# Artificial Agents

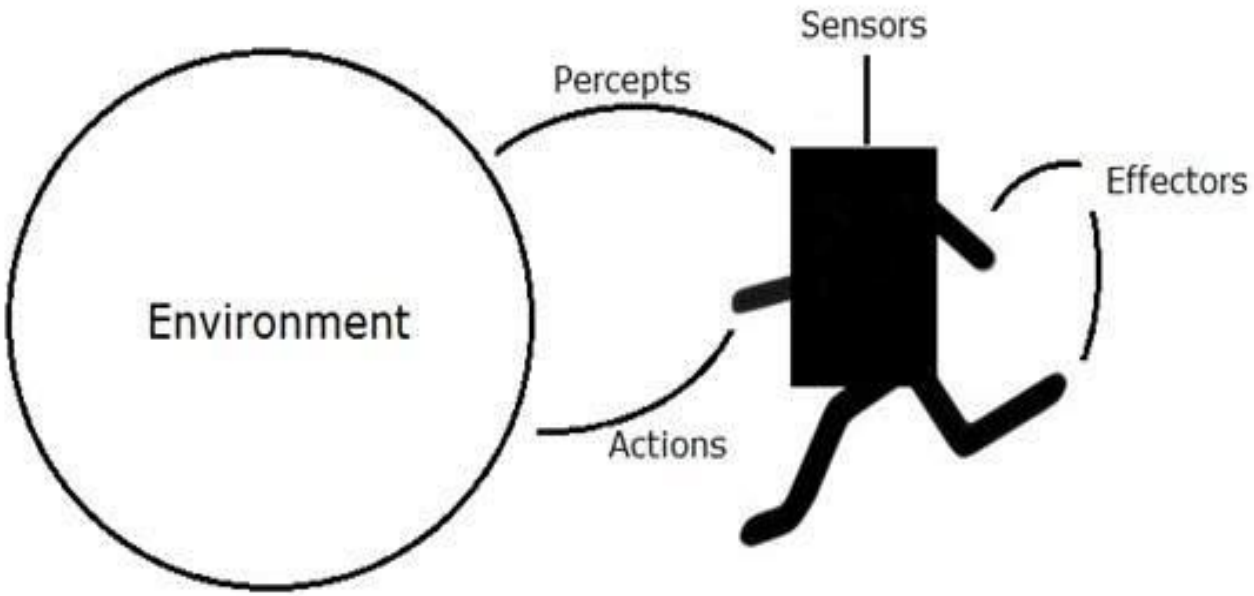
# Outline

- Agent and Environment
- Rational Agents
- Nature of Environment
- Structure of Agents

# Agent and Environment

- An AI system is composed of an agent and its environment. The agents act in their environment.
- The environment may contain other agents
- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

# Agents and Environment



# Types of Agents

- Human Agent
- Robotic Agent
- Software Agent

# Human Agent

- A **human agent** has sensory organs such as eyes, ears, nose, tongue and skin parallel to the sensors, and other organs such as hands, legs, mouth, for actuators.

# Robotics Agent

- A **robotic agent** replaces cameras and infrared range finders for the sensors, and various motors and actuators for actuators.

# Software Agents

- A software agent receives keystrokes, file contents, and network packets as sensory inputs and acts on the environment by displaying on the screen, writing files, and sending network packets

# Agent Terminology

- **Performance Measure of Agent** − It is the criteria, which determines how successful an agent is
- **Behavior of Agent** − It is the action that agent performs after any given sequence of percepts
- **Percept** − It is agent's perceptual inputs at a given instance.
- **Percept Sequence** − It is the history of all that an agent has perceived till date.
- **Agent Function** − It is a map from the precept sequence to an action.

# Example

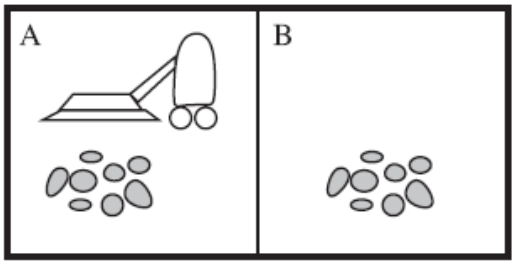



**Figure 2.2** A vacuum-cleaner world with just two locations.

| 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* |
| ⋮ | ⋮ |
| $[A, Clean], [A, Clean], [A, Clean]$ | *Right* |
| $[A, Clean], [A, Clean], [A, Dirty]$ | *Suck* |
| ⋮ | ⋮ |

**Figure 2.3** Partial tabulation of a simple agent function for the vacuum-cleaner world shown in Figure 2.2.

# Rationality

- Rationality is nothing but status of being reasonable, sensible, and having good sense of judgment.
- Rationality is concerned with expected actions and results depending upon what the agent has perceived
- Performing actions with the aim of obtaining useful information is an important part of rationality

# Rational Agent

- A rational agent is one that does the right thing
- Agent generates a sequence of actions according to the percepts it receives from environment
- Sequence of actions causes the environment to go through a sequence of states
- If the sequence is desirable, then the agent has performed well

# Factors affecting Rationality of Agent

- The performance measure that defines the criterion of success.
- The agent’s prior knowledge of the environment.
- The actions that the agent can perform.
- The agent’s percept sequence to date.

# Definition of 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."*

# Omniscience, Learning and Autonomy

- Slight difference between Omniscience and Rationality
- An omniscient agent knows the actual outcome of its actions and can act accordingly.
- Omniscience is impossible in reality.
- Rationality maximizes *expected performance, while perfection maximizes actual performance.*

# Learning

- Rationality maximizes expected performance, while perfection maximizes actual performance.
- The agent's initial configuration could reflect some prior knowledge of the environment, but as the agent gains experience this may be modified and augmented.

# Autonomy

- To the extent that an agent relies on the prior knowledge of its designer rather than on its own percepts, we say that the agent lacks **autonomy.**
- A rational agent should be autonomous

# Nature of Environment

- Task Environments are essentially the “problems” to which rational agents are the “solutions.”
- PEAS (Performance, Environment, Actuators, Sensors)

# PEAS Chart

| Agent Type | Performance Measure | Environment | Actuators | Sensors |
|---|---|---|---|---|
| Taxi driver | Safe, fast, legal, comfortable trip, maximize profits | Roads, other traffic, pedestrians, customers | Steering, accelerator, brake, signal, horn, display | Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard |

**Figure 2.4** PEAS description of the task environment for an automated taxi.

# PEAS Chart

| 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 image analysis system | Correct image categorization | Downlink from orbiting satellite | Display of scene categorization | Color pixel arrays |
| Part-picking robot | Percentage of parts in correct bins | Conveyor belt with parts; bins | Jointed arm and hand | Camera, joint angle sensors |
| Refinery controller | Purity, yield, safety | Refinery, operators | Valves, pumps, heaters, displays | Temperature, pressure, chemical sensors |
| Interactive English tutor | Student's score on test | Set of students, testing agency | Display of exercises, suggestions, corrections | Keyboard entry |

**Figure 2.5** Examples of agent types and their PEAS descriptions.

# Properties of Task Enviromnet

- **Fully observable:** If an agent's sensors give it access to the complete state of the environment at each point in time
- **Partially observable :** If an agent's sensors give it access to the some extent of state of the environment
- **Unobservable:** If the agent has no sensors at all.

# Single agent vs. multi agent

- Single Agent: Environment have Single Agent
- Multi Agent: Environment have multiple agents

❑Competitive

❑Cooperative

# Deterministic vs. stochastic

- Deterministic: If the next state of the environment is completely determined by the current state and the action executed by the agent
- Stochastic **:** If the next state of the environment can not be determined by the current state and the action executed by the agent

# Episodic vs. sequential

- Episodic : In an episodic task environment, the agent's experience is divided into atomic episodes.
- In each episode the agent receives a percept and then performs a single action
- Sequential **:** the current decision could affect all future decisions

# Static vs. dynamic

- Static: If the environment cannot change while an agent is deliberating
- Dynamic: If the environment can change while an agent works

# Discrete vs. continuous

- Discrete: If Environment is changing with discrete point of time
- Continuous : If Environment is changing continuously with time

# Structure of Agent

- Agent = Architecture + Agent Program
- Architecture = the machinery that an agent executes on.
- Agent Program = an implementation of an agent function.

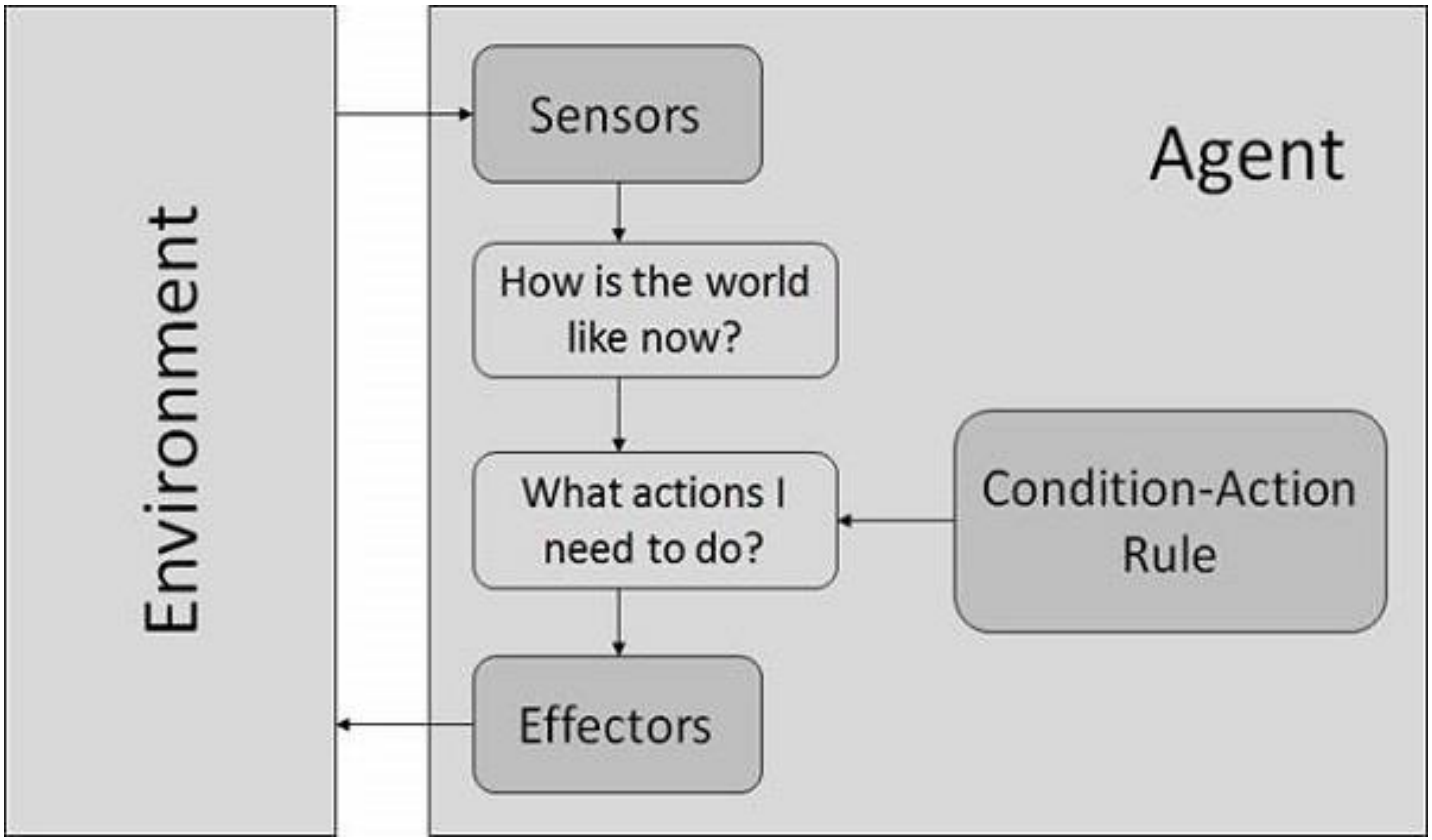
# Simple Reflex Agents

- They choose actions only based on the current percept.
- They are rational only if a correct decision is made only on the basis of current precept.
- Their environment is completely observable.

# Condition-Action Rule

- It is a rule that maps a state (condition) to an action.

# Simple Reflex Agents



# **Model** Based Reflex Agents

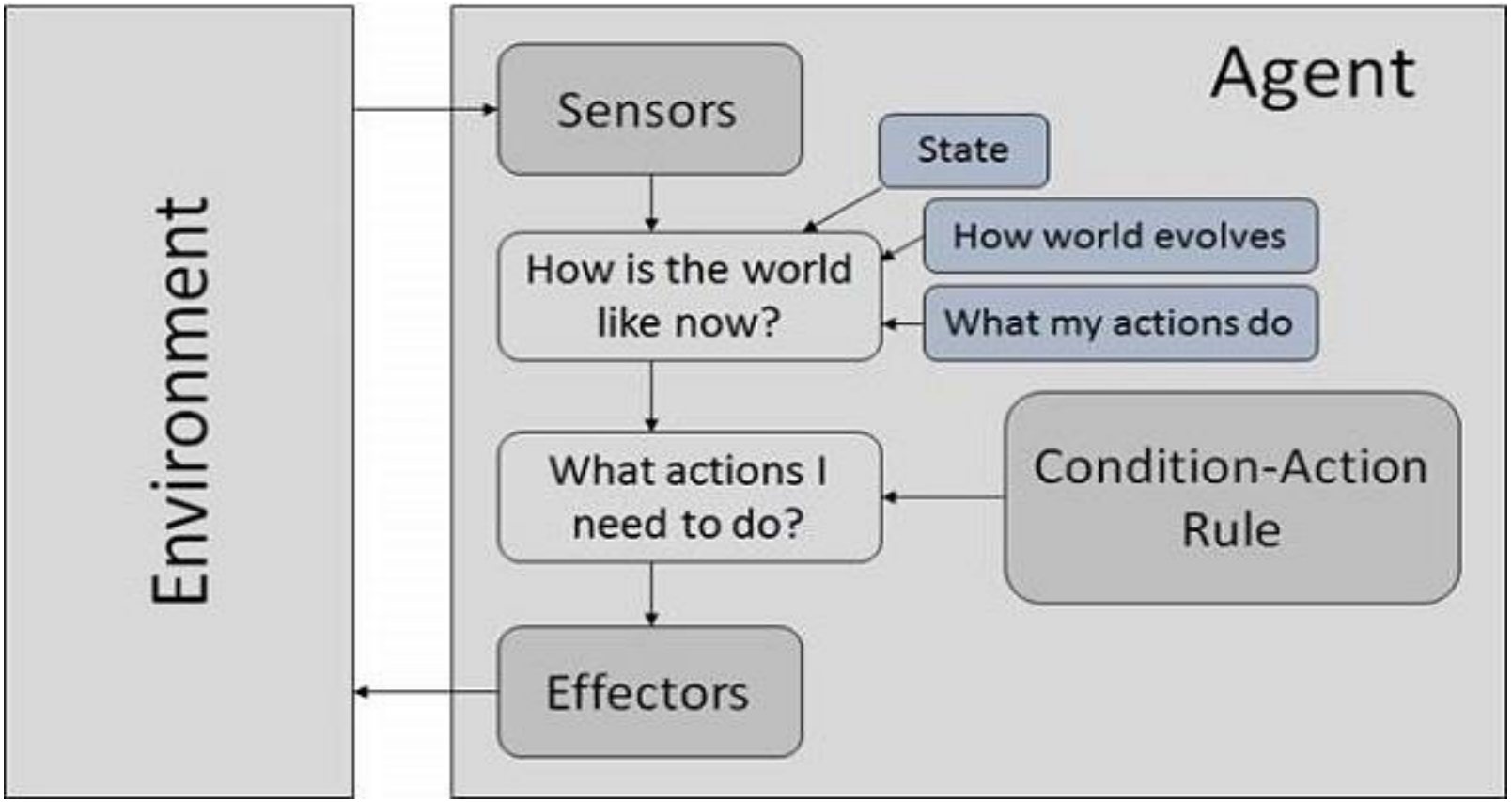
- They use a model of the world to choose their actions. They maintain an internal state.
- **Model** – The knowledge about “how the things happen in the world”.
- **Internal State** – It is a representation of unobserved aspects of current state depending on percept history.

# Conti..

**Updating the state requires the information about –**

- How the world evolves.
- How the agent’s actions affect the world.

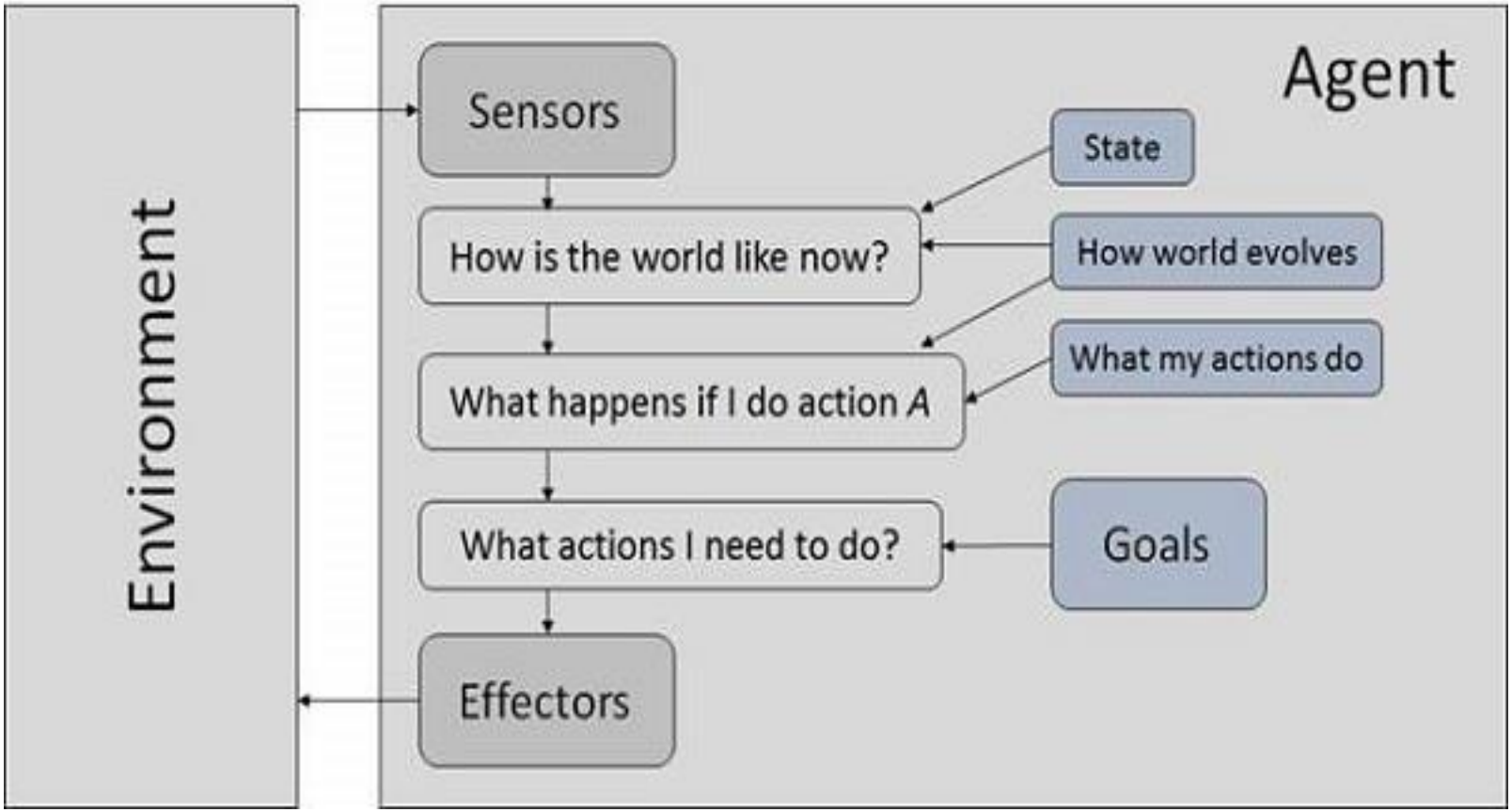
# Conti..


Environment
Agent
Sensors
State
How world evolves
How is the world like now?
What my actions do
What actions I need to do?
Condition-Action Rule
Effectors

# Goal Based Agents

- They choose their actions in order to achieve goals. Goal-based approach is more flexible than reflex agent since the knowledge supporting a decision is explicitly modeled, thereby allowing for modifications.
- **Goal** – It is the description of desirable situations.

# Goal Based Agents



# Utility Based Agents

- They choose actions based on a preference (utility) for each state
- Goals are inadequate when −

➢ There are conflicting goals, out of which only few can be achieved

➢ Goals have some uncertainty of being achieved and you need to weigh likelihood of success against the importance of a goal.

# Utility Based Agents