Intelligent Agents

Chapter 2

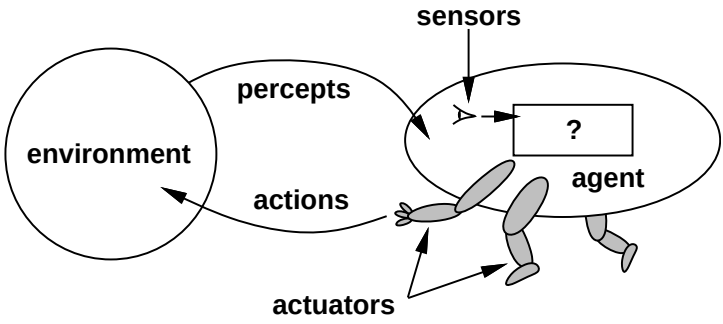
TB Artificial Intelligence

Slides from AIMA — http://aima.cs.berkeley.edu

Outline

- Agents and environments
- Rationality
- PEAS (Performance measure, Environment, Actuators, Sensors)
- Environment types
- Agent types

Agents and environments



- Agents include humans, robots, softbots, thermostats, etc.
- 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

Vacuum-cleaner world

- Percepts: location and contents, e.g., $[A, \mathit{Dirty}]$
- Actions: *Left*, *Right*, *Suck*, *NoOp*

A vacuum-cleaner agent

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*
⋮	⋮

function REFLEX-VACUUM-AGENT([*location*,*status*]) **returns** an action

if *status* = *Dirty* **then return** *Suck*
else if *location* = *A* **then return** *Right*
else if *location* = *B* **then return** *Left*

- What is the **right** function?
- Can it be implemented in a small agent program?

Rationality

- Fixed performance measure evaluates the environment sequence
  - one point per square cleaned up in time T?
  - one point per clean square per time step, minus one per move?
  - penalize for $> k$ dirty squares?
- A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date
- Rational $\neq$ omniscient
  - percepts may not supply all relevant information
- Rational $\neq$ clairvoyant
  - action outcomes may not be as expected

  Hence, rational $\neq$ successful
- Rational $\implies$ exploration, learning, autonomy

PEAS

To design a rational agent, we must specify the task environment

Consider, e.g., the task of designing an automated taxi:

- Performance measure??
- Environment??
- Actuators??
- Sensors??

PEAS

To design a rational agent, we must specify the task environment

Consider, e.g., the task of designing an automated taxi:

- Performance measure?? safety, destination, profits, legality, comfort, ...
- Environment?? streets/freeways, traffic, pedestrians, weather, ...
- Actuators?? steering, accelerator, brake, horn, speaker/display, ...
- Sensors?? video, accelerometers, gauges, engine sensors, keyboard, GPS, ...

Internet shopping agent

- Performance measure??
- Environment??
- Actuators??
- Sensors??

Internet shopping agent

- Performance measure?? price, quality, appropriateness, efficiency
- Environment?? current and future WWW sites, vendors, shippers
- Actuators?? display to user, follow URL, fill in form
- Sensors?? HTML pages (text, graphics, scripts)

Environment types

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??				
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment types

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??				
Episodic??				
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Discrete??				
Single-agent??				

Environment types

	Solitaire	Backgammon	Internet shopping	Taxi
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Deterministic??	Yes	No	Partly	No
Episodic??				
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Discrete??				
Single-agent??				

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The environment type largely determines the agent design

The real world is (of course) partially observable, stochastic, sequential, dynamic, continuous, multi-agent

Agent types

Four basic types in order of increasing generality:

- simple reflex agents
- reflex agents with state
- goal-based agents
- utility-based agents

All these can be turned into learning agents

Simple reflex agents

Example

function REFLEX-VACUUM-AGENT([*location*,*status*]) **returns** an action

if *status* = *Dirty* **then return** *Suck*
else if *location* = *A* **then return** *Right*
else if *location* = *B* **then return** *Left*

```
(setq joe (make-agent :name 'joe :body (make-agent-body)
                      :program (make-reflex-vacuum-agent-program)))

(defun make-reflex-vacuum-agent-program ()
  #'(lambda (percept)
      (let ((location (first percept)) (status (second percept)))
        (cond ((eq status 'dirty) 'Suck)
              ((eq location 'A) 'Right)
              ((eq location 'B) 'Left)))))
```

Reflex agents with state

Example

function REFLEX-VACUUM-AGENT([*location*,*status*]) **returns** an action
static: *last_A*, *last_B*, numbers, initially ∞

if *status* = *Dirty* **then** . . .

```
(defun make-reflex-vacuum-agent-with-state-program ()
  (let ((last-A infinity) (last-B infinity))
  #'(lambda (percept)
      (let ((location (first percept)) (status (second percept)))
        (incf last-A) (incf last-B)
        (cond
         ((eq status 'dirty)
          (if (eq location 'A) (setq last-A 0) (setq last-B 0))
          'Suck)
         ((eq location 'A) (if (> last-B 3) 'Right 'NoOp))
         ((eq location 'B) (if (> last-A 3) 'Left 'NoOp)))))))
```

Goal-based agents

Utility-based agents

Learning agents

Summary

- Agents interact with environments through actuators and sensors
- The agent function describes what the agent does in all circumstances
- The performance measure evaluates the environment sequence
- A perfectly rational agent maximizes expected performance
- Agent programs implement (some) agent functions
- PEAS descriptions define task environments
- Environments are categorized along several dimensions:
  observable? deterministic? episodic? static? discrete? single-agent?
- Several basic agent architectures exist:
  reflex, reflex with state, goal-based, utility-based