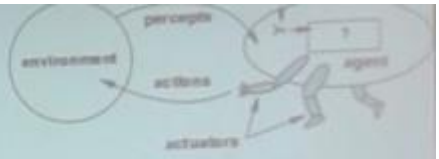
Agents

- An agent is anything that can be viewed as
  - **Sensors**: perceive environment
  - **Actuators**: act upon environment

- Samples of agents
  - Human agent
    - Sensors: eyes, ears, and other organs for sensors
    - Actuators: hands, legs, vocal tract, and other movable or changeable body parts
  - Robotic agent
    - Sensors: cameras and infrared range finders
    - Actuators: various motors
  - Software agents
    - Sensors: keystrokes, file contents, received network packages
    - Actuators: displays on the screen, files, sent network packets

Agents & environments



- Agent behavior can be described as an agent function that maps entire perception histories to actions:

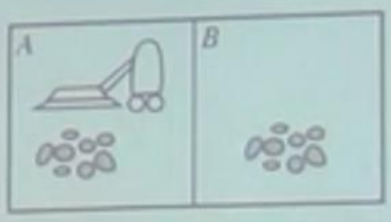
$$f: P^* \rightarrow A$$

Percept sequence to date — Action set

- The agent program runs on the physical architecture to produce f
  - Program is a concrete implementation of agent function
  - Architecture includes sensors, actuators, computing device

agent = architecture + program

Vacuum-cleaner world



- Percepts: location and dirt/clean status of its location
  - e.g., [A,Dirty]
- Actions: *Left*, *Right*, *Suck*, *NoOp*

A vacuum-cleaner agent

Tabulation of the agent function

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
...	...

Rational agents

- **"do the right thing"** based on the perception history and the actions it can perform.
- **Rational Agent**: 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.

Performance measure

- Evaluates the sequence of environment states
- Vacuum-cleaner agent: samples of performance measure
  - Amount of dirt cleaned up

Rational agents (vacuum cleaner example)

- Is this rational? If dirty then suck, otherwise move to the other square
  - Depends on
    - Performance measure, e.g., Penalty for energy consumption?
    - Environment, e.g., New dirt can appear?
    - Actuators, e.g., No-op action?
    - Sensors, e.g., Only sense dirt in its location?

Rationality vs. Omniscience

- Rationality is distinct from omniscience (all-knowing with infinite knowledge, impossible in reality)
- Doing actions in order to modify future percepts to obtain useful information
  - information gathering or exploration (important for rationality)
    - e.g., eyeballs and/or neck movement in human to see different directions

Autonomy

- An agent is autonomous if its behavior is determined by its own experience (with ability to learn and adapt)
  - Not just relies only on prior knowledge of designer
  - Learns to compensate for partial or incorrect prior knowledge
    - Benefit: changing environment
    - Starts by acting randomly or base on designer knowledge and then learns form experience
  - Rational agent should be autonomous

- Example: vacuum-cleaner agent
  - If dirty then suck, otherwise move to the other square
    - Does it yield an autonomous agent?
  - learning to foresee occurrence of dirt in squares

PEAS Samples…

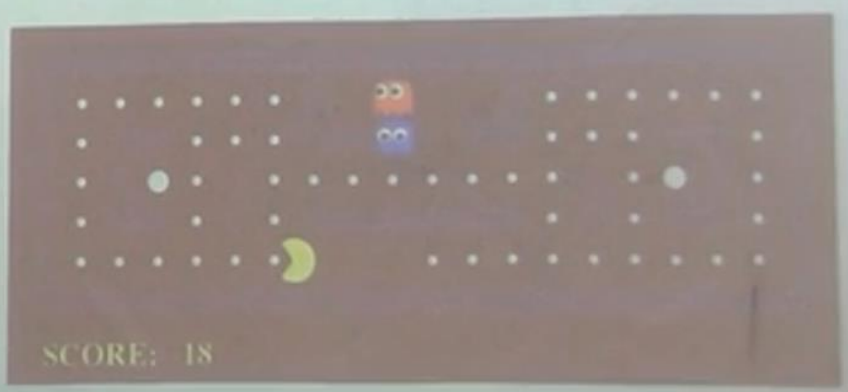
- Agent: Automated taxi driver
  - Performance measure: Safe, fast, legal, comfortable trip, maximize profits, …
  - Environment: Roads, other traffic, pedestrians, customers, …

PEAS Samples…

- Agent: Part picking robot
  - Performance measure: Percentage of parts in correct bins
  - Environment: Conveyor belt with parts, bins

PEAS Samples…

- Agent: Pacman



Environment types

- Fully observable (vs. partially observable): Sensors give access to the complete state of the environment at each time
  - Sensors detect all aspects relevant to the choice of action
  - Convenient (need not any internal state)
  - Noisy and inaccurate sensors or missing parts of the state from sensors cause partially observability

Environment types

- Deterministic (vs. stochastic): Next state can be completely determined by the current state and the executed action
  - If the environment is deterministic except for the actions of other agents, then the environment is strategic (we ignore this uncertainty)
  - Partially observable environment could appear to be stochastic.
  - Environment is uncertain if it is not fully observable or not deterministic

Environment types

- Single agent (vs. multi-agent):
  - Crossword puzzle is a single-agent game (chess is a multi-agent one)
  - Is B an agent or just an object in the environment?
    - B is an agent when its behavior can be described as maximizing a performance measure whose value depends on A's behavior.
  - Multi-agent: competitive, cooperative
    - Randomized behavior and communication can be rational
- Discrete (vs. continuous): A limited number of distinct, clearly defined states, percepts and actions, time steps
  - Chess has finite number of discrete states, and discrete set of percepts and actions while Taxi driving has continuous states, and actions

Environment types

- Episodic (vs. sequential): The agent's experience is divided into atomic "episodes" where the choice of action in each episode depends only on the episode itself.
  - E.g., spotting defective parts on an assembly line (independency)
  - In sequential environments, short-term actions can have long-term consequences
    - Episodic environment can be much simpler
- Static (vs. dynamic): The environment is unchanged while an agent is deliberating.
  - Semi-dynamic: if the environment itself does not change with the passage of time but the agent's performance score does.
  - Static (cross-word puzzles), dynamic (taxi driver), semi-dynamic (clock chess)

Pacman game

- Fully observable?
- Single-agent?
- Deterministic?
- Discrete?
- Episodic?
- Static?
- Known?