Intelligent Agents

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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

  Human Agent:
  eyes, ears, and other organs for sensors;
  hands, legs, mouth, and other body parts for actuators

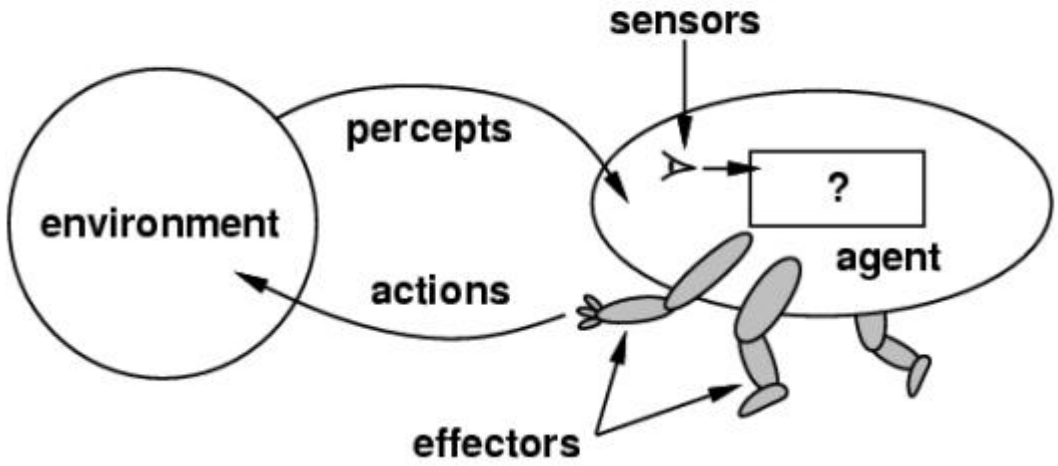
  Robotic Agent:
  cameras and infrared range finders for sensors;
  various motors for actuators;

How to design an intelligent agent?

- An **intelligent agent** perceives its environment via **sensors** and acts rationally upon that environment with its **effectors**.

- A discrete agent receives **percepts** one at a time, and maps this percept sequence to a sequence of discrete **actions**.

- Properties:
  - ❖ Autonomous
  - ❖ Reactive to the environment
  - ❖ Pro-active (goal-directed)
  - ❖ Interacts with other agents via the environment



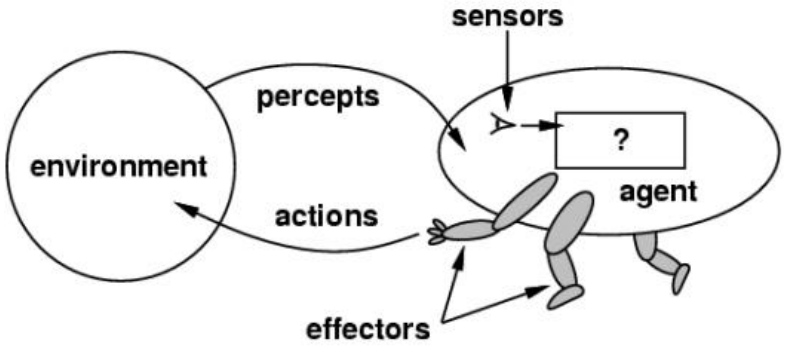
Agents and environments

- The agent function maps from percept histories to actions:

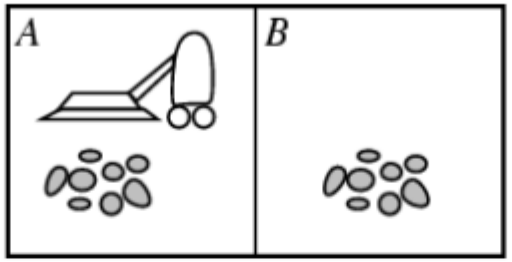
$$[f: \mathcal{P}^* \rightarrow \mathcal{A}]$$

- 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], [A,Clean], [B,Dirty]
- Actions: *Left*, *Right*, *Suck*, *NoOp*

Rational agents

- Performance measure: An objective criterion for success of an agent's behavior, e.g.,
  - Robot driver?
  - Chess-playing program?
  - Spam email classifier?

- Rational Agent: selects actions that is *expected* to maximize its performance measure,
  - given percept sequence
  - given agent's built-in knowledge

  - sidepoint: how to maximize expected future performance, given only historical data

Rational agents

- Rational Agent → Always try to maximize performance.
- No Agent is Omniscience. 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 built-in knowledge
- To survive, agents must have:
  - Enough built-in knowledge to survive.
  - The ability to learn

Task Environment

- Before we design an intelligent agent, we must specify its "task environment":

PEAS:
Performance measure
Environment
Actuators
Sensors

PEAS

- Example: Agent = robot driver in DARPA Challenge
  - Performance measure:
    - Time to complete course
  - Environment:
    - Roads, other traffic, obstacles
  - Actuators:
    - Steering wheel, accelerator, brake, signal, horn
  - Sensors:
    - Optical cameras, lasers, sonar, accelerometer, speedometer, GPS, odometer, engine 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
  - Deterministic environments can appear stochastic to an agent (e.g., when only partially observable)

- 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 discrete set of distinct, clearly defined percepts and actions.
  - How 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?

Some agent types

- **Table-driven agents**
  - use a percept sequence/action table in memory to find the next action. They are implemented by a (large) **lookup table**. It is not autonomous.
- **Simple reflex agents**
  - are based on **condition-action rules**, implemented with an appropriate production system. They are stateless devices which do not have memory of past world states. It can not save history.
- **Agents with memory**
  - have **internal state**, which is used to keep track of past states of the world.
- **Agents with goals**
  - are agents that, in addition to state information, have **goal information** that describes desirable situations. Agents of this kind take future events into consideration. **Never thinks about cost.**
- **Utility-based agents**
  - base their decisions on **classic axiomatic utility theory** in order to act rationally. **Always thinks about cost.**

Summary

- An **agent** perceives and acts in an environment, has an architecture, and is implemented by an agent program.
- An **ideal agent** always chooses the action which maximizes its expected performance, given its percept sequence so far.
- An **autonomous agent** uses its own experience rather than built-in knowledge of the environment by the designer.