CS 3011: Artificial Intelligence

Introduction

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Agents

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators
- The human agent has:
  - Eyes, ears, and other organs for sensors
  - Hands, legs, mouth, and other body parts for actuators
- A robotic agent has:
  - Cameras and infrared range finders for sensors
  - Various motors for actuators.
- A software agent
  - Receives file contents, network packets, and human input (keyboard/mouse /touchscreen/voice) as sensory inputs
  - Acts on the environment by writing files, sending network packets, and displaying information or generating sounds

Agent

Sensors

?

Actuators

Percepts

Actions

Environment
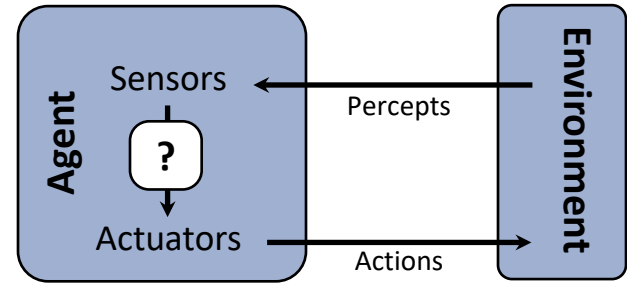
Key terms

- Percept vs Percept sequence:
  - **Percept** refers to the content an agent's sensors are perceiving at any given instant.
  - An agent's **percept sequence** is the complete history of everything the agent has ever perceived.
  - In general, an agent's choice of action at any given instant can depend on its built-in knowledge and on the entire percept sequence observed to date, but not on anything it hasn't perceived.

- Agent function vs Agent Program:
  - An agent's behavior is described by the **agent function** that maps any given percept sequence to an action.
  - The **agent function** for an artificial agent will be implemented by an **agent program**.

Vacuum-cleaner Agent

- ## The vacuum-cleaner World
    - Has just two locations: squares A and B

- ## The vacuum agent
    - Perceives which square it is in and whether there is dirt in the square
    - Can choose to move left, move right, suck the dirt or do nothing

- ## The agent function
    - If the current square is dirty, then suck; otherwise move to the other square
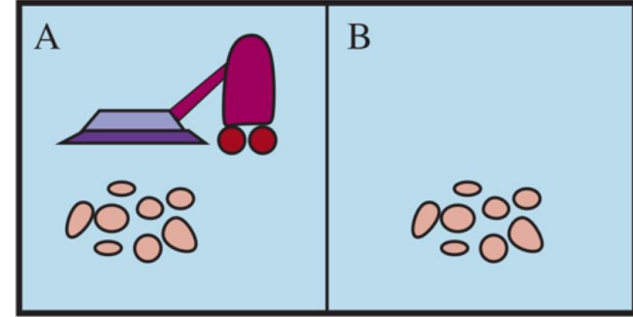
Vacuum-cleaner Agent…

- Percepts: *location* and *contents*, e.g., [A,Dirty]
- Actions: *Left, Right, Suck*
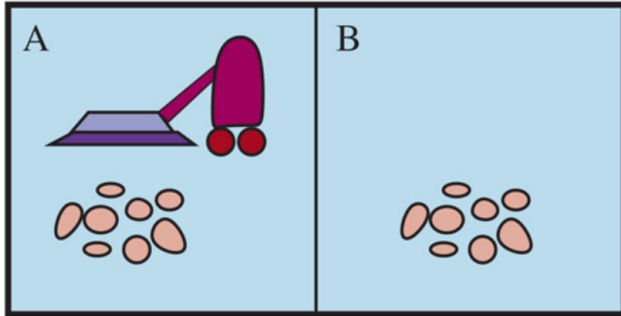
Percept sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
[A, Clean], [A, Clean]	Right
[A, Clean], [A, Dirty]	Suck
⋮	⋮
[A, Clean], [A, Clean], [A, Clean]	Right
[A, Clean], [A, Clean], [A, Dirty]	Suck
⋮	⋮

Rationality – Performance Measure

- An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform
- The right action is the one that will cause the agent to be most successful
- 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.
- It is better to design performance measures according to what one wants in the environment. Rather than according to how one thinks the agent should behave.

Rationality

- What is rational at any given time depends on four things:
  - The performance measure that defines the criterion of success.
  - The agent's prior knowledge of the environment.
  - The actions that the agent can perform.
  - The agent's percept sequence to date.

  This leads to a **definition of a rational agent**: ....

Rationality…

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

Rationality…

- Let us assume the following for the simple vacuum-cleaner agent:
  - **Performance measure:** awards one point for each clean square at each time step, over a "lifetime" of 1000-time steps
  - **Prior Knowledge:** the agent knows the environment, but it does not know the dirt distribution.
  - **Agent actions:** available actions are Left, Right, and Suck
  - **Percept sequence:** The agent correctly perceives its location and whether that location contains dirt

  Is the vacuum-cleaner agent a rational agent?
  - Under these circumstances the agent is indeed rational; its expected performance is at least as good as any other agent's.

Rationality…

- One can see easily that the same agent would be irrational under different circumstances.

  What will the agent do after all dirt is cleaned up?
  - The agent will oscillate needlessly back and forth; if the performance measure includes a penalty of one point for each movement, the agent will fare poorly.
  - A better agent for this case would do nothing once it is sure that all the squares are clean. If clean squares can become dirty again, the agent should occasionally check and re-clean them if needed.

Specifying the Task Environment

- In designing an agent, the first step must be to specify the task environments.

- The task environment is specified using four parameters:
  - Performance
  - Environment
  - Actuators
  - Sensors

- These four parameters are called as PEAS (**P**erformance, **E**nvironment, **A**ctuator, **S**ensor).

PEAS

- Agent: an 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

- Agent: Spam filter
  - Performance measure: Minimizing false positives, Minimizing false negatives
  - Environment: A user's email account, email server
  - Actuators: Mark as spam, delete, etc.
  - Sensors: Incoming messages, other information about user's account

PEAS

- Agent: refinery controller
  - Performance measure: maximize purity, yield, safety
  - Environment: refinery, operators
  - Actuators: valves, pumps, heaters, displays
  - Sensors: temperature, pressure, chemical sensors

PEAS

- 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

- 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.

PEAS

- Agent: Interactive English tutor
  - Performance measure: Maximize student's score on test
  - Environment: Set of students
  - Actuators: Screen display (exercises, suggestions, corrections)
  - Sensors: Keyboard.