What is Artificial Intelligence (AI)?

In today's world, technology is growing very fast, and we are getting in touch with different new technologies day by day.

Here, one of the booming technologies of computer science is Artificial Intelligence which is ready to create a new revolution in the world by making intelligent machines. The Artificial Intelligence is now all around us. It is currently working with a variety of subfields, ranging from general to specific, such as self-driving cars, playing chess, proving theorems, playing music, Painting, etc.

Artificial Intelligence (AI) refers to programming computers to do tasks that normally require human intelligence, like learning, problem solving, and understanding language. It is like giving computers the ability to think and make decisions on their own, similar to how humans do. AI helps machines learn from data, adapt to new situations, and perform tasks without being explicitly programmed for each step.

AI is one of the fascinating and universal fields of Computer science which has a great scope in future. AI holds a tendency to cause a machine to work as a human.

Artificial Intelligence is composed of two words **Artificial** and **Intelligence**, where Artificial defines "*man made,*" and intelligence defines "*thinking power*", hence AI means "*a man made thinking power.*"

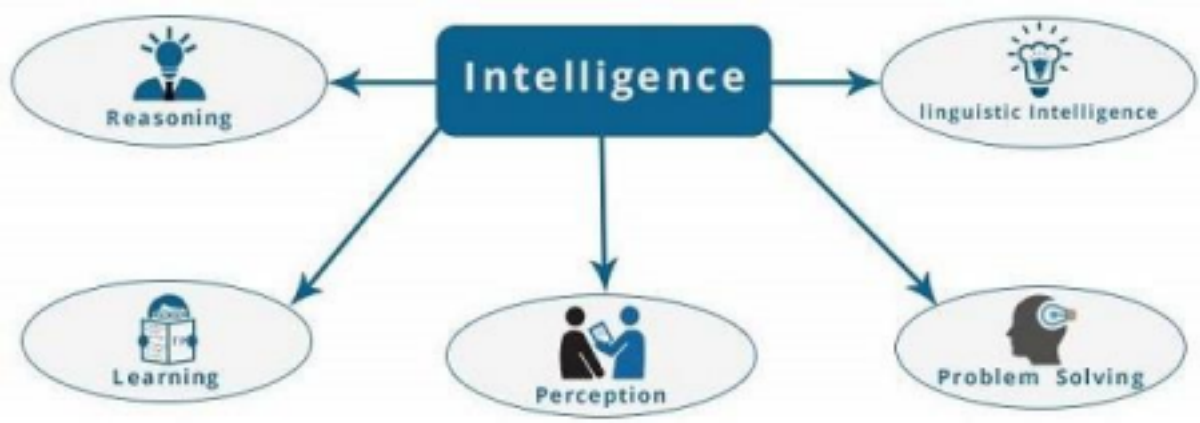
What is Intelligence?

The ability of a system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize, and adapt new situations.

What is Intelligence Composed of?

The intelligence is intangible. It is composed of −

- Reasoning
- Learning
- Problem Solving
- Perception
- Linguistic Intelligence



Let us go through all the components briefly –

- **Reasoning** − It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction. There are broadly two types −

Inductive Reasoning	**Deductive Reasoning**
It conducts specific observations to makes broad general statements.	It starts with a general statement and examines the possibilities to reach a specific, logical conclusion.
Even if all of the premises are true in a statement, inductive reasoning allows for the conclusion to be false.	If something is true of a class of things in general, it is also true for all members of that class.
Example − "Nita is a teacher. Nita is studious. Therefore, All teachers are studious."	Example − "All women of age above 60 years are grandmothers. Shalini is 65 years. Therefore, Shalini is a grandmother."

- **Learning** − It is the activity of gaining knowledge or skill by studying, practising, being taught, or experiencing something. Learning enhances the awareness of the subjects of the study. The ability of learning is possessed by humans, some animals, and AI-enabled systems. Learning is categorized as −
    - **Auditory Learning** − It is learning by listening and hearing. For example, students listening to recorded audio lectures.
    - **Episodic Learning** − To learn by remembering sequences of events that one has witnessed or experienced. This is linear and orderly.
    - **Motor Learning** − It is learning by precise movement of muscles. For example, picking objects, Writing, etc.
    - **Observational Learning** − To learn by watching and imitating others. For example, child tries to learn by mimicking her parent.
    - **Perceptual Learning** − It is learning to recognize stimuli that one has seen before. For example, identifying and classifying objects and situations.
    - **Relational Learning** − It involves learning to differentiate among various stimuli on the basis of relational properties, rather than absolute properties. For Example, Adding 'little less' salt at the time of cooking potatoes that came up salty last time, when cooked with adding say a tablespoon of salt.
    - **Spatial Learning** − It is learning through visual stimuli such as images, colors, maps, etc. For Example, A person can create roadmap in mind before actually following the road.
    - **Stimulus-Response Learning** − It is learning to perform a particular behavior when a certain stimulus is present. For example, a dog raises its ear on hearing doorbell.
- **Problem Solving** − It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.

Problem solving also includes **decision making**, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.

- **Perception** − It is the process of acquiring, interpreting, selecting, and organizing sensory information.
  Perception presumes **sensing**. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.
- **Linguistic Intelligence** − It is one's ability to use, comprehend, speak, and write the verbal and written language. It is important in interpersonal communication.

So, we can define AI as:

"It is a branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions."

Why Artificial Intelligence?

Before Learning about Artificial Intelligence, we should know that what is the importance of AI and why should we learn it. Following are some main reasons to learn about AI:

- With the help of AI, you can create such software or devices which can solve real-world problems very easily and with accuracy such as health issues, marketing, traffic issues, etc.
- With the help of AI, you can create your personal virtual Assistant, such as Cortana, Google Assistant, Siri, etc.
- With the help of AI, you can build such Robots which can work in an environment where survival of humans can be at risk.
- AI opens a path for other new technologies, new devices, and new Opportunities.

Goals of Artificial Intelligence

Following are the main goals of Artificial Intelligence:

1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:
    - Proving a theorem
    - Playing chess
    - Plan some surgical operation
    - Driving a car in traffic
5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.
6. **To Create Expert Systems** − The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users. 7. **To Implement Human Intelligence in Machines** − Creating systems that understand, think, learn, and behave like humans.

History of AI

- Throughout history, people have been intrigued by the idea of making non-living things smart. In ancient times, Greek stories mentioned gods creating clever machines, and in Egypt, engineers made statues move. Thinkers like **Aristotle and Ramon Llull** laid the groundwork for AI by describing how human thinking works using symbols.
- In the late 1800s and early 1900s, modern computing started to take

shape. Charles Babbage and Ada Lovelace designed machines that could be programmed in the 1830s. In the 1940s, John Von Neumann came up with the idea of storing computer programs. At the same time, Warren McCulloch and Walter Pitts started building the basics of neural networks.

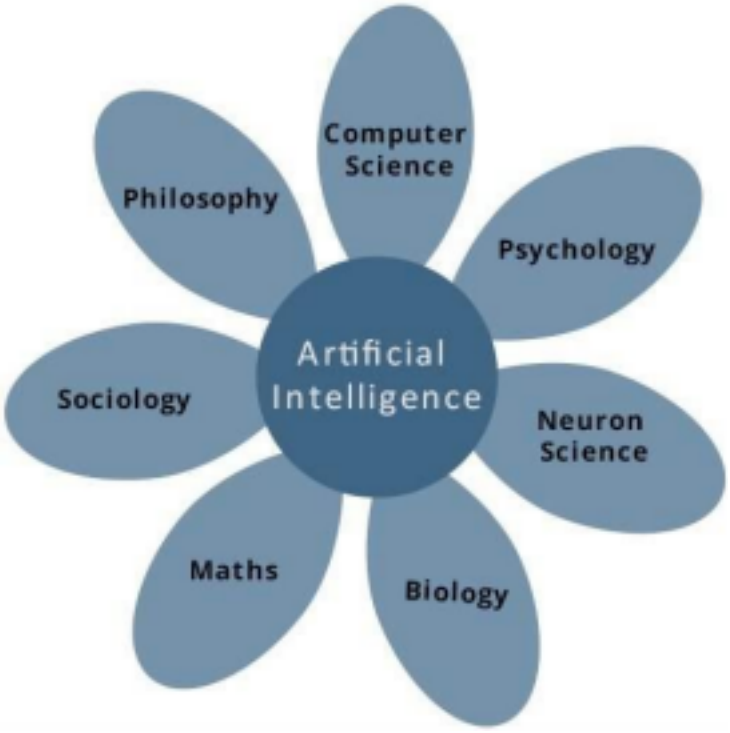
- The **1950s** brought us modern computers, letting scientists dig into machine intelligence. **Alan Turing's** Turing test became a big deal in computer smarts. The term "**artificial intelligence" was first used in a 1956 Dartmouth College meeting,** where they introduced the first AI program, the Logic Theorist.
- The following years had good times and bad times for AI, called "**AI Winters**." In the 1970s and 1980s, we hit limits with computer power and complexity. But in the late 1990s, things got exciting again. Computers were faster, and there was more data. **IBM's Deep Blue** beating chess champion Garry Kasparov in 1997 was a big moment.
- The 2000s started a new era with machine learning, language processing, and computer vision. This led to cool new products and services. The 2010s saw AI take off with things like voice assistants and self-driving cars. Generative AI, which makes creative stuff, also started getting big.
- In the 2020s, generative AI like **ChatGPT-3** and **Google's Bard** grabbed everyone's attention. These models can create all sorts of new things when you give them a prompt, like essays or art. But remember, this tech is still new, and there are things to fix, like making sure it doesn't make things up.

What Comprises to Artificial Intelligence?

Artificial Intelligence is not just a part of computer science even it's so vast and requires lots of other factors which can contribute to it. To create the AI first we should know that how intelligence is composed, so the Intelligence is an intangible part of our brain which is a combination

of **Reasoning, learning, problem-solving perception, language understanding, etc**.
To achieve the above factors for a machine or software Artificial Intelligence requires the following discipline:

- Mathematics
- Biology
- Psychology
- Sociology
- Computer Science
- Neurons Study
- Statistics



Types of Artificial Intelligence

Artificial Intelligence can be categorized in several ways, primarily based on two main criteria: capabilities and functionality.

AI Type 1: Based on Capabilities

1. **Weak AI or Narrow AI:** Narrow AI, also known as Weak AI, is like a specialist in the world of Artificial Intelligence. Imagine it as a

virtual expert dedicated to performing one specific task with intelligence. For example, think of Apple's Siri. It's pretty smart when it comes to voice commands and answering questions, but it doesn't understand or do much beyond that. Narrow AI operates within strict limits, and if you ask it to step outside its comfort zone, it might not perform as expected. This type of AI is everywhere in today's world, from self-driving cars to image recognition on your smartphone. BM's Watson is another example of Narrow AI. It's a supercomputer that combines Expert Systems, Machine Learning, and Natural Language Processing, but it's still a specialist. It's excellent at crunching data and providing insights but doesn't venture far beyond its defined tasks.

2. **General AI:** General AI, often referred to as Strong AI, is like the holy grail of artificial intelligence. Picture it as a system that could do any intellectual task with the efficiency of a human. General AI aims to create machines that think and learn like humans, but here's the catch: there's no such system in existence yet. Researchers worldwide are working diligently to make it a reality, but it's a complex journey that will require significant time and effort.
3. **Super AI:** Super AI takes AI to another level entirely. It's the pinnacle of machine intelligence, where machines surpass human capabilities in every cognitive aspect. These machines can think, reason, solve puzzles, make judgments, plan, learn, and communicate independently. However, it's important to note that Super AI is currently a hypothetical concept. Achieving such a level of artificial intelligence would be nothing short of revolutionary, and it's a challenge that's still on the horizon.

AI Type 2: Based on Functionality

1. **Reactive Machines:** Reactive Machines represent the most basic form of Artificial Intelligence. These machines live in the present moment and don't have memories or past experiences to guide their actions. They focus solely on the current scenario and

respond with the best possible action based on their programming. An example of a reactive machine is IBM's Deep Blue, the chess playing computer, and Google's AlphaGo, which excels at the ancient game of Go.

2. **Limited Memory:** Limited Memory machines can remember some past experiences or data but only for a short period. They use this stored information to make decisions and navigate situations. A great example of this type of AI is seen in self-driving cars. These vehicles store recent data like the speed of nearby cars, distances, and speed limits to safely navigate the road.
3. **Theory of Mind:** Theory of Mind AI is still in the realm of research and development. These AI systems aim to understand human emotions and beliefs and engage in social interactions much like humans. While this type of AI hasn't fully materialized yet, researchers are making significant strides toward creating machines that can understand and interact with humans on a deeper, more emotional level.
4. **Self-Awareness:** Self-Awareness AI is the future frontier of Artificial Intelligence. These machines will be extraordinarily intelligent, possessing their own consciousness, emotions, and self awareness. They'll be smarter than the human mind itself. However, it's crucial to note that Self-Awareness AI remains a hypothetical concept and does not yet exist in reality. Achieving this level of AI would be a monumental leap in technology and understanding.

Agents in Artificial Intelligence

In artificial intelligence, an agent is a computer program or system that is designed to perceive its environment, make decisions and take actions to achieve a specific goal or set of goals.

An AI system can be defined as the study of the rational agent and its environment. The agents sense the environment through sensors and act

on their environment through actuators. An AI agent can have mental properties such as knowledge, belief, intention, etc.

What is an Agent?

An agent can be anything that perceiveits 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:

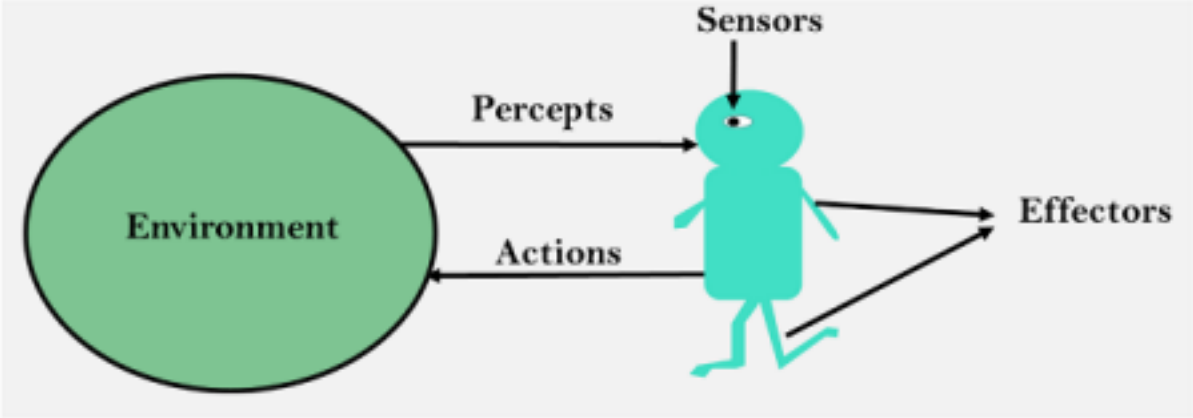
- **Human-Agent:** A human agent has eyes, ears, and other organs which work for sensors and hand, legs, vocal tract work for actuators.
- **Robotic Agent:** A robotic agent can have cameras, infrared range finder, NLP for sensors and various motors for actuators.
- **Software Agent:** Software agent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

Hence the world around us is full of agents such as thermostat, cellphone, camera, and even we are also agents.
Before moving forward, we should first know about sensors, effectors, and actuators.

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.

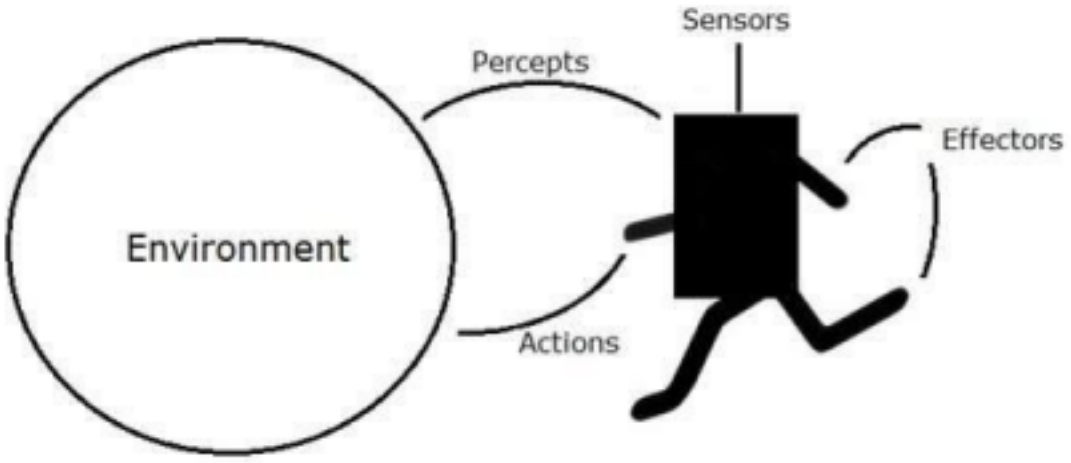
Effectors: Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.



What are Agent and Environment?

An **agent** is anything that can perceive its environment through **sensors** and acts upon that environment through **effectors.**

- A **human agent** has sensory organs such as eyes, ears, nose, tongue and skin parallel to the sensors, and other organs such as hands, legs, mouth, for effectors.
- A **robotic agent** replaces cameras and infrared range finders for the sensors, and various motors and actuators for effectors.
- A **software agent** has encoded bit strings as its programs and actions.



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
8. Accessible vs Inaccessible

Rationality

Rationality is nothing but status of being reasonable, sensible, and having good sense of judgment.

Rationality is concerned with expected actions and results depending upon what the agent has perceived. Performing actions with the aim of obtaining useful information is an important part of rationality.
What is Ideal Rational Agent?

An ideal rational agent is the one, which is capable of doing expected actions to maximize its performance measure, on the basis of −

- Its percept sequence
- Its built-in knowledge base

Rationality of an agent depends on the following −

- The **performance measures**, which determine the degree of success.
- Agent's **Percept Sequence** till now.
- The agent's **prior knowledge about the environment**.
- The **actions** that the agent can carry out.

A rational agent always performs right action, where the right action means the action that causes the agent to be most successful in the given percept sequence. The problem the agent solves is characterized by Performance Measure, Environment, Actuators, and Sensors (PEAS).

The Structure of Intelligent Agents

Agent's structure can be viewed as −

· Agent = Architecture + Agent Program
· Architecture = the machinery that an agent executes on. ·
Agent Program = an implementation of an agent function.

Types of Agents in Artificial Intelligence With Examples

Based on their degree of perceived intelligence and capability, types of agents in artificial intelligence can be divided into:

1. Simple Reflex Agents
2. Model-Based Agents
3. Goal-Based Agents
4. Utility-Based Agents
5. Learning Agents

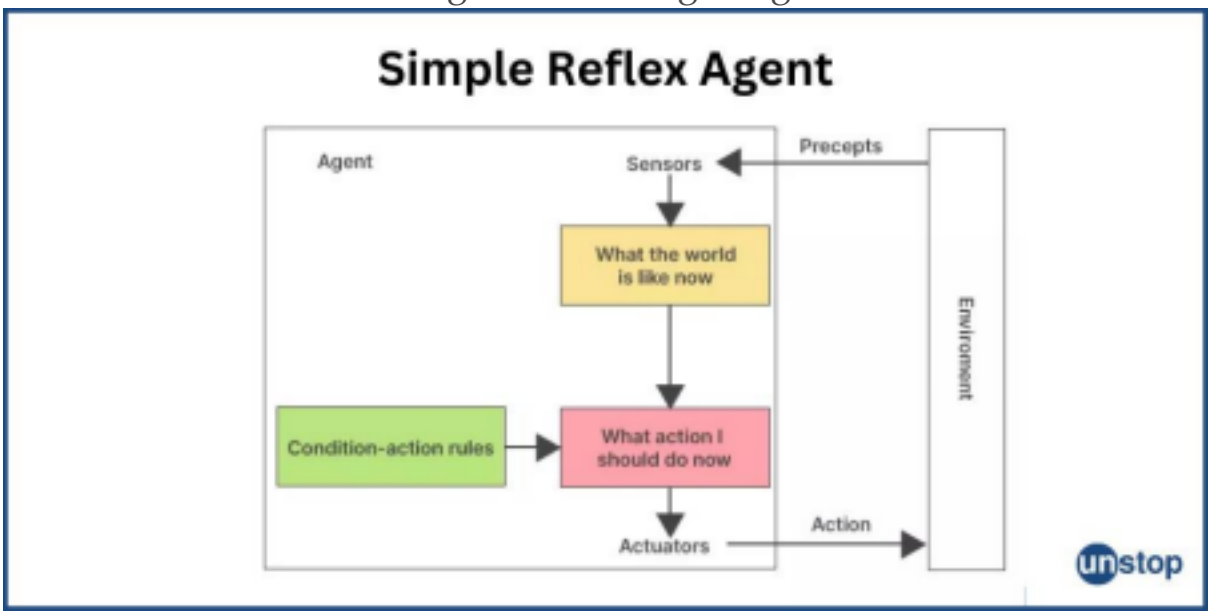
Performance can be improved and better action can be generated for each of these types of agents in AI.

Simple Reflex Agents

1. This is a simple type of agent which works on the basis of current percept and not based on the rest of the percepts history.
2. The agent function, in this case, is based on condition-action rule where the condition or the state is mapped to the action such that action is taken only when condition is true or else it is not.
3. If the environment associated with this agent is fully observable, only then is the agent function successful, if it is partially observable, in that case the agent function enters into infinite loops that can be escaped only on randomization of its actions.
4. The problems associated with this type include very limited intelligence, No knowledge of non-perceptual parts of the state, huge size for generation and storage and inability to adapt to changes in the environment.

5. **Example:** A thermostat in a heating system.

This can be illustrated using the following image:



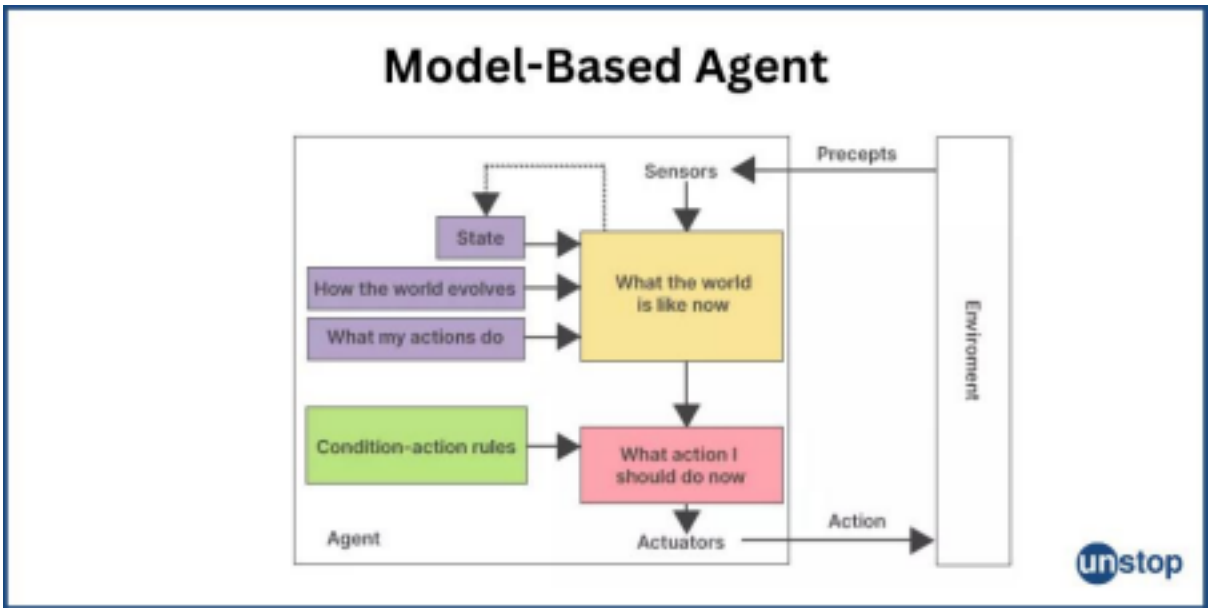
Model-Based Agents

1. Model-based agent utilizes the condition-action rule, where it works by finding a rule that will allow the condition, which is based on the current situation, to be satisfied.
2. Irrespective of the first type, it can handle partially observable environments by tracking the situation and using a particular model related to the world.
3. It consists of two important factors, which are Model and Internal State.
4. Model provides knowledge and understanding of the process of occurrence of different things in the surroundings such that the current situation can be studied and a condition can be created. Actions are performed by the agent based on this model.
5. Internal State uses the perceptual history to represent a current percept. The agent keeps a track of this internal state and is adjusted by each of the percepts. The current internal state is stored by the agent inside it to maintain a kind of structure that can describe the unseen world.
6. The state of the agent can be updated by gaining information about

how the world evolves and how the agent's action affects the world.

7. **Example:** A vacuum cleaner that uses sensors to detect dirt and obstacles and moves and cleans based on a model.

This can be illustrated as:



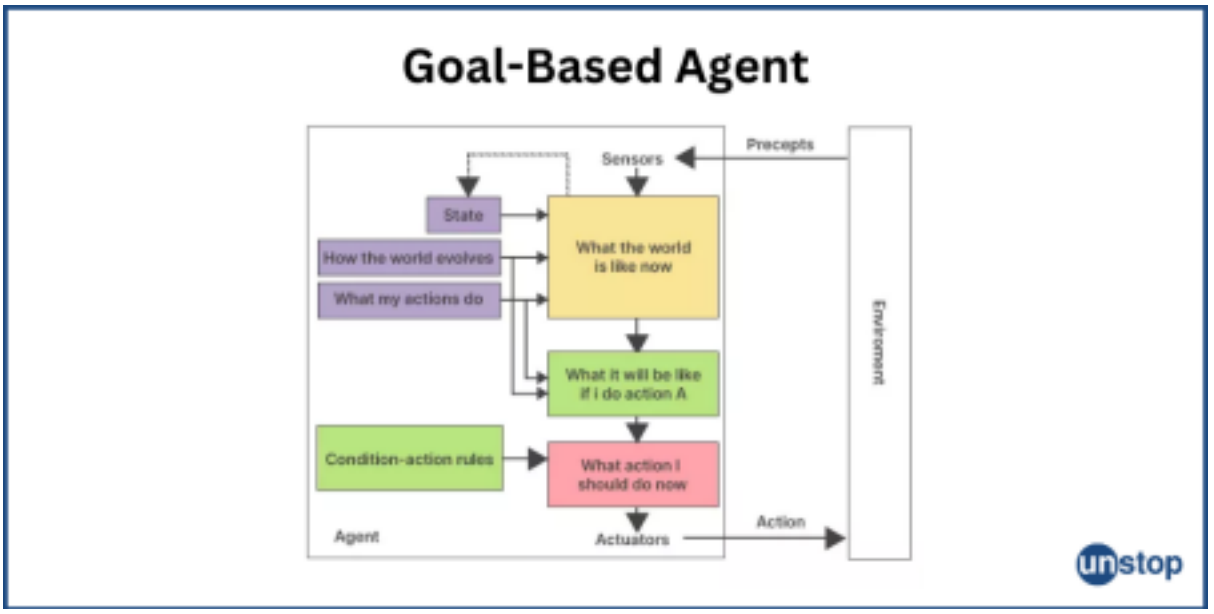
Goal-Based Agents

1. This type takes decisions on the basis of its goal or desirable situations so that it can choose such an action that can achieve the goal required.
2. It is an improvement over model based agent where information about the goal is also included. This is because it is not always sufficient to know just about the current state, knowledge of the goal is a more beneficial approach.
3. The aim is to reduce the distance between action and the goal so that the best possible way can be chosen from multiple possibilities. Once the best way is found, the decision is represented explicitly which makes the agent more flexible.
4. It carries out considerations of different situations called searching and planning by considering long sequence of possible actions for confirming its ability to achieve the goal. This makes the agent proactive.

5. It can easily change its behavior if required.

6. **Example:** A chess-playing AI whose goal is winning the game.

This can be illustrated as follows:



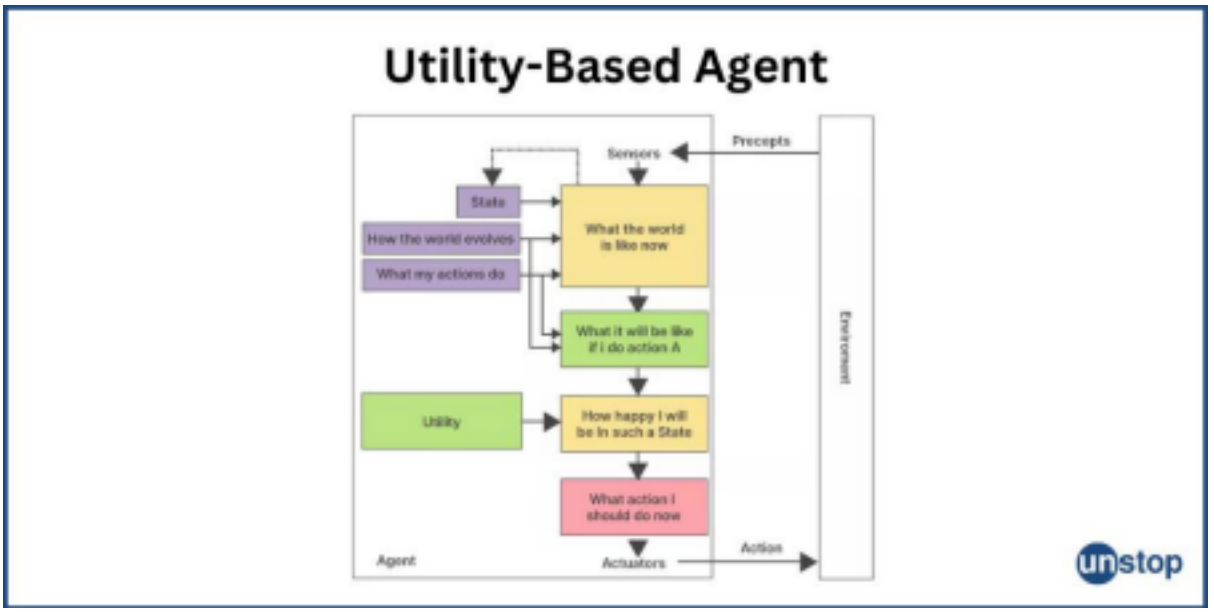
Utility-Based Agents

1. Utility agent have their end uses as their building blocks and is used when best action and decision needs to be taken from multiple alternatives.
2. It is an improvement over goal based agent as it not only involves the goal but also the way the goal can be achieved such that the goal can be achieved in a quicker, safer, cheaper way.
3. The extra component of utility or method to achieve a goal provides a measure of success at a particular state that makes the utility agent different.
4. It takes the agent happiness into account and gives an idea of how happy the agent is because of the utility and hence, the action with maximum utility is considered. This associated degree of happiness can be calculated by mapping a state onto a real number.
5. Mapping of a state onto a real number with the help of utility

function gives the efficiency of an action to achieve the goal.

6. **Example:** A delivery drone that delivers packages to customers efficiently while optimizing factors like delivery time, energy consumption, and customer satisfaction.

This can be illustrated as follows:



Learning Agents

1. Learning agent, as the name suggests, has the capability to learn from past experiences and takes actions or decisions based on learning capabilities. **Example:** A spam filter that learns from user feedback.

2. It gains basic knowledge from past and uses that learning to act and adapt automatically.

3. It comprises of **four conceptual components**, which are given as follows:

- **Learning element**: It makes improvements by learning from the environment.
- **Critic**: Critic provides feedback to the learning agent giving the performance measure of the agent with respect to the fixed performance standard.
- **Performance element**: It selects the external action.

- **Problem generator**: This suggests actions that lead to new and informative experiences.

This can be illustrated as follows: