Unit -2: Intelligent Agent

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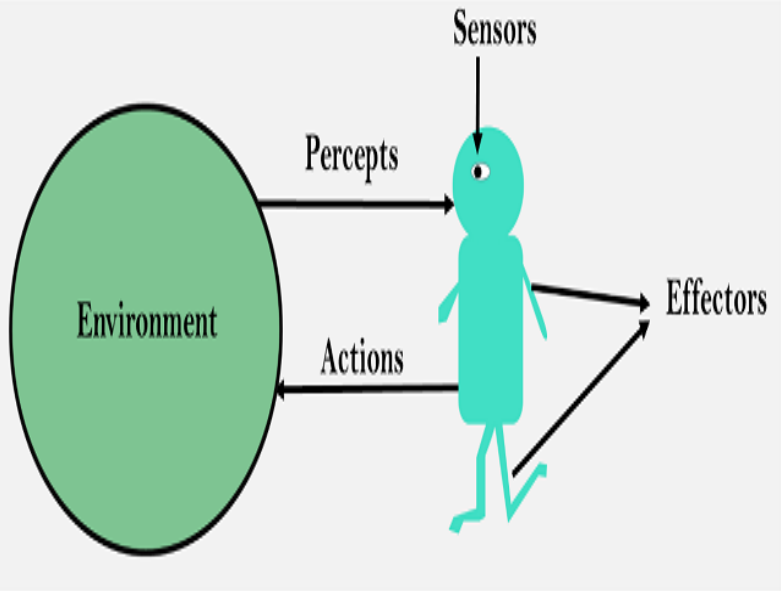
Introduction of agents



- An Agent is a computer program or system that runs in the cycle of perceiving, thinking, and acting.
- An agent can be anything that perceiveits and act on environment through sensors and actuators.
- The agent functions independently, which means a human operator does not have direct control over it.

Intelligent Agent

- An intelligent agent is an autonomous thing that uses sensors and actuators to interact with its surroundings in order to accomplish objectives.
- An intelligent agent may learn from the environment to achieve their goals.

Following are the main four rules for an AI agent:

1. An AI agent must have the ability to perceive the environment.
2. The observation must be used to make decisions.
3. Decision should result in an action.
4. The action taken by an AI agent must be a rational action.

Intelligent Agent

Here are some Intelligent agent Terminology:

- **Sensors:** Sensors the device or tool which is used to percept it's inputs from environment. An sensors can be eyes, camera, touchpad, microphone etc.
- **Actuators:** Actuators are componets of machine which is used to perform action in environment. 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.
- **Percepts:** Percepts are the electrical signals generated from sensors after processing objects in environment.

Structure of Intelligent agent

$$\text{Agent} = \text{Architecture} + \text{Agent Program}$$

- **Architecture** is the machinery that the agent executes on. **For example:** Robotic Car, Camera, and PC.
- **Agent program** is an implementation of agent function. An agent program executes on the physical architecture to produce function f.
- **Agent function** is a map from the percept sequence(history of all that an agent has perceived to date) to an action.

$$\textit{Agent Function}(F) : P^* \rightarrow A$$

Example of Intelligent Agents

- **Human:**
  - **Sensors:** eyes, ears, skin, tongue, nose etc.
  - **Actuators:** hand, legs, vocal tract etc.
- **Automated Driving System:**
  - **Sensors:** speedometer, GPS, camera,radar sensor etc.
  - **Actuators:** steering, brakes, gear shifting, accelerator etc.
- **Automated vacuum cleaner:**
  - **Sensors:** Dust sensors, Pressure sensors, Obstacle sensors, Wheel sensors etc.
  - **Actuators:** Suction motor, Brush roll motor, Steering motors etc.

Properties of Intelligent Agents

- **Autonomy:** An intelligent agent is autonomous, meaning it operates independently without human intervention. It can perceive its environment, reason, and take actions to achieve its goals without constant external control.
- **Learning and Adaptation:** Intelligence agents have the ability to learn from their experiences and adapt to new situations. They can acquire knowledge, improve their performance, and make better decisions over time.
- **Perception:** Intelligent agents can perceive their surroundings using sensors and interpret the information they receive. This perception helps them understand the state of the environment and make informed decisions.
- **Reasoning and Decision Making:** An intelligent agent can reason and make decisions based on available information. It can use logic, algorithms, or statistical methods to analyze data and derive conclusions.

Properties of Intelligent Agents

- **Communication:** Intelligent agents can communicate with other agents or humans. They can exchange information, collaborate, and coordinate their actions to achieve common goals.
- **Goal-Oriented Behavior:** Intelligent agents have specific goals or objectives to accomplish. They are designed to act in a way that maximizes their chances of achieving these goals.
- **Reactive and Proactive:** An intelligent agent can react to immediate stimuli from the environment and respond accordingly. It can also be proactive by anticipating future events and taking actions in advance.
- **Rationality:** Intelligent agents exhibit rational behavior by selecting the most appropriate action based on their goals and available information. They aim to make decisions that maximize their expected utility.

Rational Agent

- A rational agent is an agent which does the right thing(i.e, maximize its performance measure with all possible actions).
- Performance measures are the criterion for success of an agent behavior.
- A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date and prior environment knowledge.
- A rational agent depends upon folloing things:
  - Performance measure which defines the success criterion.
  - Agent prior knowledge of its environment.
  - Best possible actions that an agent can perform.
  - Percept sequence to date.

Configuration of Agents

- We must specify it's task environment to design a rational.
- The task environment means: **PEAS** description of the environment.

$$P \rightarrow \textit{Performance}$$
$$E \rightarrow \textit{Environment}$$
$$A \rightarrow \textit{Actuators}$$
$$S \rightarrow \textit{Sensors}$$

- The PEAS description of Agents allows us to classify the properties of an AI agent or rational agent after they are defined.

PEAS description of Agents

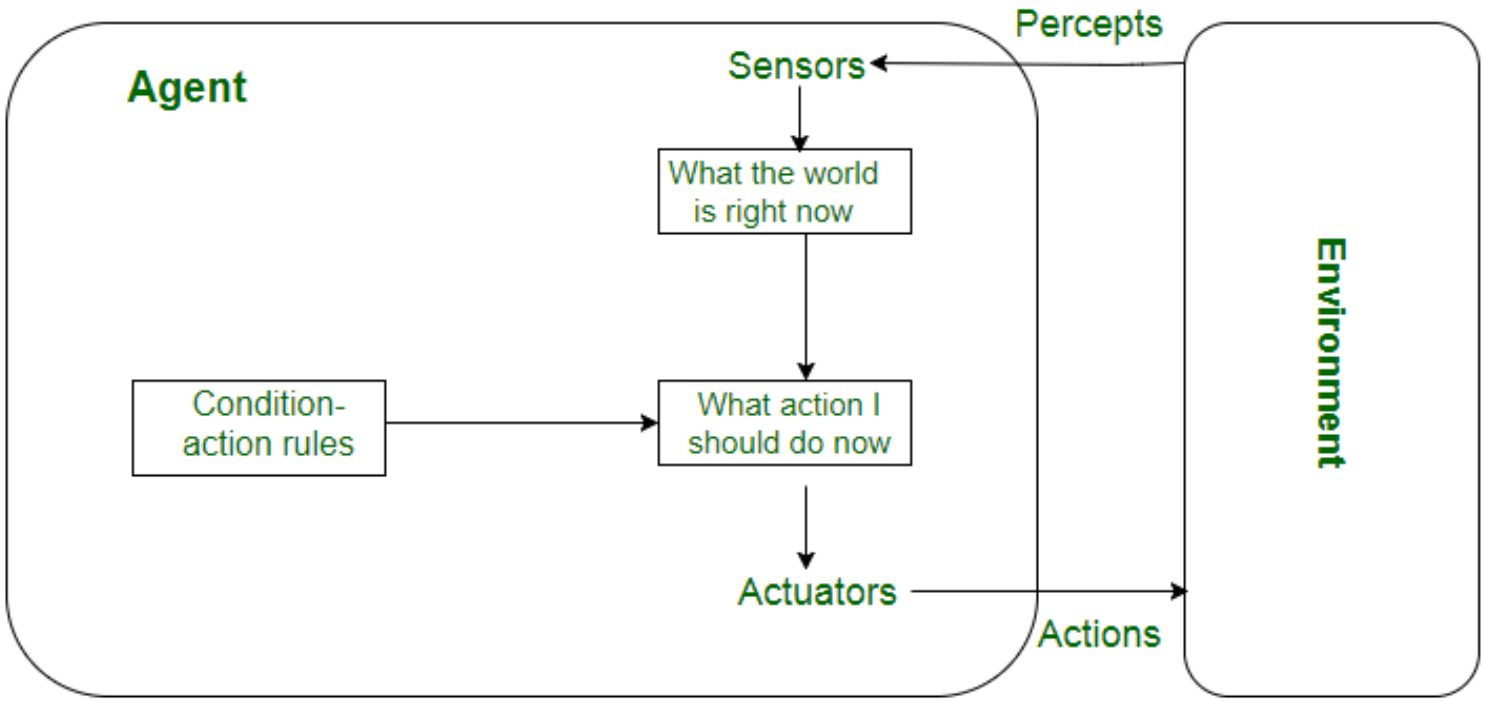
Agent	Performance Measure	Environment	Actuator	Sensor
Hospital Management System	Patient's health, Admission process, Payment	Hospital, Doctors, Patients	Prescription, Diagnosis, Scan report	Symptoms, Patient's response
Automated Car Drive	The comfortable trip, Safety, Maximum Distance	Roads, Traffic, Vehicles	Steering wheel, Accelerator, Brake, Mirror	Camera, GPS, Odometer
Subject Tutoring	Maximize scores, Improvement is students	Classroom, Desk, Chair, Board, Staff, Students	Smart displays, Corrections	Eyes, Ears, Notebooks
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arms and hand	Camera, joint angle sensors
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display categorization of scene	Color pixel arrays

Types of Agent

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

Simple Reflex Agents

- IT ignore the rest of the percept history and act only on the basis of the current percept.
- The agent function is based on the condition-action rule.
- If the condition is true, then the action is taken, else not.



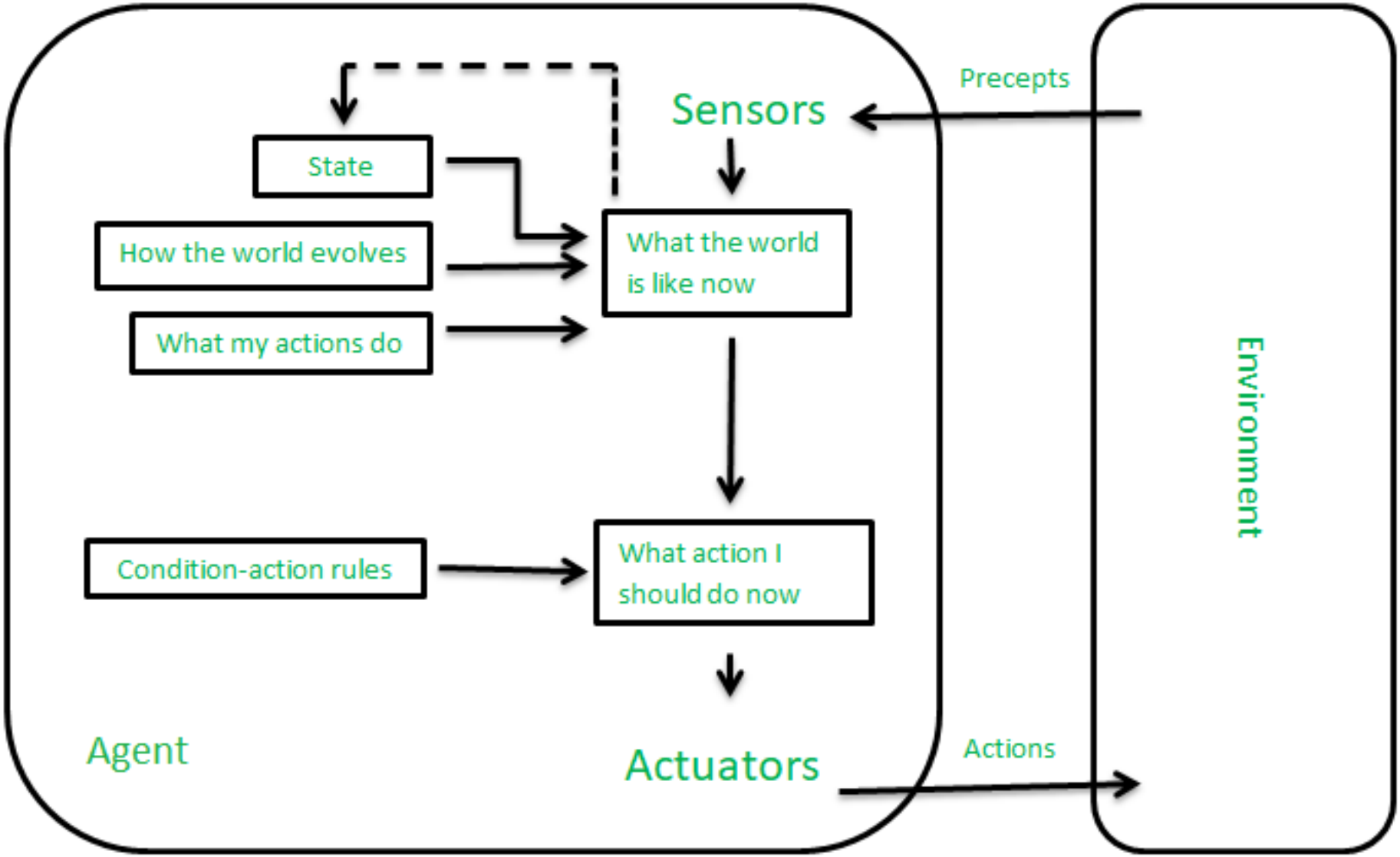
Simple Reflex Agents

- **For eg:** light is on if person walk in room.

Problems with Simple reflex agents are:

- Limited intelligence.
- rules are needed to update, if changed in environment occured.
- no knowledge of non-perceptual parts of the state.

Model Based Reflex Agents

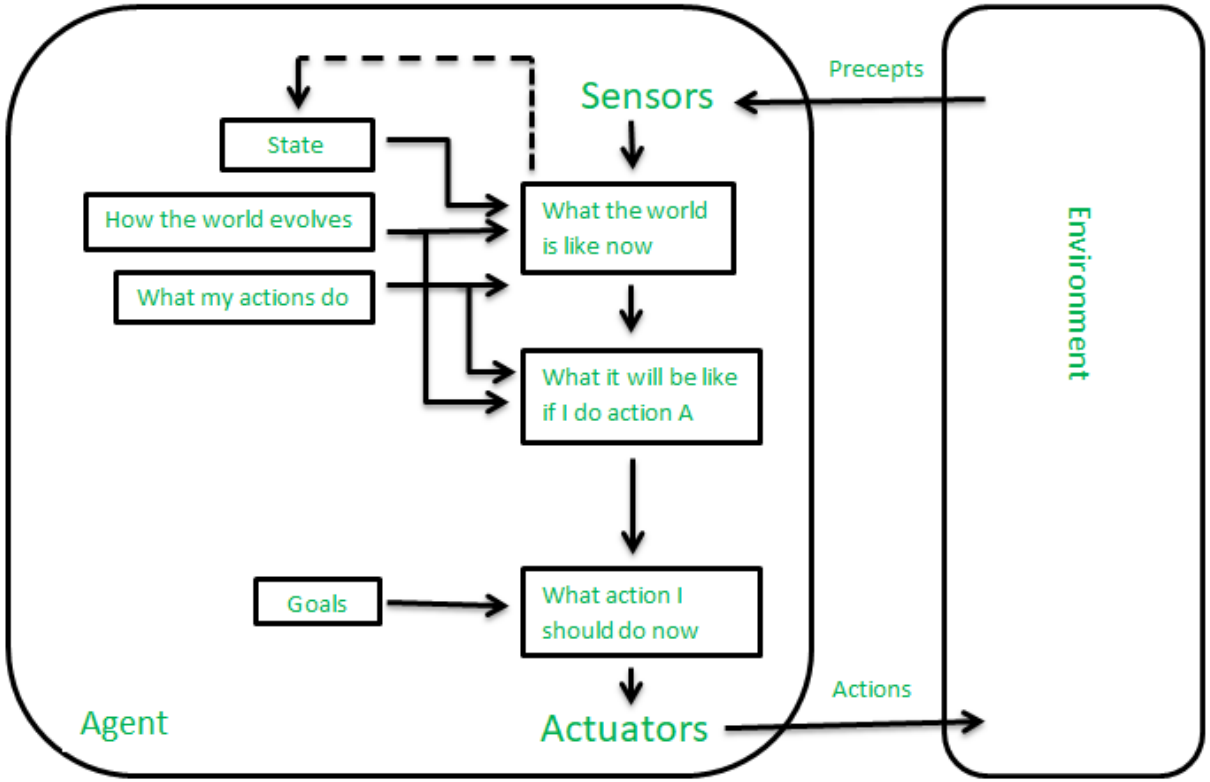


Model Based Reflex Agents

- It works by finding a rule whose condition matches the current situation.
- handle partially observable environments by the use of a model.
- Maintain a internal state to keep track of percept history. can not see now.
- Internal state keeps two kinds of knowledge:
  1. How the world evolves independently of the agent.
  2. How the agent's own actions affect the world

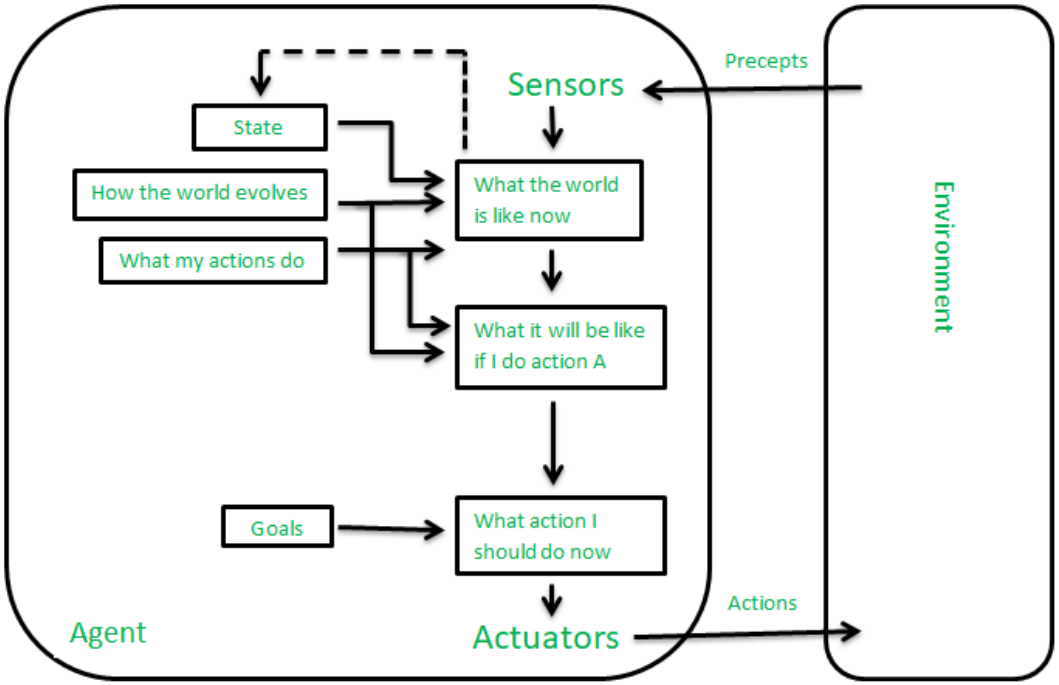
Goal Based Agents

- Goal-based agents further expand on the capabilities of the model based agents, by using "goal" information.
- This allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state.
- The goal-based agent's behavior can easily be changed.

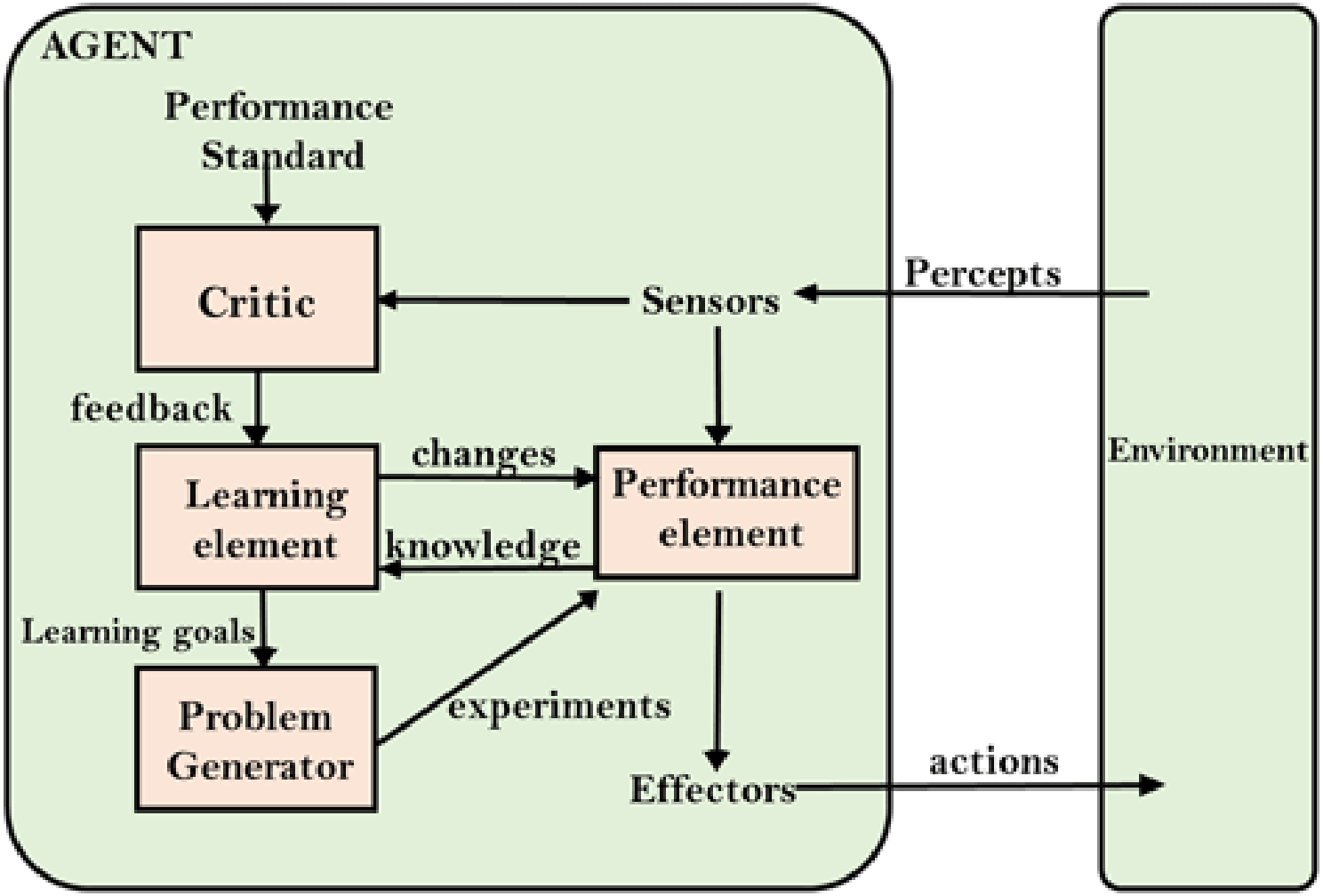


Utility Based Agents

- Sometimes achieving the desired goal is not enough.
- When there are multiple possible alternatives, then to decide which one is best, utility-based agents are used.
- Utility-based agent act based not only goals but also the best way to achieve the goal.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.



Learning Agent



Learning Agent

- It is agent which can learn from its past experiences, or it has learning capabilities.
- A learning agent has mainly four conceptual components:
  1. **Learning element:** It is responsible for making improvements by learning from the environment.
  2. **Critic:** It take feedback from critic which describe how well the agent is doing with respect to a fixed performance standard.
  3. **Performance element:** It is responsible for selecting external action
  4. **Problem generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.

Environment Types

- Fully observable vs Partially observable
- Single agent vs Multi-agent
- Deterministic vs Stochastic
- Episodic vs Sequential
- Static vs Dynamic
- Discrete vs Continuous

Fully observable vs Partially observable

Fully observable

- If an agent sensor can sense or access the complete state of an environment at each point in time then it is a fully observable environment.
- Maintaining a fully observable environment is easy as there is no need to keep track of the history of the surrounding.
- **For Eg:** chess-playing agent, in which agent has perfect information about the state of the world (like: all the the state of the chessboard and current position of all pieces).

Partially observable

- An environment is called partially observable when the agent has parts of the state are simply missing from the sensor data.
- **For Eg:** self-driving car in which it doesn't have complete and constant access to all relevant information.

Single agent vs Multi agent

Single agent

- If only one agent is involved in an environment, and operating by itself then such an environment is called a single agent environment.
- **For Eg:** Puzzel Solving, you're the only agent involved in which decisions and actions to achieve a goal is determined by only you.

Multi agent

- if multiple agents are operating in an environment, then such an environment is called a multi-agent environment.
- **For Eg:** Playing PUBG, here multiple player are involved to win a match.

Deterministic vs Stochastic

Deterministic

- If an agent's current state and selected action can completely determine the next state of the environment, then such an environment is called a deterministic environment.
- **For Eg:** Chess, In chess, the rules are well-defined, and each move made by a player has a clear and predictable outcome based on those rules.

Stochastic

- A stochastic environment is random and cannot be determined completely by an agent.
- **For Eg:** stock market, in stock market, It's highly influenced by different unpredictable factors, including economic events, investor sentiment, and news.

Episodic vs Sequential

Episodic

- In this environment each of the agent's actions is divided into atomic incidents or episodes.
- There is no dependency between current and previous incidents.
- In each incident, an agent receives input from the environment and then performs the corresponding action.
- **For Eg:** Defective part detection, on an assembly line bases each decision on the current part, regardless of previous decisions.

Sequential

- the previous decisions can affect all future decisions.
- The next action of the agent depends on what action he has taken previously and what action he is supposed to take in the future.
- **For Eg:** Chess.

Static vs Dynamic

Static

- An idle environment with no change in its state is called a static environment.
- Static environments are easy to deal with because the agent need not keep looking at the world while it is deciding on an action, nor need it worry about the passage of time.
- **For Eg:** Crossword puzzles, the puzzle itself doesn't change while you're thinking about your next move.

Dynamic

- An environment that keeps constantly changing itself when the agent is up with some action is said to be dynamic.
- for a dynamic environment, agents need to keep looking at the world at each action
- **For Eg:** Taxi driving.

Discrete vs Continuous:

Discrete

- If an environment consists of a finite number of actions that can be deliberated in the environment to obtain the output, it is said to be a discrete environment.
- **For Eg:** Chess, The number of moves are finite.

Continuous

- The environment in which the actions are performed cannot be numbered.
- **For Eg:** Self-driving cars, the speed and location of the car sweep through a range of continuous values and do so smoothly over time.


Thank you!