Intelligent Agents

Chapter 2

Agent

- An AI system is composed of an agent and its environment.
- The agents act in their environment.

Agents

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

- An agent runs in the **cycle** of **perceiving**, **thinking**, and **acting**. An agent can be:

- **1. Human-Agent:** A human agent has eyes, ears, and other organs which work for sensors and

  hand, legs, mouth, vocal tract work and other body parts for actuators.

Agents

2. Robotic Agent: A robotic agent can have cameras, infrared range finder, NLP for sensors and various motors for actuators.

- Cog-MIT, Aibo-Sony

3. Software Agent: Software agent can have keystrokes, file contents as sensory input and act on those inputs and display output on the screen.

- Hence the world around us is full of agents such as thermostat, cellphone, camera, and even we are also agents.

Agent Terminology

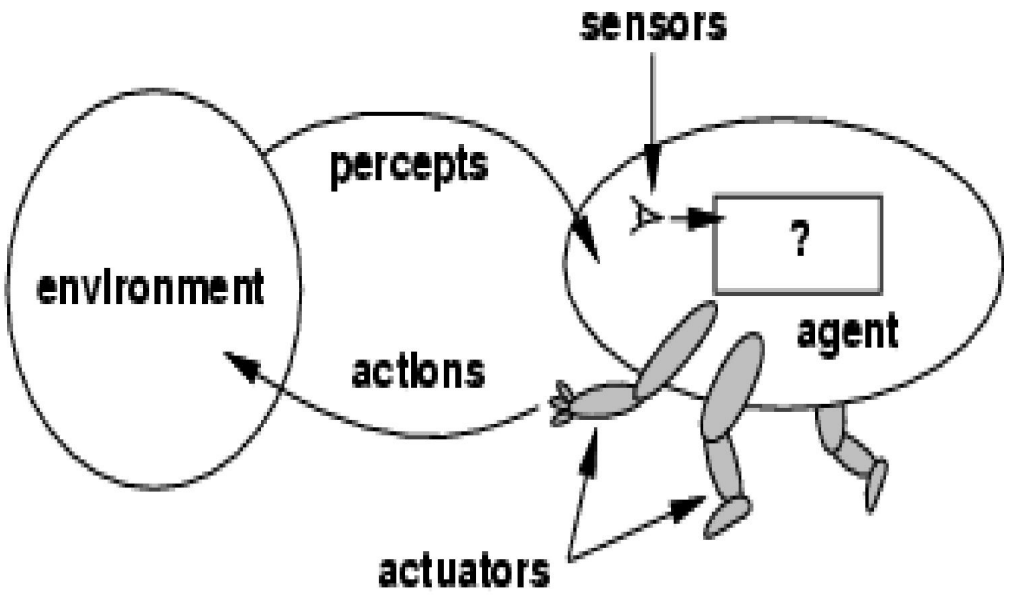
- **Performance Measure of Agent** − It is the criteria, which determines how successful an agent is.
- **Behavior of Agent** − It is the action that agent performs after any given sequence of percepts.
- **Percept** − It is agent's perceptual inputs at a given instance.
- **Percept Sequence** − It is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

Agents and Environments

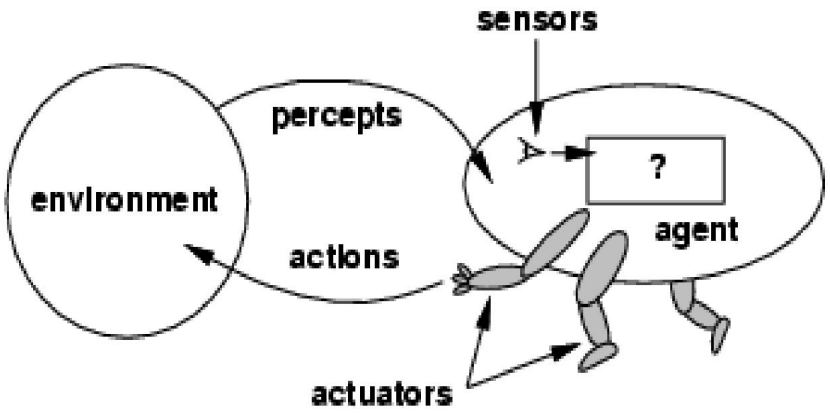
Sensor: Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.

Actuators: Actuators are the component of machines that converts energy into motion. The actuators are only responsible for moving and controlling a system. An actuator can be an electric motor, gears, rails, etc.

Effectors: Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.



Agents and Environments

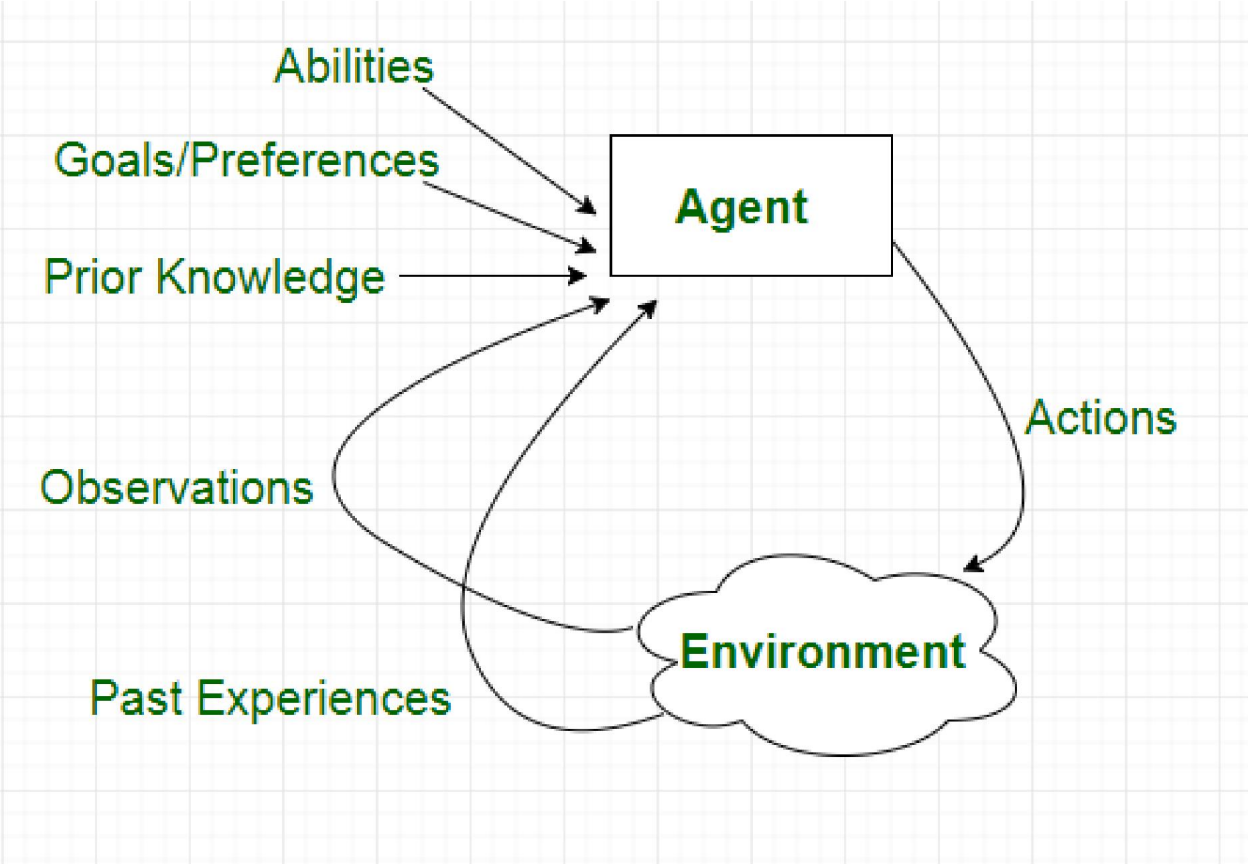


- The agent function maps from percept histories to actions:

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

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

Agent


Abilities
Goals/Preferences
Prior Knowledge
Agent
Actions
Observations
Environment
Past Experiences

Intelligent Agent

- An intelligent agent is an autonomous entity which act upon an environment using sensors and actuators for achieving goals.
- An intelligent agent may learn from the environment to achieve their goals. A thermostat is an example of an intelligent agent.
- **Four rules** for an AI agent:
- **Rule 1:** An AI agent must have the ability to perceive the environment.
- **Rule 2:** The observation must be used to make decisions.
- **Rule 3:** Decision should result in an action.
- **Rule 4:** The action taken by an AI agent must be a rational action.

Rational Agent

- A rational agent is an agent which has clear preference, models uncertainty, and acts in a way to maximize its performance measure with all possible actions.
- A rational agent is said to perform the right things. AI is about creating rational agents to use for game theory and decision theory for various real-world scenarios.
- For an AI agent, the rational action is most important because in AI reinforcement learning algorithm, for each best possible action, agent gets the positive reward and for each wrong action, an agent gets a negative reward.

Rationality

- The rationality of an agent is measured by its performance measure.
- Rationality can be judged on the basis of following points:
  - Performance measure which defines the success criterion.
  - Agent prior knowledge of its environment.
  - Best possible actions that an agent can perform.
  - The sequence of percepts.

Features of Environment

- As per Russell and Norvig, an environment can have various features from the point of view of an agent:
  - Fully observable vs Partially Observable
  - Static vs Dynamic
  - Discrete vs Continuous
  - Deterministic vs Stochastic
  - Single-agent vs Multi-agent
  - Episodic vs sequential
  - Known vs Unknown
  - Accessible vs Inaccessible

Fully observable vs Partially Observable

- If an agent sensor can sense or access the complete state of an environment at each point of time then it is **a fully observable** environment, else it is **partially observable**.
- A fully observable environment is easy as there is no need to maintain the internal state to keep track history of the world.
- An agent with no sensors in all environments then such an environment is called as **unobservable**.

Deterministic vs Stochastic

- If an agent's current state and selected action can completely determine the next state of the environment, then such environment is called a deterministic environment.
- A stochastic environment is random in nature and cannot be determined completely by an agent.
- In a deterministic, fully observable environment, agent does not need to worry about uncertainty.

Episodic vs Sequential

- In an episodic environment, there is a series of one-shot actions, and only the current percept is required for the action.

- However, in Sequential environment, an agent requires memory of past actions to determine the next best actions.

Single-agent vs Multi-agent

- If only one agent is involved in an environment, and operating by itself then such an environment is called single agent environment.
- However, if multiple agents are operating in an environment, then such an environment is called a multi-agent environment.
- The agent design problems in the multi-agent environment are different from single agent environment.

Static vs Dynamic

- If the environment can change itself while an agent is deliberating then such environment is called a dynamic environment else it is called a static environment.
- Static environments are easy to deal because an agent does not need to continue looking at the world while deciding for an action.
- However for dynamic environment, agents need to keep looking at the world at each action.
- Taxi driving is an example of a dynamic environment whereas Crossword puzzles are an example of a static environment.

Discrete vs Continuous

- If in an environment there are a finite number of percepts and actions that can be performed within it, then such an environment is called a discrete environment else it is called continuous environment.
- A chess game comes under discrete environment as there is a finite number of moves that can be performed.
- A self-driving car is an example of a continuous environment.

Known vs Unknown Accessible vs Inaccessible

- Known and unknown are not actually a feature of an environment, but it is an agent's state of knowledge to perform an action.
- In a known environment, the results for all actions are known to the agent. While in unknown environment, agent needs to learn how it works in order to perform an action.
- It is quite possible that a known environment to be partially observable and an Unknown environment to be fully observable.
- If an agent can obtain complete and accurate information about the state's environment, then such an environment is called an Accessible environment else it is called inaccessible.
- An empty room whose state can be defined by its temperature is an example of an accessible environment.
- Information about an event on earth is an example of Inaccessible environment.

Types of Agent

- Agents can be grouped into five classes based on their degree of perceived intelligence and capability.
- All these agents can improve their performance and generate better action over the time. These are given below:
- Simple Reflex Agent
- Model-based Reflex Agent
- Goal-based Agents
- Utility-based Agent
- Learning Agent

Simple Reflex Agent

- Are the simplest agents. These agents take decisions on the basis of the current percepts and ignore the rest of the percept history.
- These agents only succeed in the fully observable environment.
- It does not consider any part of percepts history during their decision and action process.
- It works on Condition-action rule, which means it maps the current state to action. Such as a **Room Cleaner agent**, it works only if there is dirt in the room.
- Problems for the simple reflex agent design approach:
  - They have very limited intelligence
  - They do not have knowledge of non-perceptual parts of the current state
  - Mostly too big to generate and to store.
  - Not adaptive to changes in the environment.

Model-based Reflex Agent

- Can work in a partially observable environment, and track the situation.
- A model-based agent has **two i**mportant **factors**:
  - **Model:** It is knowledge about "how things happen in the world," so it is called a Model-based agent.
  - **Internal State:** It is a representation of the current state based on percept history.
- These agents have the model, "which is knowledge of the world" and based on the model they perform actions.
- Updating the agent state requires information about:
  - How the world evolves
  - How the agent's action affects the world.

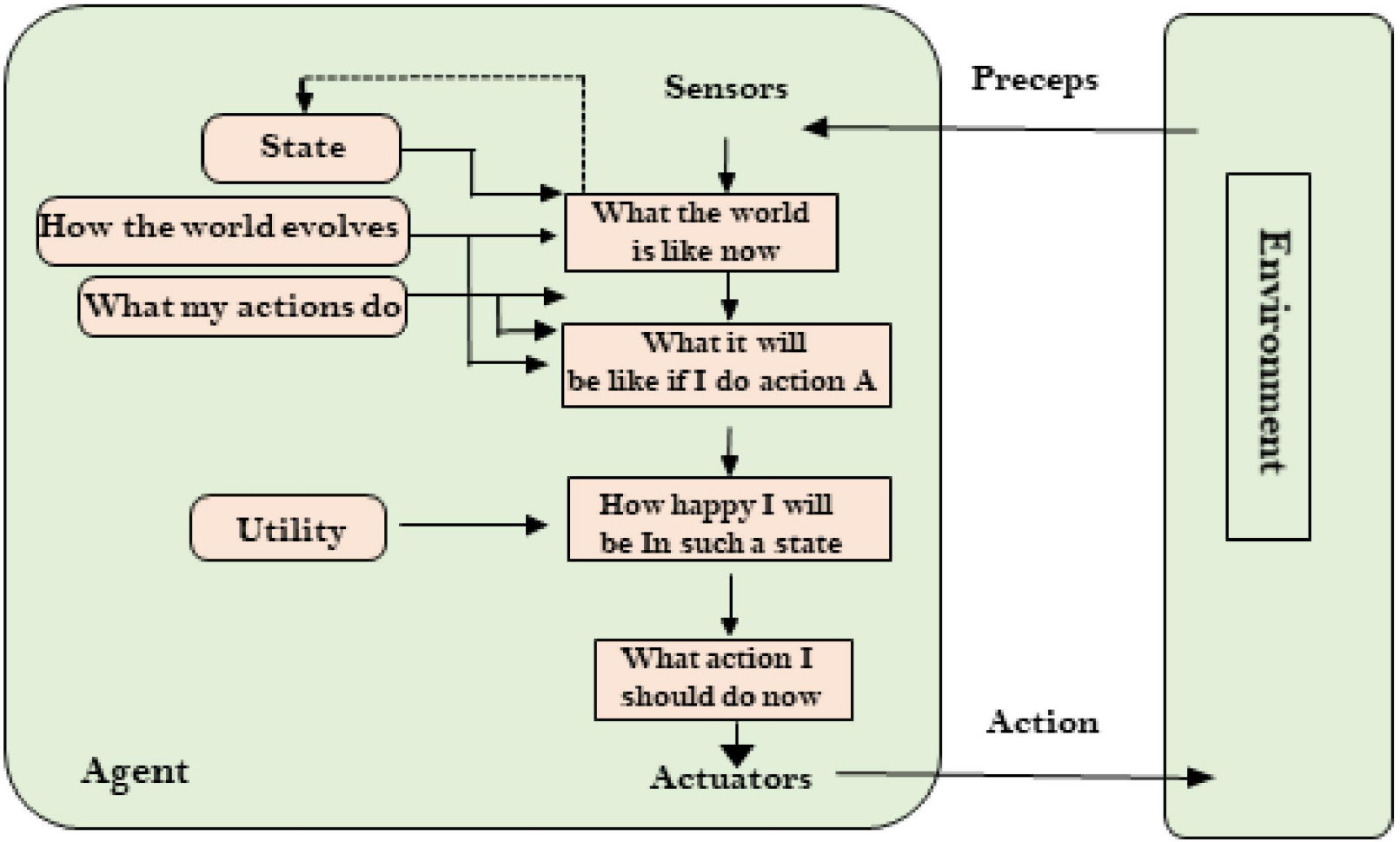
Goal-based Agents

- The knowledge of the current state environment is not always sufficient to decide for an agent to what to do.
- The agent needs to know its goal which describes desirable situations.
- It expand the capabilities of the model-based agent by having the "goal" information.
- They choose an action, so that they can achieve the goal.
- These agents may have to consider a long sequence of possible actions before deciding whether the goal is achieved or not. Such considerations of different scenario are called searching and planning, which makes an agent proactive.

Utility-based Agents

- Are similar to the goal-based agent but provide an extra component of utility measurement which makes them different by providing a measure of success at a given state.
- It act based on not only goals but also the best way to achieve that goal.
- Useful when there are multiple possible alternatives, and an agent has to choose in order to perform the best action.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.

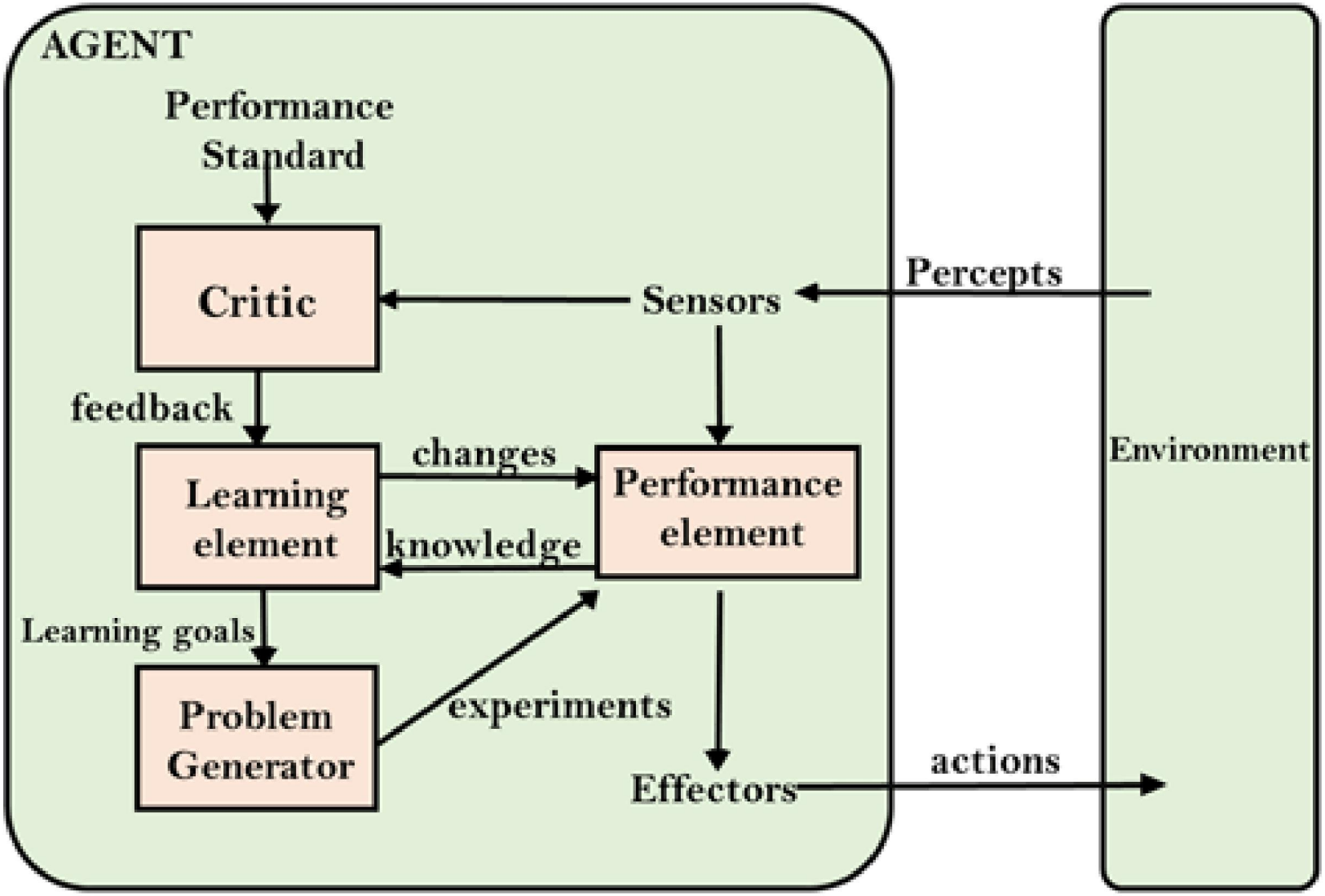
Utility-based Agents



Learning Agents

- It can learn from its past experiences, or it has learning capabilities.
- It starts to act with basic knowledge and then able to act and adapt automatically through learning.
- Has mainly four conceptual components:
  - **Learning Element:** It is responsible for making improvements by learning from environment
  - **Critic:** Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.
  - **Performance Element:** It is responsible for selecting external action
  - **Problem Generator:** Responsible for suggesting actions that will lead to new and informative experiences.
- Hence, its able to learn, analyze performance, and look for new ways to improve the performance.

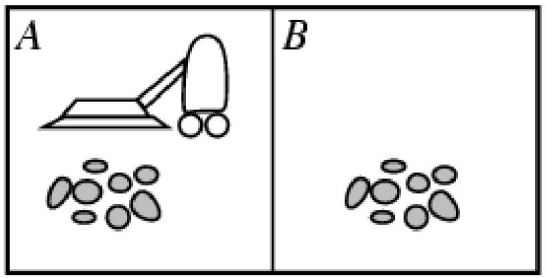
Learning Agents



Agent Environment in AI

- An environment is everything in the world which surrounds the agent, but it is not a part of an agent itself. An environment can be described as a situation in which an agent is present.
- The environment is where agent lives, operate and provide the agent with something to sense and act upon it.

Vacuum-cleaner World



- Percepts: location and contents, e.g., [A,Dirty]
- Actions: *Left*, *Right*, *Suck*, *NoOp*
- One very simple agent function is: if the current square is dirty, then suck; otherwise, move to the other square.

Vacuum-cleaner World

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.

Vacuum-cleaner World

- Its seen that various vacuum-world agents can be defined simply by filling in the right-hand column in various ways.
- The obvious question, then, is this: *What is the right way to fill out the table?*
- In other words, what makes an agent good or bad, intelligent or stupid?

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 (!= perfect 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 of a vacuum-cleaner agent could be:
  1. amount of dirt cleaned up
  2. amount of time taken
  3. amount of electricity consumed
  4. amount of noise generated, etc.

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)

PEAS of Rational Agent

- 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, findings, patient's answers)

PEAS

Agent	Performance measure	Environment	Actuators	Sensors
1. Medical Diagnose	◦ Healthy patient ◦ Minimized cost	◦ Patient ◦ Hospital ◦ Staff	◦ Tests ◦ Treatments	Keyboard (Entry of symptoms)
2. Vacuum Cleaner	◦ Cleanness ◦ Efficiency ◦ Battery life ◦ Security	◦ Room ◦ Table ◦ Wood floor ◦ Carpet ◦ Various obstacles	◦ Wheels ◦ Brushes ◦ Vacuum Extractor	◦ Camera ◦ Dirt detection sensor ◦ Cliff sensor ◦ Bump Sensor ◦ Infrared Wall Sensor
3. Part -picking Robot	◦ Percentage of parts in correct bins.	◦ Conveyor belt with parts, ◦ Bins	◦ Jointed Arms ◦ Hand	◦ Camera ◦ Joint angle sensors.

Thank You