CSE 604

Artificial Intelligence

Chapter 2: Intelligent Agents

Adapted from slides available in Russell & Norvig's textbook webpage

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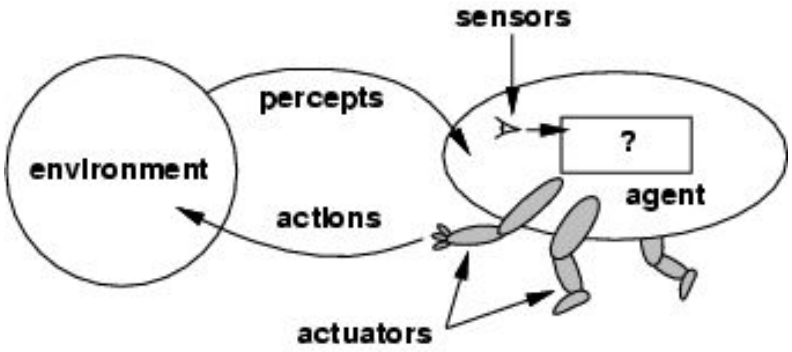
Outline

- 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
- **Software agent**: receives keystrokes, file contents, network packets as sensory inputs; acts by displaying on screen, writing files etc.

Agents and environments

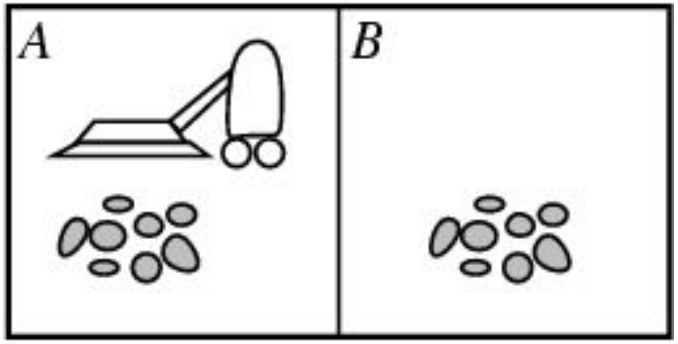


- The agent function maps from percept histories to actions:

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

- 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*

Rational Agent

- A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date
- Rational ≠ omniscient
  - percepts may not supply all relevant information
- Rational ≠ clairvoyant
  - action outcomes may not be as expected
- Hence, rational ≠ successful
- Rational ⇒ exploration, learning, autonomy

Rational agents

- An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform.

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

- E.g., performance measure of a vacuum-cleaner agent could be :
  - amount of dirt cleaned up
  - amount of time taken
  - amount of electricity consumed

PEAS

- Specifying the task environment:
  - **P**erformance measure
  - **E**nvironment
  - **A**ctuators
  - **S**ensors

PEAS

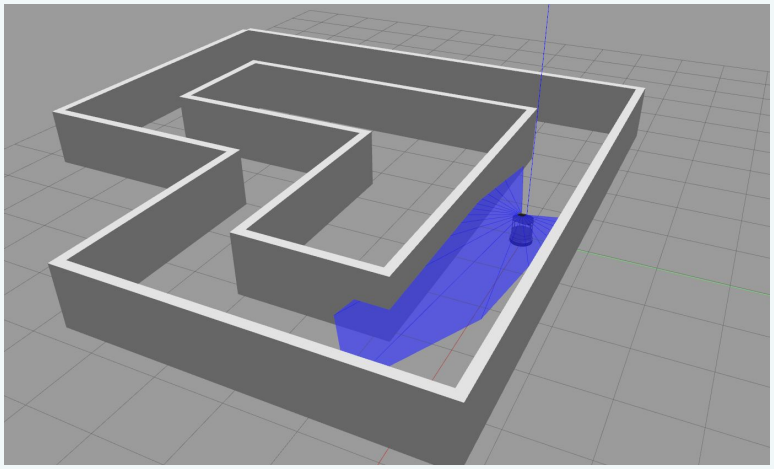
- Agent: **Part-picking robot**
  - **Performance measure**: % of parts in correct bins
  - **Environment**: Conveyor belt, parts, bins
  - **Actuators**: Jointed arm and hand
  - **Sensors**: Camera, joint angle sensors

PEAS

- Agent: **Automated car**
  - **Performance measure**: Safe, fast, legal, comfortable trip
  - **Environment**: Roads, other traffic, pedestrians
  - **Actuators**: Steering wheel, accelerator, brake
  - **Sensors**: Camera, GPS, Speedometer, engine sensor

Environment types

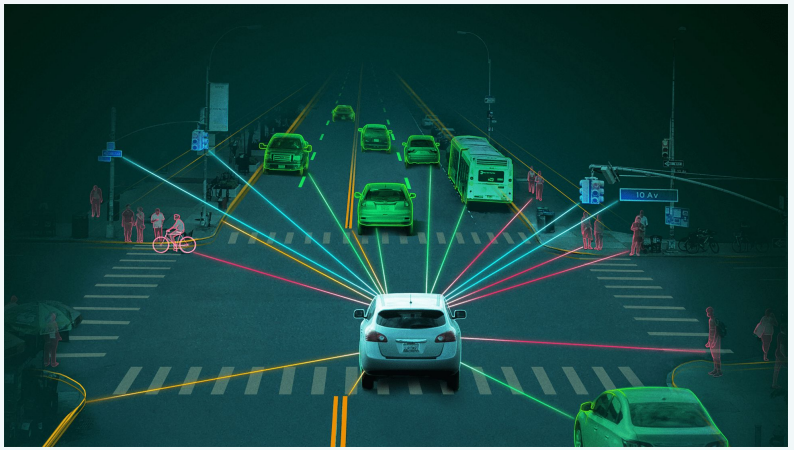
- Fully observable vs. partially observable
- Single agent vs. multiagent
- Deterministic vs. stochastic
- Episodic vs. sequential
- Static vs dynamic
- Discrete vs continuous

Fully Observable	Partially Observable
Agent can observe (see/hear/perceive) all relevant information from the environment	Agent can observe only partial information from the environment
	

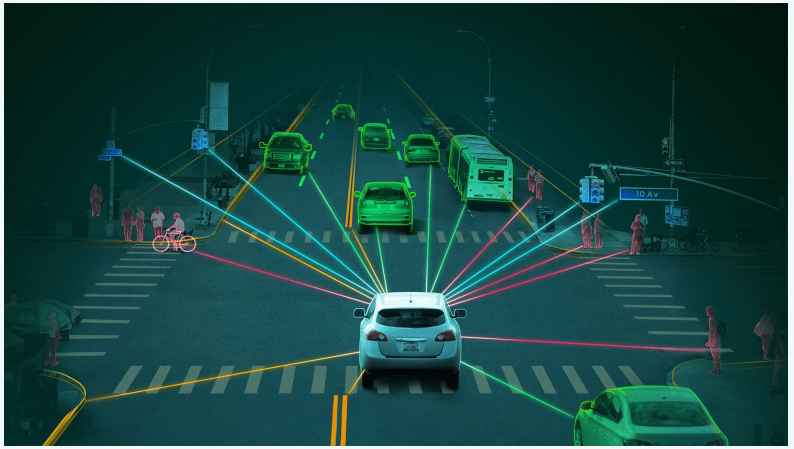
Single Agent	Multiagent
Our agent is the only intelligent agent in the environment	There are multiple intelligent agents which can be either cooperative or competitive
	

Deterministic	Stochastic
Agent can fully determine the outcome of it's action (next step, not necessarily the full task)	Agent is uncertain of the outcome of it's action

Episodic	Sequential
Agent's actions are completely independent of each other, not linked to past or future actions	Agent's actions are dependent on it's past/future actions. The actions form a sequence.

Static	Dynamic
While the agent is in the process of taking it's action, the environment doesn't change	The environment is constantly changing even when the agent is taking an action
	

Discrete	Continuous
Agent's task can be broken down into discrete set of actions (you can make a list of agent's actions A_1, A_2, ..., A_n)	Actions are happening continuously and can not be listed, i.e., you cannot say where one action ends and the other begins



Environment types

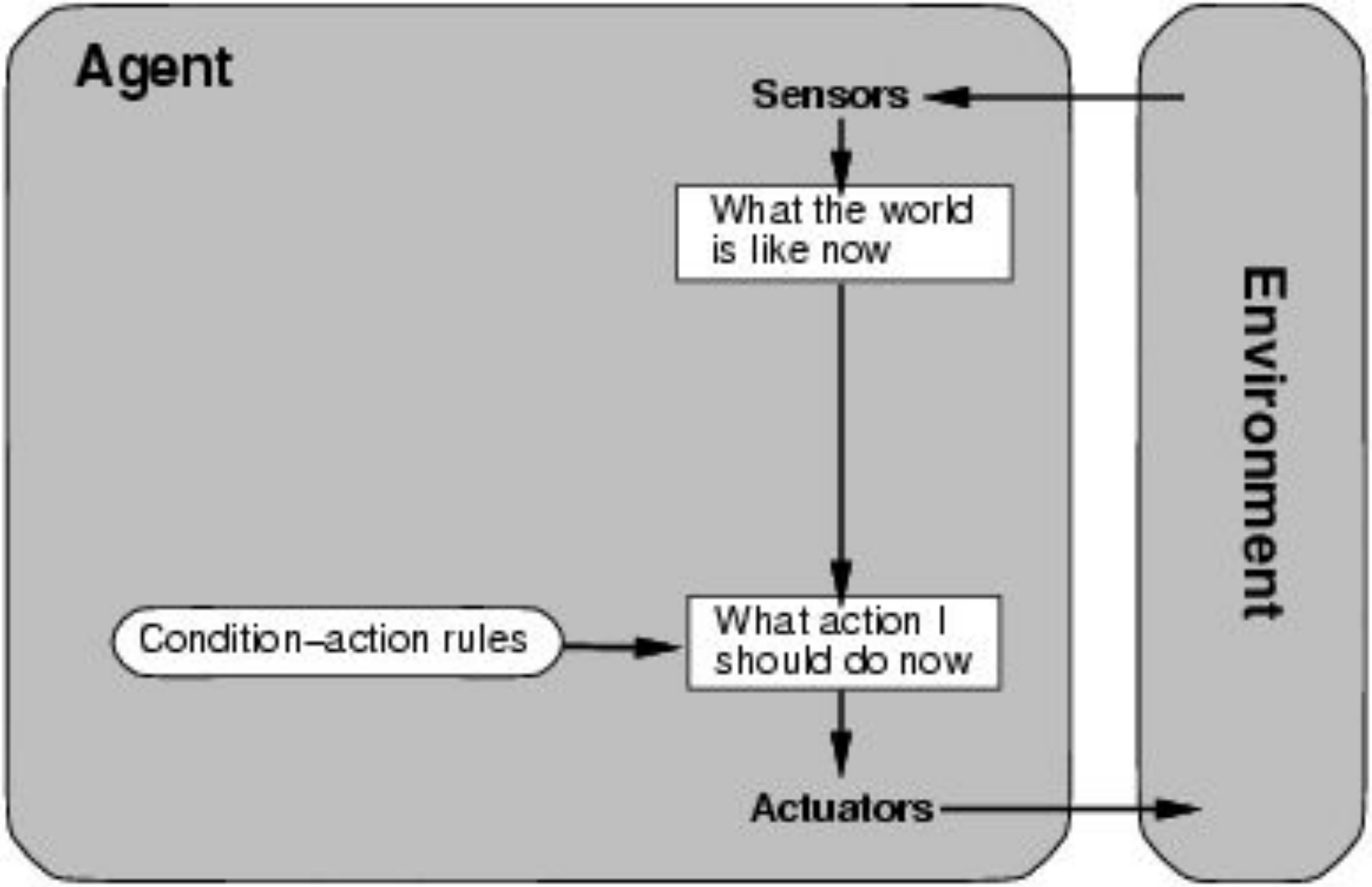
	Chess with a clock	Chess without a clock	Taxi driving
Fully observable	Yes	Yes	No
Deterministic	Strategic	Strategic	No
Episodic	No	No	No
Static	Semi	Yes	No
Discrete	Yes	Yes	No
Single agent	No	No	No

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

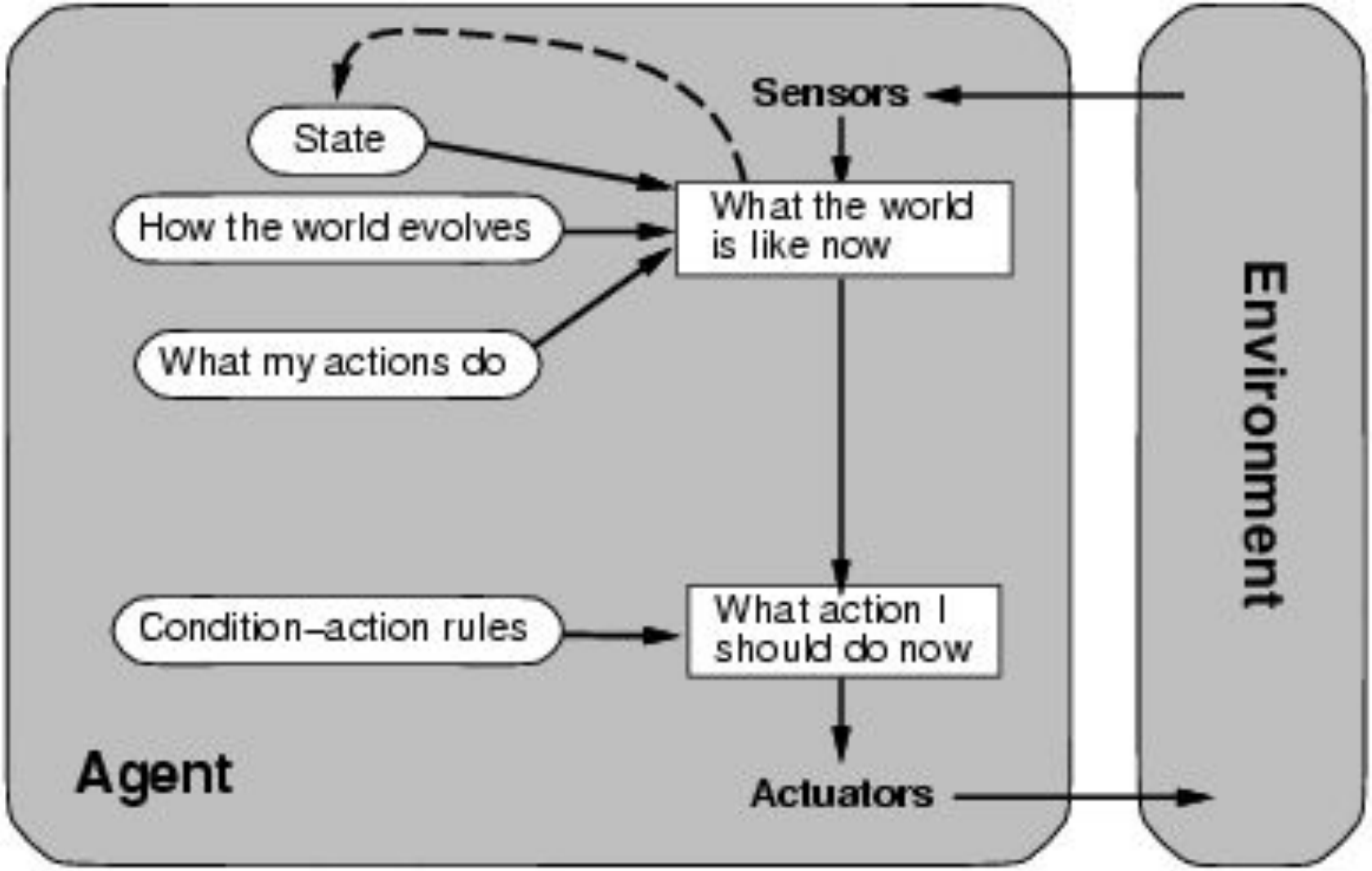
Agent types

- Four basic types in order of increasing generality:
  - Simple reflex agents
  - Model-based reflex agents
  - Goal-based agents
  - Utility-based agents

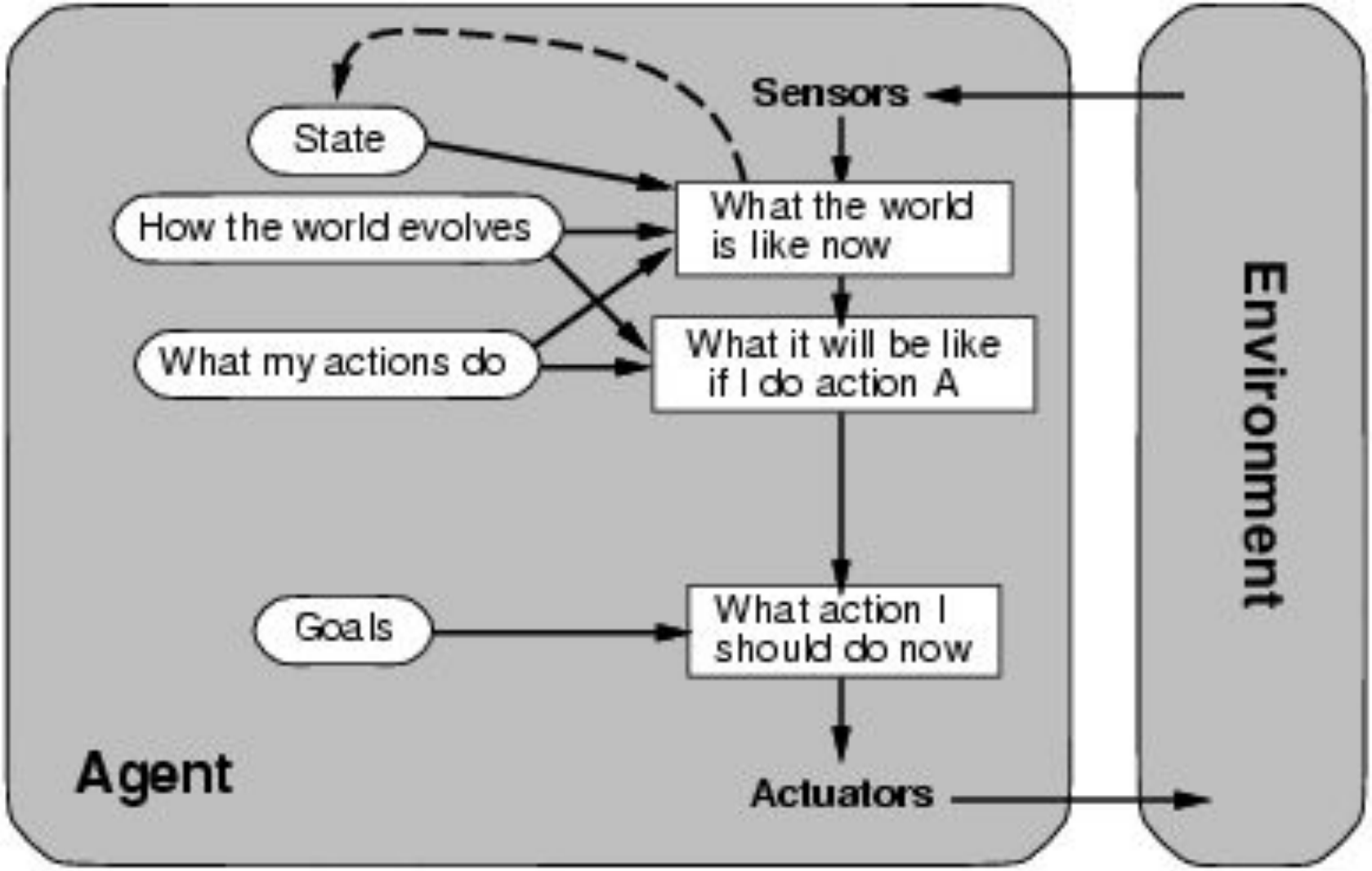
Simple reflex agents



Model-based reflex agents



Goal-based agents



Utility-based agents