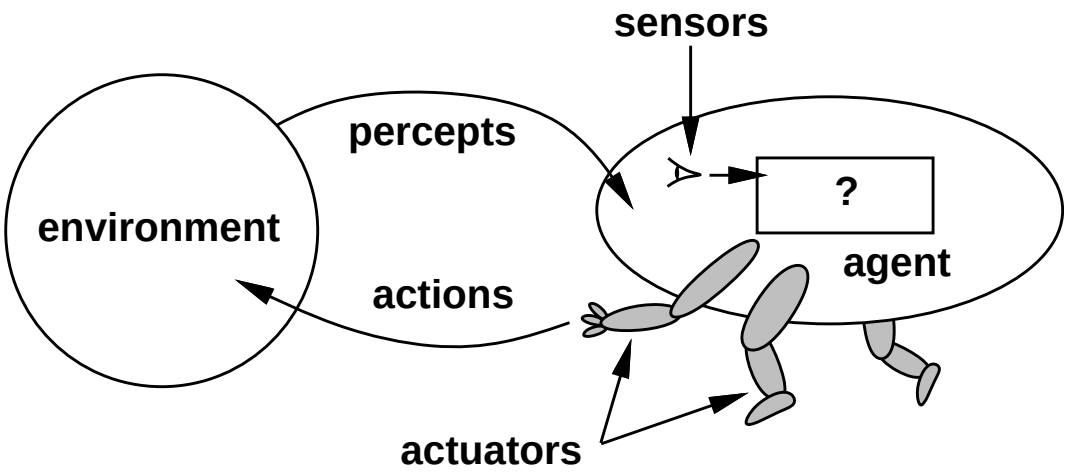
Last update: January 26, 2010

Intelligent Agents

CMSC 421: Chapter 2

Agents and environments



Russell & Norvig's book is organized around the concept of *intelligent agents*

♢ humans, robots, softbots, thermostats, etc.

The *agent function* maps from percept histories to actions:

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

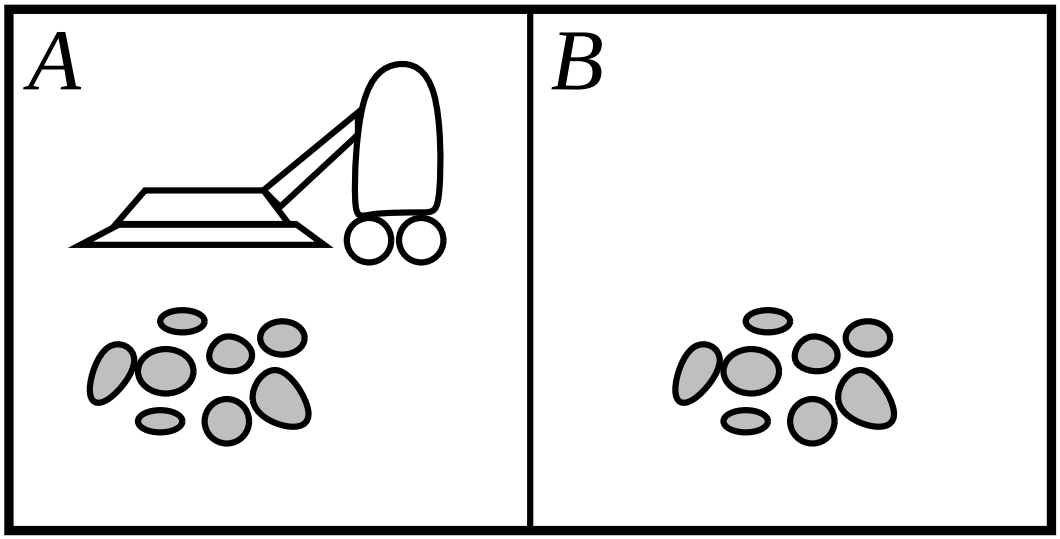
The *agent program* runs on the physical *architecture* to produce f

Chapter 2 - Purpose and Outline

Purpose of Chapter 2:
basic concepts relating to agents

- ♢ Agents and environments
- ♢ Rationality
- ♢ The PEAS model of an environment
- ♢ Environment types
- ♢ Agent types

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? 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
Fully observable? *Deterministic?* *Episodic?* *Static?* *Discrete?* *Single-agent?*				

Environment types

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

*After the cards have been dealt

Episodic: task divided into atomic episodes, each to be considered by itself
Sequential: Current decision may affect all future decisions

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Static?				
Discrete?				
Single-agent?				

*After the cards have been dealt

Static: the world does not change while the agent is thinking

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Single-agent?	Yes	No	No	No

*After the cards have been dealt

The environment type largely determines the agent design

Real world: partially observable, stochastic, sequential, dynamic, continuous, multi-agent

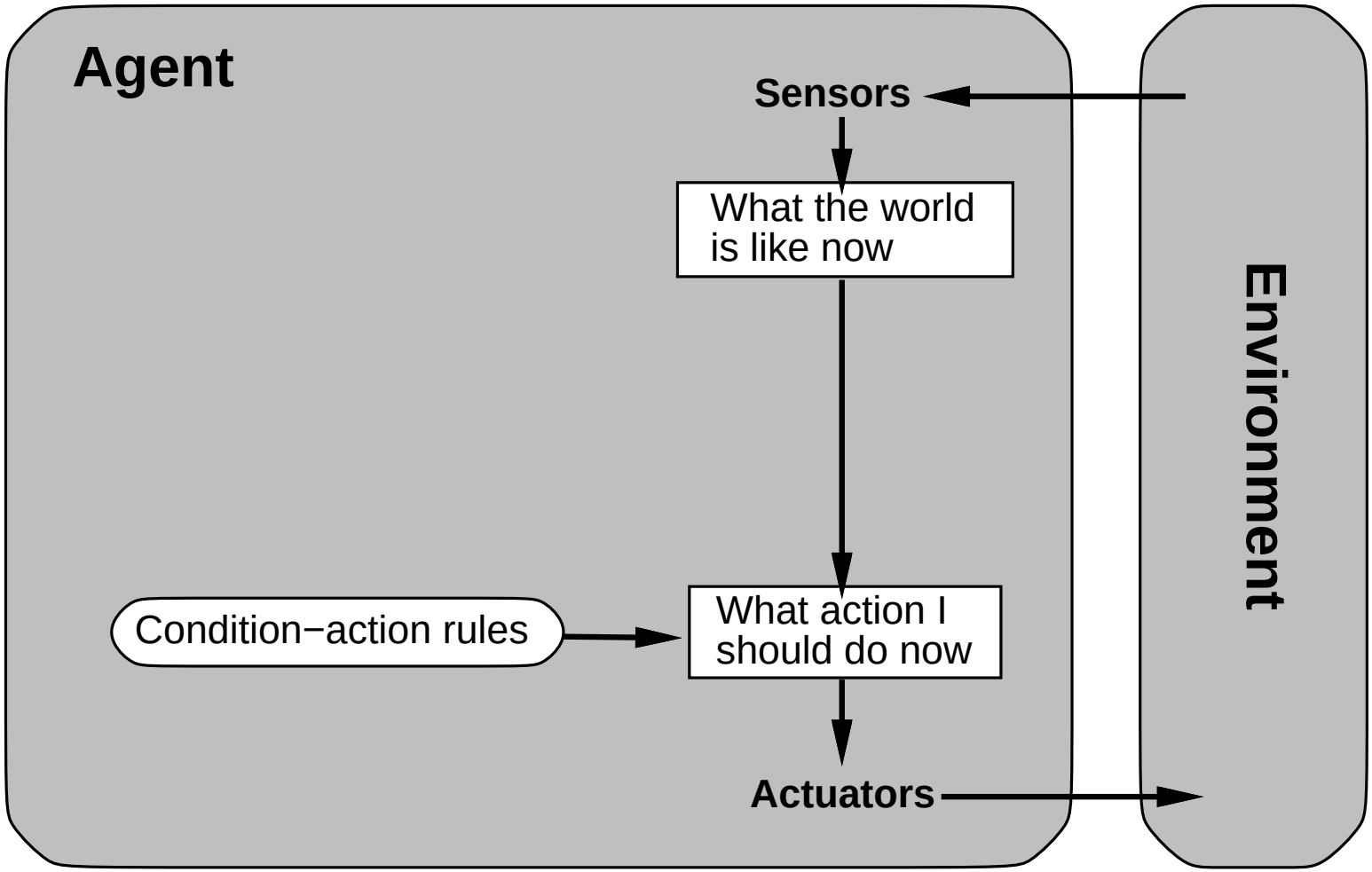
Agent types

Four basic types in order of increasing generality:

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

All of these can be turned into learning agents

Simple reflex agents



Example

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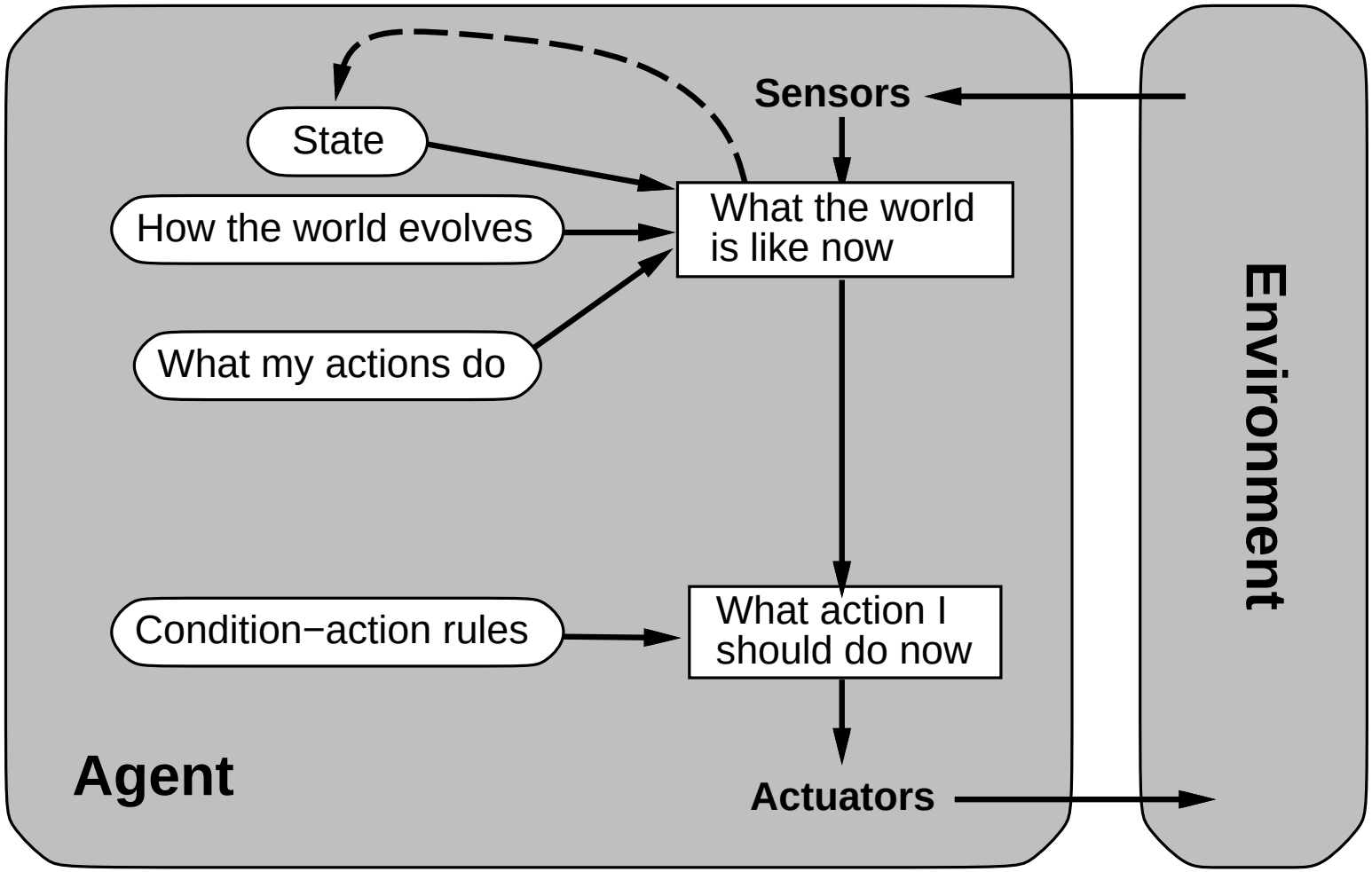

Reflex agents with state



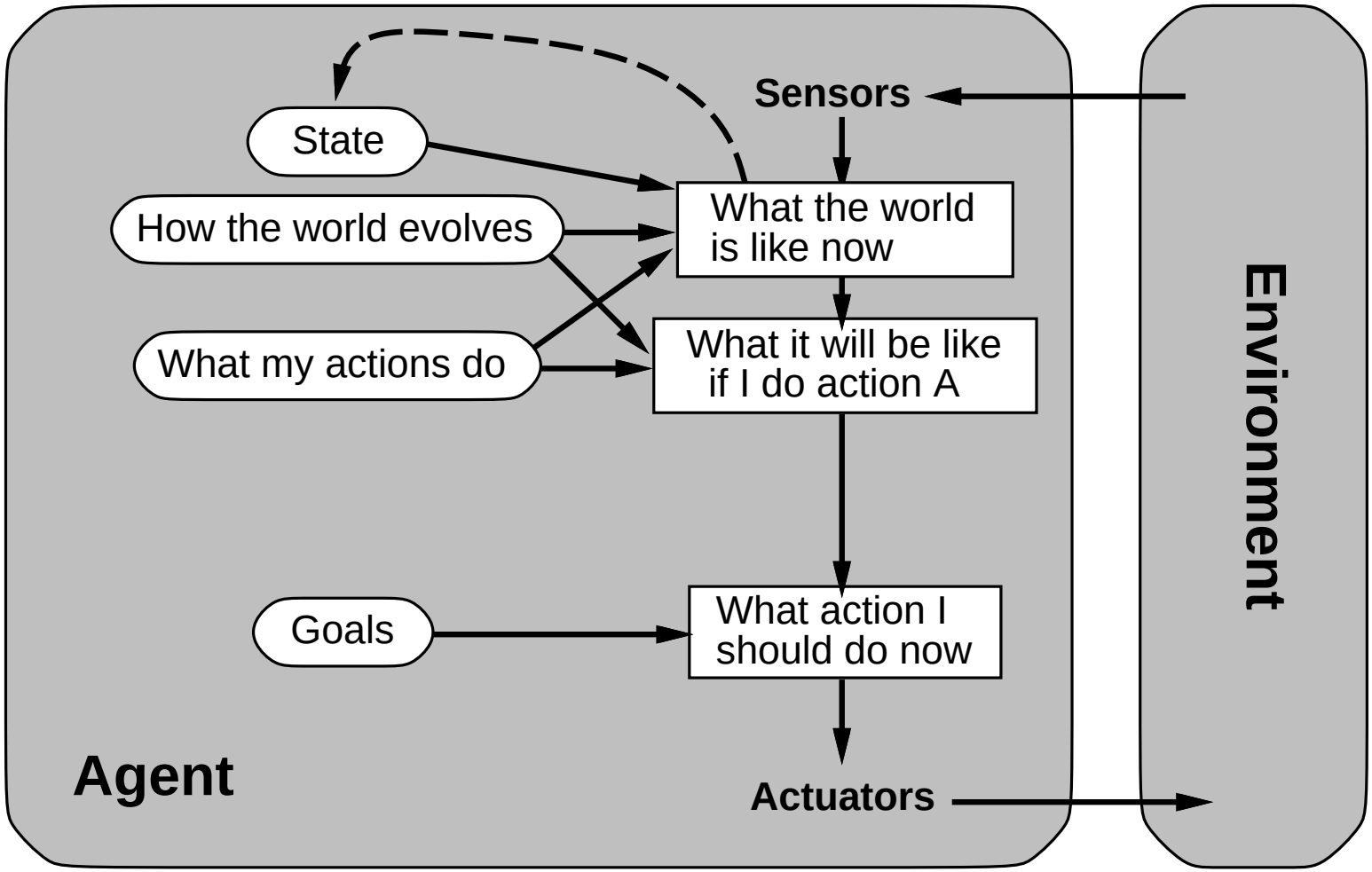
Example

Suppose the percept didn't tell the agent what room it's in. Then the agent could remember its location:

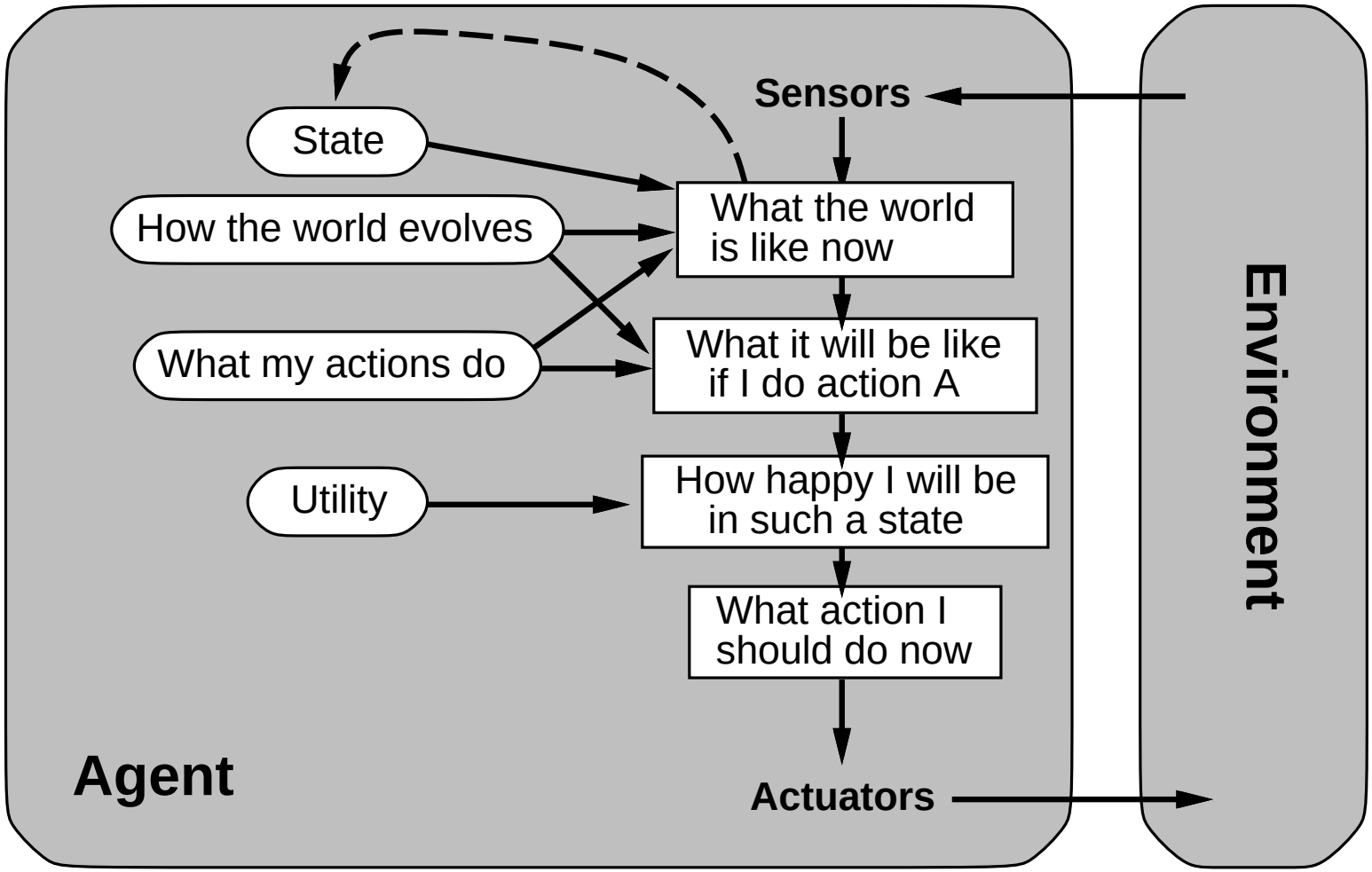
```
function VACUUM-AGENT-WITH-STATE( [location]) returns an action
static: location, initially A

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

Above, I've assumed we know the agent always starts out in room A. What if we didn't know this?

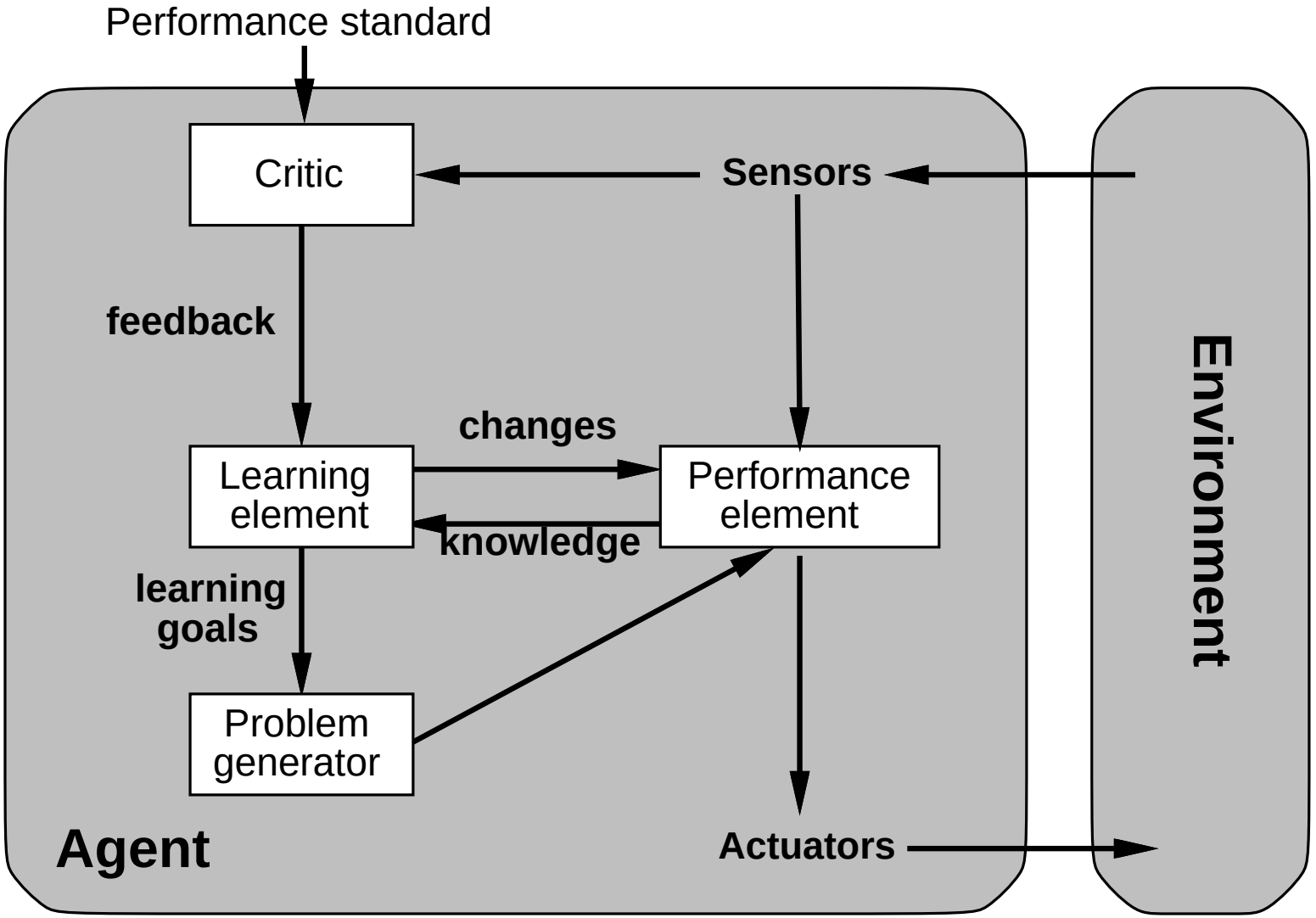
Goal-based agents



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*?

Some basic agent architectures:
reflex, *reflex with state*, *goal-based*, *utility-based*