ARTIFICIAL INTELLIGENCE

2023/2024 Semester 2

Intelligent Agents: Chapter 2

Outline

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

Agents

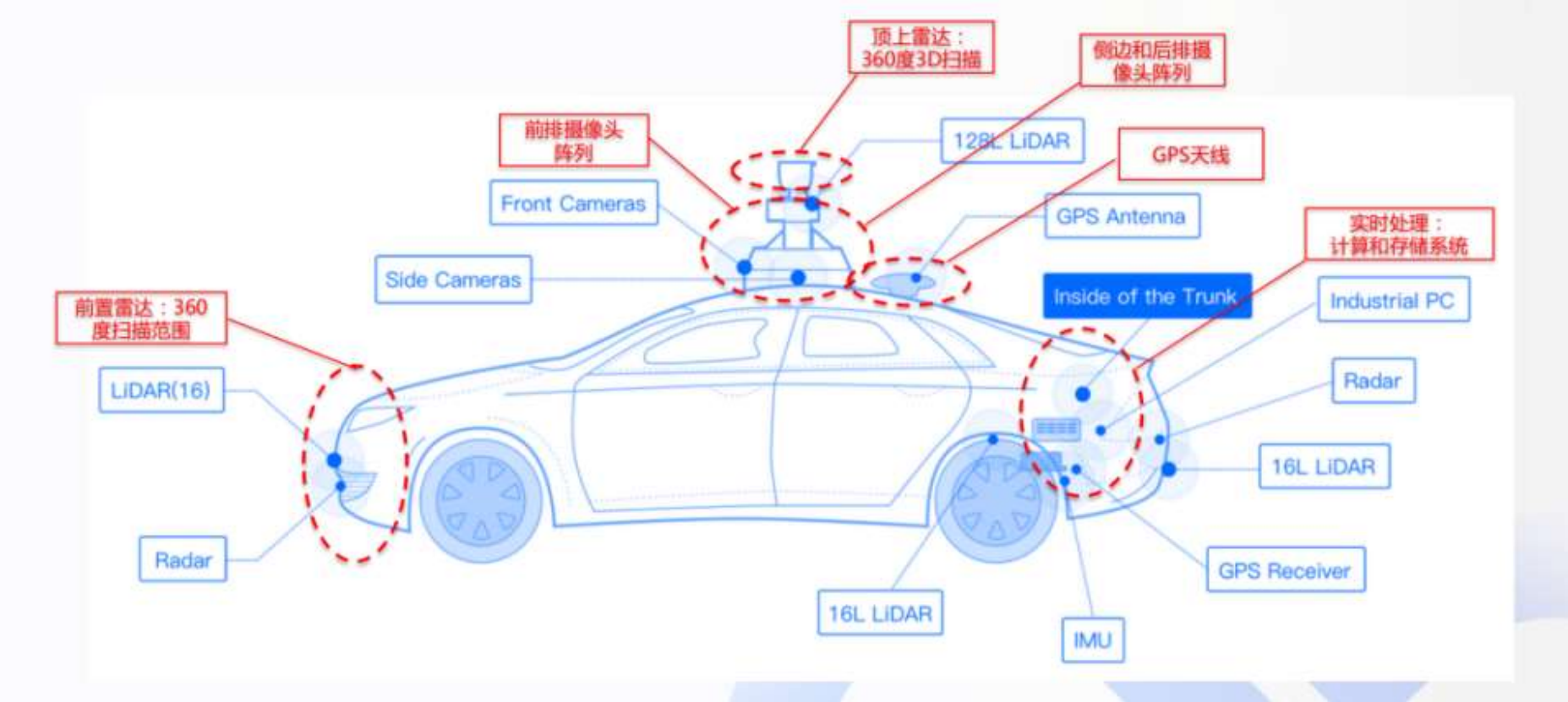
- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators

- Human agent: eyes, ears, and other organs for sensors; hands, legs, mouth, and other body parts for actuators

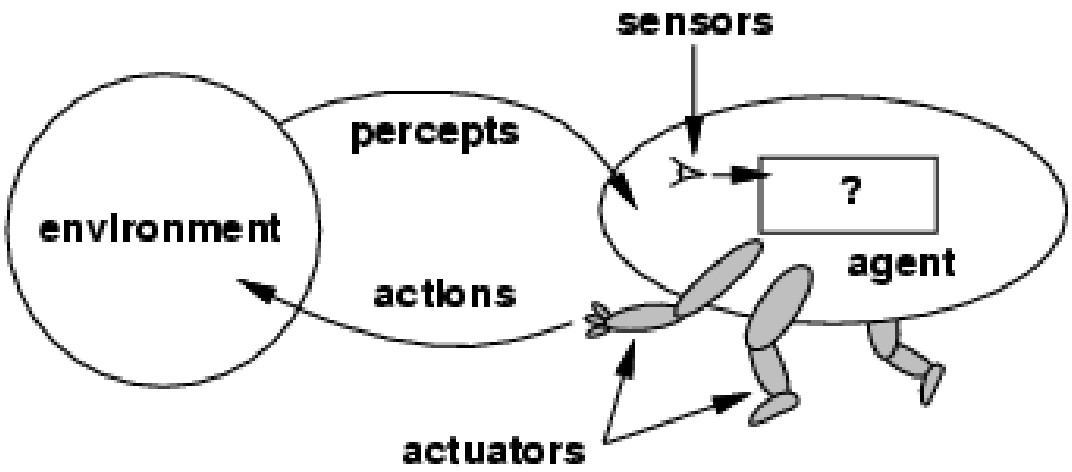
- Robotic agent: cameras and infrared range finders for sensors; various motors for actuators

Agents

- Self-driving Car agent



Agents and environments

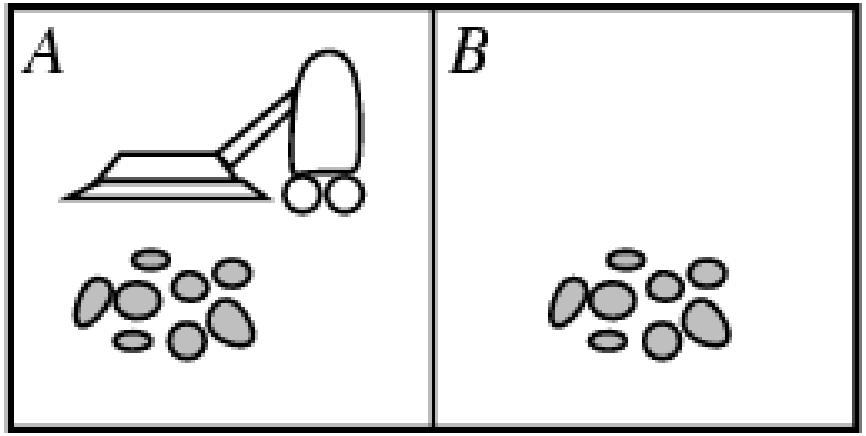


- The agent function maps from percept histories to actions:

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

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

Vacuum-cleaner world



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

Vacuum-cleaner world

Example vacuum agent program:

function 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

Rational agents

- An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform. The right action is the one that will cause the agent to be most successful.

- **Performance measure:** An objective criterion for success of an agent's behavior.

- E.g., performance measure
  - amount of dirt cleaned up, amount of time taken
  - amount of electricity consumed, amount of noise generated

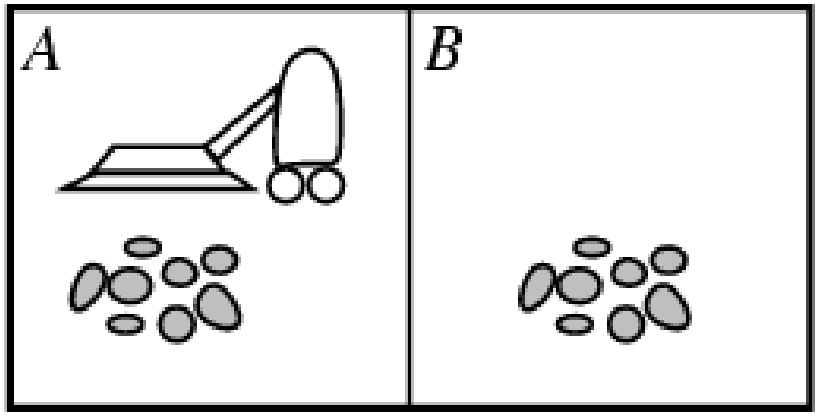
Rational agents

- Rational Agent: For each possible percept sequence, a rational agent should select an action that is expected
  - to maximize its performance measure,
  - given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

Rational agents

- Rationality is distinct from omniscience (all-knowing with infinite knowledge)
- Agents can perform actions in order to modify future percepts so as to obtain useful information (information gathering, exploration)
- An agent is autonomous if its behavior is determined by its own experience (with ability to learn and adapt)

Back to vacuum-cleaner world



- **Percepts:**

  Location and status,

  e.g., [A, Dirty]

- **Actions:**

  Left, Right, Suck, NoOp

function 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
- Is this agent rational?
  - Depends on performance measure, environment properties

PEAS

- PEAS: Performance measure, Environment, Actuators, Sensors
- Must first specify the setting for intelligent agent design

- Consider, e.g., the task of designing an automated taxi driver:
  - Performance measure
  - Environment
  - Actuators
  - Sensors

PEAS

- Must first specify the setting for intelligent agent design
- Consider, e.g., the task of designing an automated taxi driver:
  - **Performance measure:** Safe, fast, legal, comfortable trip, maximize profits
  - **Environment:** Roads, other traffic, pedestrians, customers
  - **Actuators:** Steering wheel, accelerator, brake, signal, horn
  - **Sensors:** Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard

PEAS

- Agent: Medical diagnosis system
  - **Performance measure:** Healthy patient, minimize costs, lawsuits
  - **Environment:** Patient, hospital, staff
  - **Actuators:** Screen display (questions, tests, diagnoses, treatments, referrals)
  - **Sensors:** Keyboard (entry of symptoms, patient's answers, examination reports)

PEAS

- Agent: Part-picking robot
  - **Performance measure:** Percentage of parts in correct bins
  - **Environment:** Conveyor belt with parts, bins
  - **Actuators:** Jointed arm and hand
  - **Sensors:** Camera, joint angle sensors

PEAS

- Agent: Interactive English tutor
  - **Performance measure:** Maximize student's score on test
  - **Environment:** Set of students
  - **Actuators:** Screen display, Speaker (exercises, suggestions, corrections)
  - **Sensors:** Keyboard

PEAS

- Agent: Spam filter
  - **Performance measure: ?**
  - **Environment :?**
  - **Actuators:?**
  - **Sensors :?**

Environment types

- Fully observable (vs. partially observable): An agent's sensors give it access to the complete state of the environment at each point in time.

- Deterministic (vs. stochastic): The next state of the environment is completely determined by the current state and the action executed by the agent. (If the environment is deterministic except for the actions of other agents, then the environment is strategic)

- Episodic (vs. sequential): The agent's experience is divided into atomic "episodes" (each episode consists of the agent perceiving and then performing a single action), and the choice of action in each episode depends only on the episode itself.

Environment types

- Static (vs. dynamic): The environment is unchanged while an agent is deliberating. (The environment is semidynamic if the environment itself does not change with the passage of time but the agent's performance score does)
- Discrete (vs. continuous): A limited number of distinct, clearly defined percepts and actions.
- Single agent (vs. multiagent): An agent operating by itself in an environment.

Environment types

	Chess with a clock	Chess without a clock	Taxi driving
Fully observable	Yes	Yes	No
Deterministic	Strategic	Strategic	No
Episodic	No	No	No
Static	Semi	Yes	No
Discrete	Yes	Yes	No
Single agent	No	No	No

- The environment type largely determines the agent design
- The real world is (of course) partially observable, stochastic, sequential, dynamic, continuous, multi-agent

Agent functions and programs

- An agent is completely specified by the agent function mapping percept sequences to actions
- One agent function (or a small equivalence class) should be rational

- Aim: find a way to implement the rational agent function concisely

Table-lookup agent

- \input{algorithms/table-agent-algorithm}

- Drawbacks:
  - Huge table
  - Take a long time to build the table
  - No autonomy
  - Even with learning, need a long time to learn the table entries

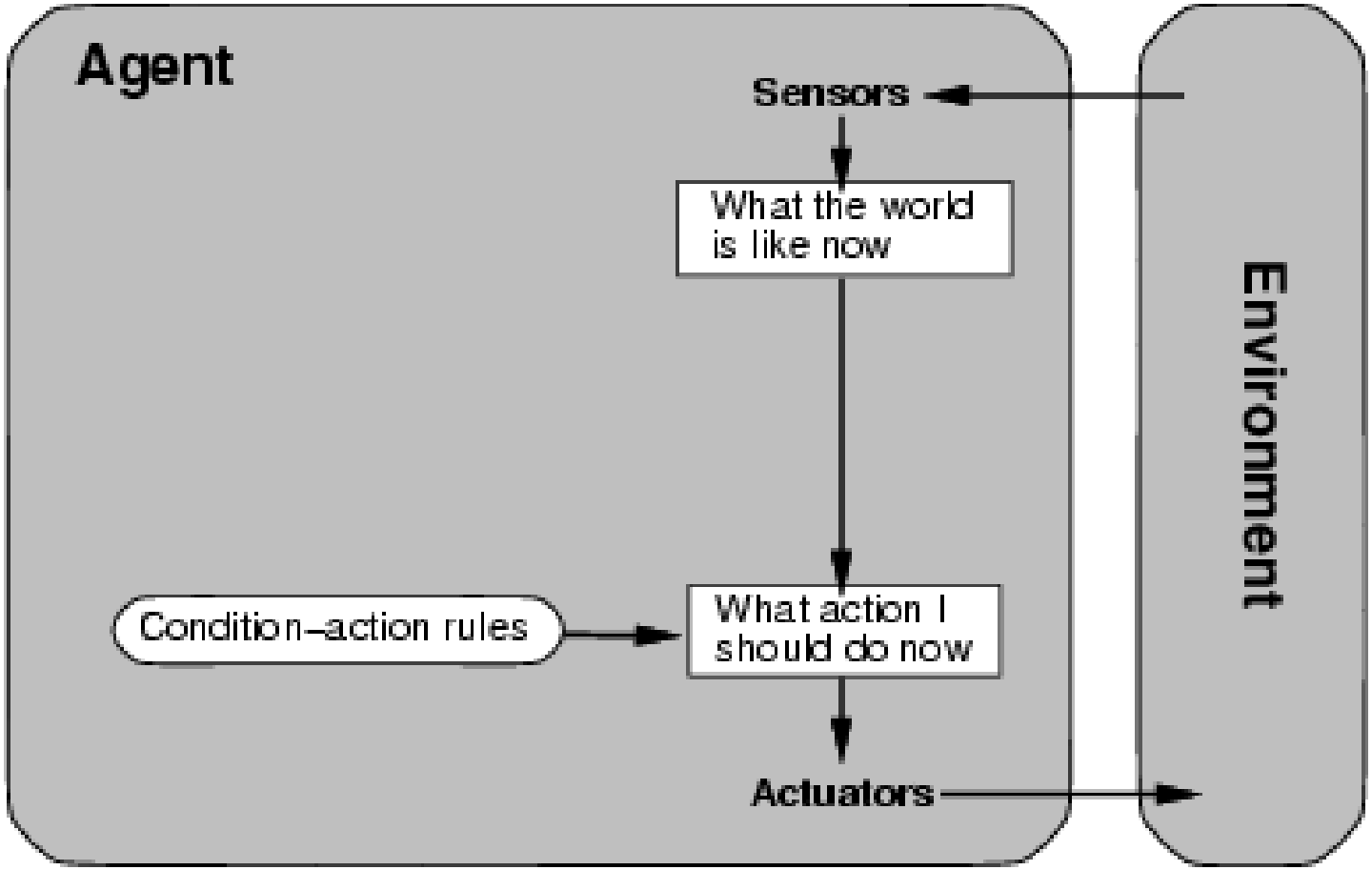
Agent types

- Four basic types in order of increasing generality:

- Simple reflex agents
- Model-based reflex agents
- Goal-based agents
- Utility-based agents

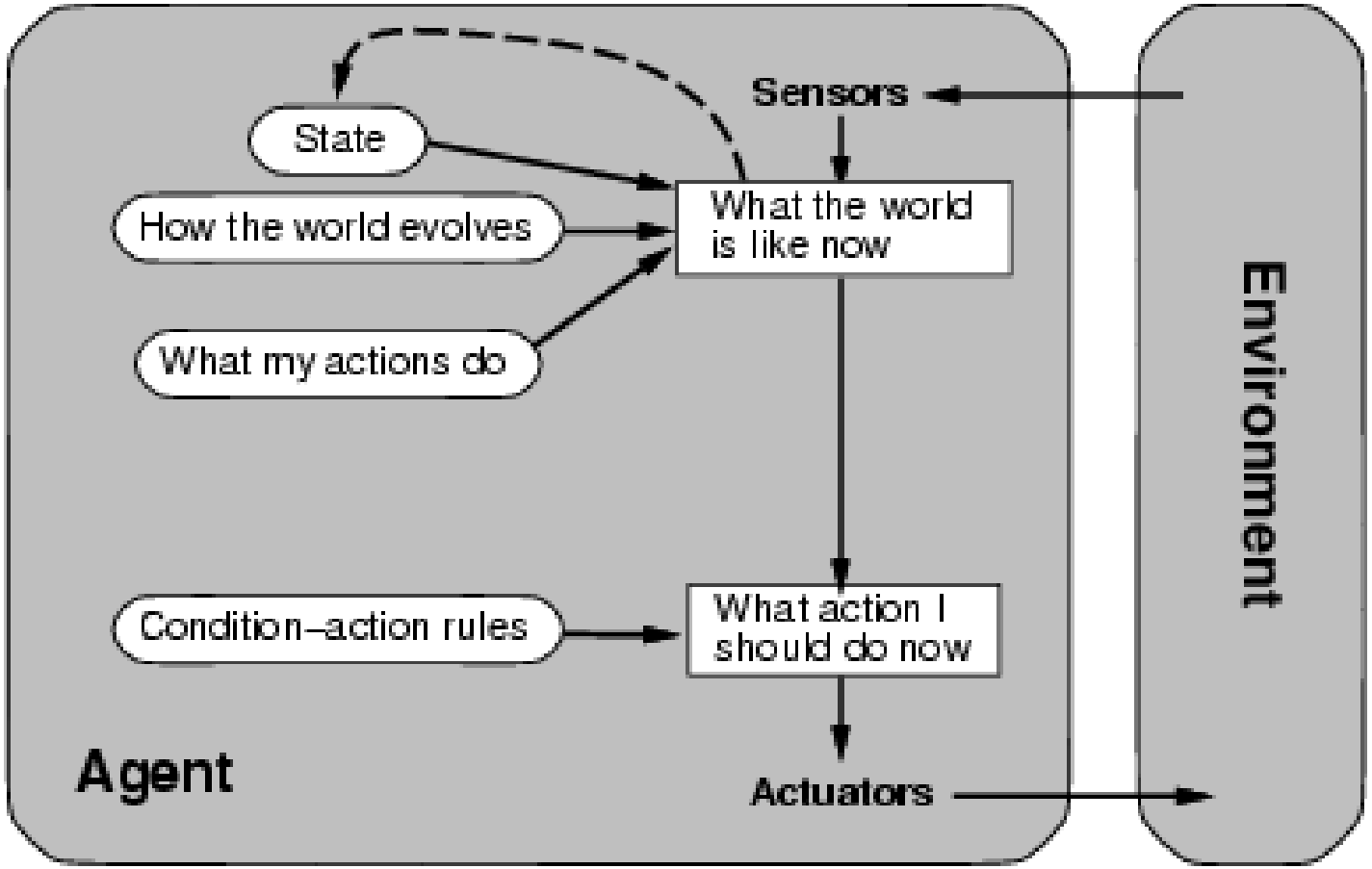
Simple reflex agents

Select action on the basis of current percept, ignoring all past percepts



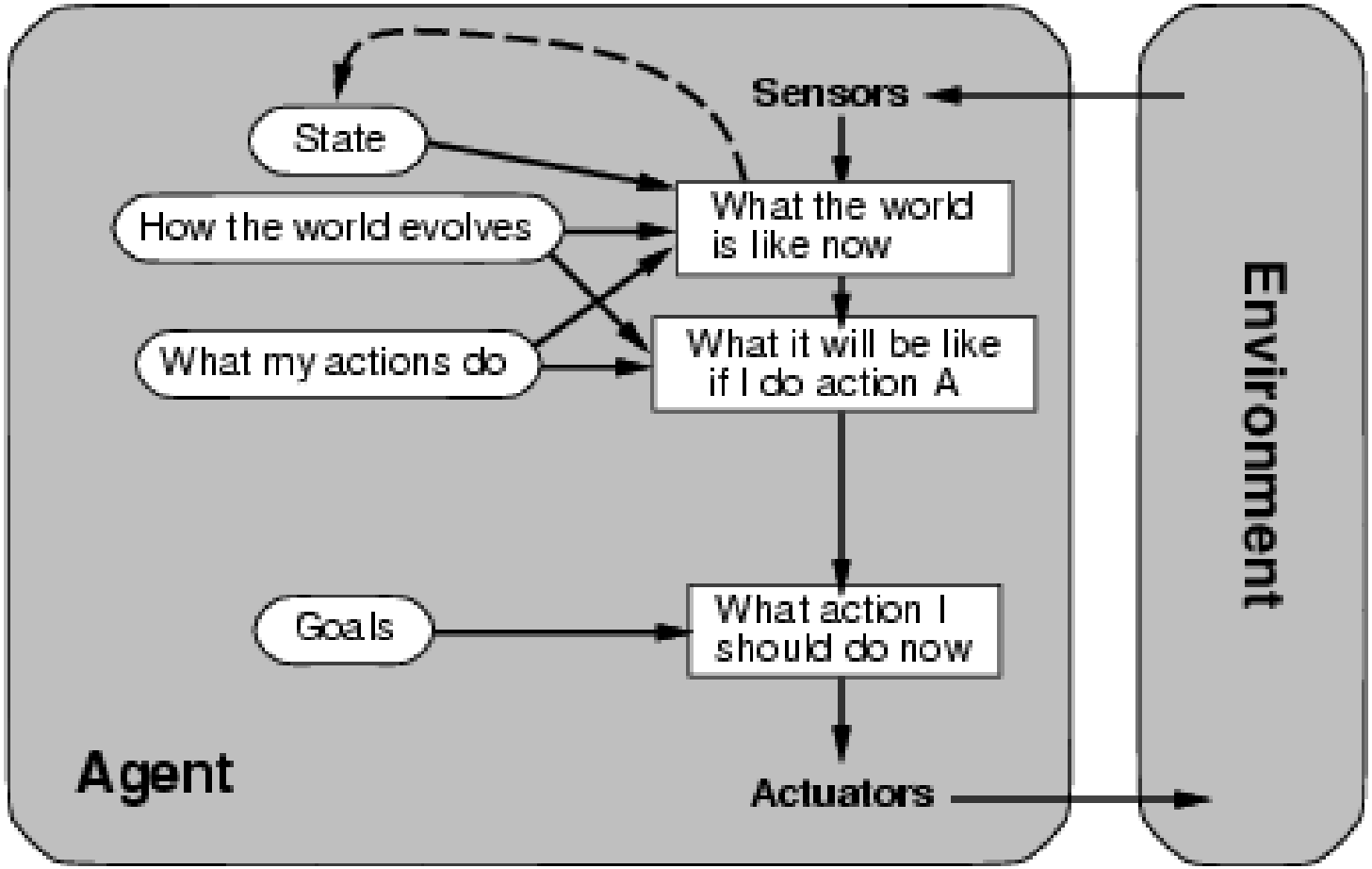
Model-based reflex agents

Maintains internal state that keeps track of aspects of the environment that cannot be currently observed



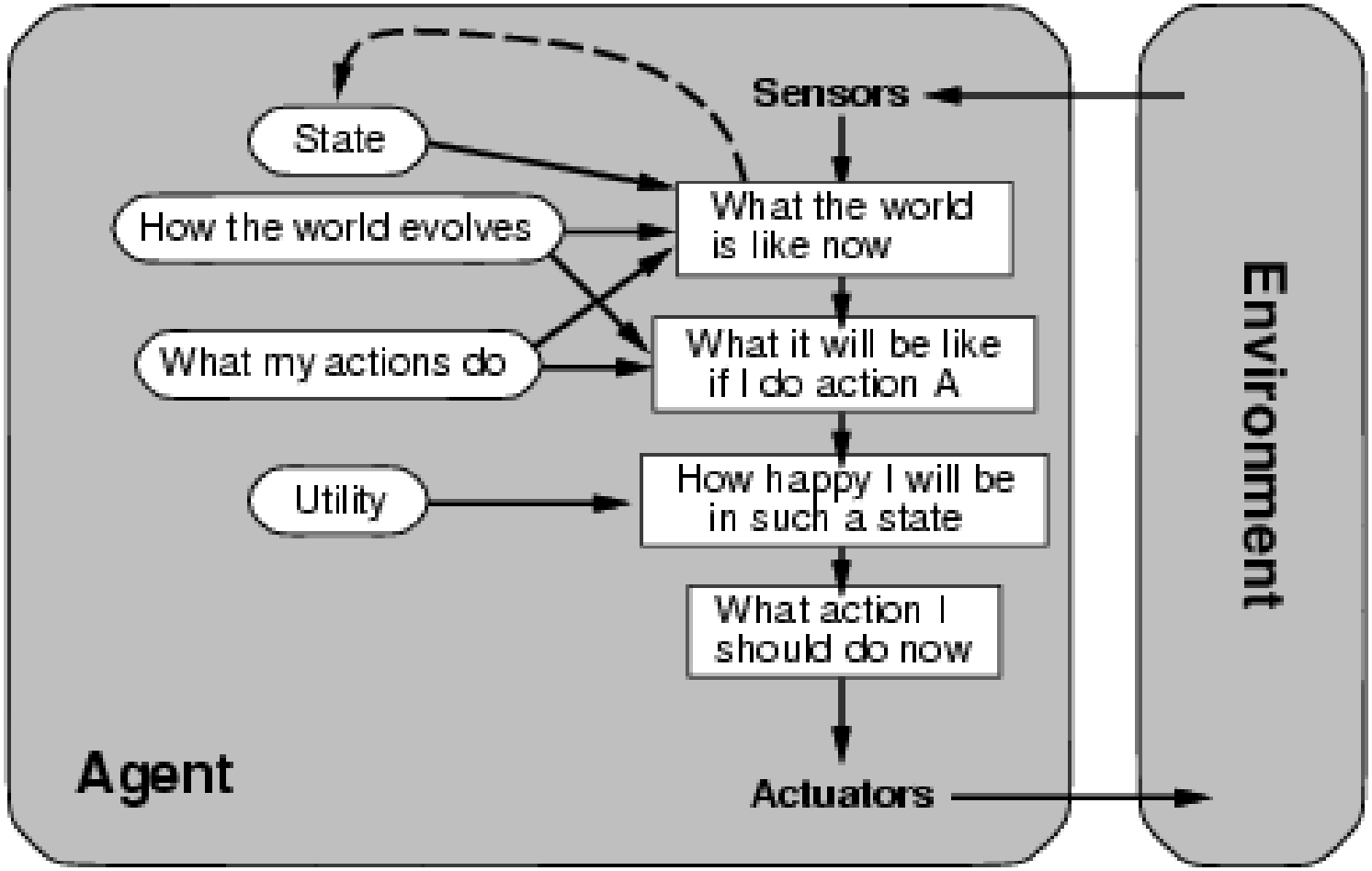
Goal-based agents

The agent uses goal information to select between possible actions in the current state

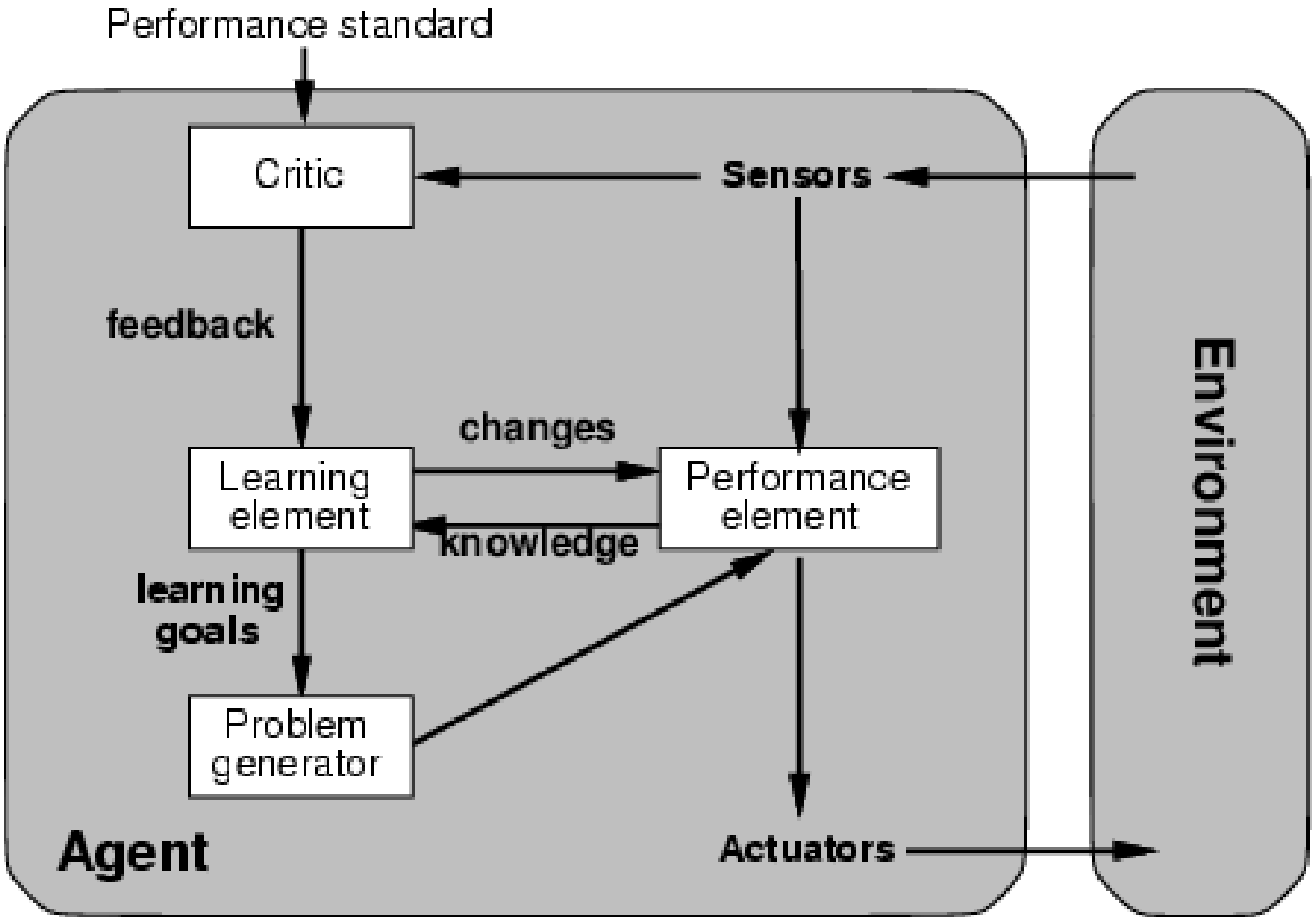


Utility-based agents

The agent uses a utility function to evaluate the desirability of states that could result from each possible action



Learning agents



Questions?

Homework

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