AKTU

ARTIFICIAL INTELLIGENCE

KHU-071

UNIT-1

ONE SHOT

INTRODUCTION :
Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

Introduction to Artificial Intelligence (AI)

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Artificial Intelligence, or AI, is a branch of computer science dedicated to creating machines that can perform tasks typically requiring human intelligence. These tasks include **problem-solving, learning, reasoning, perception, language** understanding, and decision-making. AI encompasses a variety of technologies and approaches, **from rule-based systems and symbolic AI to advanced machine learning and neural networks.**

Defination of Artificial Intelligence:

It is the science of creating computers and machines that can **think, learn, and make decisions in ways that usually require human intelligence**. This includes analyzing large amounts of data that would be too overwhelming for people to handle.

AI is a big field that combines knowledge from several areas:

- **Computer Science** for building software and algorithms.
- **Data Analytics and Statistics** for understanding and interpreting data.
- **Engineering** to design both the software and hardware that AI systems need.
- **Linguistics and Neuroscience** for language processing and understanding how the brain works.
- **Philosophy and Psychology** to address ethical issues and understand human behavior.

In business, AI is a toolkit powered by machine learning and deep learning. Companies use AI to:

- Analyze data for insights and trends.
- Make predictions and forecasts.
- Recognize and categorize objects (like in image recognition).
- Understand and respond to language (as in chatbots and virtual assistants).
- Provide recommendations (like those on streaming services or online shopping).
- Retrieve information quickly and accurately.

Goals of AI

- **Automate Tasks**: AI is used to take over tasks that need thinking or understanding, like sorting emails, recognizing faces, or answering customer questions.
- **Help People Make Better Decisions**: AI assists in providing suggestions or insights, especially in complex areas like medicine or business.
- **Learn About Human Intelligence**: By creating AI, scientists learn more about how the human mind works, which helps in other fields like psychology.

A Brief History of AI

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- **1950s-1960s**: AI started with simple systems that used rules to solve problems. These early AI programs could play games and solve puzzles.
- **1970s-1980s**: AI grew to include "expert systems" that could do specific jobs, like diagnosing diseases.
- **1990s-2000s**: AI shifted to "**machine learning**," where systems learn patterns from data instead of just following rules.
- **2010s-Present**: "**Deep learning**" uses large networks inspired by the brain to process massive amounts of data, helping AI achieve impressive abilities in areas like image and speech recognition.

Define Artificial Intelligence. Is it different from intelligence?

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Difference from Natural Intelligence:
AI operates based on algorithms and data processing, lacking emotions and consciousness, while human intelligence is adaptive, influenced by emotions, and capable of understanding abstract concepts.

Describe the turing test for intelligence

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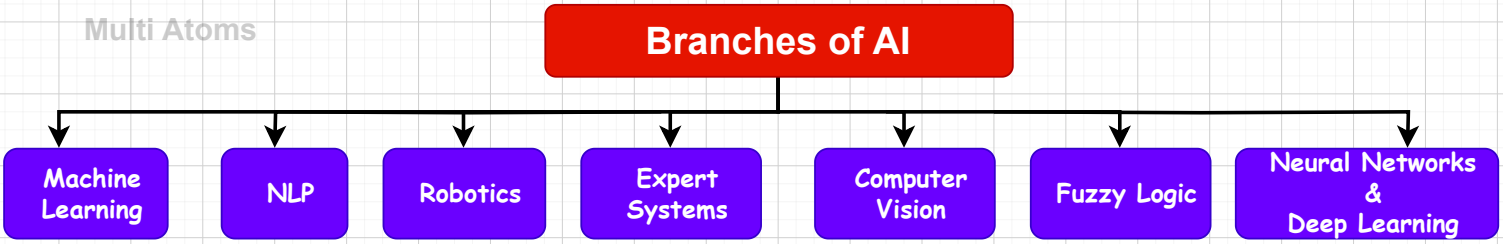
The Turing Test is a method proposed by Alan Turing in 1950 to evaluate a machine's ability to exhibit intelligent behavior similar to a human or not.

It is a way to check if a machine can "think" like a human. In this test, a person talks with both a human and a machine through text, without knowing which is which. If the person can't tell which one is the machine, then the machine is said to have passed the test, meaning it can imitate human intelligence well.



1. **Machine Learning (ML):** Teaches machines to learn from data and improve over time without being explicitly programmed. Examples include image recognition and recommendation systems.
2. **Natural Language Processing (NLP):** Helps machines understand and respond to human language. Used in chatbots and virtual assistants like Siri and Alexa.
3. **Robotics:** Combines AI with robotics to create machines that can perform physical tasks, such as assembly line work, delivery, or even surgery.
4. **Expert Systems:** AI systems that use specialized knowledge to make decisions or solve problems, often used in medical and technical fields.
5. **Computer Vision:** Enables machines to interpret and make decisions based on visual information, like identifying objects in photos or videos.
6. **Fuzzy Logic:** Allows AI to handle uncertain or imprecise information, useful in systems where decisions aren't always clear-cut, like temperature control in appliances.
7. **Neural Networks and Deep Learning:** Uses networks modeled after the human brain to process complex data patterns, widely used in image and speech recognition.

Artificial Intelligence (AI) can be categorized in two main ways: **by stages of development and by its capabilities.**

Stages of AI Development

1. Reactive Machines:

- Basic AI that only reacts to specific situations based on pre-set rules.
- Does not learn from past experiences and has no memory.
- Example: IBM's Deep Blue chess program, which defeated Garry Kasparov.

2. Limited Memory:

- Most modern AI falls into this category.
- Can learn from past experiences and improve over time by being trained on data.
- Uses memory, often through neural networks, and is used in deep learning.
- Examples include self-driving cars and image recognition systems.

3. Theory of Mind:

- This type of AI does not yet exist but is being researched.
- It aims to understand emotions and social interactions, mimicking human decision-making.
- It would allow AI to interact in a more human-like manner in social situations.

4. Self-Aware AI:

- Hypothetical AI that would have consciousness and self-awareness.
- Such AI would understand its own existence and have human-like emotional and intellectual capabilities.
- Currently, this type of AI is purely theoretical.

Types of AI by Capability

1. Artificial Narrow Intelligence (ANI):

- Also known as "Weak AI."
- Performs specific, narrow tasks, often limited to one area, such as language translation or image classification.
- Examples include Google Search, virtual assistants, and recommendation systems.

2. Artificial General Intelligence (AGI):

- Also called "Strong AI."
- This would allow a machine to perform any intellectual task a human can, with the ability to "sense, think, and act" in a human-like way.
- AGI does not currently exist.

3. Artificial Superintelligence (ASI):

- An advanced form of AGI that would surpass human intelligence.
- ASI could outperform humans in every field, including scientific research, social intelligence, and creativity.
- ASI is still theoretical and not yet achieved.

Intelligent Agent

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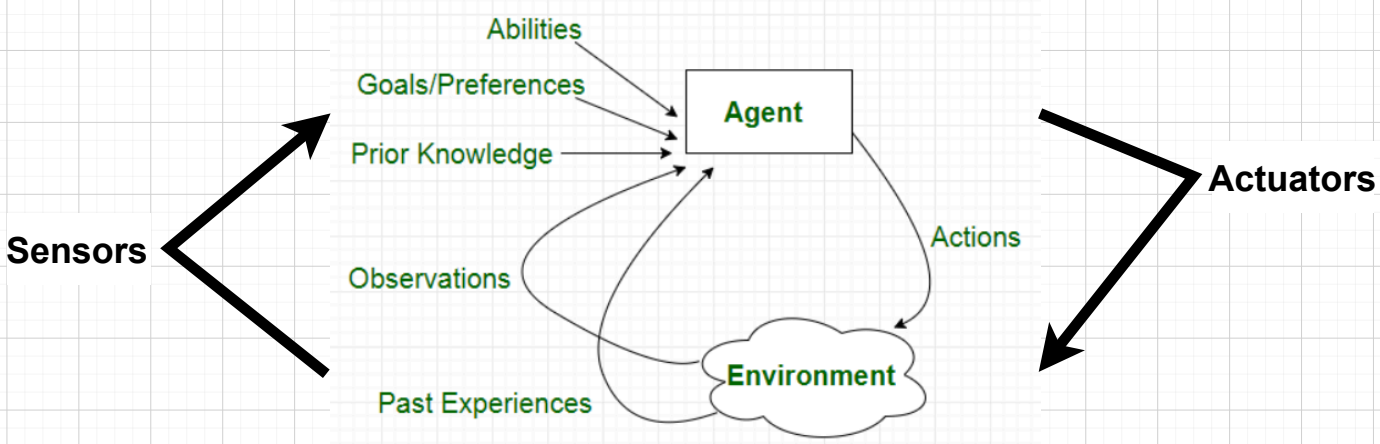
An intelligent agent is a system or entity that **perceives its environment and takes actions to achieve specific goals**. It operates autonomously, using its knowledge and abilities to make decisions based on the information it gathers.

Intelligent agents can be found in various forms, from simple software programs to complex robotic systems.



An **actuator** is a device that converts energy (often electrical) into physical motion. Actuators are essential components in various systems, enabling automation by controlling the movement or operation of machines, mechanisms, or systems. They work in conjunction with sensors and controllers to achieve desired actions based on input signals.

Example: In a smart home system, sensors detect the temperature, and based on that data, the actuator adjusts the heating or cooling system.

Key Characteristics of Intelligent Agents:

- **Perception:** It can sense their environment through sensors or data inputs, allowing them to gather information about their surroundings.
- **Autonomy**: They can operate independently without direct human intervention, making decisions based on their programming and learned experiences.
- **Goal-oriented Behavior**: They are designed to achieve specific objectives or goals, such as solving problems or completing tasks.
- **Adaptability:** They can learn from their experiences and adjust their behavior based on new information or changing circumstances.

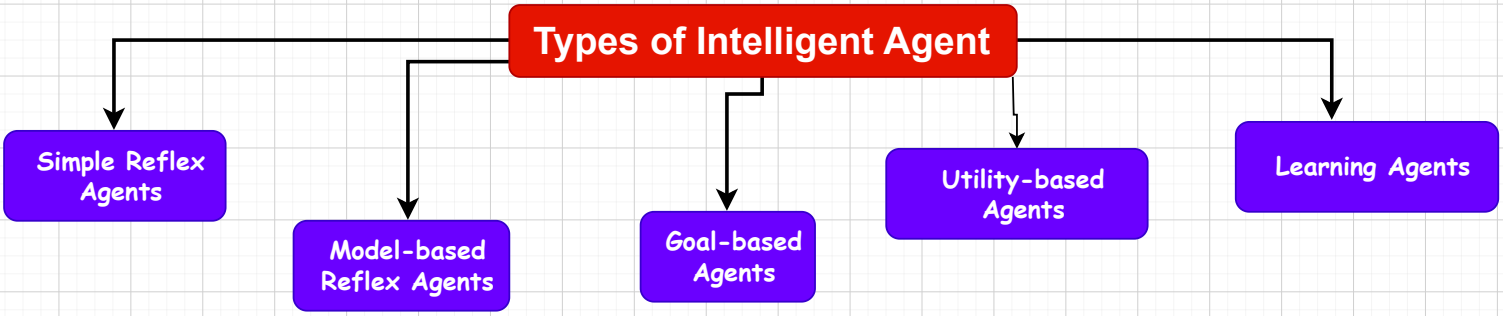
Agent Structure

Agent = Architecture + Agent Program

- Architecture provides the physical or virtual environment for the agent to operate.
- Agent Program contains the logic that enables the agent to make decisions based on its perceptions and achieve its goals.

Example: Autonomous Delivery Drone = Architecture + Agent Program

- **Architecture:** The physical components (sensors, actuators, computing unit) that enable the drone to operate.
- **Agent Program:** The software that processes sensor data, makes decisions based on the percept history, and controls the actions of the drone.



1. Simple Reflex Agents

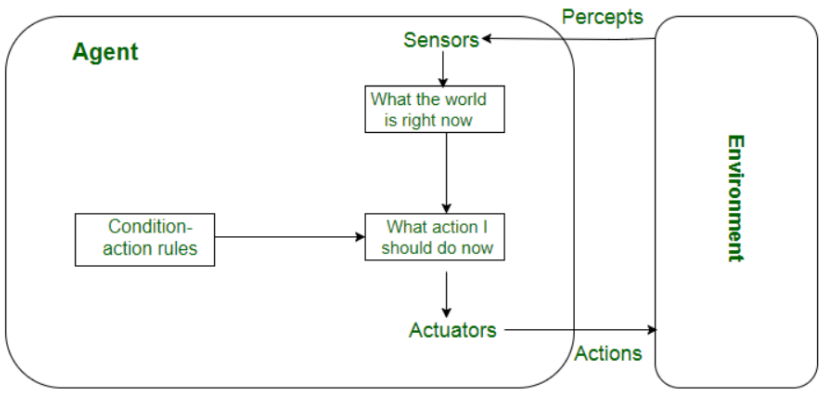
Simple reflex agents are the most basic type of AI agents. They respond immediately to specific stimuli in their environment based on predefined rules. They do not retain any information about past events, which limits their decision-making capabilities.

How They Work:

- Simple reflex agents evaluate the current state of their environment using sensors.
- They apply a set of predefined rules to determine their actions.

Example: Thermostat

A thermostat measures the room temperature. If the temperature drops below a set level (say 68°F), it turns the heating system on.



2. Model-based Reflex Agents

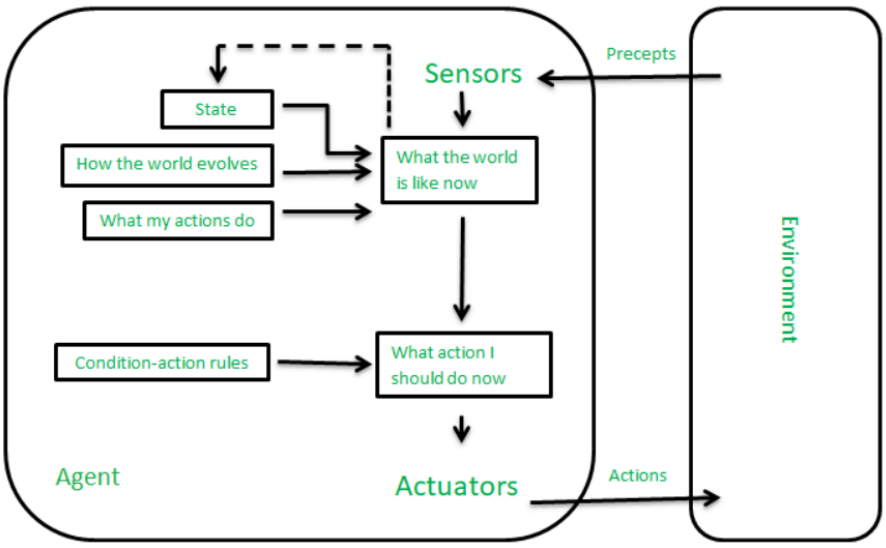
Model-based reflex agents extend the capabilities of simple reflex agents by maintaining an internal model of the world. This allows them to handle more complex situations, remember past states, and make decisions based on a more comprehensive understanding of their environment.

How They Work:

- They use sensors to gather information about their environment.
- They maintain a model that keeps track of relevant details and past states.
- They apply rules based on their internal model to determine appropriate actions.

Example: Automated Vacuum Cleaner

An automated vacuum cleaner maps the layout of a room. It remembers areas it has cleaned and areas that need cleaning.



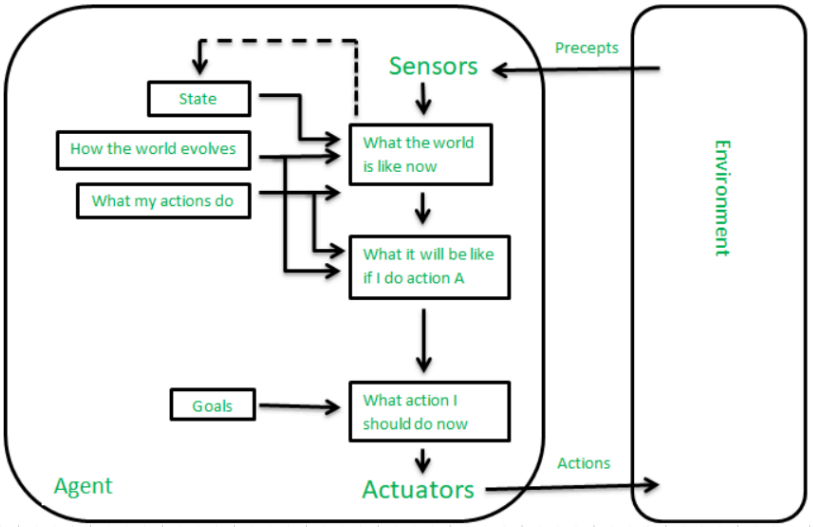
3. Goal-based Agents

Goal-based agents evaluate their actions based on specific goals they want to achieve. They can plan and make decisions based on their current state and desired end state.

How They Work:

- They assess the current state of their environment.
- They define one or more goals to achieve.
- They evaluate possible actions and choose the best path to reach their goals.

Example: Chess-playing Program
A chess program looks at the board and assesses different moves to find the best one that leads to winning the game.



4. Utility-based Agents

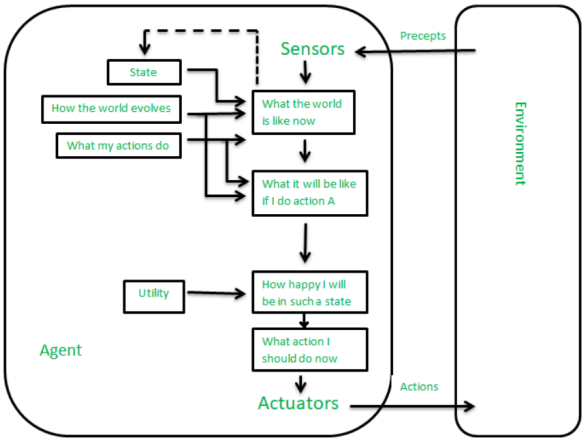
Utility-based agents consider various factors and the overall satisfaction (utility) of different actions. They aim to choose actions that maximize their performance based on predefined criteria.

How They Work:

- They evaluate the current state of their environment.
- They assign a utility value to different possible actions based on their effectiveness in achieving goals.
- They choose the action with the highest utility value.

Example: Self-driving Car

A self-driving car decides the best route to take by considering factors like traffic, speed, and travel time. It chooses the safest and most efficient path.



5. Learning Agents

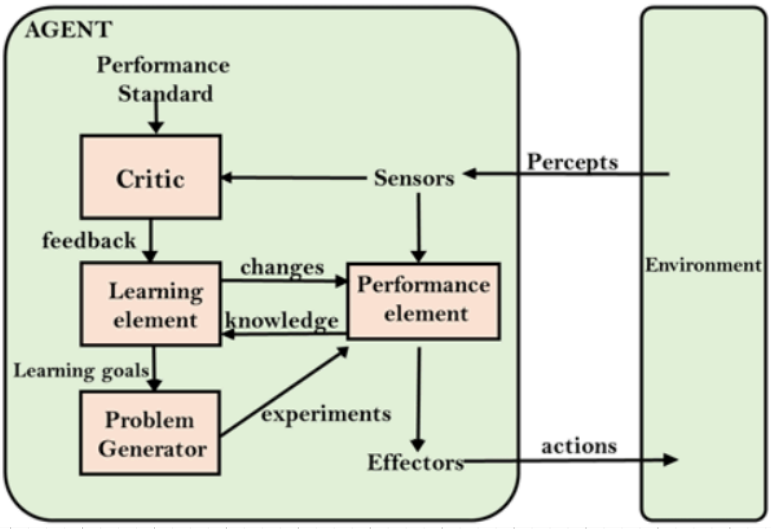
Learning agents improve their performance over time by learning from their experiences and adjusting their behavior based on feedback from their environment.

How They Work:

- They gather data from their interactions with the environment.
- They analyze this data to identify patterns or preferences.
- They update their strategies to enhance future performance based on learned experiences.

Example: Recommendation System

A recommendation system on a shopping website learns from user preferences. It suggests products based on what the user has viewed or purchased before.



1. **Learning element**: It is responsible for making improvements by learning from the environment.
2. **Critic:** The learning element takes feedback from critics which describes 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.

Q. Explain the role of sensors and effectors in the functioning of intelligent agents.

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In intelligent agents, sensors and effectors are essential components that enable the agent to interact with and respond to its environment.

1. Sensors

Role of Sensors: Sensors allow an agent to perceive or sense its environment. They gather information about the surroundings, which could include physical conditions, other agents, objects, or user inputs. The information collected by sensors is essential because it enables the agent to understand its current state, which it then uses to make decisions or take action.

Example: In a robot vacuum, sensors include proximity sensors (to detect walls or obstacles) and dirt sensors.

2. Effectors (or Actuators)

Role of Effectors: It allow an agent to act on or affect its environment based on its decisions. They execute the commands that the agent generates as a response to sensory input. Effectors enable physical actions, like movement, or digital actions, like generating recommendations or playing sounds.

Example: In a robot vacuum, effectors include wheels (to move) and brushes (to clean).

Q. Explain **PEAS** and **properties of task environments**. Write the PEAS description of the task environment for an **automated car driving system**

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- In artificial intelligence, PEAS is an acronym used to define an agent's Performance measure, Environment, Actuators, and Sensors.
- This framework helps describe the goals and requirements for any AI agent, including what it needs to achieve, the environment it operates in, and the components it uses to interact with that environment.
- Additionally, understanding the properties of task environments is important to determine how well an agent will perform in a particular situation.

PEAS Components

1. **Performance Measure**: This defines how we measure the success of an agent's actions. It sets the criteria or goals the agent is trying to achieve.
2. **Environment**: This is the world or context in which the agent operates. It includes everything the agent interacts with and reacts to.
3. **Actuators**: These are the tools or devices the agent uses to perform actions in its environment. They allow the agent to carry out decisions it makes based on sensory data.
4. **Sensors**: These are the components that allow the agent to perceive its environment by gathering data or information, which it then uses to make decisions.

Properties of Task Environments

1. **Fully vs. Partially Observable**: A fully observable environment gives the agent access to complete information at all times, whereas a partially observable environment provides only limited or partial data.
2. **Deterministic vs. Stochastic**: In a deterministic environment, each action has a predictable outcome, while in a stochastic environment, actions have uncertain or random results.
3. **Episodic vs. Sequential**: In an episodic environment, each task or episode is independent of others, while in a sequential environment, actions affect future decisions.
4. **Static vs. Dynamic**: A static environment does not change while the agent is deciding, whereas a dynamic environment changes continuously, requiring the agent to adapt in real-time.

5. **Discrete vs. Continuous:** In a discrete environment, actions and observations are distinct and limited, while a continuous environment has an infinite range of actions or values.
6. **Single-Agent vs. Multi-Agent:** In a single-agent environment, the agent operates alone, whereas in a multi-agent environment, it interacts with other agents.

PEAS Description for an Automated Car Driving System

1. **Performance Measure:**

- **Safety**: Avoid accidents and follow traffic rules.
- **Efficiency:** Minimize travel time and fuel consumption.
- **Comfort:** Ensure a smooth ride by avoiding sharp turns or sudden braking.
- **Compliance:** Obey traffic signals, speed limits, and road signs.

2. **Environment:**

- **Roads, highways, city streets, rural areas.**
- **Traffic**: Other vehicles and cyclists.
- **Weather conditions**: Rain, snow, fog, and varying visibility.
- **Road conditions:** Potholes, lanes, traffic signals, and signs.

3. **Actuators:**

- **Steering system** (to control direction).
- **Accelerator** (to increase speed).
- **Brake system** (to decrease speed or stop).
- **Indicators and lights** (to signal other drivers).
- **Wipers and HVAC** (Heating, Ventilation & Air Condition) system (for comfort and visibility).

4. **Sensors:**

- **Cameras** (to detect road signs, lanes, pedestrians).
- **LIDAR and Radar** (for obstacle detection and distance measurement).
- **GPS** (for location tracking and navigation).
- **Speed sensors** (to measure vehicle speed).
- **Inertial sensors** (to detect acceleration and orientation).

Problem Solving Approach to Typical AI problems.

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Steps in a Problem-Solving Agent's Approach

1.Goal Setting

- The agent first understands its surroundings (the environment) and sets a goal, like reaching a specific location.

2.Goal Formulation

- The agent formalizes the goal:
- Observing the Current State: It takes note of where it is now.
- Measuring Performance: It checks what success will look like (for example, getting to the target without hitting any obstacles).

3.Problem Formulation

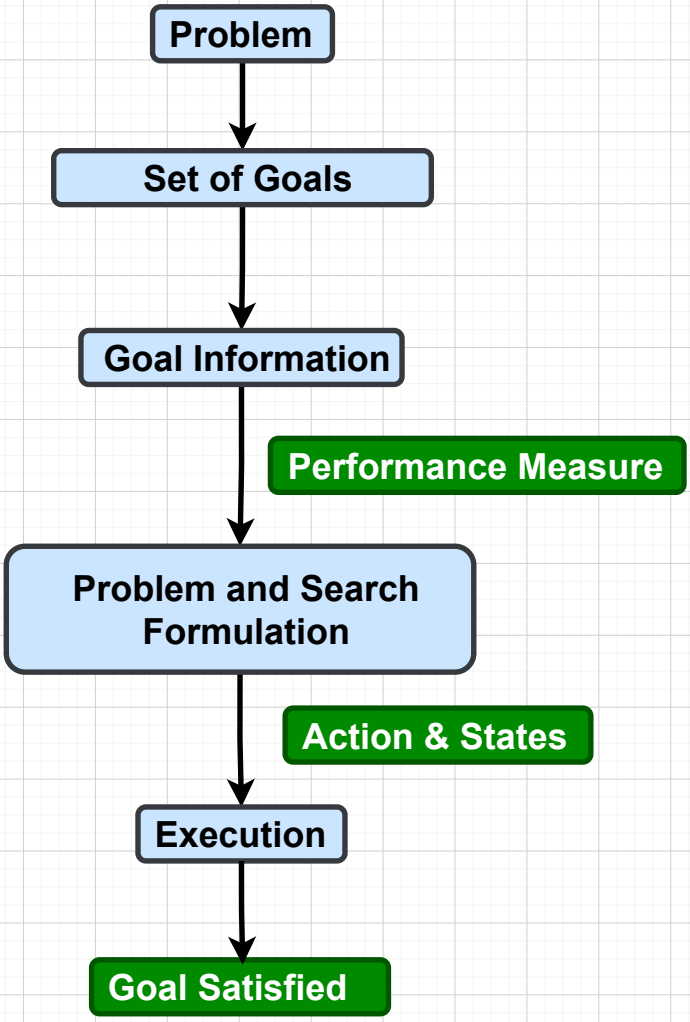
- Once the goal is clear, the agent figures out a plan:
- It thinks of possible actions it can take to reach the goal, predicting the results of these actions.
- The goal is to find a sequence of steps that will get it to the end successfully.

4.Search in Unknown Environment

- If the agent is in an unfamiliar environment:
- It tries out different actions, learns from the results, and gradually builds a plan to reach its goal.
- This trial and error method helps it learn which actions lead to success, called a "search process."
- With what it learns, the agent can design a "search algorithm"—a method that helps it find the best path to reach the goal.

5.Execution Phase

- Once it has a solution from the search algorithm, it starts taking the steps in the plan.
- This is called the "execution phase," where it follows the planned actions to reach the goal.
- After reaching the goal, it sets a new goal if needed.



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