Artificial Intelligence

Intelligent agents

"Artificial Intelligence - A Modern Approach", Chapter 2

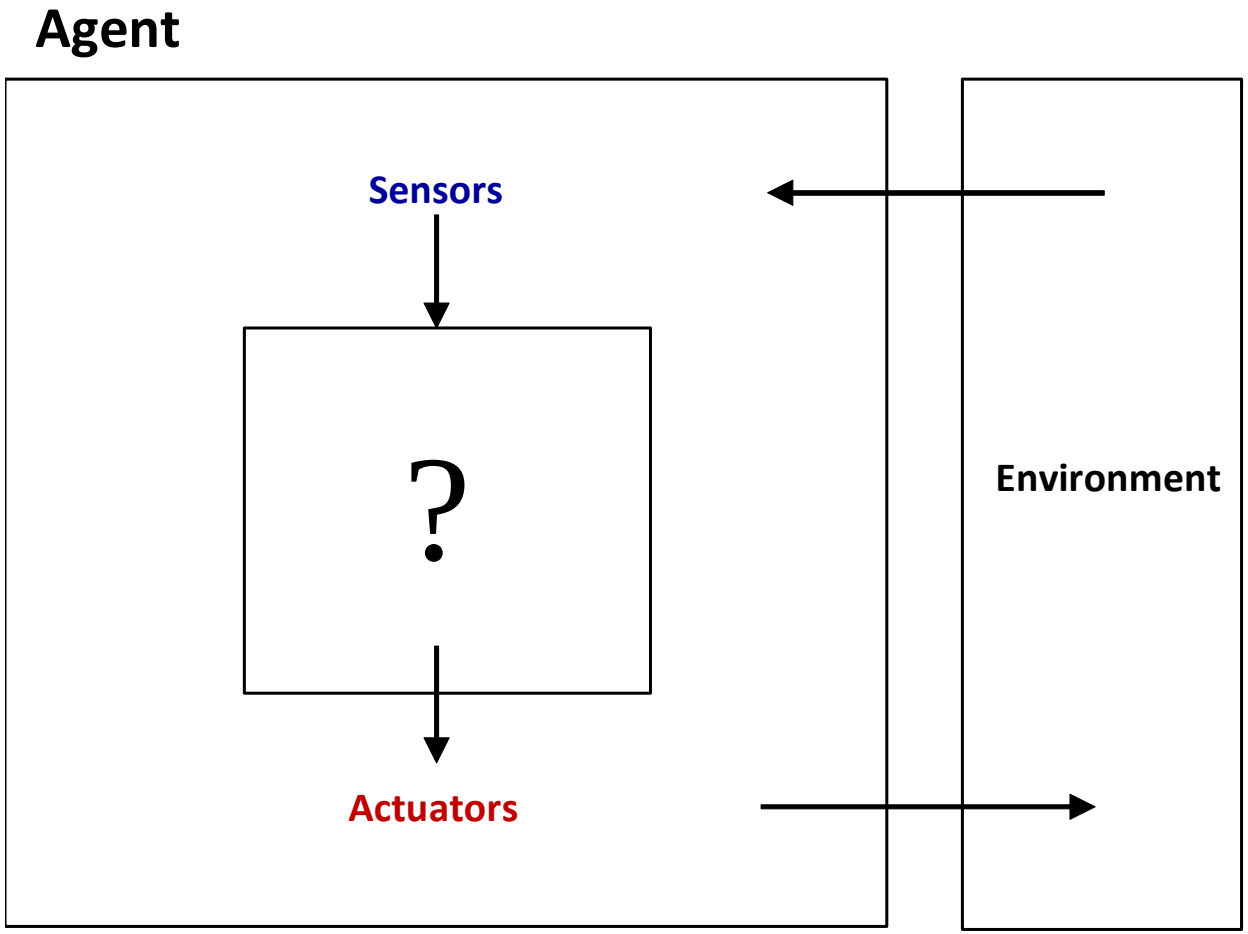
Slides by Carlos Grilo

The structure of agents

Agent = Architecture + Program

- Architecture = material support
- Program = function that links perceptions to actions

Agents



- Man: eyes, ..., hands, ...
- Robots: cameras, microphones, ..., wheels, “hands”, ...

How agents should behave

- Example: vacuum-cleaner agent
- Performance measures:
  - Amount of dirt cleaned (there is a trap here…)
  - Did it clean the floor?
  - Noise
  - Energy
  - Time
- When should the evaluation be done?

As a general rule, it is better to design performance measures according to what one actually wants in the environment, rather than according to how one thinks the agent should behave

Is it better to have an agent that cleans always at the same pace or one that cleans very fast and then rests a lot?

On rationality

- Intelligent = Rational
- A rational agent acts so as to achieve the best possible outcome or, when there is uncertainty, the best expected outcome (do you remember of this first approximation?)
- Being rational depends on:
  - An (objective) performance measure
  - The agent's prior knowledge of the environment
  - The actions that the agent can perform
  - The agent's percept sequence (~ Omniscience)

Rational agents

A rational agent, for each percept sequence, selects 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

- A rational agent should be able to learn
- A rational agent should be as autonomous as possible

PEAS descriptions

Agent type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite images analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, … values
Taxi driver	Security Velocity Comfort Profit...	Streets,Traffic People in the streets, Clients	Acelerate, Brake, Talk,...	Cameras, Velocimeters, GPS, Sonar, Microphone,

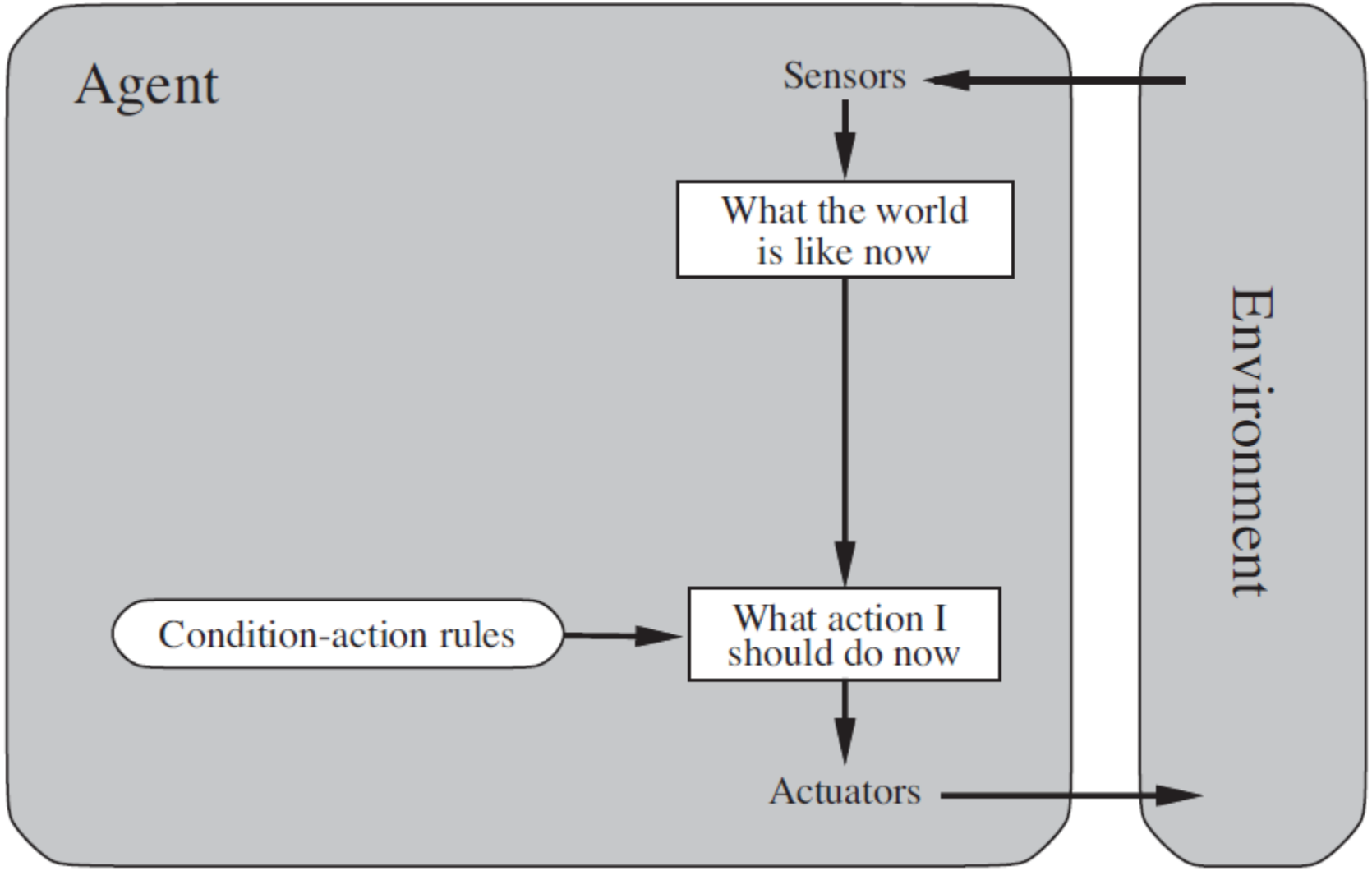
Agents' types

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

Simple reflex agents

- Just react to the most recent perception
- Answer always the same way to the same perceptions
- Don’t possess general knowledge about the domain
- Don’t have the hability to adapt to new environments
- They are simple but they turn out to be of limited intelligence

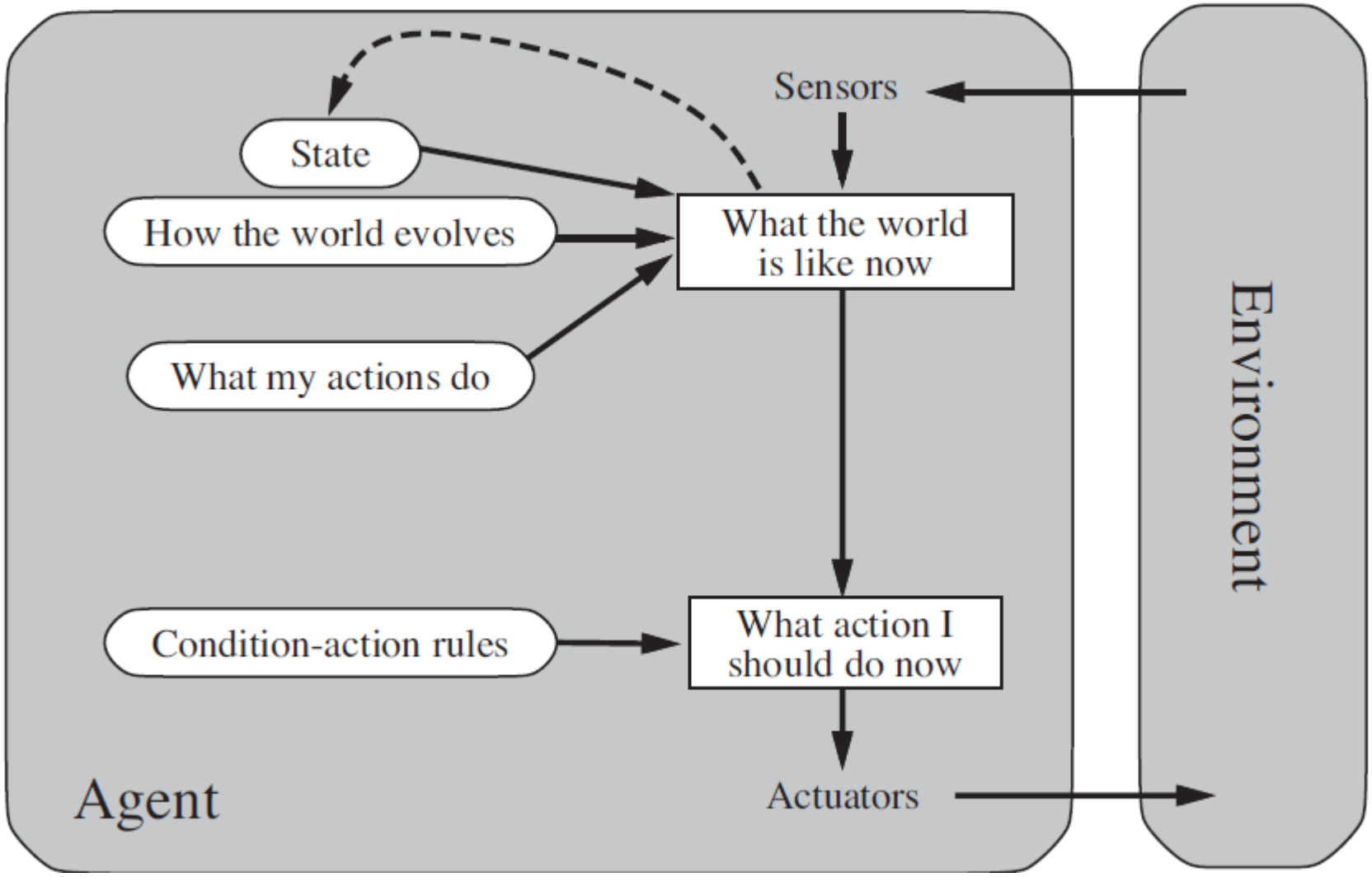
Simple reflex agents



Model-based reflex agents

- They are reflexive agents...
- However, they maintain an internal state that depends on the percept history and thereby reflects at least some of the unobserved aspects of the environment
- In order to maintain the internal state, they need:
  - Information about how the world evolves
  - Information about how their actions affect the world

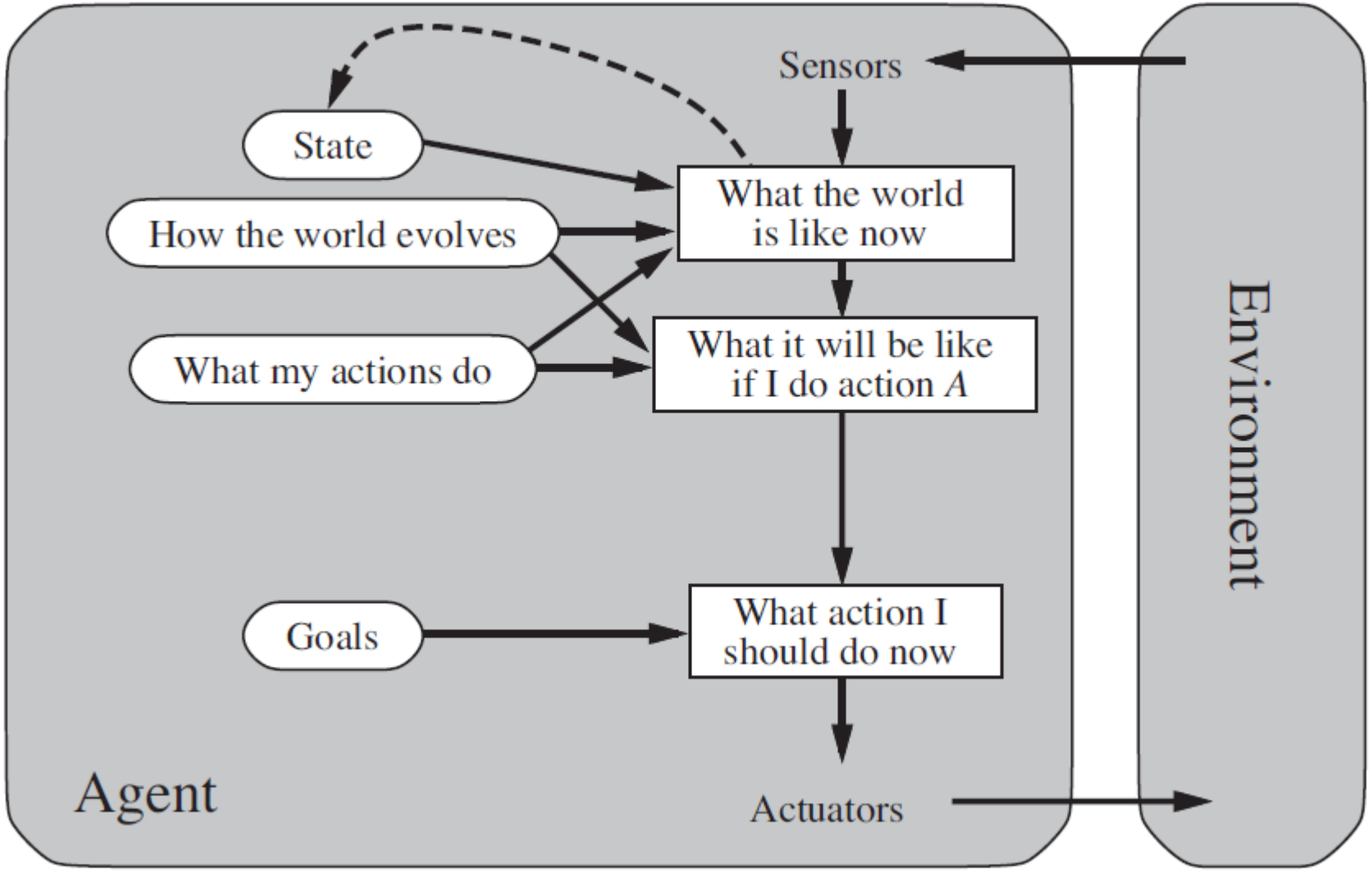
Model-based reflex agents



Goal-based agents

- These agents can use information about the consequences of their actions in order to choose an action that allows them to reach the goal
- This choice may be complicated when several actions must be considered in order to reach the goal
- In these cases it is necessary to use search or planning methods

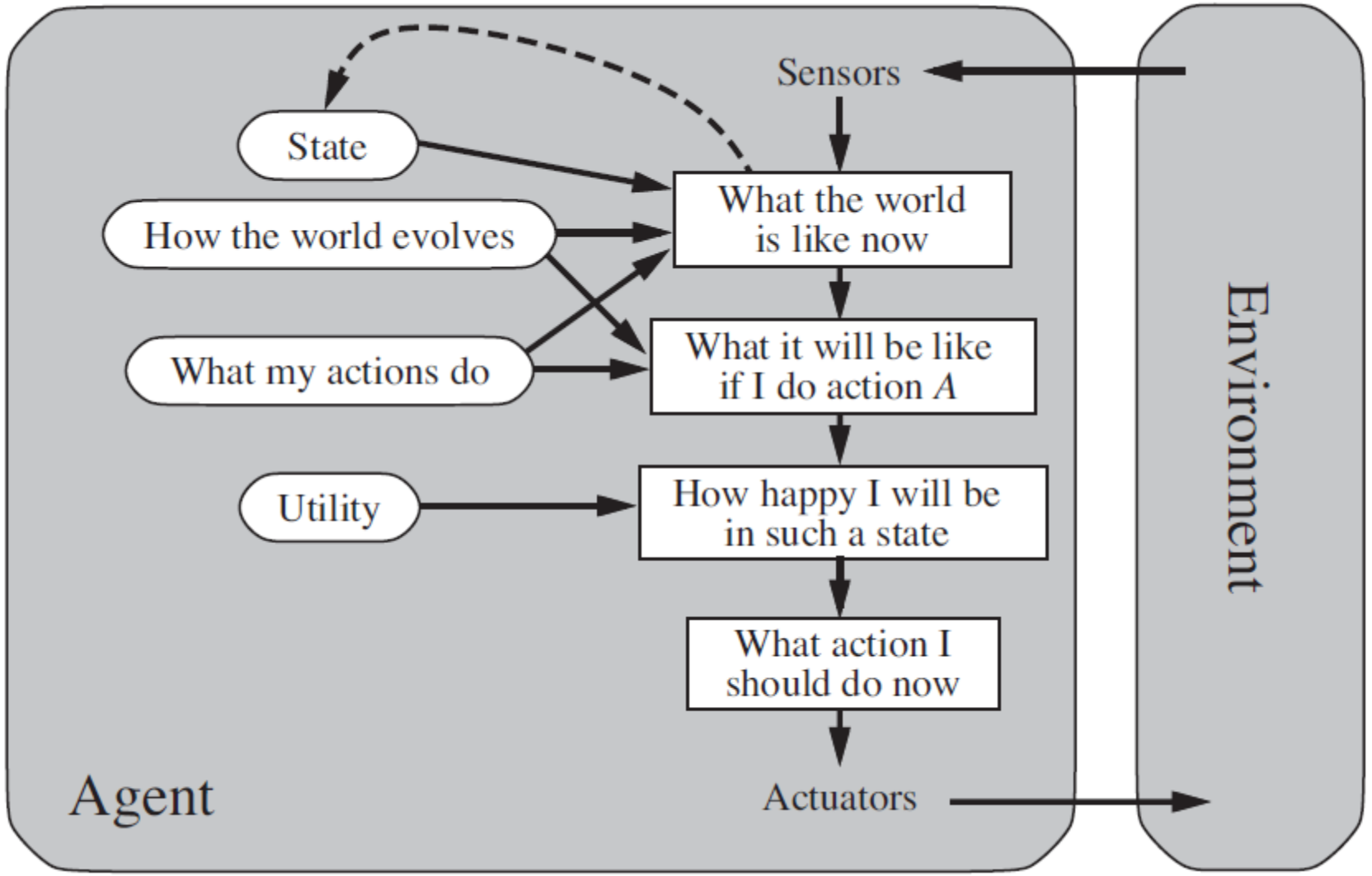
Goal-based agents



Utility-based agents

- Usually, there are several ways of reaching a goal, but some are better than others...
- This type of agents uses an utility function that maps each state into a real number reflecting the degree of success reached by the agent
- After computing these values, the agent chooses the action that leads to the best expected utility

Utility-based agents



Environments

- The study of the properties of the environments in which agents must live is important since they can influence the type of agent that one should build

- Properties of environments:
  - Fully observable vs. Partially observable
  - Deterministic vs. stochastic
  - Episodic vs. Sequential
  - Static vs. Dynamic
  - Discrete vs. Continuous

Properties of environments

- Fully observable vs. Partially observable
  - If the agent's sensors give it access to the complete state of the environment at each point in time, then we say that the environment is fully observable
  - A fully observable environment is more convenient because the agent does not need to save information about the environment's state

Properties of environments

- Deterministic vs. stochastic
  - The environment is deterministic if the next state is completely defined by the current state and the action executed by the agent
  - If an environment is partially observable, it may seem stochastic

Properties of environments

- Episodic vs. Sequential
  - In an episodic environment the agent's experience is divided into atomic episodes, so that subsequent episodes do not depend on the actions done in previous episodes
  - Episodic environments are simpler than sequential ones because the agent does not need to think ahead (that is, consider the consequences of its actions in the future)

Properties of environments

- Static vs. Dynamic
  - An environment is dynamic if it may change while the agent "thinks"
  - It is easier to deal with static environments because the agent must not keep looking at the environment while it is deciding which action to take
  - If the environment does not change while the agent deliberates but its performance score does, we say that the environment is semi-dynamic

Properties of environments

- Discrete vs. Continuous
  - If there is a clearly defined number of perceptions and actions, we say that the environment is discrete

Properties of environments

Environment	Fully observable	Deterministic	Episodic	Static	Discrete
Chess	Yes	Yes	No	Yes	Yes
Chess with a Clock	Yes	Yes	No	Semi	Yes
Poker	No	No	No	Yes	Yes
Image analysis system	Yes	Yes	Yes	Semi	No
Taxi driving	No	No	No	No	No