Chapter 2
Agents & Environments

Outline

• Agents and environments
• Rationality
• PEAS specification
• Environment types
• Agent types
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.

Types of Agents

• Immobots (Immobile Robots)
  Intelligent buildings
  Intelligent forests
  Autonomous spacecraft

• Softbots
  Jango (early softbot for shopping)
  Microsoft Clippy
  Askjeeves.com (now Ask.com)
  Expert Systems
    • Cardiologist
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 is expected to maximize its performance measure on the basis of evidence perceived so far and built-in knowledge.”

- Rationality vs. omniscience
  - Rationality maximizes expected performance
  - Omniscience maximizes actual performance (but impossible to achieve in reality)
- Need to use information gathering actions and learning

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
Properties of Environments

- Observability: full vs. partial
- Deterministic vs. stochastic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single vs. multiagent

- Chess
- Poker
- Coffee delivery mobile robot

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
Example

Vacuum-cleaner world

Percepts: location and contents, e.g., [A, Dirty]

Actions: Left, Right, Suck, NoOp

Example: vacuum world state space graph

How should the agent be designed if...

• It has location and dirt sensors, but no internal state?
• It has no sensors, but knows the starting state?
• It has no sensors, and does not know the starting state?
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

Environments

Sensors

Percept

Condition-Action rules

what action should I do now?

Effectors
Simple Reflex Agents

Reflex Agent with Internal State

AGENT

- Condition-Action rules
- What my actions do
- How world evolves
- what world is like now
- what action should I do now?

ENVIRONMENT

- Sensors
- Effectors
- state
Goal-Based Agents

- **Environment**
  - Sensors
  - How world evolves
  - What my actions do

- **Agent**
  - Goals
  - State
  - What world is like now
  - What it’ll be like if I do action A
  - What action should I do now?

Utility-Based Agents

- **Environment**
  - Sensors
  - How world evolves
  - What my actions do
  - Utility function

- **Agent**
  - Goals
  - State
  - What world is like now
  - 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?