Intelligent Agents

Chapter 2

Reminders

Assignment 0 (lisp refresher) due 1/28

Lisp/emacs/AIMA tutorial: 11-1 today and Monday, 271 Soda

Outline

◇ Agents and environments

◇ Rationality

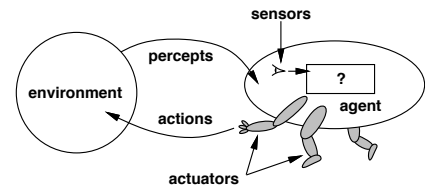◇ PEAS (Performance measure, Environment, Actuators, Sensors)

◇ Environment types

◇ Agent types

Agents and environments

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

The agent function maps from percept histories to actions:
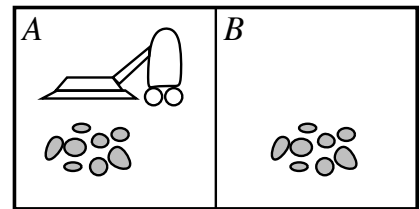
$$f : \mathcal{P}^* \to \mathcal{A}$$

The agent program runs on the physical architecture to produce f

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Vacuum-cleaner world

Percepts: location and contents, e.g., $[A, Dirty]$

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 $\Rightarrow$ 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?? US 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??				
Static??				
Discrete??				
Single-agent??				

Environment types

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

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Single-agent??				

Environment types

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Single-agent??				

Environment types

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??	Yes	No	Partly	No
Episodic??	No	No	No	No
Static??	Yes	Semi	Semi	No
Discrete??	Yes	Yes	Yes	No
Single-agent??	Yes	No	Yes (except auctions)	No

The environment type largely determines the agent design

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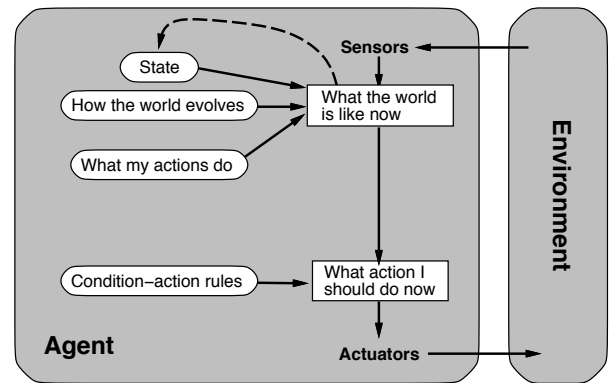
Agent types

Four basic types in order of increasing generality:
    – simple reflex agents
    – reflex agents with state
    – goal-based agents
    – utility-based agents
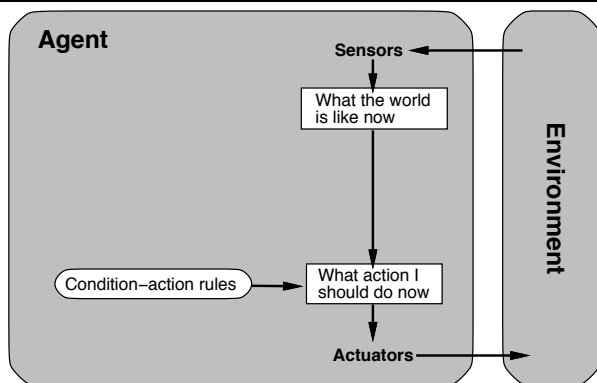
All these can be turned into learning agents

Reflex agents with state

State
How the world evolves
What my actions do
Sensors
What the world is like now
Condition–action rules
What action I should do now
Agent
Actuators
Environment

Simple reflex agents

Agent
Sensors
What the world is like now
Condition–action rules
What action I should do now
Actuators
Environment

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)))))))
```
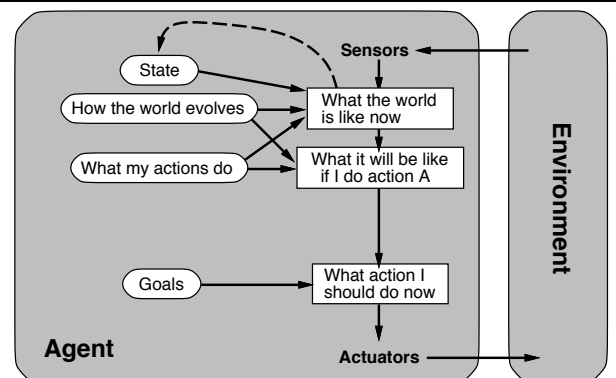
Example

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)))))
```
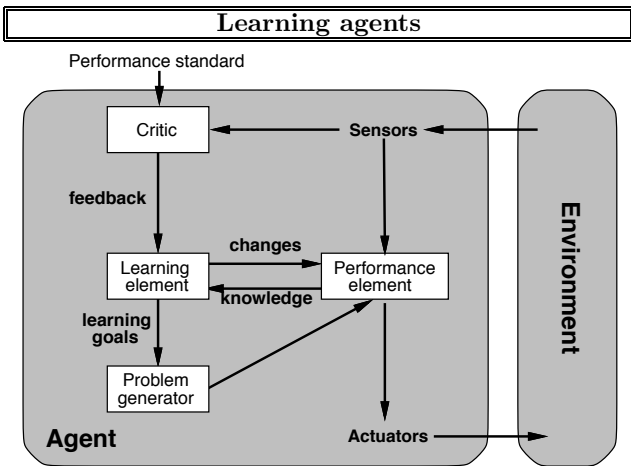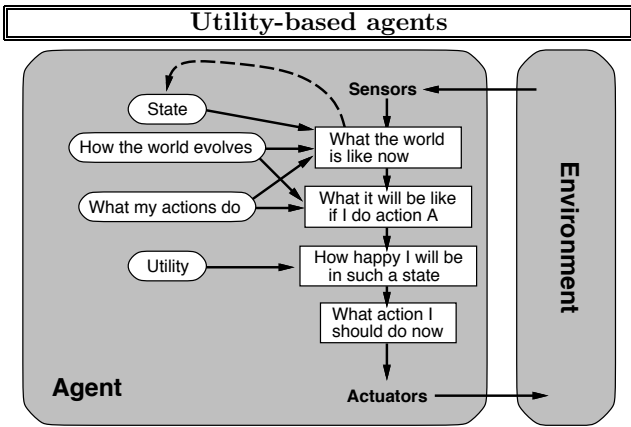
Goal-based agents

State
How the world evolves
What my actions do
Sensors
What the world is like now
What it will be like if I do action A
Goals
What action I should do now
Agent
Actuators
Environment

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