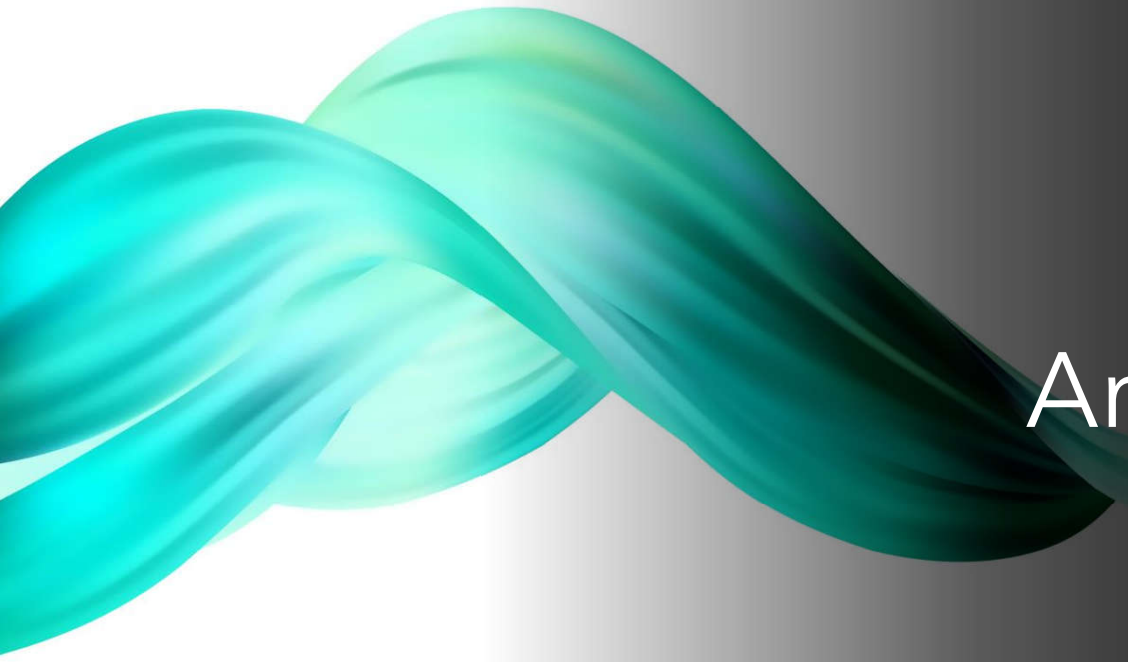


Artificial Intelligence

Dr. Mubashir Ahmad (Ph.D.)

What is an Agent?

- An agent can be anything that perceive its environment through sensors and act upon that environment through actuators. An Agent runs in the cycle of **perceiving**, **thinking**, and **acting**. An agent can be:

- **Human-Agent:** A human agent has eyes, ears, and other organs which work for sensors and hand, legs, vocal tract work for actuators.
- **Robotic Agent:** A robotic agent can have cameras, infrared range finder, NLP for sensors and various motors for actuators.
- **Software Agent:** Software agent can have keystrokes, file contents as sensory input and act on those inputs and display output on the screen.

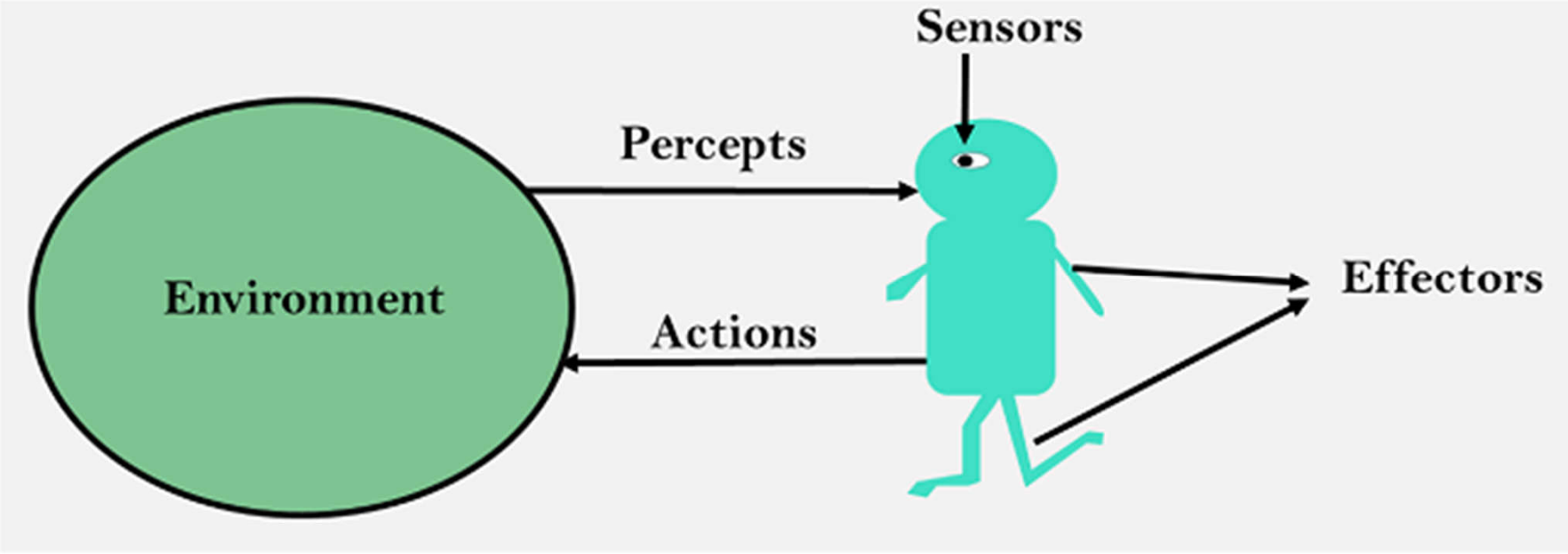
What is an Agent?

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

What is an Agent?

- **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.

What is an Agent?



Intelligent Agents:

- 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.
- Following are the main 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.

that always aims to perform optimal actions based on given premises and information.

Rational Agent:

- Rational Thinker: "Lots of people make mistakes. I doubt anyone even noticed, it didn't take away from the overall message, and I'll do better next time."
- 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.

PEAS Representation

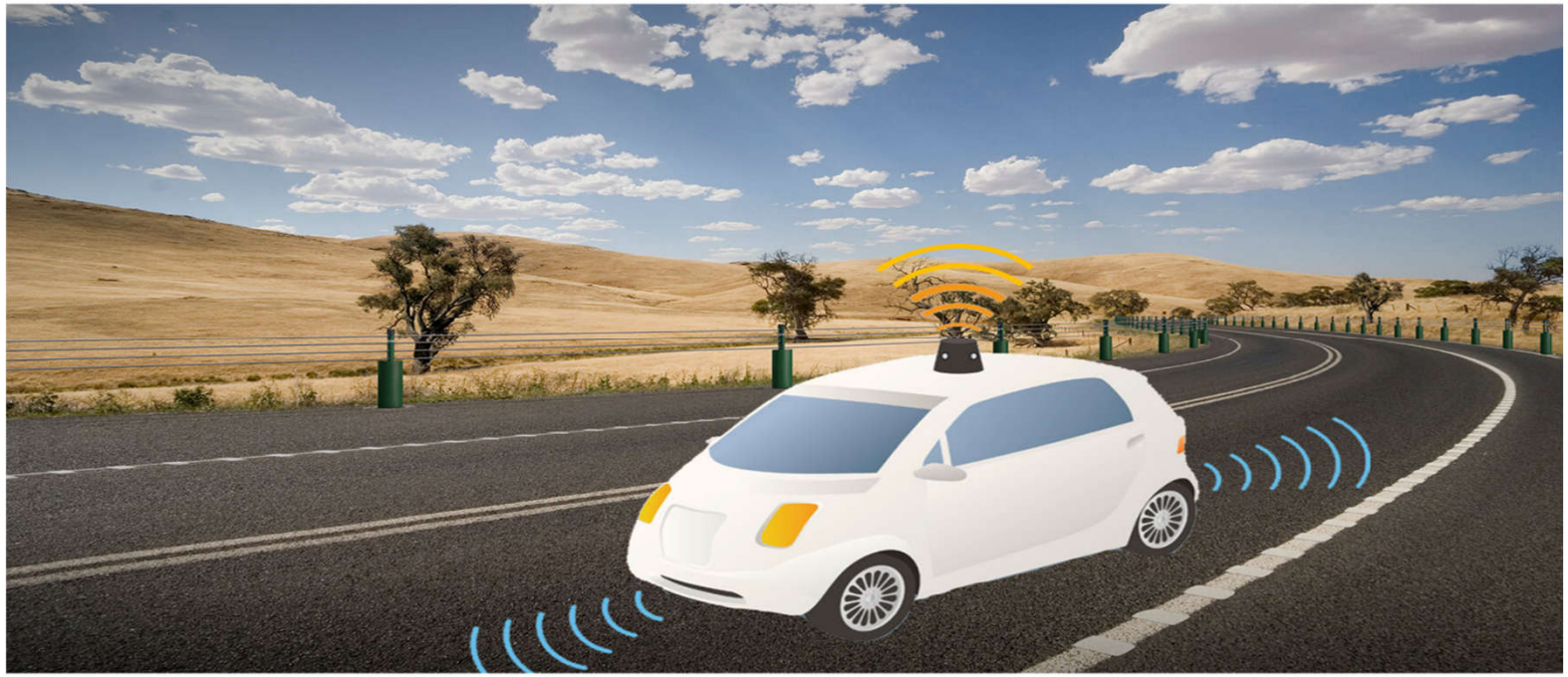
- PEAS is a type of model on which an AI agent works upon. When we define an AI agent or rational agent, then we can group its properties under PEAS representation model. It is made up of four words:
- **P:** Performance measure
- **E:** Environment
- **A:** Actuators
- **S:** Sensors

PEAS for self-driving cars:

- Let's suppose a self-driving car then PEAS representation will be:

- **Performance:** Safety, time, legal drive, comfort
- **Environment:** Roads, other vehicles, road signs, pedestrian
- **Actuators:** Steering, accelerator, brake, signal, horn
- **Sensors:** Camera, GPS, speedometer.

PEAS for self-driving cars:



Example of Agents with their 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

Agent Environment in AI

- An environment can be described as a situation in which an agent is present.

Features of Environment

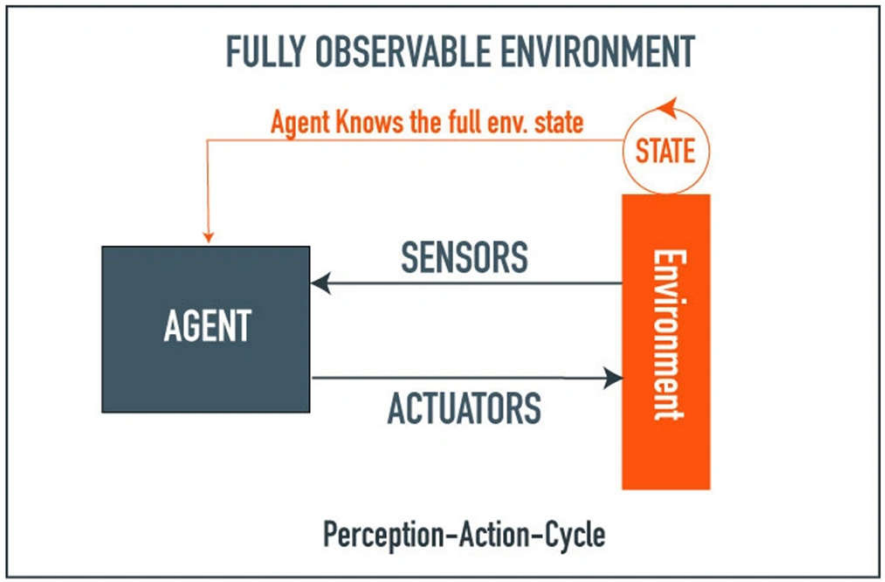
- As per Russell and Norvig, an environment can have various features from the point of view of an agent:

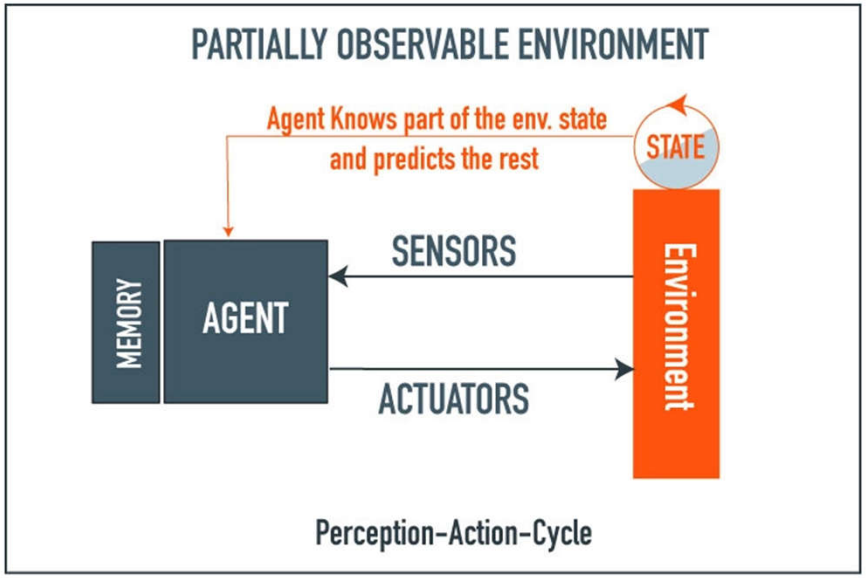
1. Fully observable vs Partially Observable
2. Static vs Dynamic
3. Discrete vs Continuous
4. Deterministic vs Stochastic
5. Single-agent vs Multi-agent
6. Episodic vs sequential
7. Known vs Unknown

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.
- or example in a Tic-Tac-Toe game, seeing the position of the elements on the board is enough to make an optimal decision on the next move.
- An agent with no sensors in all environments then such an environment is called as **unobservable**.

1. Fully observable vs Partially Observable:





2. Deterministic vs Stochastic:

- When a uniqueness in the agent's current state completely determines the next state of the agent, the environment is said to be deterministic.
- The stochastic environment is random in nature which is not unique and cannot be completely determined by the agent.
- **Examples:**
  - **Chess –** there would be only a few possible moves for a coin at the current state and these moves can be determined.
  - **Self-Driving Cars-** the actions of a self-driving car are not unique, it varies time to time.

3. Episodic vs Sequential:

- In **an Episodic task 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.
- **Example:** Consider an example of **Pick and Place robot**, which is used to detect defective parts from the conveyor belts. Here, every time robot(agent) will make the decision on the current part i.e. there is no dependency between current and previous decisions.
- In a **Sequential environment**, 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.
- **Example:**
  - **Checkers-** Where the previous move can affect all the following moves.

4. Single-agent vs Multi-agent

- An environment consisting of only one agent is said to be a single-agent environment.
- A person left alone in a maze is an example of the single-agent system.
- An environment involving more than one agent is a multi-agent environment.
- The game of football is multi-agent as it involves 11 players in each team.

5. Static vs Dynamic:

- An environment that keeps constantly changing itself when the agent is up with some action is said to be dynamic.
- A roller coaster ride is dynamic as it is set in motion and the environment keeps changing every instant.
- An idle environment with no change in its state is called a static environment.
- An empty house is static as there’s no change in the surroundings when an agent enters.

6. Discrete vs Continuous:

- 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.
- The game of chess is discrete as it has only a finite number of moves. The number of moves might vary with every game, but still, it's finite.
- The environment in which the actions are performed cannot be numbered i.e. is not discrete, is said to be continuous.
- Self-driving cars are an example of continuous environments as their actions are driving, parking, etc. which cannot be numbered.

7. Known vs Unknown

- 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.

Intelligent agent

- An intelligent agent is a program that can make decisions or perform a service based on its environment, user input and experiences. These programs can be used to autonomously gather information on a regular, programmed schedule or when prompted by the user in real time. An intelligent agent is also referred to as a bot, which is short for *robot*.

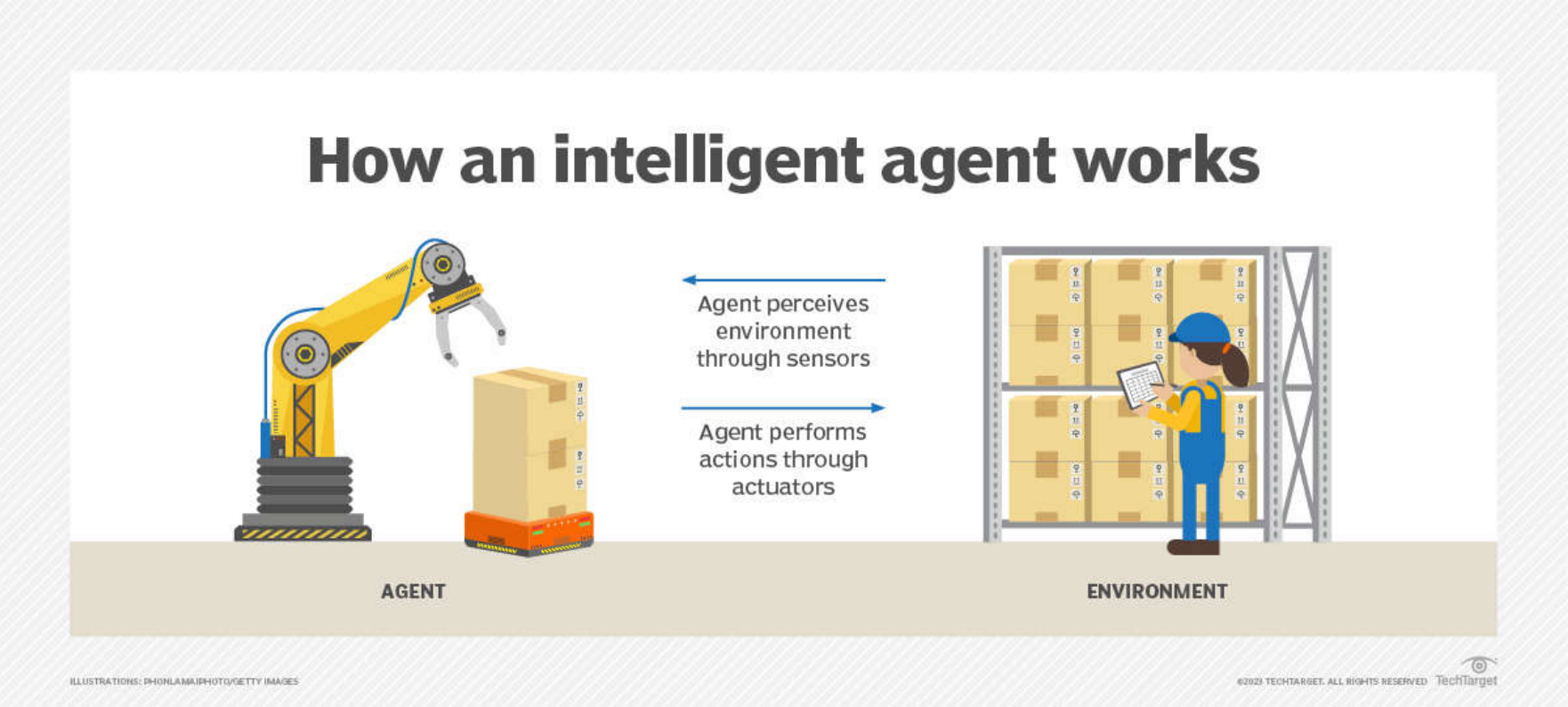
Intelligent agent

- Agents that use artificial intelligence (AI) and machine learning use sensors, such as microphones and cameras, to collect user input. They also use effectors, such as fingers and wheels, to affect their environment, as well as actuators, such as speakers and screens, to deliver agent output. The practice of having information brought to a user by an agent is called push notification technology.
- Common characteristics of intelligent agents are adaptation based on experience, real-time problem-solving, analysis of error or success rates, and the use of memory-based storage and retrieval.

Intelligent agent

- For enterprises, intelligent agents can be used in data science applications such as data mining and data analytics, as well as for customer service and support. Consumers use intelligent agents to compare the prices of similar products and get notifications when a website update occurs.
- Intelligent agents are also similar to software agents, which are autonomous computer programs.

What is an intelligent agent?



Types of AI Agents

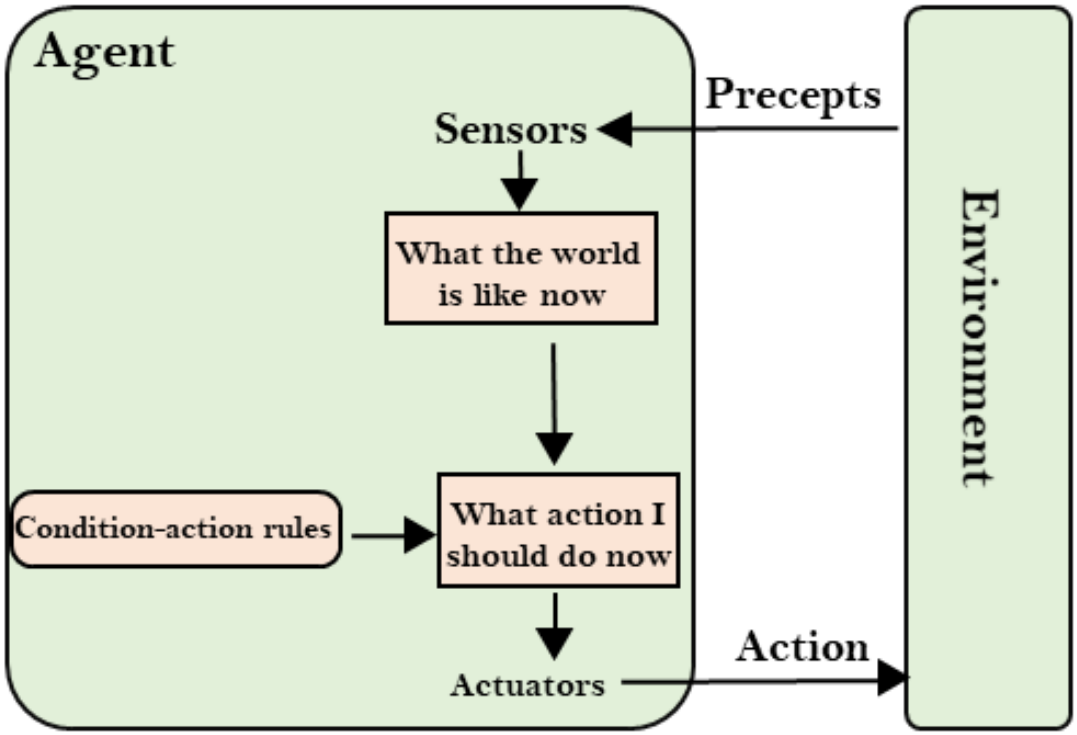
- Agents can be grouped into five classes based on their degree of perceived intelligence and capability. All these agents can improve their performance and generate better action over the time.

- •Simple Reflex Agent
- •Model-based reflex agent
- •Goal-based agents
- •Utility-based agent
- •Learning agent

1. Simple Reflex agent: (Reflex : immediately)

- 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 perception history. (example sneezing)
- 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 (if then), 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. If temperature in the room is > 40 degree then turn on the AC.
- A reflex agent, for example, could be **a home thermostat that knows to start heating or cooling your house based on reaching a certain temperature**.

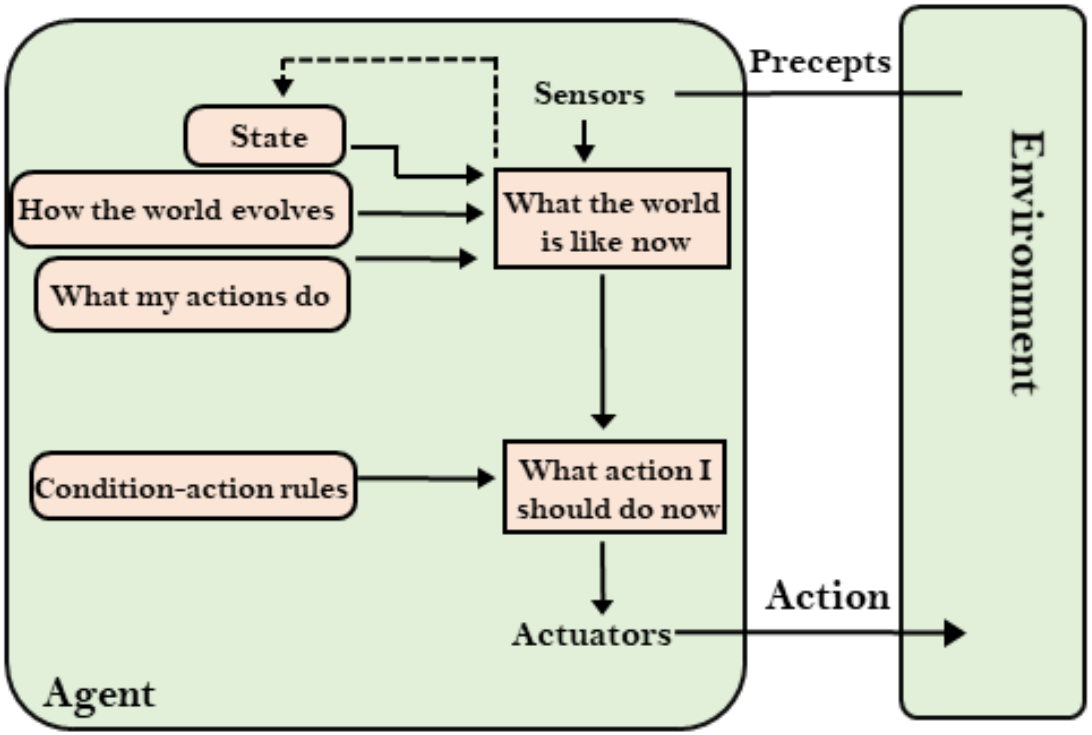
1. Simple Reflex agent:



2. Model-based reflex agent

- 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. (past history in mind)
  - **Internal State:** It is a representation of the current state based on percept history.
  - **Partially observable** environment.
- 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.
  - Current situation + History

2. Model-based reflex agent



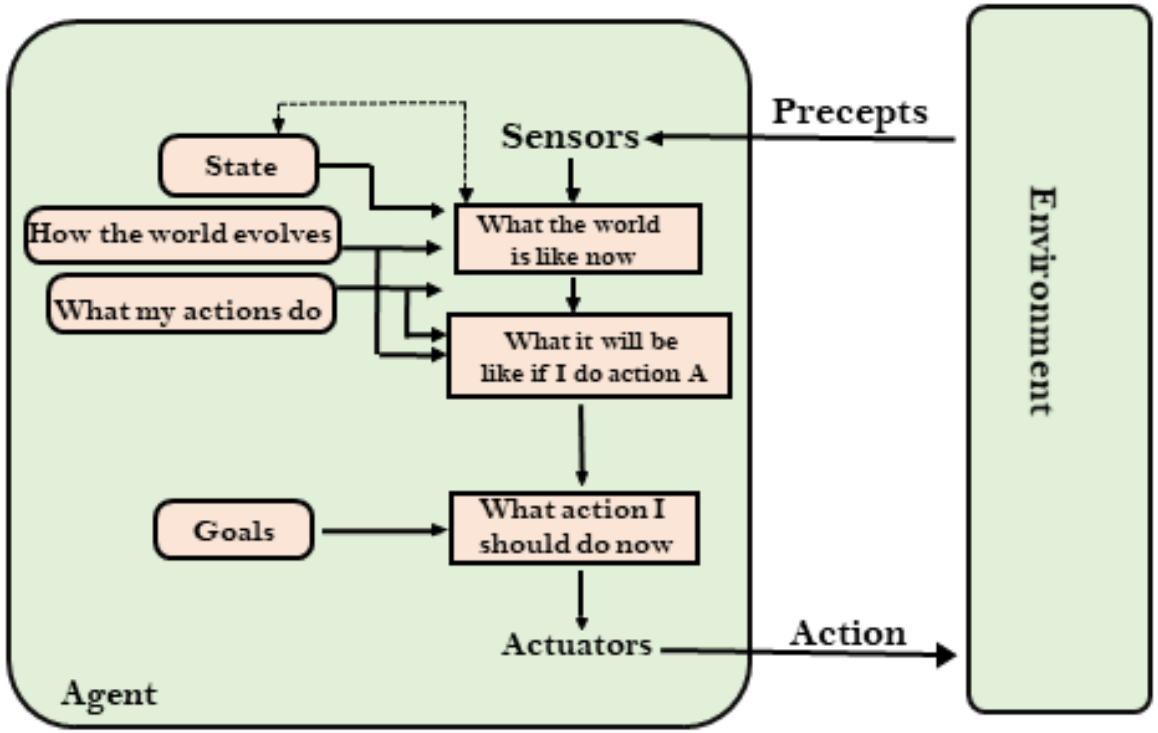
3. Goal-based agents

- It is the extension of model-based agent.
- 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. (it knows the goal, mean its some how a supervised learning).
- 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.

3. Goal-based agents

- The Chinese tech giant's latest creation is called the G Plus and is a self-driving robot which utilizes LiDAR for navigation and facial recognition in order to ensure it is delivering its packages to the correct recipients.
- Capable of hitting 9 mph, the G Plus can travel long distances and carry multiple packages at once.
- Not to mention, Alibaba says it can keep food warm.
- **Note: Lidar – Light Detection and Ranging – is a remote sensing method used to examine the surface of the Earth**.

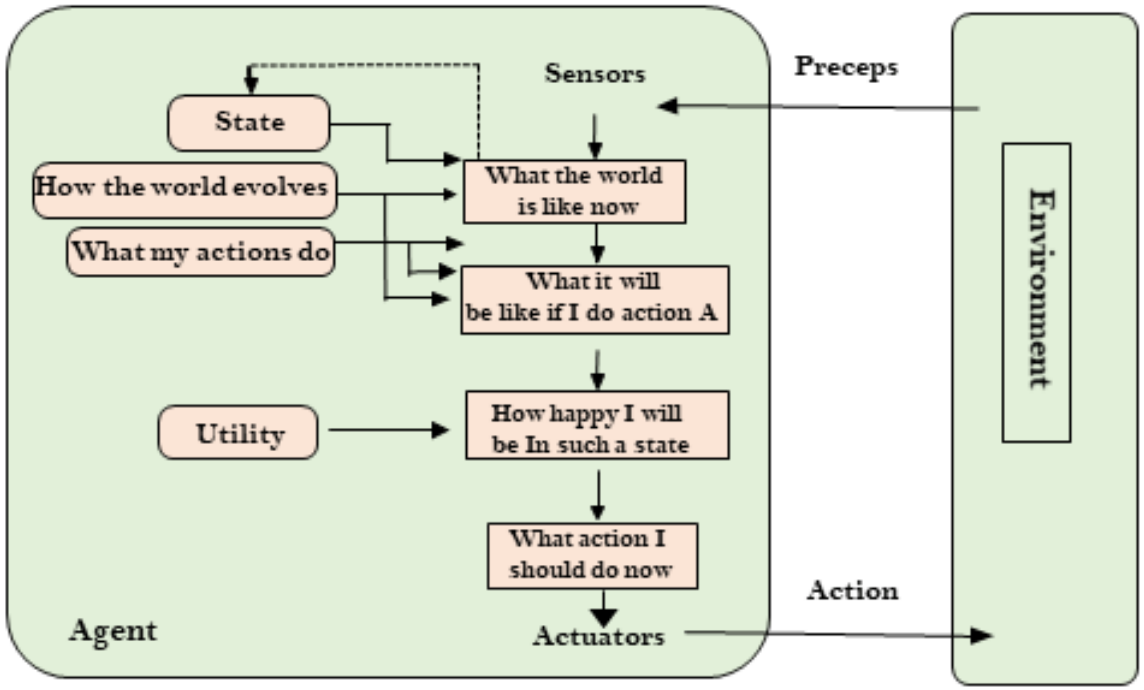
3. Goal-based agents



4. Utility-based agents

- These 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.
- 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.
- Agent is happy or not to performing this action?
- Google map, travelling from one place to another place. Destination.

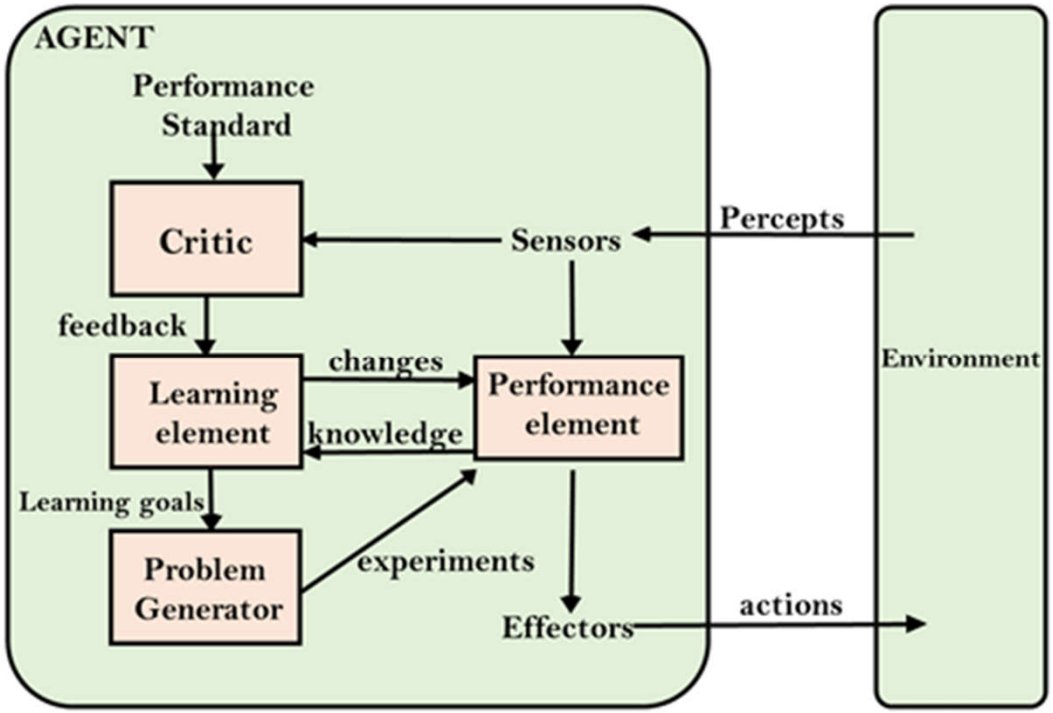
4. Utility-based agents



5. 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.
- Hence, learning agents are able to learn, analyze performance, and look for new ways to improve the performance.

5. Learning Agents



Top 10 AI Apps for Healthcare and Fitness

ada

babylon

buoy
a personal lift any time

klara

SkinVision
Together We Care

fitbod

Aaptiv

NOOM

Keelo