1.7 PROPERTIES OF ENVIRONMENT

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.

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.

Example: chess – the board is fully observable, as are opponent's moves. Driving – what is around the next bend is not observable and hence partially observable.

1. 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.

2. 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.

3. 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.

4. 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.

5. Discrete vs Continuous

· If in an environment there are a finite number of precepts 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.

6. Known vs Unknown

· 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.

7. Accessible vs. Inaccessible

· 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.

Task environments, which are essentially the "problems" to which rational agents are the "solutions."

PEAS: Performance Measure, Environment, Actuators, Sensors

Performance

The output which we get from the agent. All the necessary results that an agent gives after processing comes under its performance.

Environment

All the surrounding things and conditions of an agent fall in this section. It basically consists of all the things under which the agents work.

Actuators

The devices, hardware or software through which the agent performs any actions or processes any information to produce a result are the actuators of the agent.

Sensors

The devices through which the agent observes and perceives its environment are the sensors of the agent.

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 1.5 Examples of agent types and their PEAS descriptions

Rational Agent - A system is rational if it does the "right thing". Given what it knows. **Characteristic of Rational Agent**

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

For every 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.

· An **omniscient agent** knows the actual outcome of its actions and can act accordingly; but omniscience is impossible in reality.

· **Ideal Rational Agent** precepts and does things. It has a greater performance measure.

Eg. Crossing road. Here first perception occurs on both sides and then only action. No perception occurs in **Degenerate Agent**.

Eg. Clock. It does not view the surroundings. No matter what happens outside. The clock works based on inbuilt program.

· **Ideal Agent** describes by ideal mappings. "Specifying which action an agent ought to take in response to any given percept sequence provides a design for

ideal agent".

· **Eg.** SQRT function calculation in calculator.

· Doing actions in order to modify future precepts-sometimes called **information gathering**- is an important part of rationality.

· A rational agent should be **autonomous**-it should learn from its own prior knowledge (experience).

The Structure of Intelligent Agents

Agent = Architecture + Agent Program

Architecture = the machinery that an agent executes on. (Hardware)

Agent Program = an implementation of an agent function. (Algorithm, Logic – Software)

1.8 TYPES OF AGENTS

Agents can be grouped into four classes based on their degree of perceived intelligence and capability :

· Simple Reflex Agents
· Model-Based Reflex Agents
· Goal-Based Agents
· Utility-Based Agents
· Learning Agent

The Simple reflex agents

· The Simple reflex agents are the simplest agents. These agents take decisions on the basis of the current percepts and ignore the rest of the percept history (**past State).**

· These agents only succeed in the fully observable environment.

· The Simple reflex agent does not consider any part of percepts history during their decision and action process.

· The Simple reflex agent 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.

Condition-Action Rule − It is a rule that maps a state (condition) to an action. **Ex:** if car-in-front-is-braking then initiate- braking.

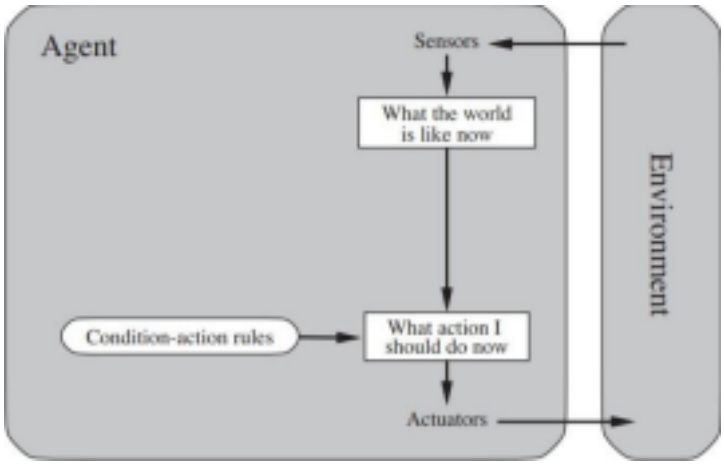

Figure 1.6 A simple reflex agent

Model Based Reflex Agents

· The Model-based agent can work in a partially observable environment, and track the situation.

· A model-based agent has two important 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:

o How the world evolves

o How the agent's action affects the world.

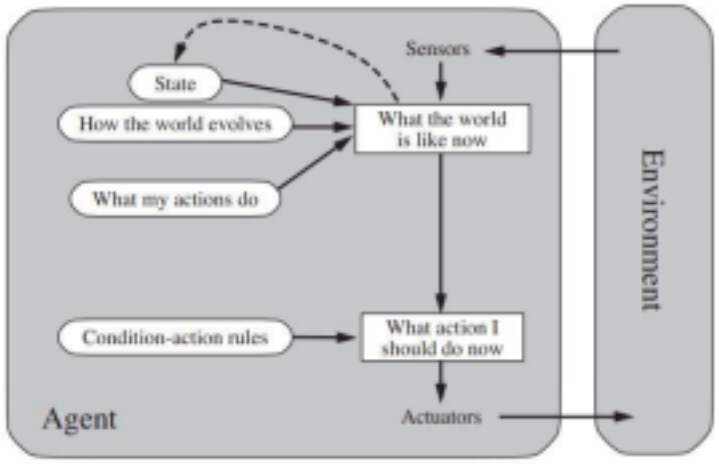

Figure 1.7 A model-based reflex agent

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.
- Goal-based agents 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.

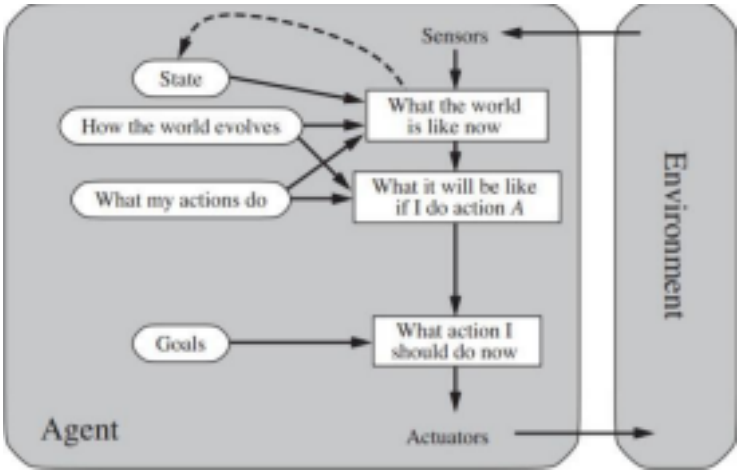

Figure 1.8 A goal-based agent

Utility Based Agents

- These agents are similar to the goal-based agent but provide an extra component of utility measurement **("Level of Happiness")** which makes them different by providing a measure of success at a given state.

- Utility-based agent act based not only goals but also the best way to achieve the goal.
- The Utility-based agent is 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.

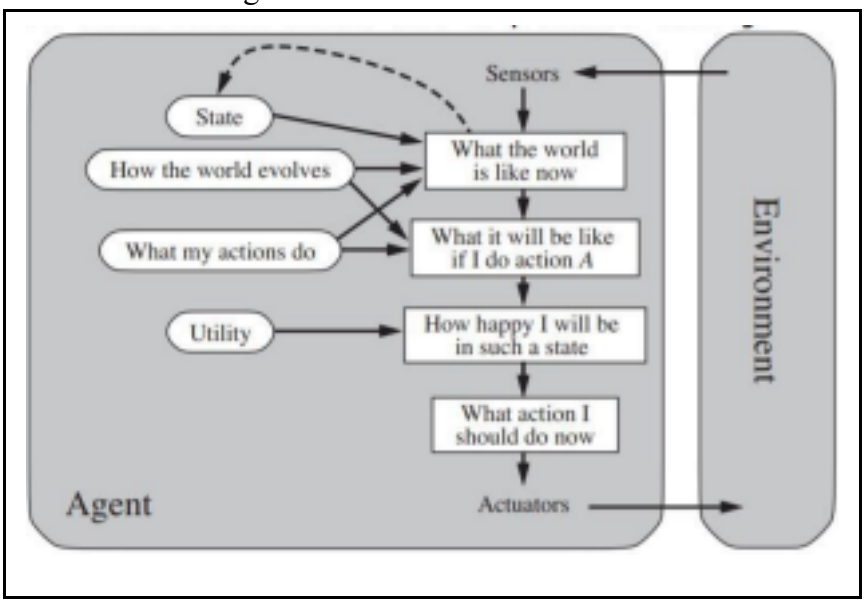

Figure 1.9 A utility-based agent

Learning Agents

- A learning agent in AI is the type of agent which 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.
- A learning agent has mainly four conceptual components, which are:
    a. **Learning element:** It is responsible for making improvements by learning from environment
    b. **Critic:** Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.

c. **Performance element:** It is responsible for selecting external action

    d. **Problem generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.

- Hence, learning agents are able to learn, analyze performance, and look for new ways to improve the performance.

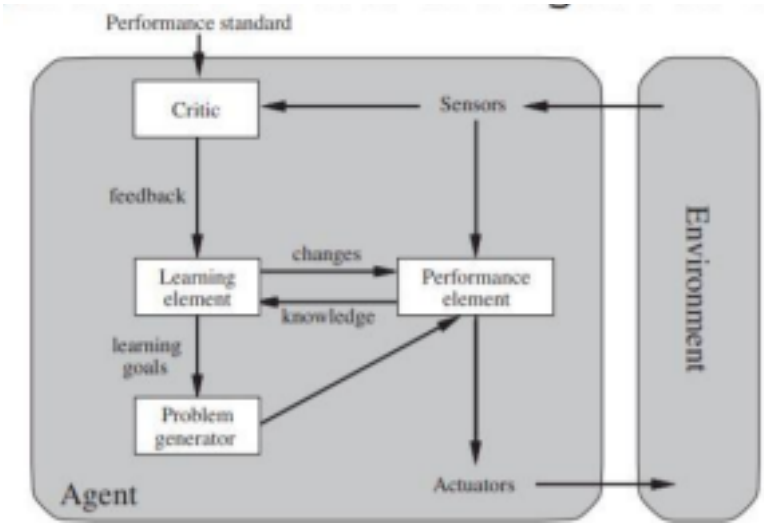

Figure 1.10 Learning Agents