Intelligent Agents

Chapter 2
ICS 279 Fall 09
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
Discussion Items

• An realistic agent has finite amount of computation and memory available. Assume an agent is killed because it did not have enough computation resources to calculate some rare eventually that ended up killing it. Can this agent still be rational?

• The Turing test was contested by Searle by using the “Chinese Room” argument. The Chinese Room agent needs an exponential large memory to work. Can we “save” the Turing test from the Chinese Room argument?
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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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

What the world is like now

What action I should do now

Agent

Sensors

Environment

Actuators
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 chances
- 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 it’s performance and suggesting better modeling, new action rules, etc.

Evaluates current world state changes action rules suggests explorations

“old agent”= model world and decide on actions to be taken