
Introduction to Artificial Intelligence

Intelligent Agents

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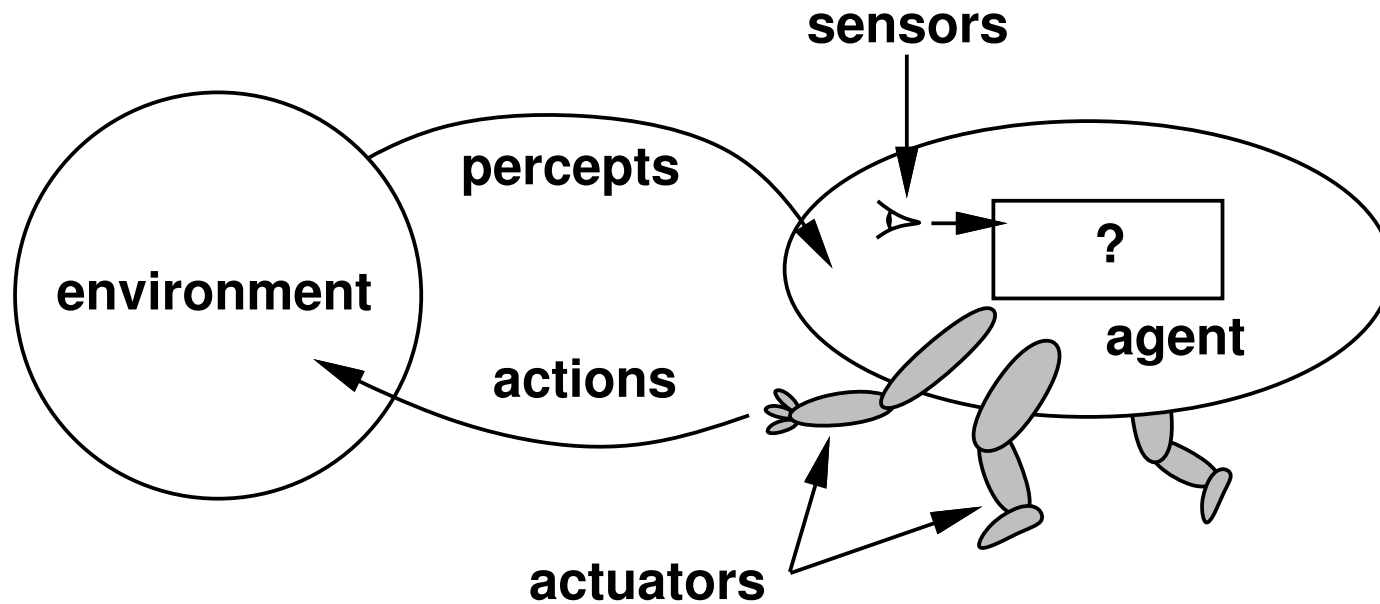
UNIVERSITÄT KOBLENZ-LANDAU

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Outline

- **Agents and environments**
- **PEAS (Performance, Environment, Actuators, Sensors)**
- **Environment types**
- **Agent types**
- **Example: Vacuum world**

Agents and environments



Agents include

- humans
- robots
- software robots (softbots)
- thermostats
- etc.

Agent functions and programs

Agent function

An agent is completely specified by the agent function

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

mapping percept sequences to actions

Agent functions and programs

Agent program

- runs on the physical architecture to produce f
- takes a single percept as input
- keeps internal state

```
function SKELETON-AGENT(percept) returns action  
  static: memory  /* the agent's memory of the world */  
  
  memory ← UPDATE-MEMORY(memory, percept)  
  action ← CHOOSE-BEST-ACTION(memory)  
  memory ← UPDATE-MEMORY(memory, action)  
  return action
```

Rationality

Goal

Specified by performance measure,
defining a numerical value for any environment history

Rational action

Whichever action maximizes the **expected** value
of the performance measure **given the percept sequence to date**

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Agents need to: gather information, explore, learn, ...

PEAS: The setting for intelligent agent design

Example: Designing an automated taxi

Performance

Environment

Actuators

Sensors

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Performance safety, reach destination, maximize profits,
obey laws, passenger comfort, . . .

Environment

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Environment streets, traffic, pedestrians, weather, customers, ...

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Actuators steer, accelerate, brake, horn, speak/display, ...

Sensors

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Example: Designing an automated taxi

Performance safety, reach destination, maximize profits, obey laws, passenger comfort, ...

Environment streets, traffic, pedestrians, weather, customers, ...

Actuators steer, accelerate, brake, horn, speak/display, ...

Sensors video, accelerometers, gauges, engine sensors, keyboard, GPS, ...

PEAS: The setting for intelligent agent design

Example: Medical diagnosis system

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Environment

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Performance Healthy patient, minimize costs, avoid lawsuits, ...

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Environment patient, hospital, staff, ...

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Actuators questions, tests, diagnoses, treatments, referrals, ...

Sensors

PEAS: The setting for intelligent agent design

Example: Medical diagnosis system

Performance Healthy patient, minimize costs, avoid lawsuits, ...

Environment patient, hospital, staff, ...

Actuators questions, tests, diagnoses, treatments, referrals, ...

Sensors keyboard (symptoms, test results, answers), ...

Environment types

Fully observable (otherwise: **partially observable**)

Agent's sensors give it access to the complete state of the environment at each point in time

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(strategic: deterministic except for behavior of other agents)

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Episodic (otherwise: **sequential**)

The agent's experience is divided atomic, independent episodes
(in each episode the agent perceives and then performs a single action)

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Static (otherwise: **dynamic**)

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have discrete values

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Single agent (otherwise: **multi-agent**)

Only one agent acts in the environment

Environment types

	Crossword puzzle	Chess	Back-gammon	Internet shopping	Taxi	Part-picking robot
Fully observable						
Deterministic						
Episodic						
Static						
Discrete						
Single agent						

Environment types

	Crossword puzzle	Chess	Back-gammon	Internet shopping	Taxi	Part-picking robot
Fully observable	yes					
Deterministic	yes					
Episodic	no					
Static	yes					
Discrete	yes					
Single agent	yes					

Environment types

	Crossword puzzle	Chess	Back-gammon	Internet shopping	Taxi	Part-picking robot
Fully observable	yes	yes				
Deterministic	yes	strat.				
Episodic	no	no				
Static	yes	semi				
Discrete	yes	yes				
Single agent	yes	no				

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Discrete	yes	yes	yes			
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Deterministic	yes	strat.	no	(yes)		
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Discrete	yes	yes	yes	yes		
Single agent	yes	no	no	no		

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Static	yes	semi	yes	semi	no	no
Discrete	yes	yes	yes	yes	no	no
Single agent	yes	no	no	no	no	yes

Environment types

The real world is

- **partially observable**
- **stochastic**
- **sequential**
- **dynamic**
- **continuous**
- **multi-agent**

Agent types

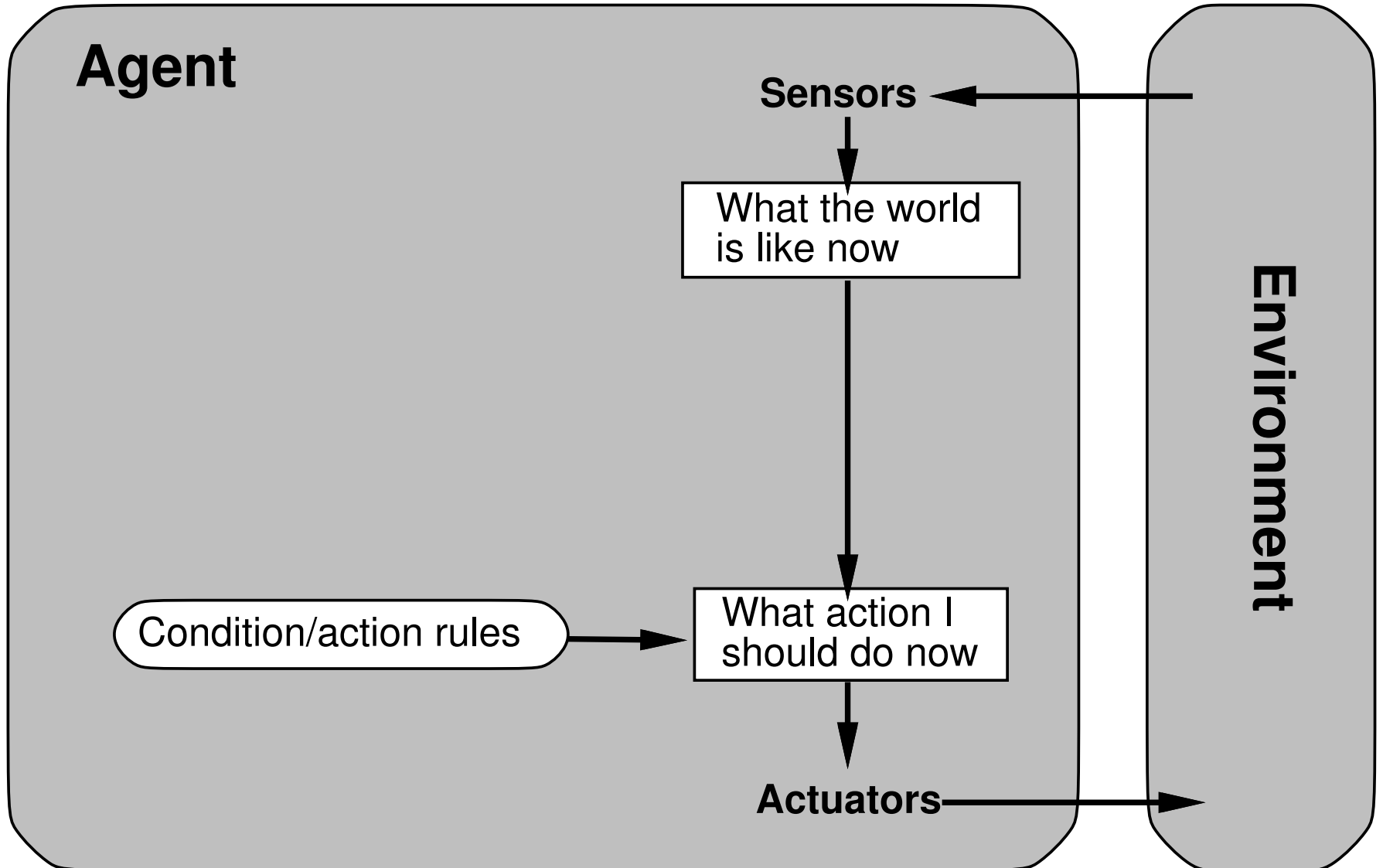
Four basic types

(in order of increasing generality)

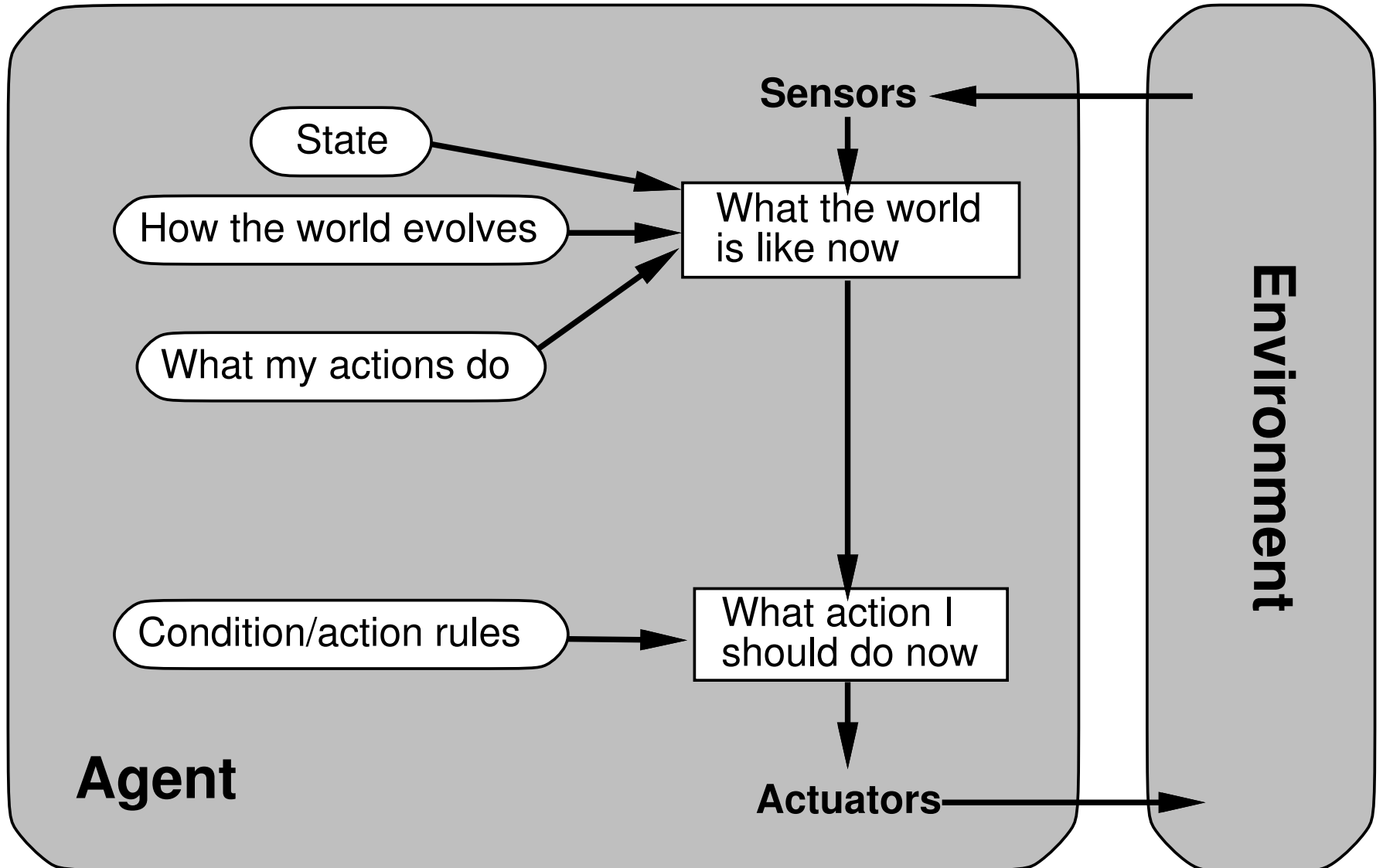
- simple reflex agents
- reflex agents with state
- goal-based agents
- utility-based agents

All these can be turned into learning agents

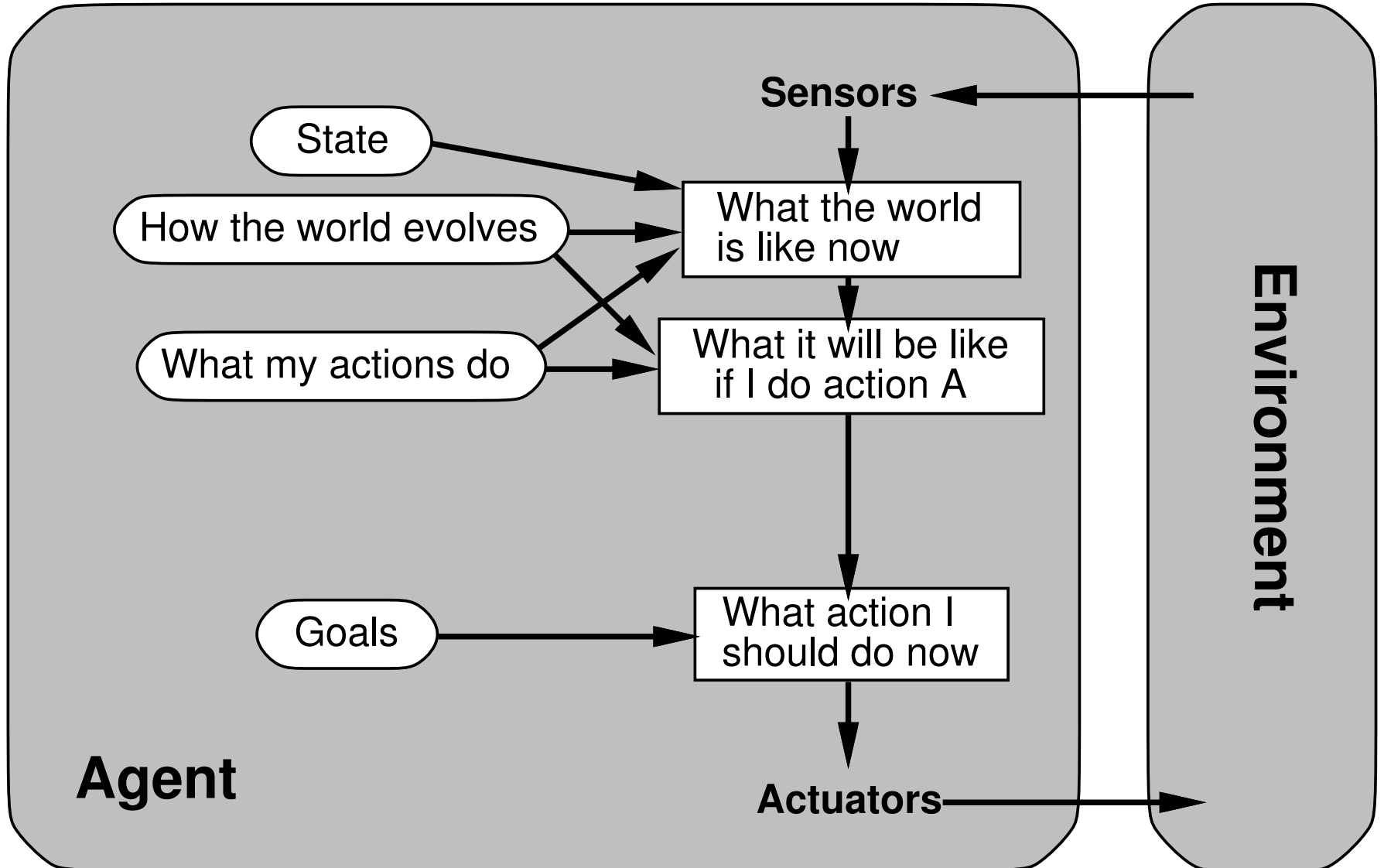
Simple reflex agents



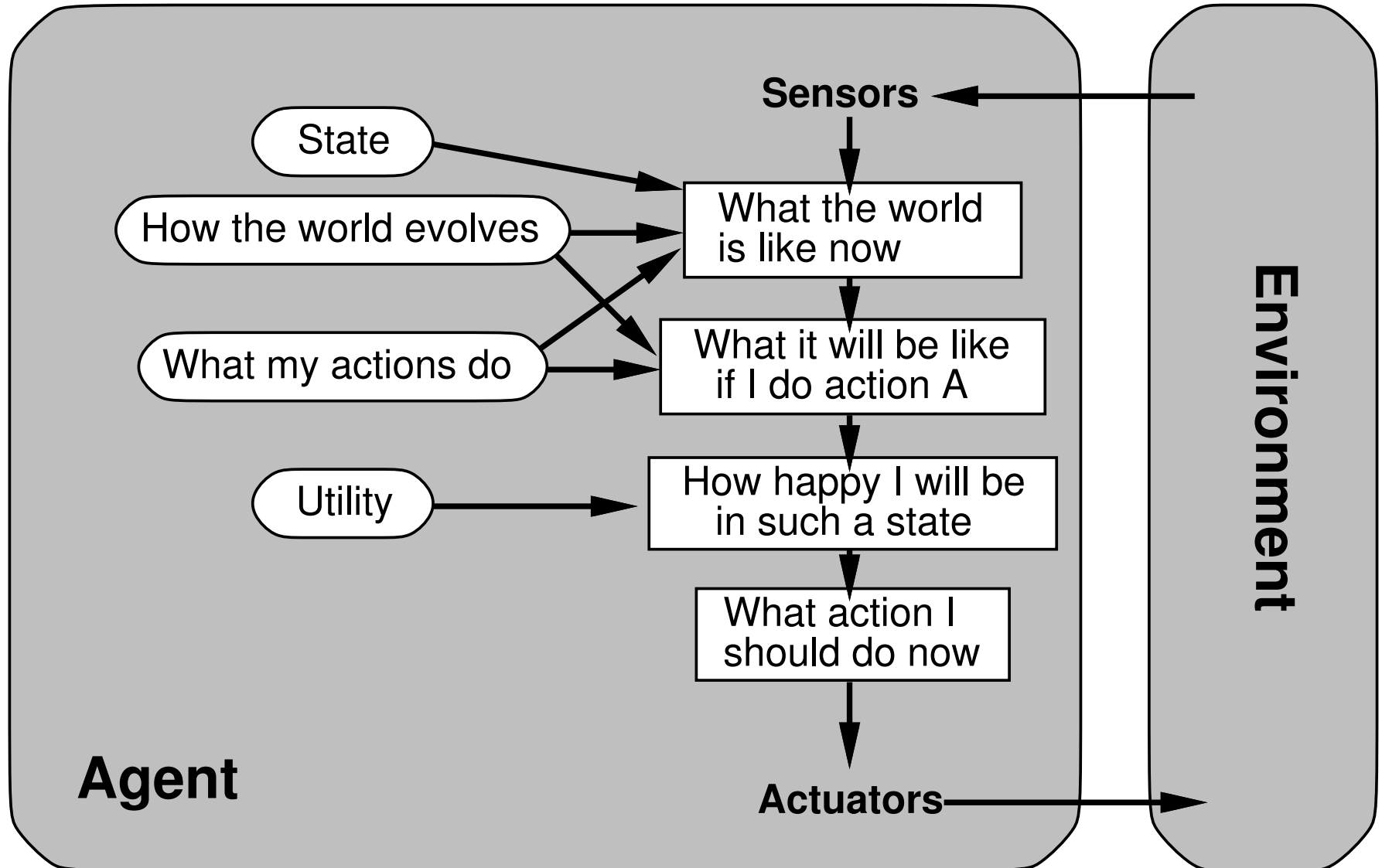
Model-based reflex agents



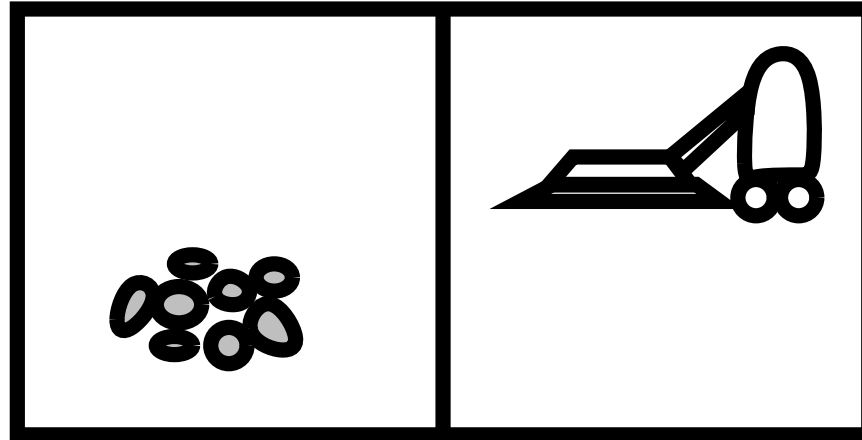
Goal-based agents



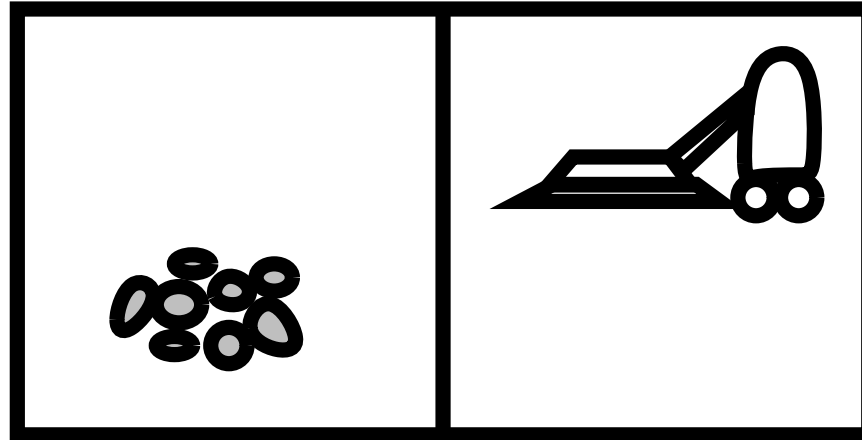
Utility-based agents



The vacuum-cleaner world



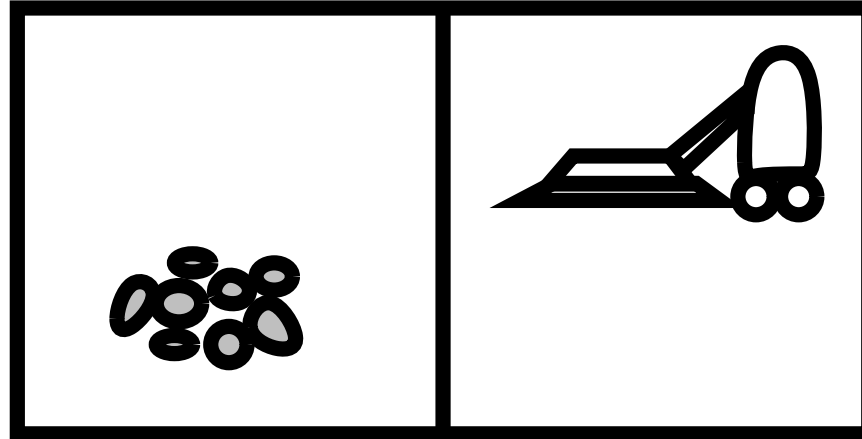
The vacuum-cleaner world



Percepts

- location
- *dirty / not dirty*

The vacuum-cleaner world



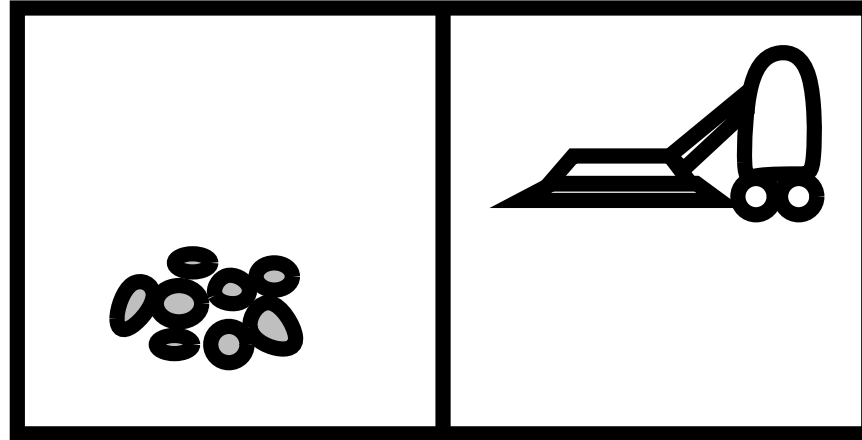
Percepts

- location
- *dirty / not dirty*

Actions

- *left*
- *right*
- *suck*
- *noOp*

The vacuum-cleaner world



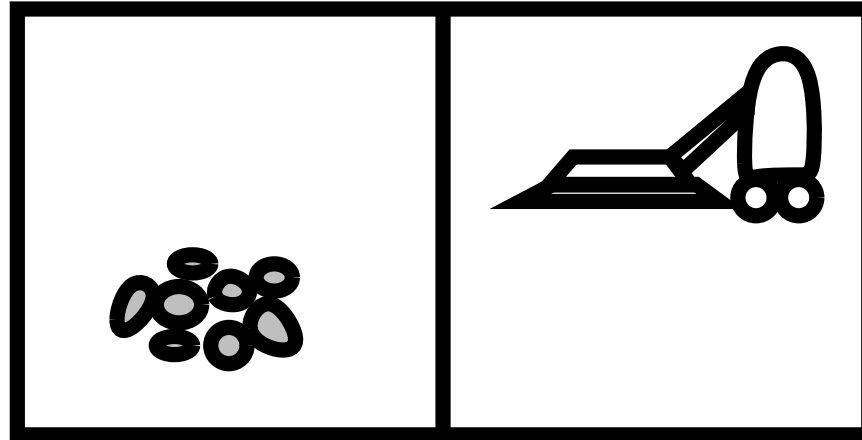
Performance measure

- +100 for each piece of dirt cleaned up
- 1 for each action
- 1000 for shutting off away from home

Environment

- grid
- dirt distribution and creation

The vacuum-cleaner world



Observable? Deterministic? Episodic? Static? Discrete?