 171, Fall 2009
Discussion

• Why is the Chinese room argument impractical and how would we have to change the Turing test so that it is not subject to this criticism?

• Godel’s theorem assures us that humans will always be superior to machines.

• A robot/agent can never be aware of itself (be self-conscious).
Agents

• An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators

   Human agent:
   eyes, ears, and other organs for sensors;
   hands, legs, mouth, and other body parts for actuators

• Robotic agent:
   cameras and infrared range finders for sensors;
   various motors for actuators
Agents and environments

• The agent function maps from percept histories to actions:

\[ f: \mathcal{P}^* \rightarrow \mathcal{A} \]

• The agent program runs on the physical architecture to produce \( f \)

• agent = architecture + program
Vacuum-cleaner world

Percepts: location and state of the environment, e.g., [A, Dirty], [B, Clean]

Actions: Left, Right, Suck, NoOp
Rational agents

- **Rational Agent**: For each possible percept sequence, a rational agent should select an action that is *expected* to maximize its *performance measure*, based on the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

- **Performance measure**: An objective criterion for success of an agent's behavior

- **E.g.,** performance measure of a vacuum-cleaner agent could be amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated, etc.
Rational agents

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

- Agents can perform actions in order to modify future percepts so as to obtain useful information (information gathering, exploration)

- An agent is **autonomous** if its behavior is determined by its own percepts & experience (with ability to learn and adapt) without depending solely on build-in knowledge
Task Environment

- Before we design an intelligent agent, we must specify its “task environment”:

**PEAS:**

Performance measure
Environment
Actuators
Sensors
PEAS

• Example: Agent = 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
PEAS

- **Example:** Agent = Medical diagnosis system

  **Performance measure:** Healthy patient, minimize costs, lawsuits

  **Environment:** Patient, hospital, staff

  **Actuators:** Screen display (questions, tests, diagnoses, treatments, referrals)

  **Sensors:** Keyboard (entry of symptoms, findings, patient's answers)
PEAS

• Example: Agent = Part-picking robot

• **Performance measure**: Percentage of parts in correct bins

• **Environment**: Conveyor belt with parts, bins

• **Actuators**: Jointed arm and hand

• **Sensors**: Camera, joint angle sensors
Environment types

- **Fully observable** (vs. partially observable): An 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 action executed by the agent. (If the environment is deterministic except for the actions of other agents, then the environment is strategic)

- **Episodic** (vs. sequential): An agent’s action is divided into atomic episodes. Decisions do not depend on previous decisions/actions.
Environment types

- **Static (vs. dynamic)**: The environment is unchanged while an agent is deliberating. (The environment is *semidynamic* if the environment itself does not change with the passage of time but the agent's performance score does)

- **Discrete (vs. continuous)**: A limited number of distinct, clearly defined percepts and actions. How do we *represent* or *abstract* or *model* the world?

- **Single agent (vs. multi-agent)**: An agent operating by itself in an environment. Does the other agent interfere with my performance measure?
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<th>determ./stochastic</th>
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Agent types

- Five basic types in order of increasing generality:
  - Table Driven agents
  - Simple reflex agents
  - Model-based reflex agents
  - Goal-based agents
  - Utility-based agents
Table Driven Agent.

- Current state of decision process
- Table lookup for entire history

Impractical
Simple reflex agents

NO MEMORY
Fails if environment is partially observable

example: vacuum cleaner world
Model-based reflex agents

Model the state of the world by:
- modeling how the world changes
- how it’s actions change the world

- This can work even with partial information
- It’s is unclear what to do without a clear goal
Goal-based agents

Goals provide reason to prefer one action over the other. We need to predict the future: we need to plan & search.
Utility-based agents

Some solutions to goal states are better than others. Which one is best is given by a utility function. Which combination of goals is preferred?
Learning agents

How does an agent improve over time?
By monitoring its performance and suggesting better modeling, new action rules, etc.
True or False?

a.(2 pts) The task environment of a taxi-driving agent is episodic.

a.(5 pts) True/False: A rational agent will always achieve its goal.

1.(2 pts) **Chess Agents** Consider two intelligent agents playing chess with a clock. One of them is called “Deep Blue”, while the other is called Gary Kasparov.

a.(1 pt) Roughly specify the task environment for Deep Blue. (This means specify each letter in “PEAS”).

b.(1 pt) Determine each of the following properties of this task environment:
   a) fully observable or partially observable, b) deterministic or stochastic, c) episodic or sequential, d) static, dynamic, or semidynamic e) discrete or continuous, f) single agent or multi-agent. Explain your answer.
3) [20pts] Consider an AI-system playing mastermind (see 1. for an explanation).

a) Specify the task environment:
   [2pts] → Performance function
   [2pts] → Environment
   [2pts] → Actuators
   [2pts] → Sensors

b) Is this task environment: (explain your answer)
   [2pts] → Fully observable or partially observable:
   [2pts] → Deterministic, stochastic or strategic
   [2pts] → Sequential or episodic
   [2pts] → Static, dynamic or semidynamic
   [2pts] → Discrete or continuous
   [2pts] → Single agent or multi-agent