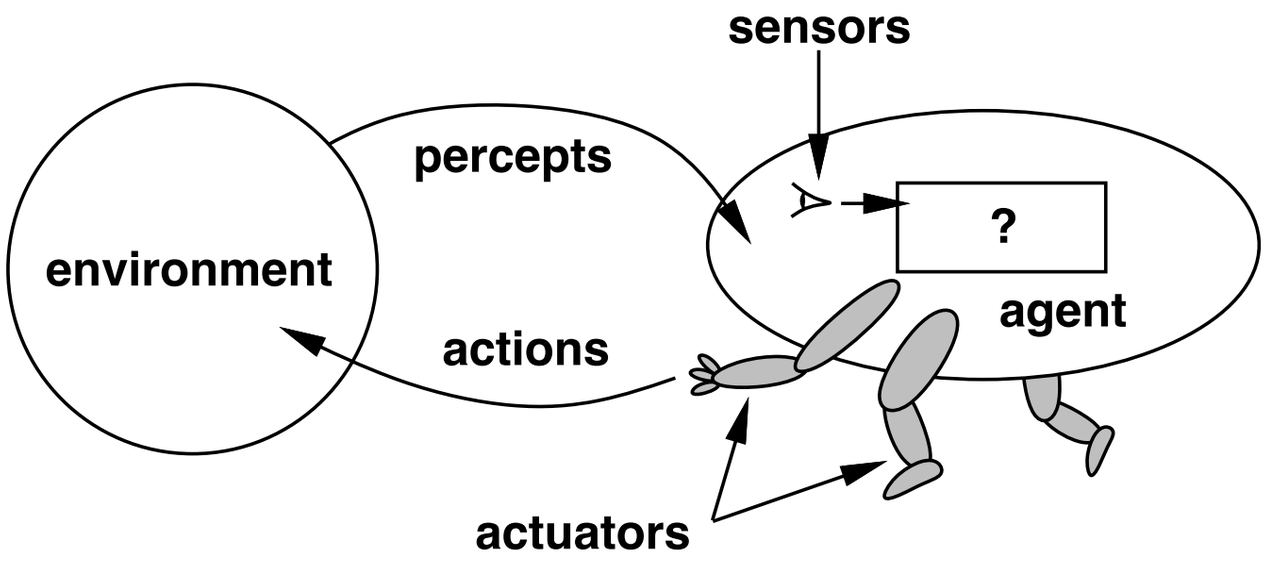
# Intelligent Agents

# Chapter 2

# Outline

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

# Agents and environments



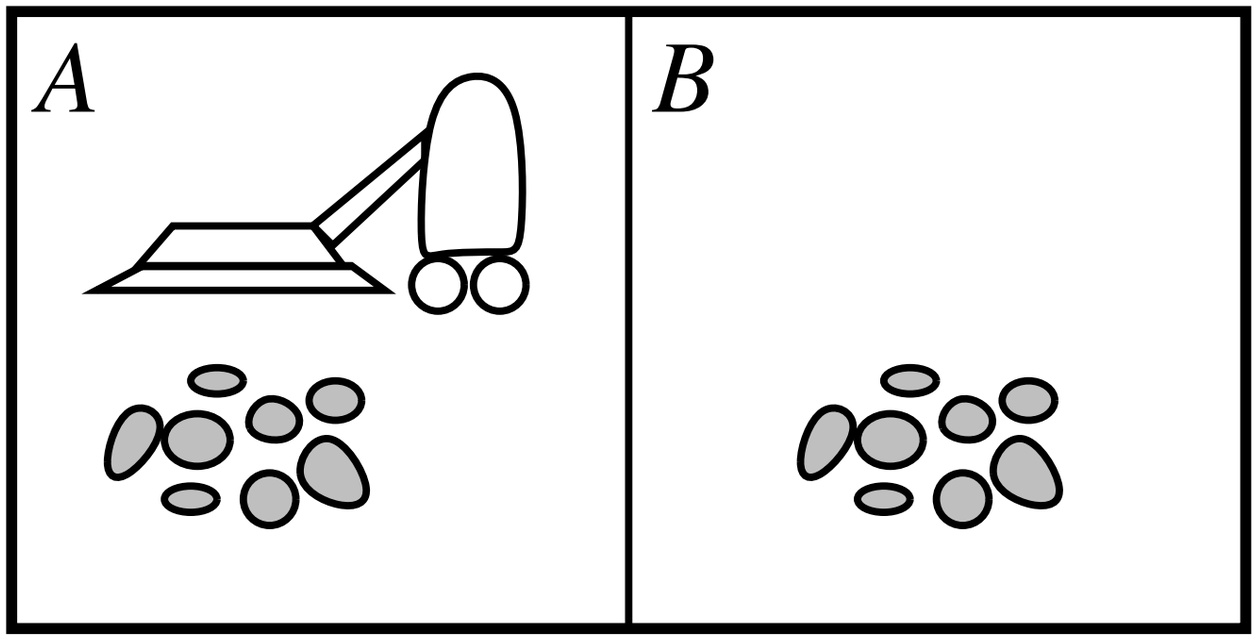

Agents include humans, robots, softbots, thermostats, etc.

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., $[A, Dirty]$

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??<br>Deterministic??<br>Episodic??<br>Static??<br>Discrete??<br>Single-agent?? | | | | |

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| 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

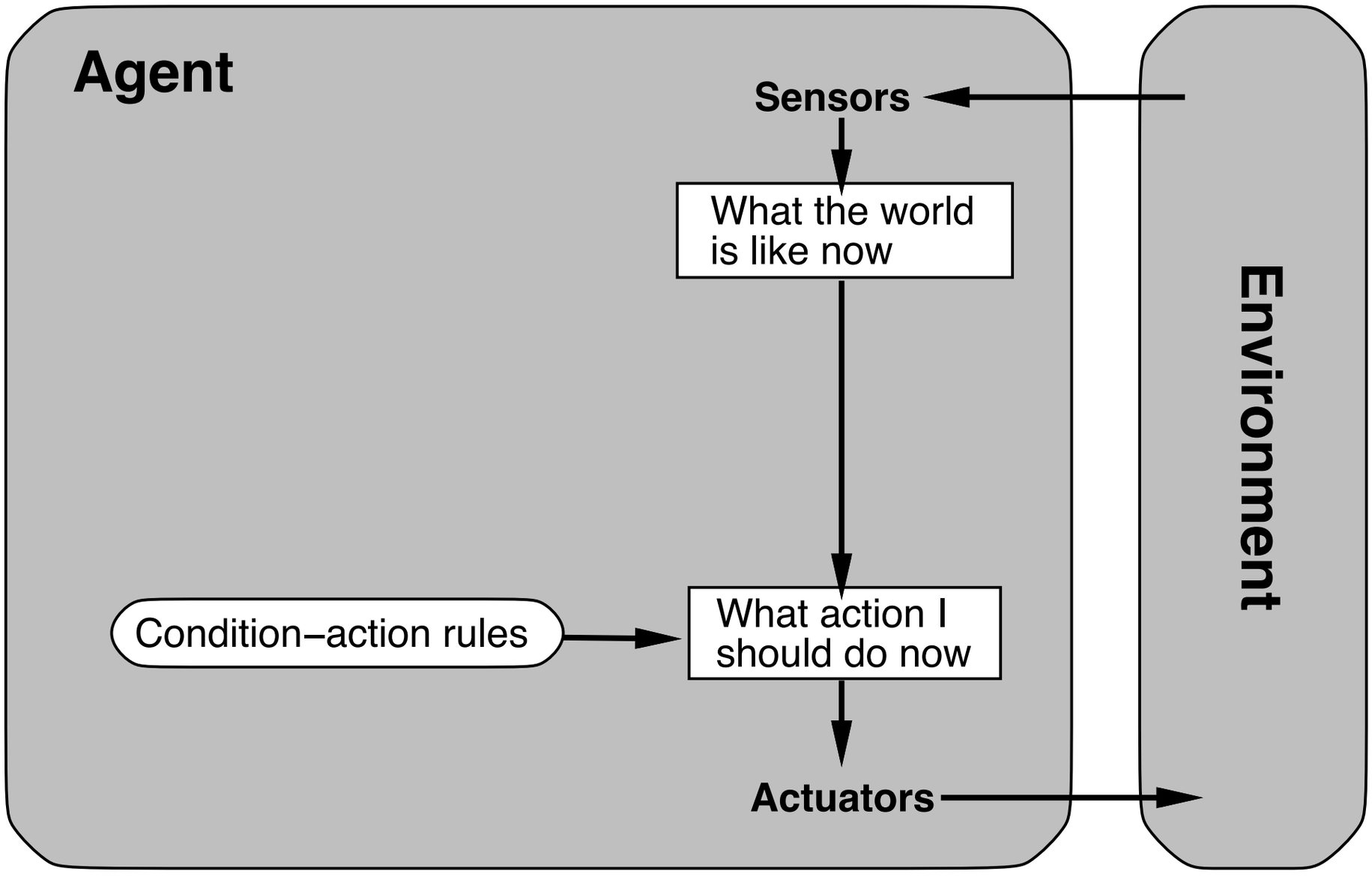
# Agent types

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

# Simple reflex agents

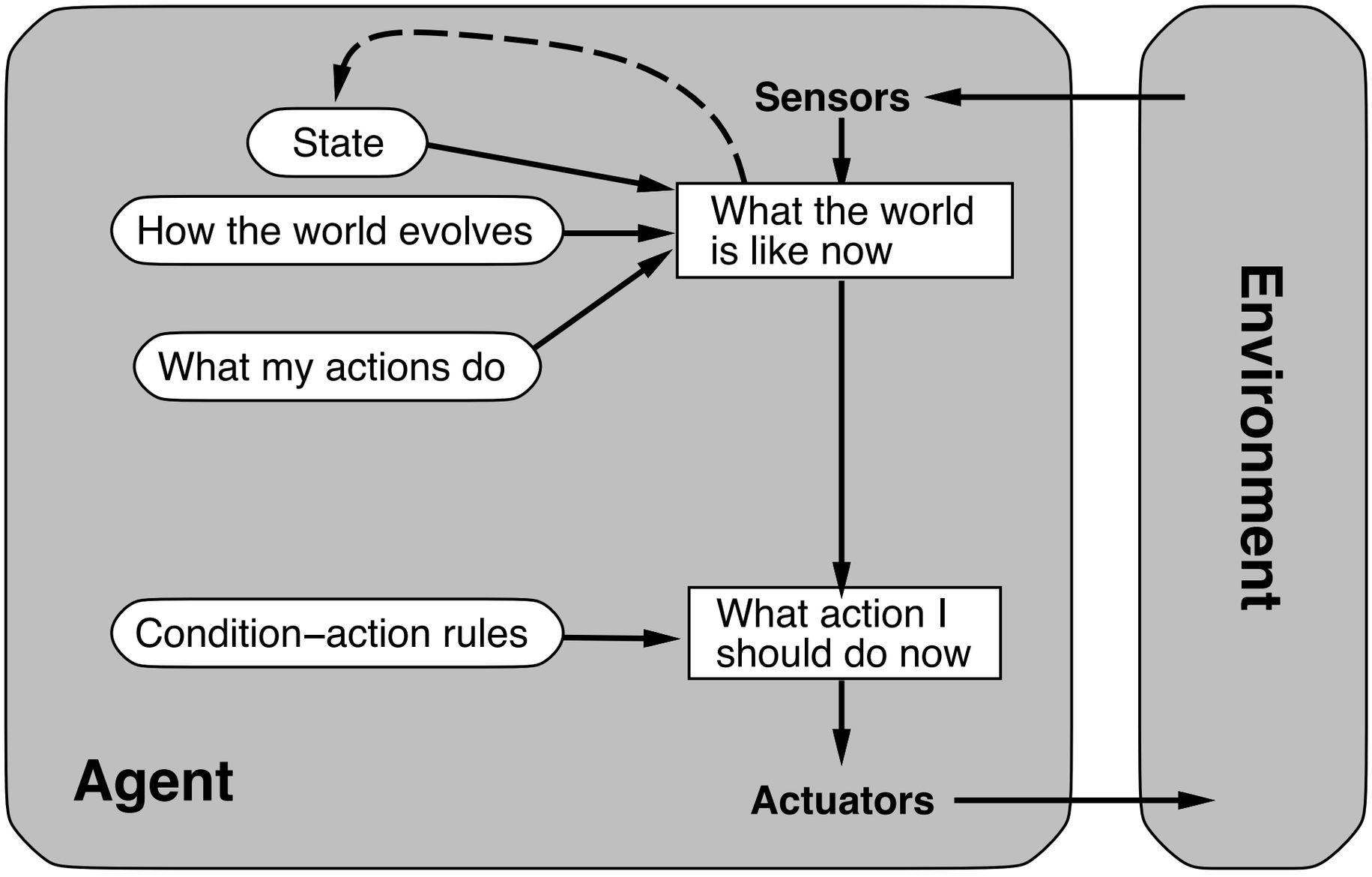


# Example

**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*

# Reflex agents with state

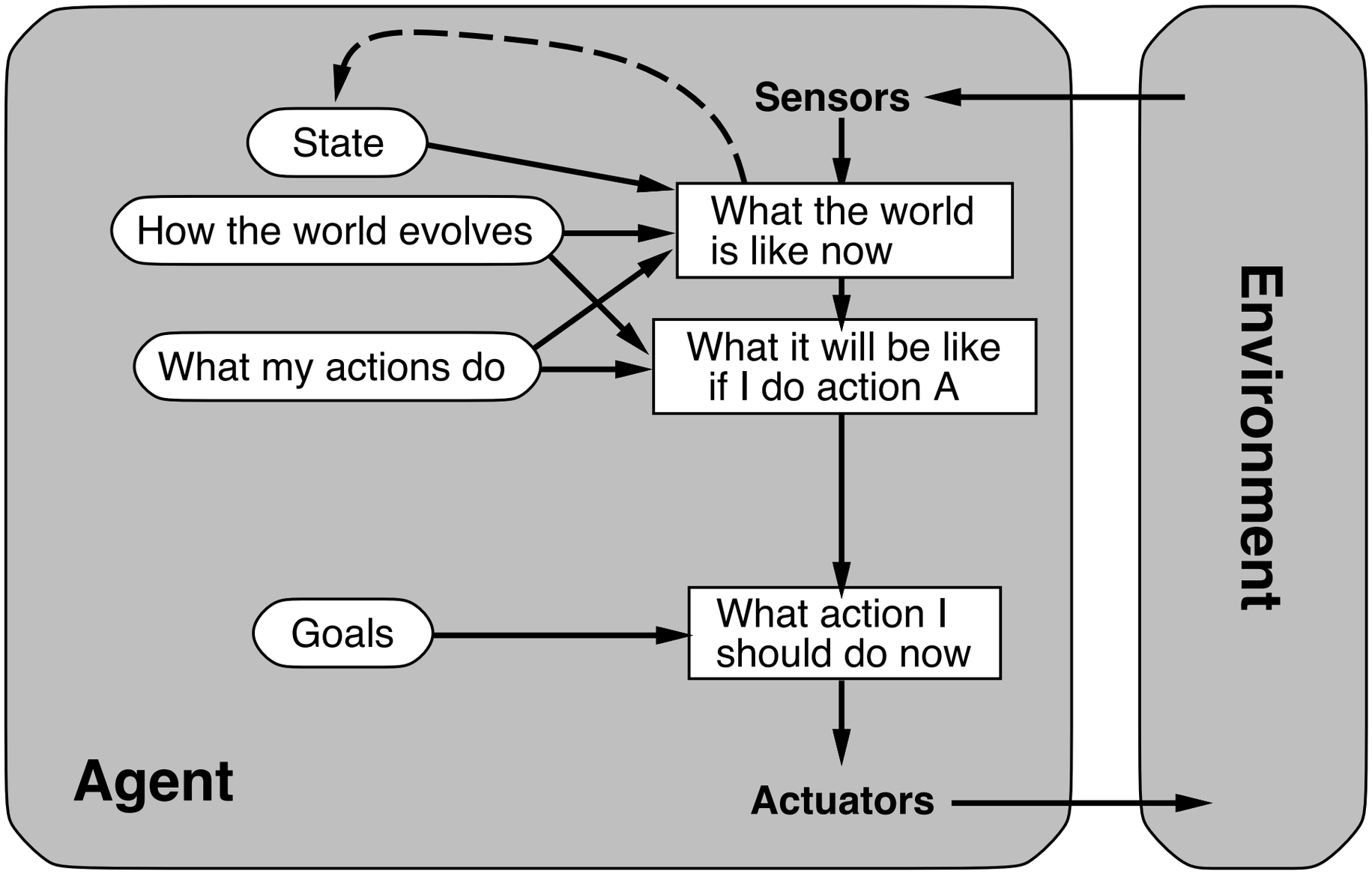


# Example

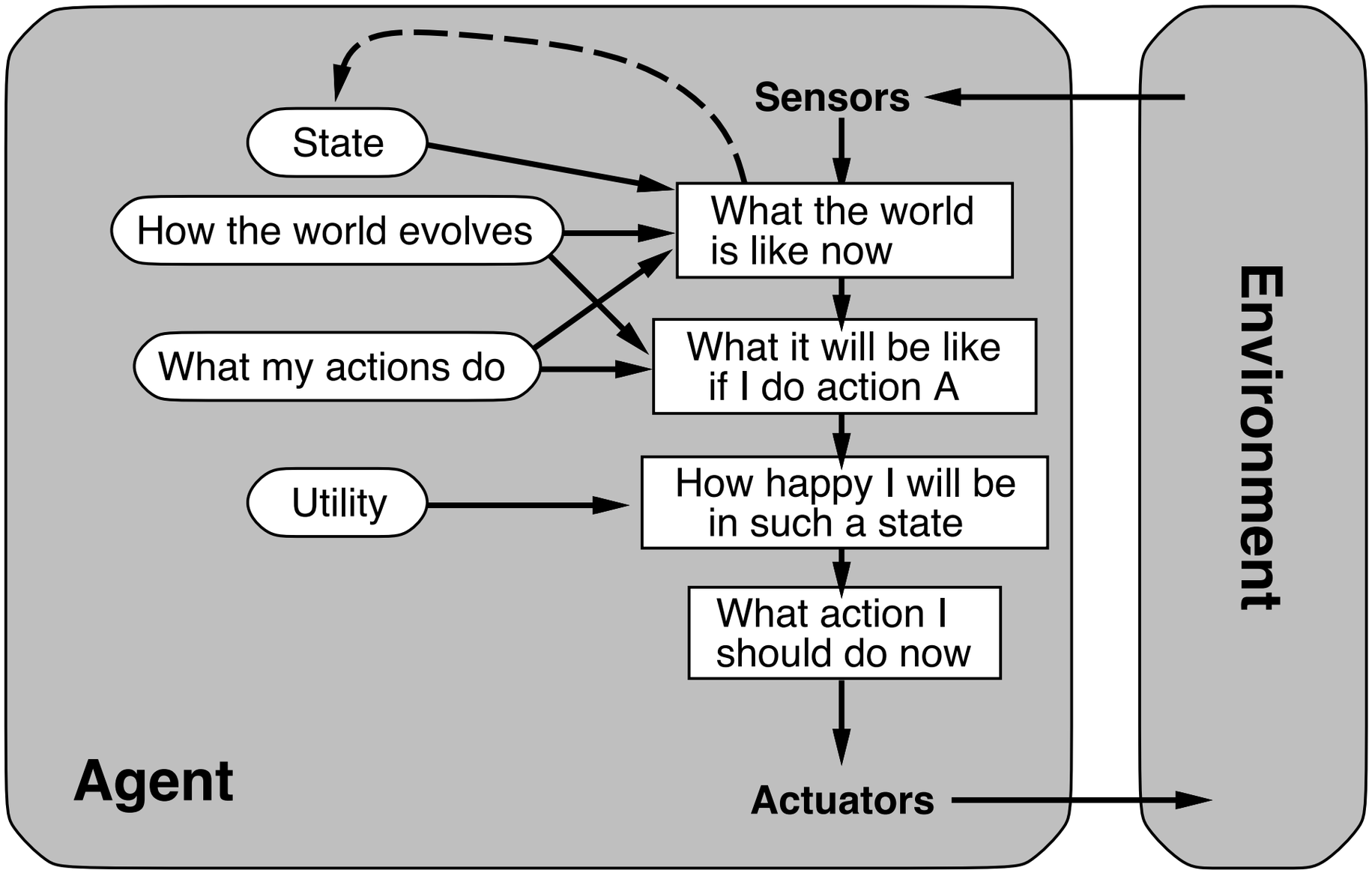
**function** REFLEX-VACUUM-AGENT( [*location*,*status*]) **returns** an action
**static**: *last_A*, *last_B*, numbers, initially $\infty$

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

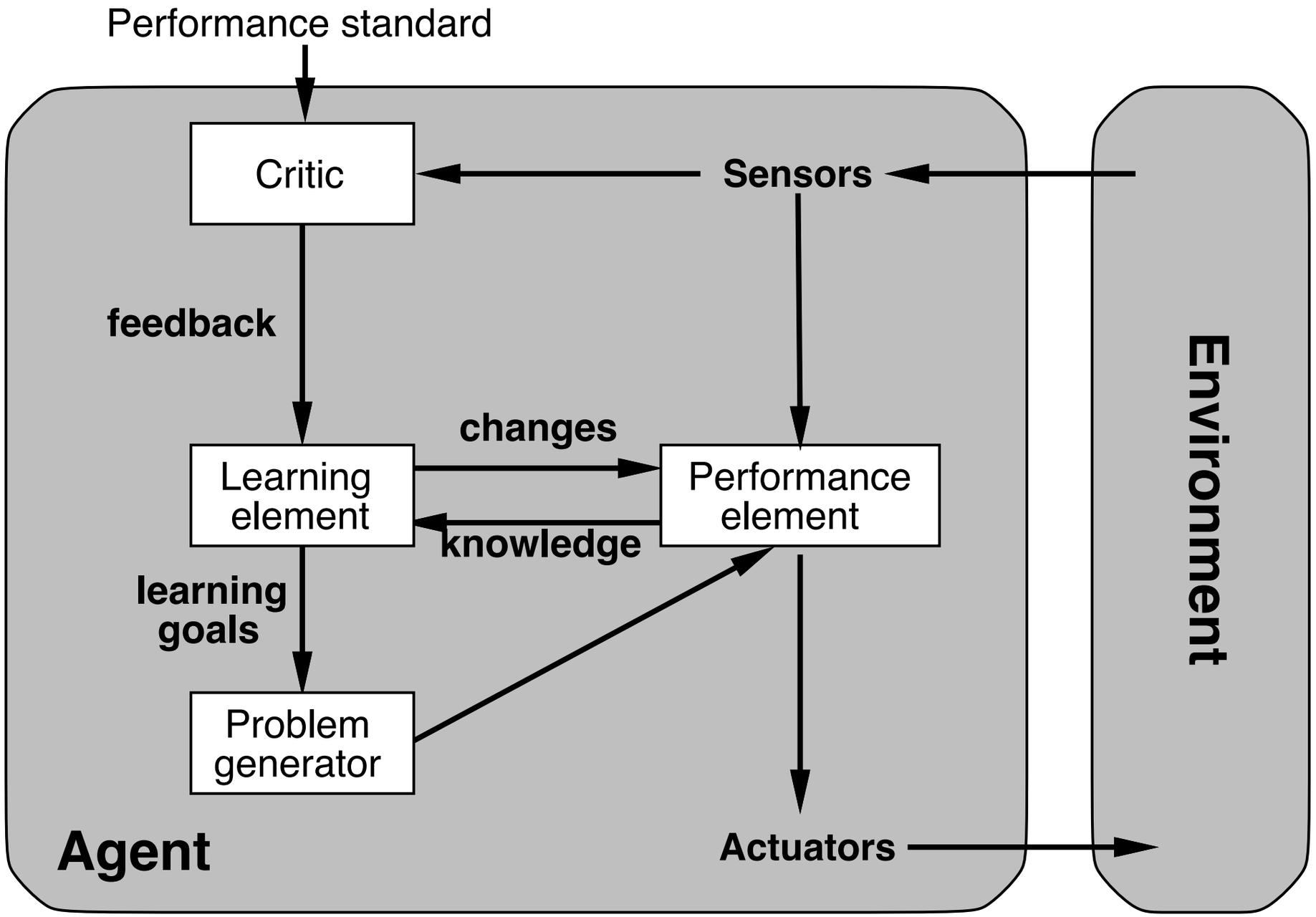
# Goal-based agents



# 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