UNIT-2: Intelligent Agents(4Hrs)

Syllabus

Unit II: Intelligent Agents (4 Hrs.)

2.1. Introduction of agents, Structure of Intelligent agent, Properties of Intelligent Agents
2.2. Configuration of Agents, PEAS description of Agents
2.3. Types of Agents: Simple Reflexive, Model Based, Goal Based, Utility Based.
2.4. Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent

Introduction of agents:

Sensor

For the detection of different actions and gestures of the surrounding a device or an element is used, called sensor. After detection of any gesture, it provides the information to the electronic device. A **sensor** is an electronic instrument that is able to measure the physical quantity and generate a considerate output. These outputs of the sensors are usually in the form of electrical signals. The different types of sensors are:

- Temperature sensor
- Tilt sensor
- Ultrasonic sensor
- Accelerometer

Actuator

Actuators provide a mechanical response according to the input provided by the sensors. It is a device that alters the physical quantity as it can cause a mechanical component to move after getting some input from the sensor. In other words, it receives control input (generally in the form of the electrical signal) and generates a change in the physical system through producing force, heat, motion, etc.

Agent

An **agent** is anything that can be viewed as perceiving its **environment** through **sensors** and acting upon that environment through **actuators**. A coupling of perception, reasoning, and acting comprises an **agent**. An agent acts in an **environment**. An agent's environment may include other agents. An agent together with its environment is called a **world**. This simple idea is illustrated in Figure below.

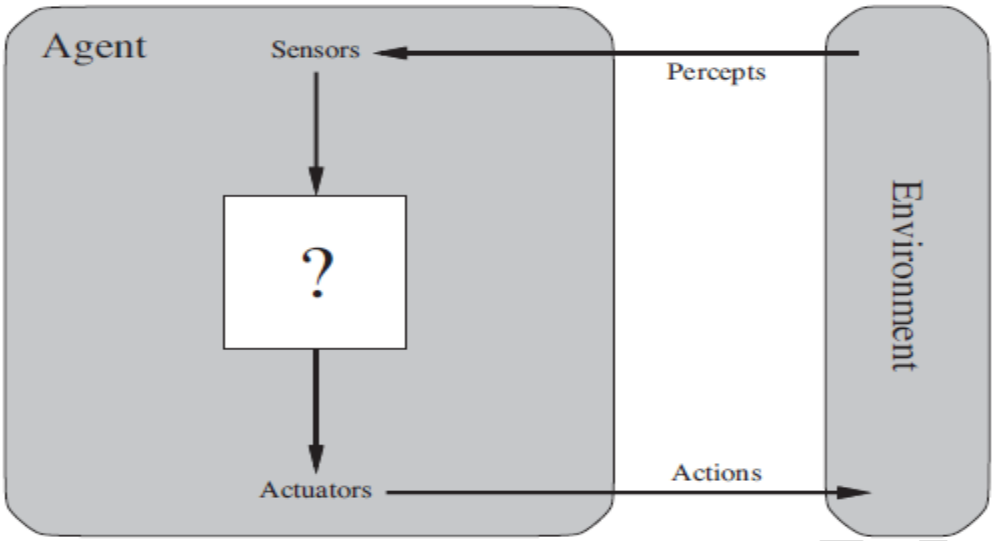


Figure: Agents interact with environments through sensors and actuators.

A **human agent** has eyes, ears, and other organs for sensors and hands, legs, vocal tract, and so on for actuators. A **robotic agent** might have cameras and infrared range finders for sensors and various motors for actuators. 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.

Structure of Intelligent agent

The structure of an intelligent agent is a combination of architecture and agent program. It can be viewed as:

Agent = Architecture + Agent program

Architecture: Architecture is machinery that an AI agent executes on.

Agent program: Agent program is an implementation of agent function. An agent program executes on the physical architecture to produce function.

Agent Function: Agent function is used to map a percept to an action.

$f:P^* \rightarrow A$

Properties of Intelligent Agents

The properties of intelligent agents can be classified into internal and external

Internal characteristics

Internal characteristics of intelligent agents are listed below,

Learning/reasoning

An agent has the ability to learn from previous experience and to successively adapt its own behaviour to the environment.

Reactivity

An agent must be capable of reacting appropriately to influences or information from its environment.

Autonomy

Autonomy allows AI agent to perform certain tasks on their own. An agent must have both control over its actions and internal states.

Geal-oriented

An agent has well-defined goals and gradually influence its environment and so achieve its own goals

External Characteristics

Communication

An agent often requires an interaction with its environment to fulfil its tasks. They can interact with other entities such as agents, humans, and systems.

Cooperation

Cooperation of several agent permits faster and better solutions for complex tasks that exceed the capabilities of a single agent.

Mobility

An agent may navigate within electronic communication networks.

Character

Like human, an agent may demonstrate an external behaviour with many human characters as possible.

Configuration of Agents

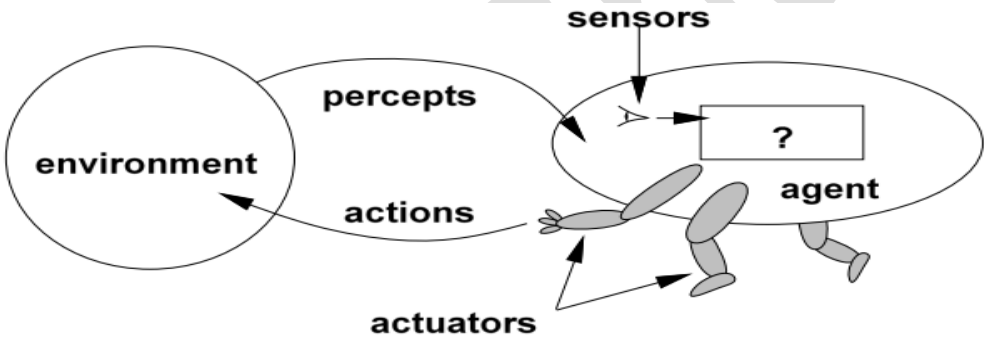
Intelligent agents have three main components and they work through it. They are sensors, actuators, and effectors. Let's see an overview of these components.

Sensors: These are devices that detect any changes in the environment. This information is sent to other devices. In artificial intelligence, the environment of the system is observed by intelligent agents through sensors.

Actuators: These are components through which energy is converted into motion. They perform the role of controlling and moving a system. Examples include rails, motors, and gears.

Effectors: The environment is affected by effectors. Examples include legs, fingers, wheels, display screen, and arms.

The following diagram shows how these components are positioned in the AI system.



The above diagram shows how these components are positioned in the AI system. Precepts or inputs from the environment are received through sensors by the intelligent agent. Using this acquired information or observations this agent uses artificial intelligence to make decisions. Actuators will then trigger actions. Percept history and past actions will influence future decisions.

PEAS description of Agents

There are various types of AI agents. But apart from these, there are many agents which are being designed and created today and they differ from each other in some aspects.

All the agent performs the action, this action or problem solved by agent is characterized by PEAS: Performance Measure, Environment, Actuators, and Sensors

PEAS stand for Performance, Environment, Actuators, and Sensors. Based on these properties of an agent, they can be grouped together or can be differentiated from each other. Each agent has these following properties defines for it.

Performance:

The output which we get from the agent. All the necessary results that an agent gives after processing comes under its performance. Let us take an example of a self-driven car. The performance factors for a self-driven car will be the Speed, Safety while driving (both of the car and the user), Time is taken to drive to a particular location, the comfort of the user, etc.

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.
for a self-driven car, The Environment will be the road on which the Car is being driven, other cars present on the road, pedestrians, crossings, road signs, traffic signals, etc., all act as its environment.

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.
for a self-driven car, The Actuators will be All those devices through which the control of the car is handled, are the actuators of the car. For example, the Steering, Accelerator, Breaks, Horn, Music system, etc.

Sensors:

The devices through which the agent observes and perceives its environment are the sensors of the agent. For a self-driven car, The Sensors will be All those devices through which the car gets an estimate about its surroundings and it can draw certain perceptions out of it are its sensors. For example, Camera, Speedometer, GPS, Odometer, Sonar, etc.

Other PEAS Examples

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	healthy patient, costs, lawsuits	patient, hospital, stuff	display 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 categorization of scene	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 exercises, suggestions, corrections	keyboard entry

Types of Agents: Simple Reflexive, Model Based, Goal Based, Utility Based.

1.Simple reflex agents

The simplest kind of agent is the simple reflex agent. These agents select actions on the basis of the current percept, ignoring the rest of the percept history. Percept history is the history of all that agent has perceived till date.

Simple reflex agent can have feature like

- Spontaneously does all act
- Act only on the basis of current perception
- Ignores the rest of percept history
- Based on if then rules
- Environment should be fully observable

Figure below gives the schematic diagram of a simple reflex agent.

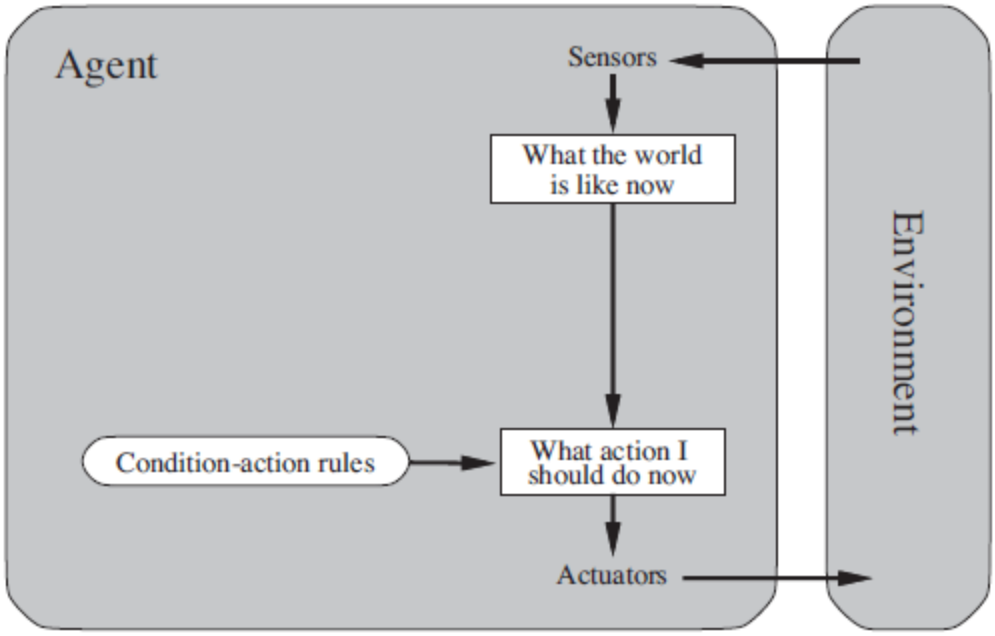


Figure: Schematic diagram of a simple reflex agent.

We use rectangles to denote the current internal state of the agent's decision process, and ovals to represent the background information used in the process.

For example, the vacuum agent whose agent function is a simple reflex agent, because its decision is based only on the current location and on whether that location contains dirt.

Simple reflex behaviours occur even in more complex environments. Imagine yourself as the driver of the automated taxi. If the car in front; brakes and its brake lights come on, then you should notice this and initiate braking. In other words, some processing is done on the visual input to establish the condition we call "The car in front is braking." Then, this triggers some established connection in the agent program to the action "initiate braking".
We call such a connection, as a "condition–action rule", which can be written as

if car-in-front-is-braking **then** initiate-braking.

A condition–action rule is a rule that maps a state, that is the condition to action. If the condition is true, then the action is taken, else not.

Example: Medical diagnosis system

if the patient has reddish brown spots, then start the treatment for measles.

2. Model-based reflex agents

- A model-based reflex agent works by finding a rule whose condition matches the current situation. It can handle partially observable environments by use of model about the world.

- The most effective way to handle partial observability is to keep track of the part of the world it can't see now. That is, the agent should maintain some sort of internal state that depends on the percept history and thereby reflects at least some of the unobserved aspects of the current state.

- The current state is stored inside the agent which maintains some kind of structure describing the part of the world which cannot be seen.

- Updating this internal state information requires two kinds of knowledge to be encoded in the agent program: How the world evolves independently from the agent, and how the agent actions affect the world.

So, the model-based agent can

1) **Maintain an internal state.**

Internal State − It is a representation of unobserved aspects of current state depending on percept history.

2) **They use a model of the world to choose their actions.**

Model − knowledge about "how the things happen in the world".

3) **And it updates the states. Updating the states requires the information about −**
   - **How the world evolves:** for example, that an overtaking car generally will be closer behind than it was a moment ago.
   - **How the agent's actions affect the world:** for example, that when the agent turns the steering wheel clockwise, the car turns to the right, or after driving for five minutes we found that we are in different direction.

Hence, this knowledge about "how the things happen in the world" or "how the world works" is called a model of the world, hence the name "model-based agent".

Figure below gives the structure of the model-based reflex…

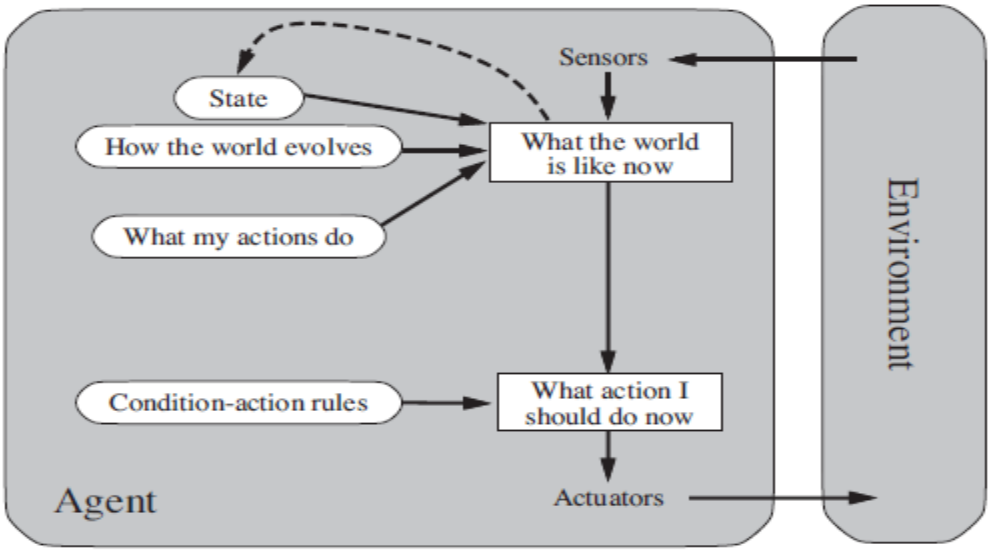


Figure: - A model-based reflex agent.

Figure above gives the structure of the model-based reflex agent with internal state, showing how the current percept is combined with the old internal state to generate the updated description of the current state, based on the agent's model of how the world works.

3. Goal-based agents

Goal-based agents further expand on the capabilities of the model-based agents, by using "goal" information. Goal information describes situations that are desirable. This allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state. Search and planning are the subfields of artificial intelligence devoted to finding action sequences that achieve the agent's goals.

Knowing something about the current state of the environment is not always enough to decide what to do. For example, at a road junction, the taxi can turn left, turn right, or go straight on. The correct decision depends on where the taxi is trying to get to. Hence the agent program can combine this with the model to choose actions that achieve the goal. Figure below shows the goal-based agent's structure.

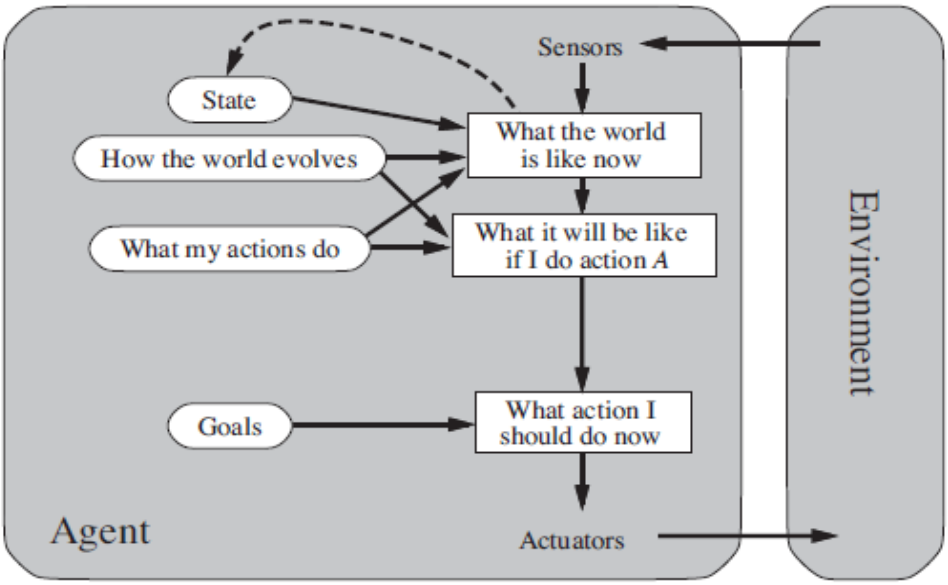


Figure: Goal-based agents

Sometimes goal-based action selection is straightforward—for example, when goal satisfaction results immediately from a single action. The goal-based agent's behaviour can easily be changed to go to a different destination, simply by specifying that destination as the goal.

Notice that decision making of this kind is fundamentally different from the condition–action rules described earlier, in that it involves consideration of the future—both "What will happen if I do such-and-such?" and "Will that make me happy?" etc.

4) Utility-based agents

Goal-based agents only distinguish between goal states and non-goal states. Goals alone are not enough to generate high-quality behavior in most environments.

For example, many action sequences will get the taxi to its destination thereby achieving the goal but some are quicker, safer, more reliable, or cheaper than others. Goals just provide a crude binary distinction between "happy" and "unhappy" states.

So, it is possible to define a measure of how desirable a particular state is. This measure can be obtained through the use of a utility function which maps a state to a measure of the utility of the state.

A more general performance measure should allow a comparison of different world states according to exactly how happy they would make the agent. The term utility can be used to describe how "happy" the agent is.

A utility-based agent chooses the action that maximizes the expected utility of the action outcomes - that is, what the agent expects to derive, on average, given the probabilities and utilities of each outcome. It has to model and keep track of its environment, tasks that have involved a great deal of research on perception, representation, reasoning, and learning. the utility-based agent which is shown in figure below.

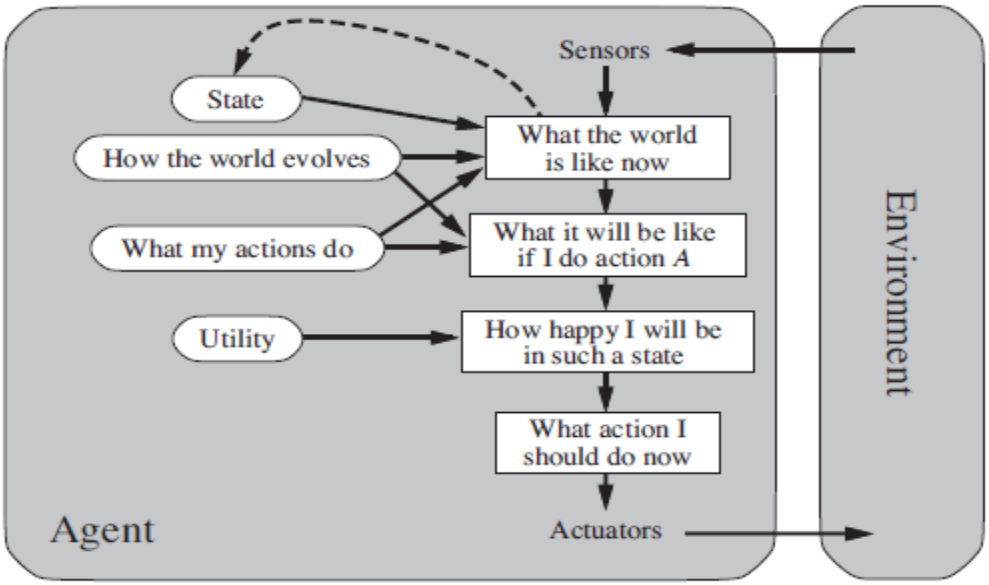


Figure: utility-based agent

As shown in figure above, the utility-based agent uses a model of the world, along with a utility function that measures its preferences among states of the world. Then it chooses the action that leads to the best expected utility, where expected utility is computed by averaging over all possible outcome states, weighted by the probability of the outcome.

Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi observable, Single Agent, Multi Agent

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.

1. 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**.

2. 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.
- The word "stochastic" generally implies that uncertainty about outcomes is quantified in terms of probabilities; a **nondeterministic** environment is one in which actions are characterized by their possible outcomes, but no probabilities are attached to them.
- Nondeterministic environment descriptions are usually associated with performance measures that require the agent to succeed for all possible outcomes of its actions.

3. 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.
- 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. the next episode does not depend on the actions taken in previous episodes.
- For example, an agent that has to spot defective parts on an assembly line bases each decision on the current part, regardless of previous decisions; moreover, the current decision doesn't affect whether the next part is defective.
- In sequential environments, on the other hand, the current decision could affect all future decisions. Chess and taxi driving are sequential: in both cases, short-term actions can have long-term consequences.
- However, in Sequential environment, an agent requires memory of past actions to determine the next best actions.

4. 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.
- For example, an agent solving a crossword puzzle by itself is clearly in a single-agent environment, whereas an agent playing chess is in a two-agent environment.

5. 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.

6. 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.

7. 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.

8. 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.

========== End Unit 2 ==========

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