Lecture 2
Agents & Environments
(Chap. 2)

Outline

• Agents and environments
• Rationality
• PEAS specification
• Environment types
• Agent types
• Pac-Man projects
Agents

• An agent is any entity that can perceive its environment through sensors and act upon that environment through actuators

• Human agent:
  Sensors: Eyes, ears, and other organs
  Actuators: Hands, legs, mouth, etc.

• Robotic agent:
  Sensors: Cameras, laser range finders, etc.
  Actuators: Motorized limbs, wheels, etc.

Other Types of Agents

• Immobots (Immobile Robots)
  Intelligent buildings
  Intelligent forests

• Softbots
  Askjeeves.com (now Ask.com)
  Expert Systems
  Microsoft Clippy
Intelligent Agents

- Have sensors and actuators (effectors)
- Implement mapping from percept sequence to actions
- Maximize a Performance Measure

Performance Measures

- Performance measure = An objective criterion for success of an agent's behavior
- E.g., vacuum cleaner agent performance measure:
  - amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated, etc.
Rational Agent

“For each possible percept sequence, does *whatever action maximizes expected performance* on the basis of evidence perceived so far and built-in prior knowledge.”

Autonomy

A rational agent is autonomous if it can *learn to compensate* for partial or incorrect prior knowledge

*Why is this important?*
Task Environments

• The “task environment” for an agent is comprised of PEAS
  (Performance measure, Environment, Actuators, Sensors)

• E.g., Consider the task of designing an automated taxi driver:
  Performance measure = ?
  Environment = ?
  Actuators = ?
  Sensors = ?

PEAS

• PEAS for 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
PEAS

- **PEAS for 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)

Properties of Environments

- **Observability: full vs. partial**
  - Sensors detect all aspects of state of environment relevant to choice of action?

- **Deterministic vs. stochastic**
  - Next state completely determined by current state and action?

- **Episodic vs. sequential**
  - Current action independent of previous actions?

- **Static vs. dynamic**
  - Can environment change over time?

- **Discrete vs. continuous**
  - State of environment, time, percepts, and actions discrete or continuous-valued?

- **Single vs. multiagent**
Fully observable vs. Partially observable

Can the agent observe the complete state of the environment?

Single agent vs. Multiagent

Is the agent the only thing acting in the world?
Deterministic vs. Stochastic

Is there uncertainty in how the world works?

Episodic vs. Sequential

Does the agent take more than one action?
Discrete vs. Continuous

Are the states, actions etc. discrete or continuous?

Agent Functions and Agent Programs

- An agent’s behavior can be described by an agent function mapping percept sequences to actions taken by the agent
- An implementation of an agent function running on the agent architecture (e.g., a robot) is called an agent program
- Our goal: Develop concise agent programs for implementing rational agents
Implementing Rational Agents

- Table lookup based on percept sequences
  - Infeasible
- Agent programs:
  - Simple reflex agents
  - Agents with memory
    - Reflex agent with internal state
    - Goal-based agents
    - Utility-based agents

Simple Reflex Agents

AGENT

Sensors

Percept

Condition-Action rules

what action should I do now?

Effectors

ENVIRONMENT
Simple Reflex Agents

Famous Reflex Agents
Reflex Agent with Internal State

ENVIRONMENT

AGENT

Sensors

Estimate of world state

Condition-Action rules

what action should I do now?

What my actions do

How world evolves

state

Effectors

Goal-Based Agents

ENVIRONMENT

AGENT

Sensors

Estimate of world state

Goals

what it’ll be like if I do action A

what action should I do now?

What my actions do

How world evolves

state

Effectors
Utility-Based Agents

Agent

- Effectors

- Sensors

- Utility function

Environment

- How world evolves
- What my actions do
- Estimate of world state
- What it’ll be like if I do action A
- How happy would I be in such a state?
- What action should I do now?

While driving, what’s the best policy?

- Always stop at a stop sign
- Never stop at a stop sign
- Look around for other cars and stop only if you see one approaching
- Look around for a cop and stop only if you see one

What kind of agent are you?
- reflex, goal-based, utility-based?
Pac-Man as an Agent

The CSE 473 Pac-Man Projects

Originality developed at UC Berkeley:
http://www-inst.eecs.berkeley.edu/~cs188/pacman/pacman.html
Project 1: Search

Goal:
• Help Pac-man find its way through the maze

Techniques:
• Search: breadth-first, depth-first, etc.
• Heuristic Search: Best-first, A*, etc.

Project 2: Game Playing

Goal: Build a rational Pac-Man agent!

Techniques: Adversarial Search: minimax, alpha-beta, expectimax, etc.
Project 3: Planning and Learning

Goal:
Help Pac-Man learn about its world

Techniques:
• Planning: MDPs, Value Iteration
• Learning: Reinforcement Learning

Project 4: Ghostbusters

Goal:
Help Pac-man hunt down the ghosts

Techniques:
• Probabilistic models: HMMs, Bayes Nets
• Inference: State estimation and particle filtering
To Do

• Project 0: Python tutorial

• Finish chapters 1 and 2; start chapter 3