Intelligent Agents

Chapter 2

Outline

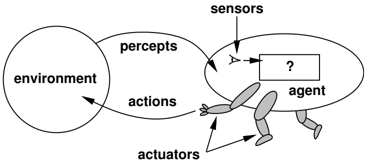
- Agents and environments
- Rationality
- Task environment:

  PEAS:

  - *Performance measure*
  - *Environment*
  - *Actuators*
  - *Sensors*
- Environment types
- Agent types

Agents and Environments

- An *agent* is anything that can be viewed as perceiving its *environment* through *sensors* and acting in that environment through *actuators*.



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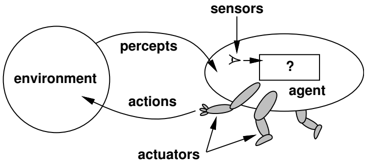
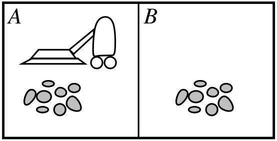


- *Agents* include humans, robots, softbots, thermostats, etc.
- The *agent function* maps from percept histories to actions:

$$f : \mathcal{P}^* \to \mathcal{A}$$

- The *agent program* runs on a physical *architecture* to give f

Vacuum-cleaner world



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

A vacuum-cleaner agent

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*
...	...

Note: This says *how* the agent should function.

- It says nothing about how this should be implemented.

A vacuum-cleaner agent

Agent program:

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

Ask:

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

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- Examples:
  - one point per square cleaned up in time T?
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- Examples:
  - one point per square cleaned up in time T?
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  - penalize for $> k$ dirty squares?
- A *rational agent* selects an action which maximizes the expected value of the performance measure given the percept sequence to date and its own knowledge.
- The action selection may range from being hardwired (e.g. in an insect or reflexive agent) to involving substantial reasoning.

Rationality

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- Rational $\neq$ omniscient
  - percepts may not supply all the relevant information
- Rational $\neq$ clairvoyant
  - action outcomes may not be as expected
- Hence, rational $\neq$ successful
- Full, general rationality requires exploration, learning, autonomy

The Task Environment

- To design a rational agent, we must specify the *task environment*
- The task environment has the following components:
  - Performance measure
  - Environment
  - Actuators
  - Sensors
- Acronym: PEAS

PEAS

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, . . .

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: ??

Actuators: ??

Sensors: ??

Internet shopping agent

Performance measure: price, quality, appropriateness, efficiency

Environment: current and future WWW sites, vendors, shippers

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Internet shopping agent

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Actuators: display to user, follow URL, fill in form

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

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- *Single-agent* vs. *multiagent*

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☞ *The environment type largely determines the agent design*

- The real world is:

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☞ *The environment type largely determines the agent design*

- The real world is:
    - partially observable,
      stochastic,
      sequential,
      dynamic,
      continuous, and
      multi-agent

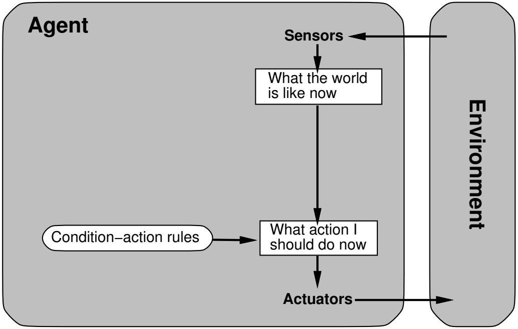
Agent types

There are four basic types in order of increasing generality:

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

All these can have a learning component added

Simple reflex agents



- Action is selected according to the current percept
- No knowledge of percept history.

A simple reflex agent algorithm

Function Simple-Reflex-Agent(percept) returns an action
    persistent: rules a set of condition-action rules

    state $\leftarrow$ Interpret-Input(percept)
    rule $\leftarrow$ Rule-Match(state,rules)
    action $\leftarrow$ rule.Action
    return action

Example

Function Reflex-Vacuum-Agent([location,status]) returns an action
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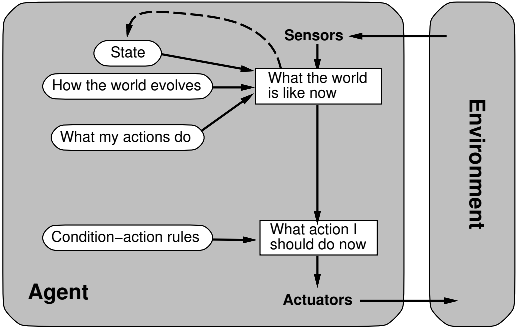
Reflex agents with state



- Also called a "model-based reflex agent"
- Agent keeps track of what it knows about the world.
- Useful for partial observability

A simple reflex agent algorithm

Function Reflex-Agent-With-State(percept) returns an action

persistent: state: the agent's conception of the world state

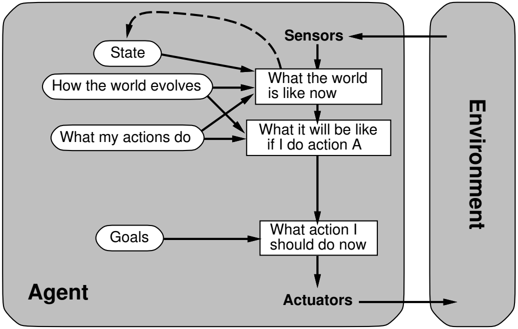
model: The transition model – how the next state depends on the present state and action

rules: a set of condition-action rules

action: the most recent action (initially none)

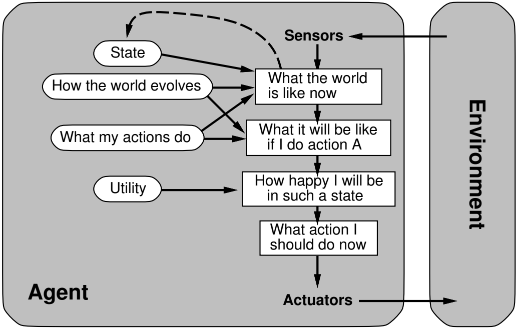
state $\leftarrow$ Update-State(state,action,percept,model)
rule $\leftarrow$ Rule-Match(state,rules)
action $\leftarrow$ rule.Action
return action

Goal-based agents



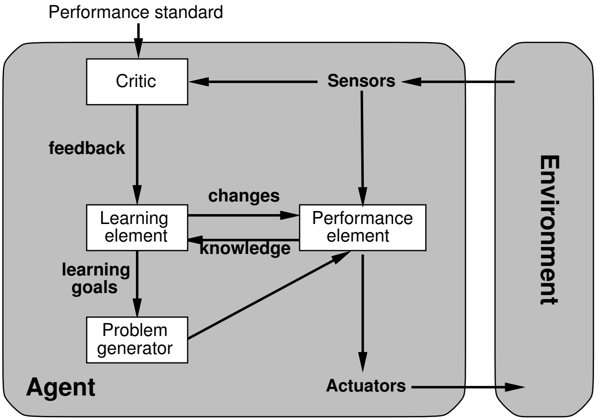
- Agent's actions are determined in part by its *goals*.
- Example: Classical planning.

Utility-based agents



- In addition to goals, use a notion of how "good" an action sequence is.
  - E.g.: Taxi to airport should be safe, efficient, etc.

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 *rational* agent maximizes expected performance
- *Agent programs* implement 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*