Intelligent Agents

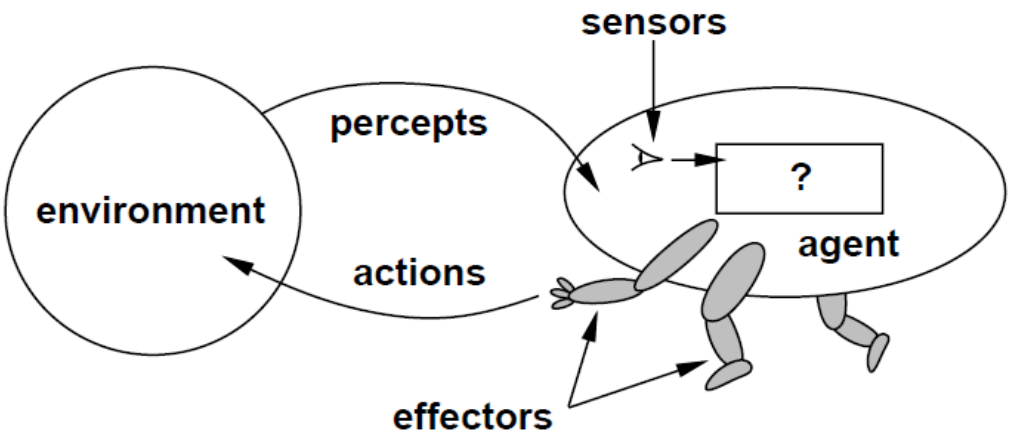
CZ3005: Artificial Intelligence

Shen Zhiqi

Outline

- What is an agent?
- What is a rational agent?
- How can one describe the task/problem for the agent?
- What are the properties of the task environment for the agent?
- What are the different basic kinds of agents for intelligent systems?

Agent



An agent is an entity that

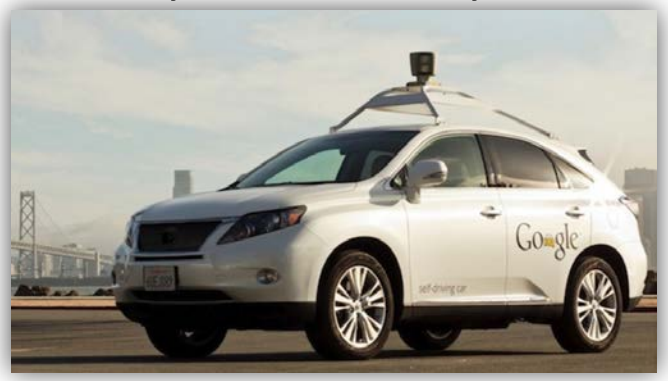
- Perceives through sensors (e.g. eyes, ears, cameras, infrared range sensors)
- Acts through effectors (e.g. hands, legs, motors)

Rational Agents

- A rational agent is one that does the right thing
- Rational action: action that maximizes the expected value of an objective performance measure given the percept sequence to date
- Rationality depends on
  - performance measure
  - everything that the agent has perceived so far
  - built-in knowledge about the environment
  - actions that can be performed

Example: Google X2: Driverless Taxi

- **Percepts:** video, speed, acceleration, engine status, GPS, radar, …
- **Actions:** steer, accelerate, brake, horn, display, …
- **Goals:** safety, reach destination, maximize profits, obey laws, passenger comfort,…
- **Environment:** Singapore urban streets, highways, traffic, pedestrians, weather, customers, …



Example: Medical Diagnosis System

- **Percepts**: symptoms, findings, patient's answers, …
- **Actions:** questions, medical tests, treatments,…
- **Goals:** healthy patient, faster recovery, minimize costs, …
- **Environment:** Patient, hospital, clinic, …

Autonomous Agents

- Do **not** rely entirely on built-in knowledge about the environment (i.e. not entirely pre-programmed)
- Otherwise,
  - The agent will **only** operates successfully when the built-in knowledge are all correct
- Adapt to the environments through experience

Example: Driverless Car

- Learn to drive in driving center
- Drive at NTU
- Drive on public roads
- Drive on highways
- Drive around City Hall

Agent Program

- A function that implements the agent mapping from percepts to actions

```
function SKELETON-AGENT(percept) returns action
   static: memory, the agent's memory of the world

   memory ← UPDATE-MEMORY(memory, percept)
   action ← CHOOSE-BEST-ACTION(memory)
   memory ← UPDATE-MEMORY(memory, action)
   return action
```

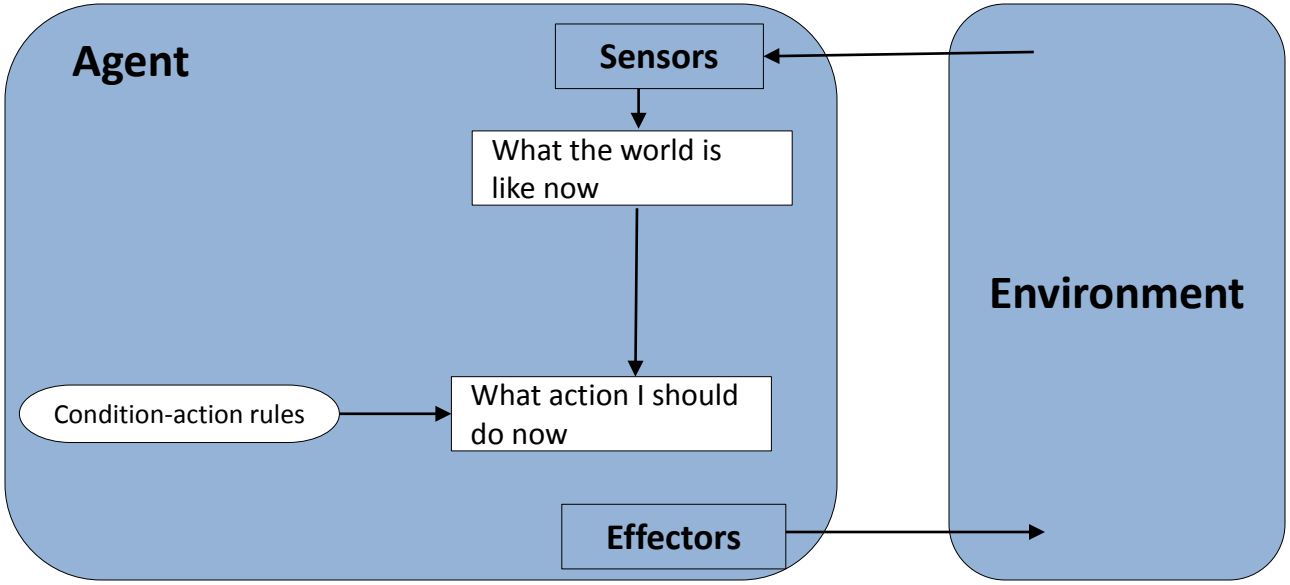
- Different types of agent programs are required to deal with different environment types effectively

Simple Reflex Agents

Example

If car-in-front-is-braking **then** initiate-braking

1. Find the rule whose condition matches the current situation (as defined by the percept)
2. Perform the action associated with that rule



Simple Reflex Agents...

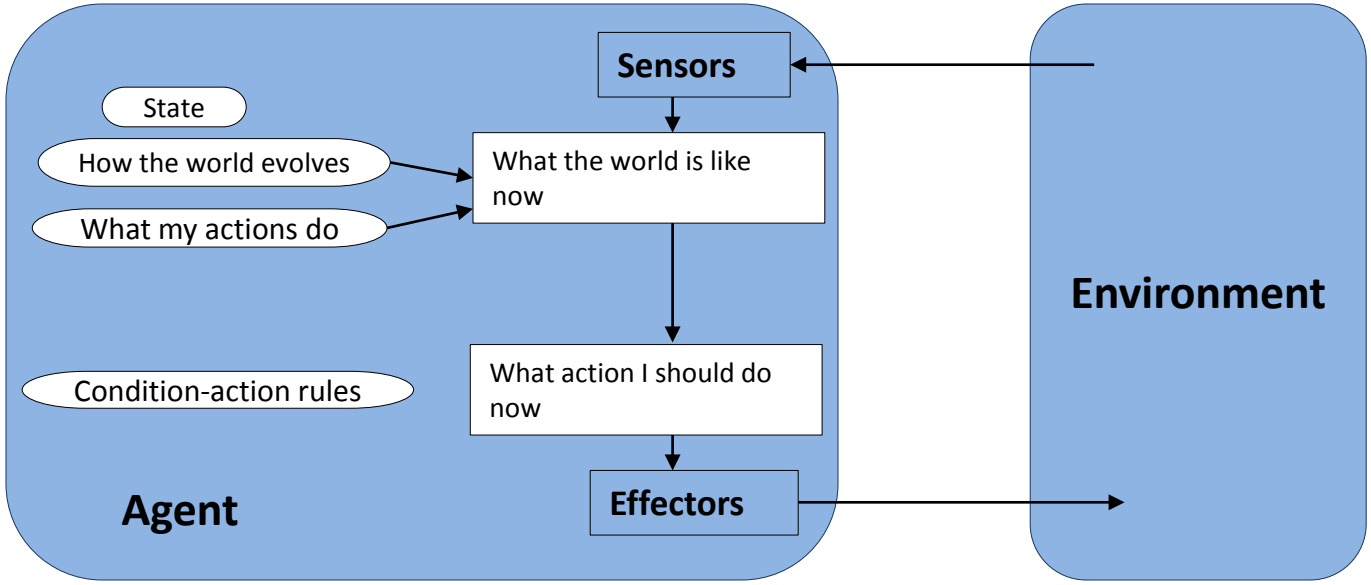
```
Function SIMPLE-REFLEX-AGENT(percept) returns action
     static: rules, a set of condition-action rules

     state ← INTERPRET-INPUT(percept)
     rule  ← RULE-MATCH(state, rules)
     action← RULE-ACTION[rule]
     return action
```

Reflex Agents with State

Example

If yesterday-at-NTU **and** no-traffic-jam-now **then** go-Orchard

1. Find the rule whose condition matches the current situation (as defined by the percept and the stored internal state)
2. Perform the action associated with that rule



Reflex Agents with State...

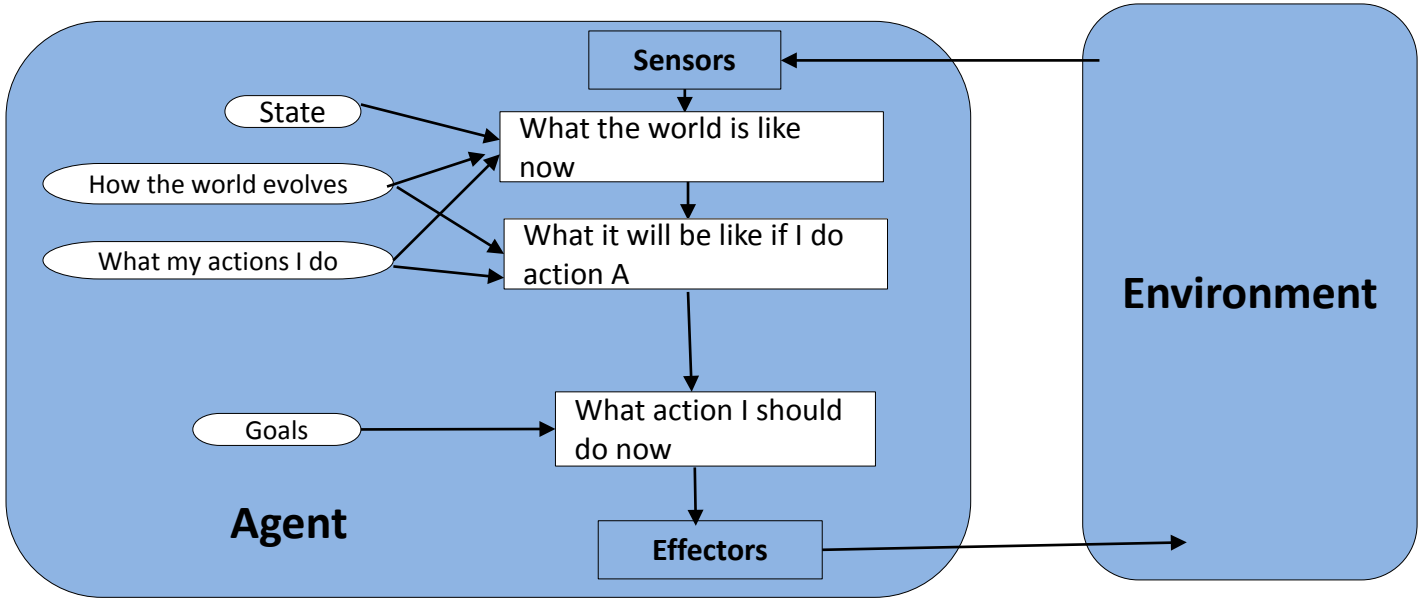
```
Function REFLEX-AGENT-WITH-STATE(percept) returns action
     static: state, a description of the current world state
             rules, a set of condition-action rules

    state  ← UPDATE-STATE(state, percept)
    rule   ← RULE-MATCH(state, rules)
    action ← RULE-ACTION[rule]
    state  ← UPDATE-STATE(state, action)
    return action
```

Goal-Based Agents

Needs some sort of goal information

Example: Driverless Taxi

- At a junction (known state), should I go left, right, or straight on?
- Reach Orchard (Destination)?

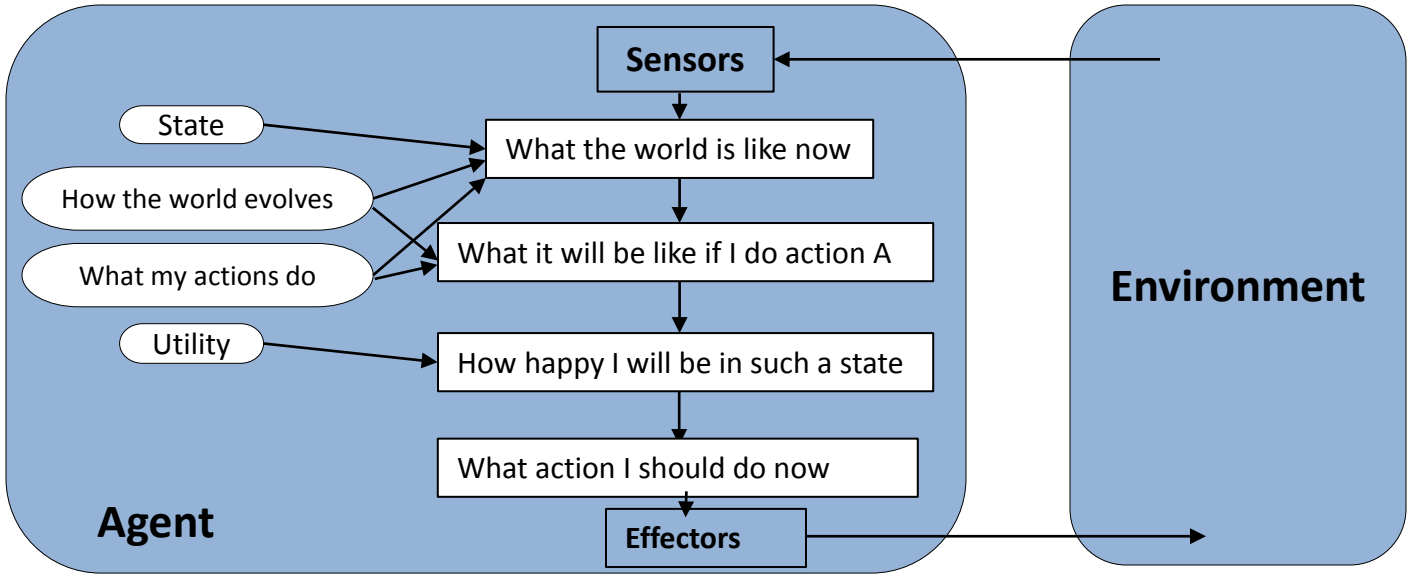


Utility-Based Agents

- There may be many action sequences that can achieve the same goal, which action sequence should it take?
- How happy will agent be if it attains a certain state? → Utility

Example: Driverless Taxi

- Go to Orchard (Destination) via PIE? AYE?
- Which one charges lower fare?



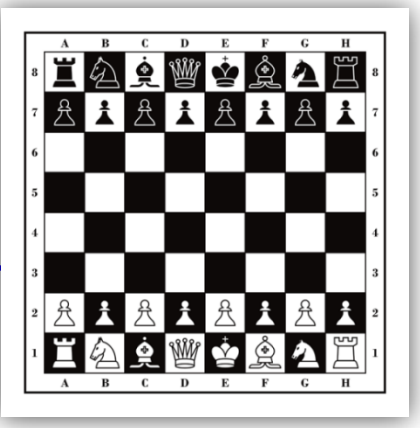
Types of Environment

- Accessible (vs inaccessible)
  - the agent's sensory apparatus gives it access to the complete state of the environment
- Deterministic (vs nondeterministic)
  - the next state of the environment is completely determined by the current state and the actions selected by the agent
- Episodic (vs Sequential)
  - each episode is not affected by the previous taken actions
- Static (vs dynamic)
  - environment does not change while an agent is deliberating
- Discrete (vs continuous)
  - a limited number of distinct percepts and actions

Example: Driverless Taxi

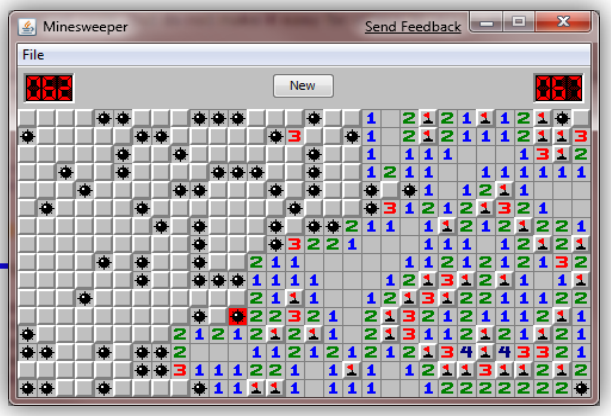
- **Accessible?**
  - No. Some traffic information on road is missing
- **Deterministic?**
  - No. Some cars in front may turn right suddenly
- **Episodic?**
  - No. The current action is based on previous driving actions
- **Static?**
  - No. When the taxi moves, Other cars are moving as well
- **Discrete?**
  - No. Speed, Distance, Fuel consumption are in real domains

Example: Chess



- **Accessible?**
  - Yes. All positions in chessboard can be observed
- **Deterministic?**
  - Yes. The outcome of each movement can be determined
- **Episodic?**
  - No. The action depends on previous movements
- **Static?**
  - Yes. When you are considering the next step, the opponent can't move
- **Discrete?**
  - Yes. All positions and movements are in discrete domains

Example: Minesweeper



- **Accessible?**
  - No. Mines are hidden
- **Deterministic?**
  - No. Mines are randomly assigned in different positions
- **Episodic?**
  - No. The action is based on previous outcomes
- **Static?**
  - Yes. When are you considering the next step, no changes in environment
- **Discrete?**
  - Yes. All positions and movements are in discrete domains

Slot machines - One-Armed Bandit

Accessible? Deterministic? Episodic? Static?

NO;NO;YES;YES