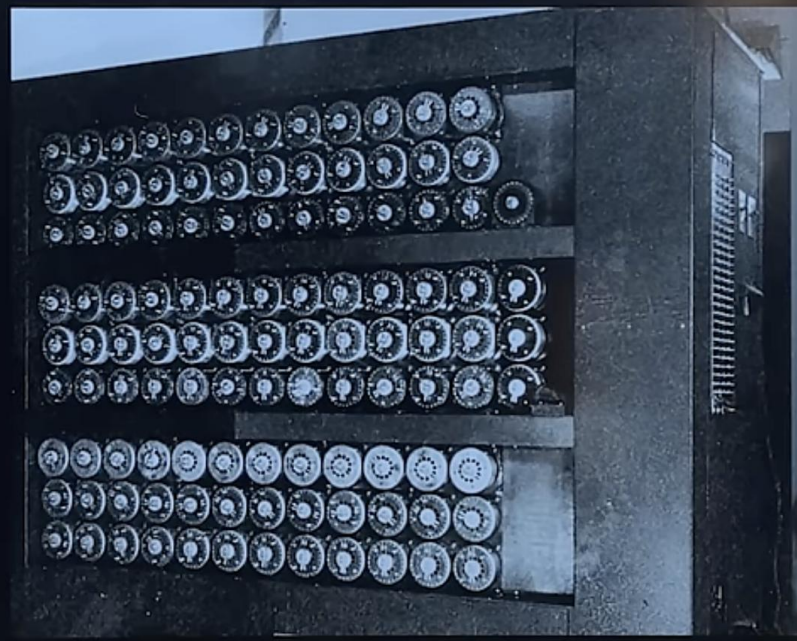
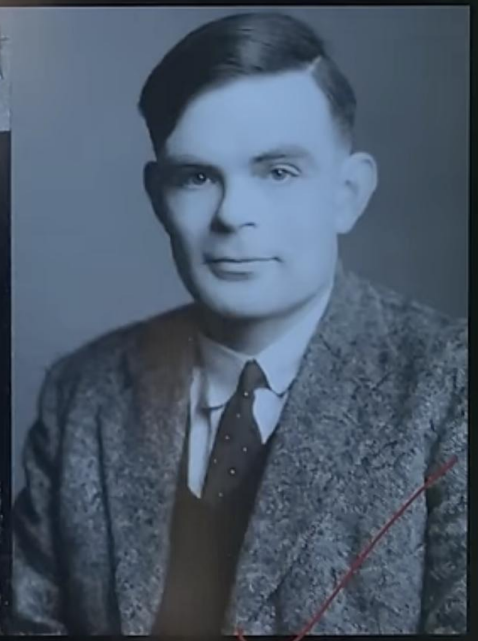
# History of AI

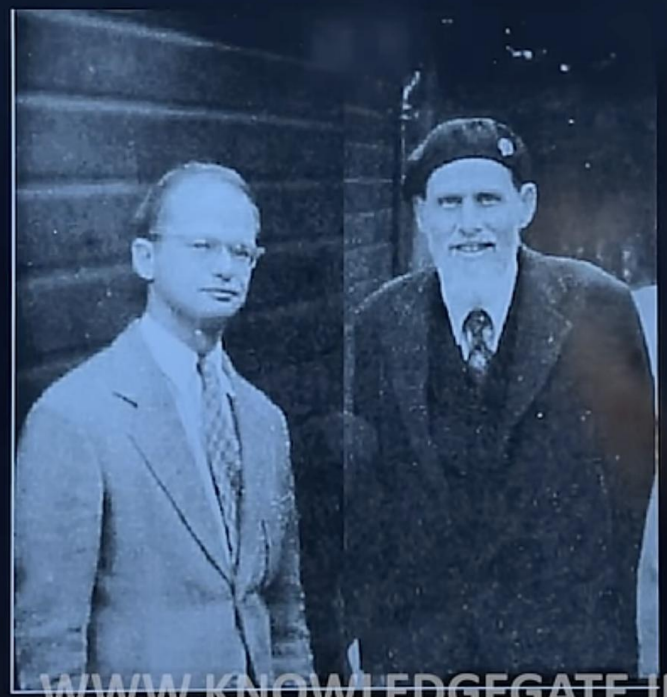
- During the Second World War, British computer scientist **Alan Turing** worked to crack the 'Enigma' code which was used by German forces to send messages securely. Alan Turing and his team created the Bombe machine that was used to decipher Enigma's messages.
- The Enigma and Bombe Machines laid the foundations for Machine Learning.





# First work in AI

- The first work that is now generally recognized as AI was done by Warren McCulloh and Walter Pits in 1943. They drew on three sources:
  - **Knowledge of basic Physiology and Functions of Neurons in brain.**
  - **A formal analysis of propositional logic**
  - **Turing's Theory of Computation**



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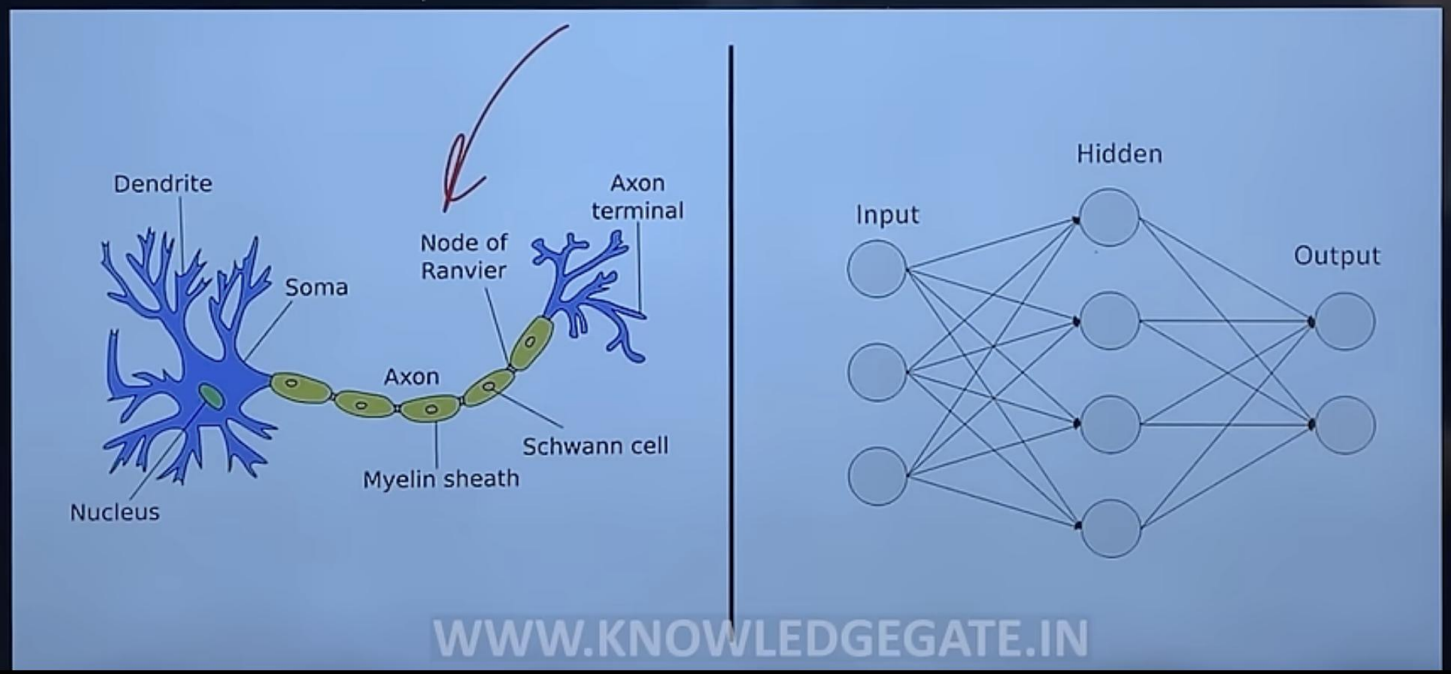
# Key Findings

- They proposed a model of artificial neurons in which each neuron can be characterized as being **on** and **off**.
- They showed that any computable function could be computed by some network of connected neurons.
- They also suggested that suitably defined networks can also learn.

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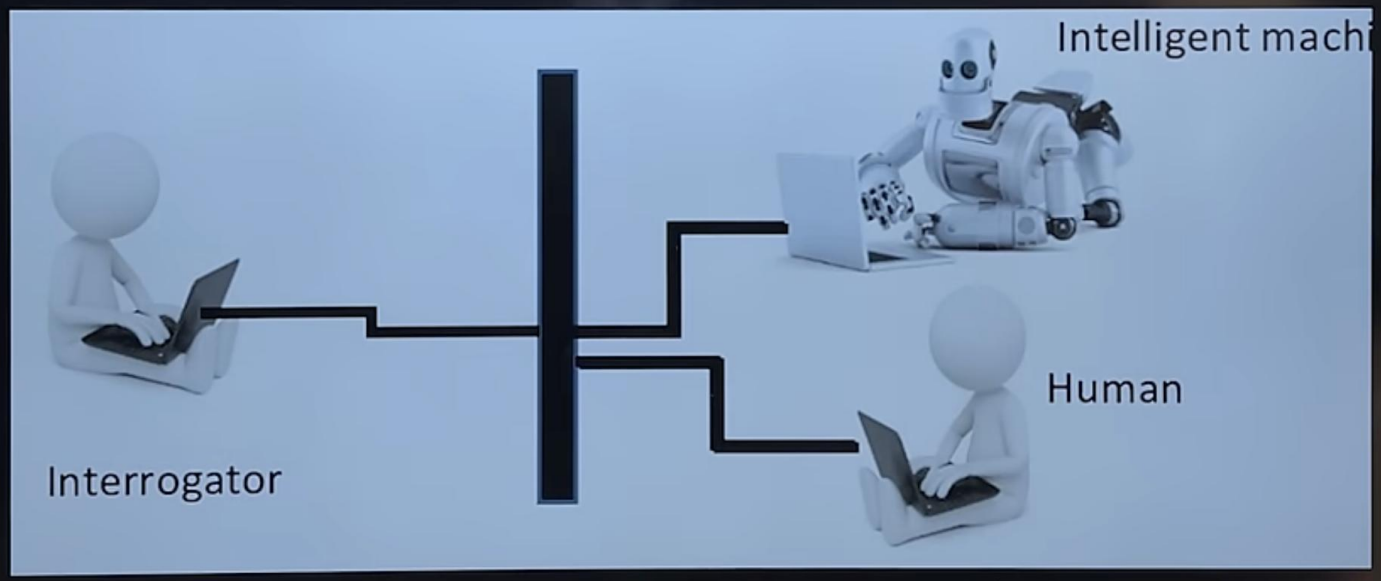
# Acting humanly: The Turing Test approach

- The Turing Test, proposed by Alan Turing (1950), was designed to provide a satisfactory operational definition of intelligence.
- A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.



# The Birth of AI

- The term AI was coined in 1956 by a computer scientist "John McCarthy" in Dartmouth Conference organized by him and three other scientists. He is often known as "***Father of AI***". McCarthy in 1958 developed LISP. There were so many discoveries going on in the field of AI from the year 1952 to 1969.

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# AI Winter (1974-1980)

- In 1970's AI was subjected to criticism and financial setbacks. The expectations from AI was quite high due to heavy optimism but the researchers had failed to materialize the promised results.

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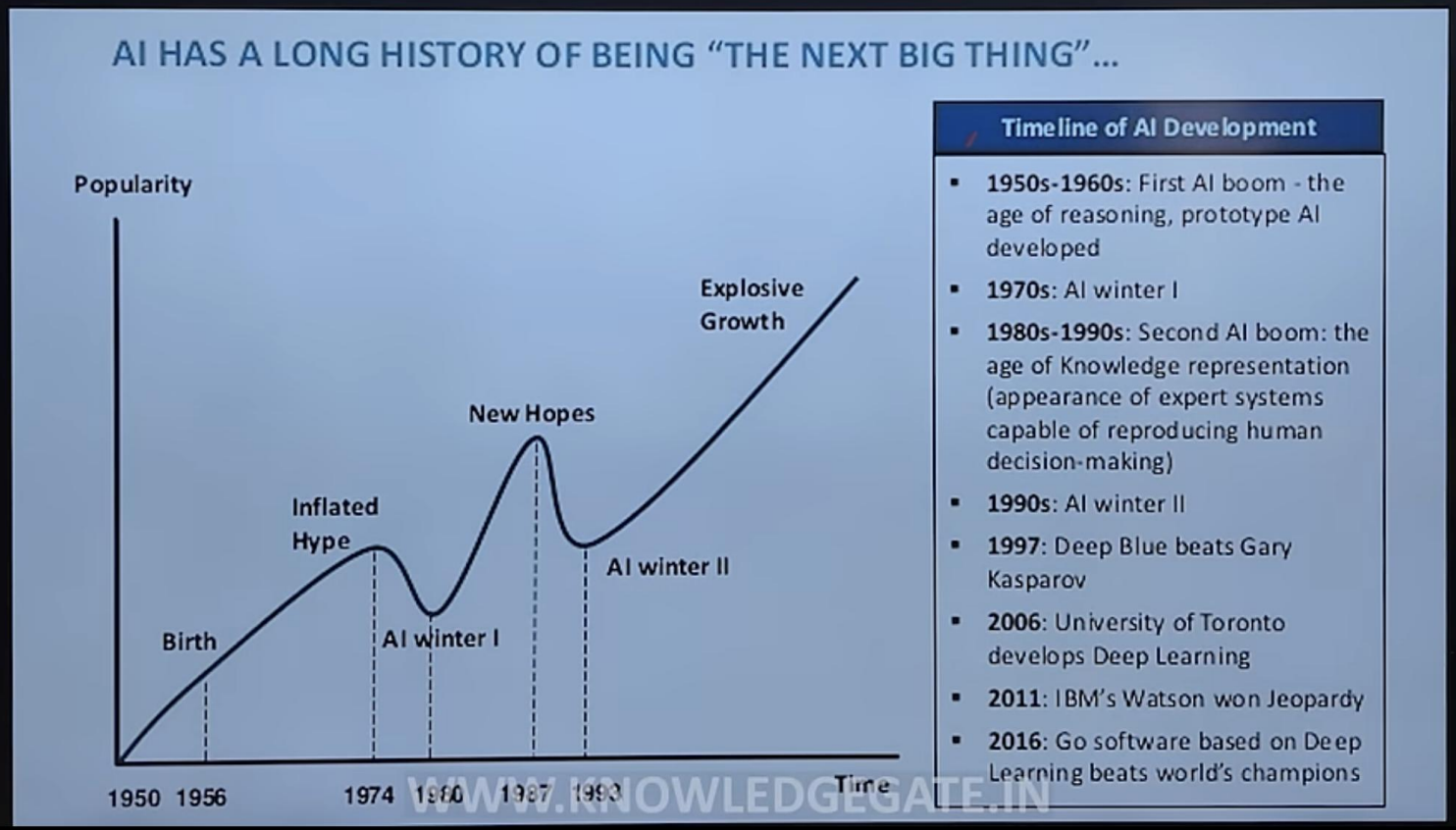
# Boom in AI after 1980 (1980-87)

- In 1980's "Expert Systems" an AI program was adopted by many corporations. **The Expert system was a program that answers questions or solves problems from a particular domain using logical rules derived from the knowledge of experts.**

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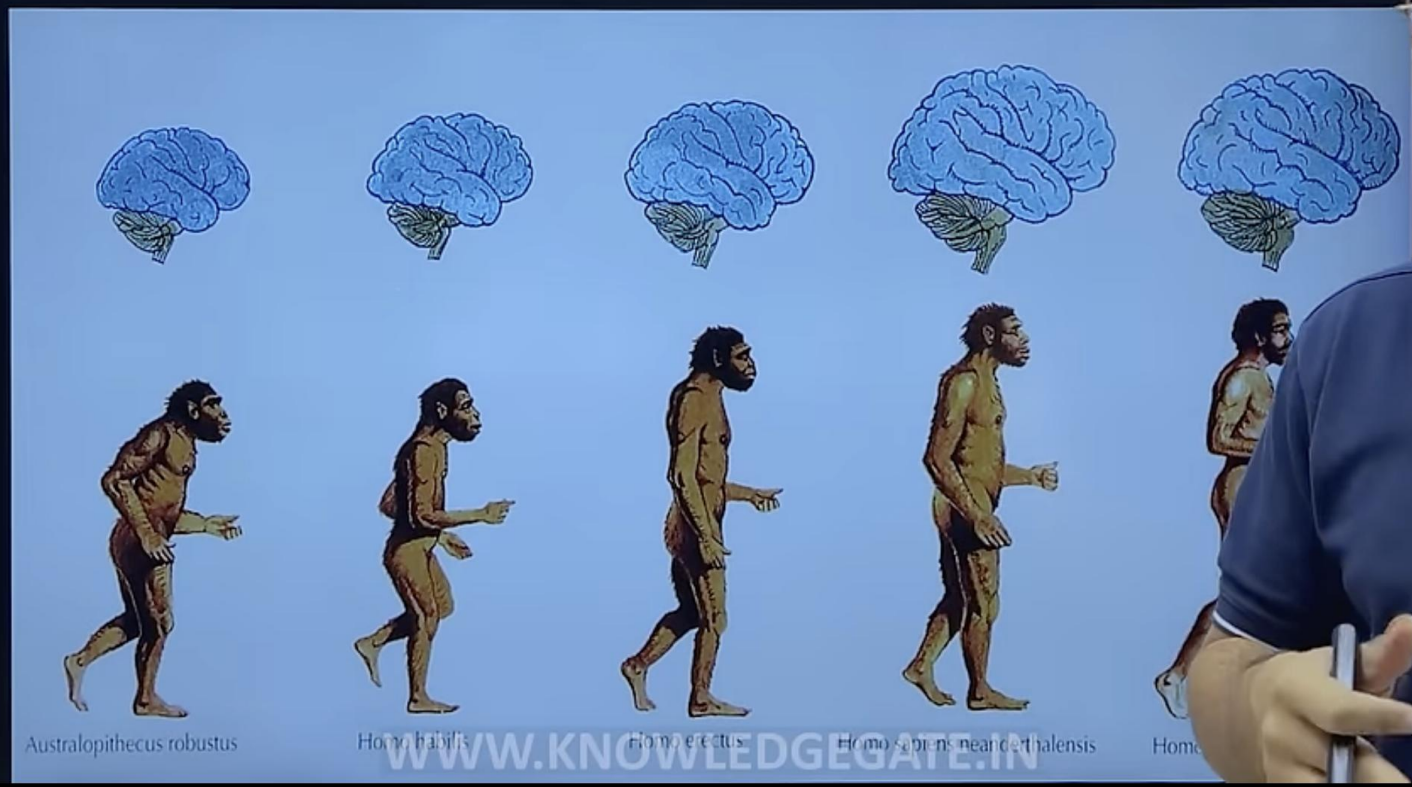
- **1997:** IBM's Deep Blue beats the world chess champion, Garry Kasparov, a significant milestone for AI in games.

- **2005:** Stanley, the self-driving car developed by Stanford University, wins the DARPA Grand Challenge.

- **2011:** IBM's Watson wins Jeopardy! against former winners, showing the capabilities of AI in natural language processing.

- **Intelligence and AI:** Intelligence in general is the "**Ability to acquire and apply knowledge and skills".** We are known as Homo-Sapiens "Homo- ***Man*** and Sapiens - ***Wise***" it is because our intelligence is so important to us.
- For thousands of years we have tried to understand how our brain functions. Th[illegible] AI goes beyond this: It not only attempts to understand it but also tries to build [illegible] entities.

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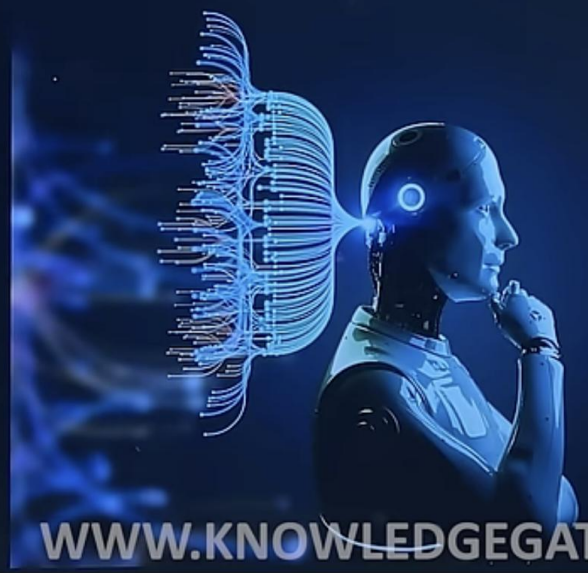
# What is AI

- There is no universally accepted definition of AI in general refers to the simulation of human intelligence processes by machines, especially computer systems.
- **Sub-fields:** It includes various sub-fields like machine learning, where machines learn from experience, natural language processing, which is about interaction with human language, and computer vision, where AI interprets and understands visual data.



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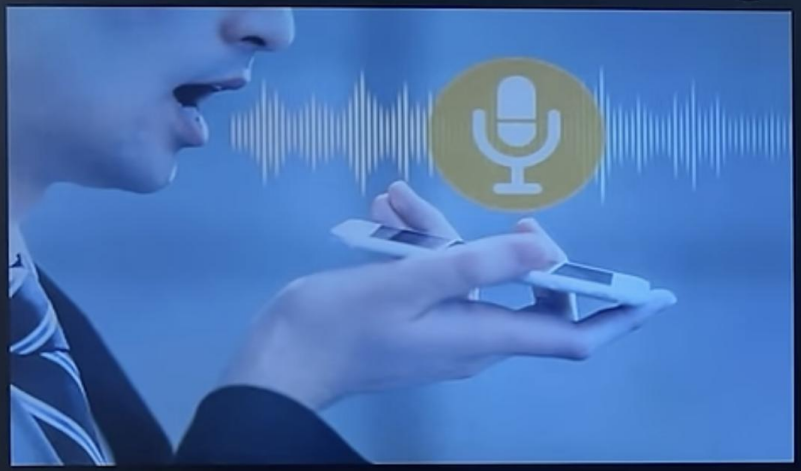
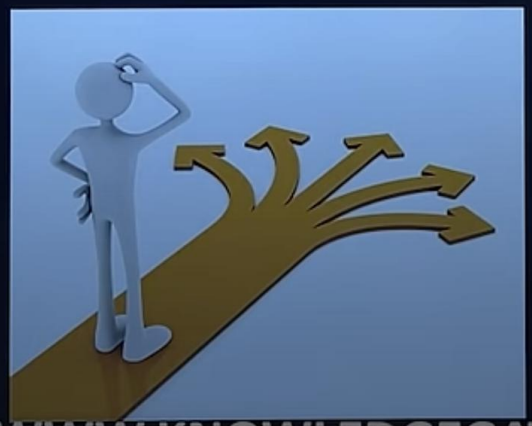
Chapter-1 (INTRODUCTION)

- **Problem-solving:** AI is used to solve complex problems and perform tasks that would usually require human intelligence. This could be anything from **recognizing speech or images, making decisions, or translating languages**





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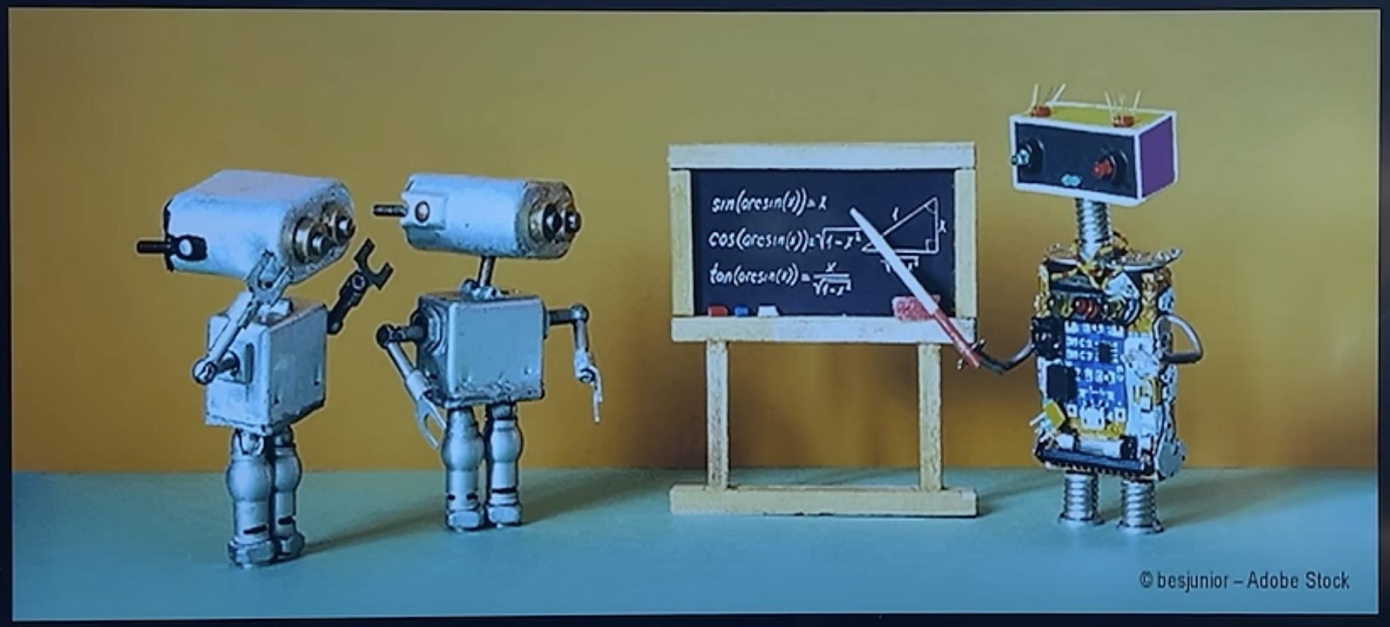
- **Training:** AI systems are trained using large amounts of data. For instance, an AI used for recognizing speech would be trained on a large database of spoken language.

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Artificial Intelligence (AI) can be classified into four categories based on capabilities and functionalities:

- **Reactive Machines:**
  - These are the most basic type of AI.
  - They can react to specific situations or inputs but don't have memory or past experience to influence their decisions.
  - Example: IBM's Deep Blue, the chess-playing AI.

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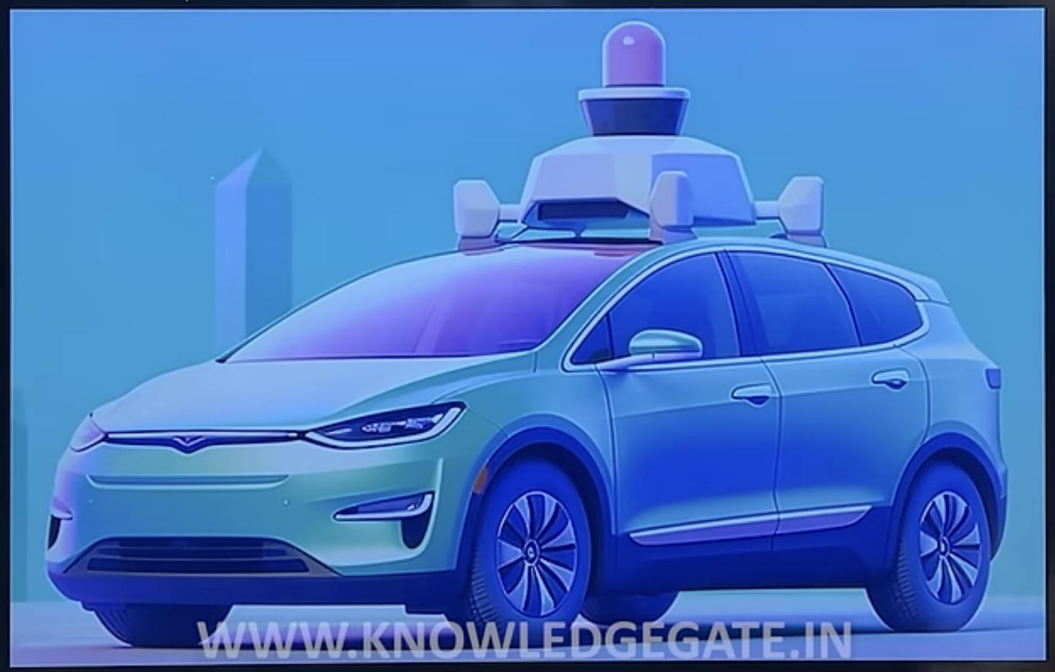
- **Limited Memory:**
  - These AI systems can use past experiences or historical data to make current decisions.
  - They have a temporary or limited memory to store past information and predictions.
  - Example: Self-driving cars.



- **Theory of Mind:**
  - This is a more advanced type of AI that researchers are still working to develop.
  - These systems would understand emotions, people, beliefs, and be able to interact socially.
  - Example: More advanced personal assistants that can understand human emotions and react accordingly.

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- **Self-aware AI:**
  - This is the most advanced form of AI, which is still theoretical and not yet realized.
  - These systems would have their own consciousness, self-awareness, and emotions.
  - They would be smarter and more capable than the human mind.

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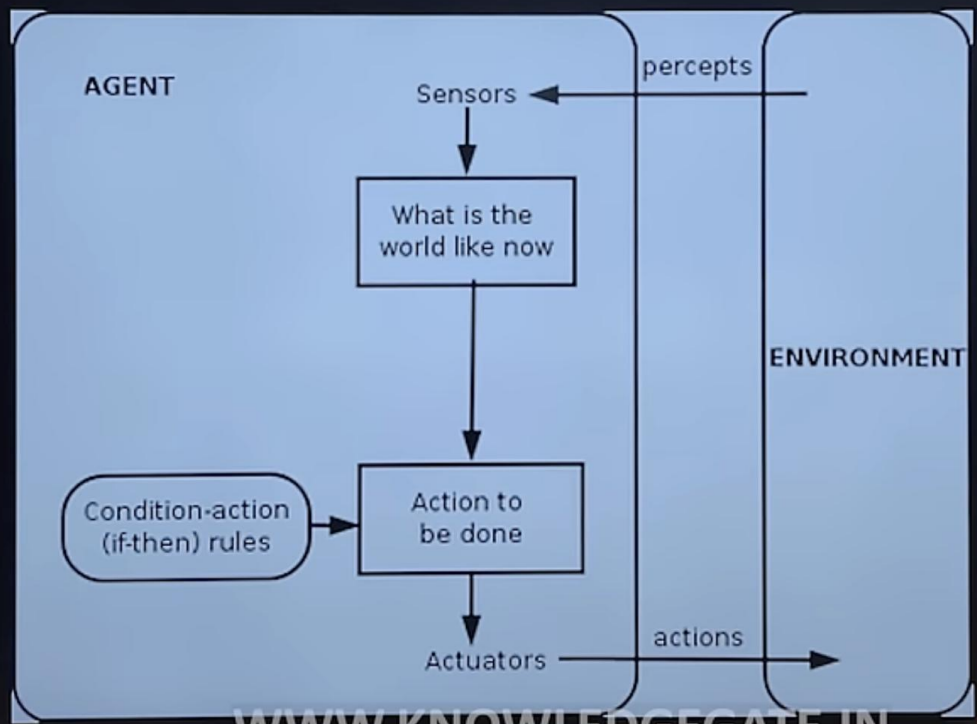
# AGENTS AND ENVIRONMENTS

- An agent is anything that can be viewed as perceiving its **environment** through sensors and acting upon that environment through **actuators.**
- A human agent has eyes, ears, and other organs for sensors are 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.

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- **Percept:** This refers to what an AI agent (like a robot or a computer program) senses or perceives at a specific moment.
- **Percept Sequence:** This is the total history or record of what the AI agent has sensed or perceived since it started operating. An AI agent's decisions or actions at any moment can be influenced by the entire percept sequence it has experienced so far. However, it can't base decisions on information it hasn't perceived or sensed.
- **Agent Function:** This is a rule or set of rules that determines what action an AI agent takes. based on its percept sequence.
- **Agent Program:** This is the practical, real-world implementation of the agent function.

## Concept of Rationality in AI

- **Rational Agent:** An AI entity that always chooses the best action.
- **Action Selection:** Based on its percepts, a rational agent selects an action that's expected to maximize its performance measure, using its percept history and innate knowledge.
- **Performance Measure:** Not a fixed measure for all tasks and agents, it varies based on the specific task at hand.
- **Designing Performance Measures:** Ideally, these are designed based on desired outcomes in the environment, not preconceived ideas about the agent's behavior.

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# Understanding Task Environments and Rational Agents

- **Task Environment:** a task environment is essentially the setting or context in which an AI agent operates. This could be a physical environment, like a warehouse where a robot is sorting boxes, or a virtual environment, like a chess game where an AI is playing against a human opponent. each task environment presents a unique set of challenges or problems that the AI agent needs to navigate.
- the task environment of a chess game includes the rules of the game, the current state of the board, and the goal of checkmating the opponent's king. The "problem" in this case is determining the best move to make at each step to win the game. In the chess example, a rational agent would be an AI system that can analyze the state of the game, consider all possible moves, and choose the one that maximizes its chances of winning.
- A rational agent, then, is the "solution" to this problem: it's an AI system designed to make the best possible decisions given the circumstances of the task environment.

- Acronymically we call it **PEAS (Performance, Environment, Actuators, Sensors)** description. **PEAS for agent Taxi Driver:**

| Agent Type | Performance Measure | Environment | Actuators | Sensors |
|---|---|---|---|---|
| Taxi driver | Safe, fast, legal, comfortable trip, maximize profits | Roads, other traffic, pedestrians, customers | Steering, accelerator, brake, signal, horn, display | Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard |

# Properties of task environments

- **Fully Observable vs. Partially Observable:**
  - **Fully Observable:** Every relevant aspect in the environment is visible to the agent.
  - **Partially Observable:** Not all aspects are visible. The agent doesn't have complete information about the environment's state because of noisy and inaccurate sensors or because parts of the state are simply missing from the sensor data.
  - **Unobservable:** If the agent has no sensors at all then the environment is **unobservable**.

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# Single Agent vs. Multi-Agent:

- **Single Agent:** Only one agent is acting in the environment, like playing solitaire.
- **Multi-Agent:** Multiple agents are interacting with the environment and potentially with each other, like playing chess.

Driving taxi requires avoiding collisions maximizes the performance measure of all agents, so it is a partially **cooperative** multiagent environment. It is also partially competitive because only one car can occupy a parking space.

## Deterministic vs. Stochastic:

- **Deterministic:** The next state of the environment is entirely determined by the current state and the action executed by the agent.
- **Stochastic:** The next state cannot be entirely predicted and might depend on probability, like playing poker.

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## Episodic vs. Sequential:

- **Episodic:** The agent's experience is divided into episodes. Each episode is independent of others, like in image recognition tasks.
- **Sequential:** The current decision could influence all future decisions, like in a game of chess.

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## Static vs. Dynamic:

- **Static:** The environment doesn't change while the agent is deciding, like a game of tic-tac-toe.
- **Dynamic:** The environment can change while the agent is mal decision, like in stock trading.

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## Discrete vs. Continuous:

- **Discrete:** There are a finite number of actions the agent can take, like moves in a chess game.
- **Continuous:** The actions or states can vary in a continuous way, like a self-driving car controlling its speed.

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# Known vs. Unknown:

- **Known**: The agent knows the rules of the environment, like in a game of checkers.
- **Unknown**: The agent doesn't fully understand the rules of the environment and must learn them, like navigating a new city.

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- Four basic kinds of agent programs that embody the principles underlying almost all intelligent systems are:
  - **Simple reflex agents;**
  - **Model-based reflex agents;**
  - **Goal-based agents; and**
  - **Utility-based agents.**

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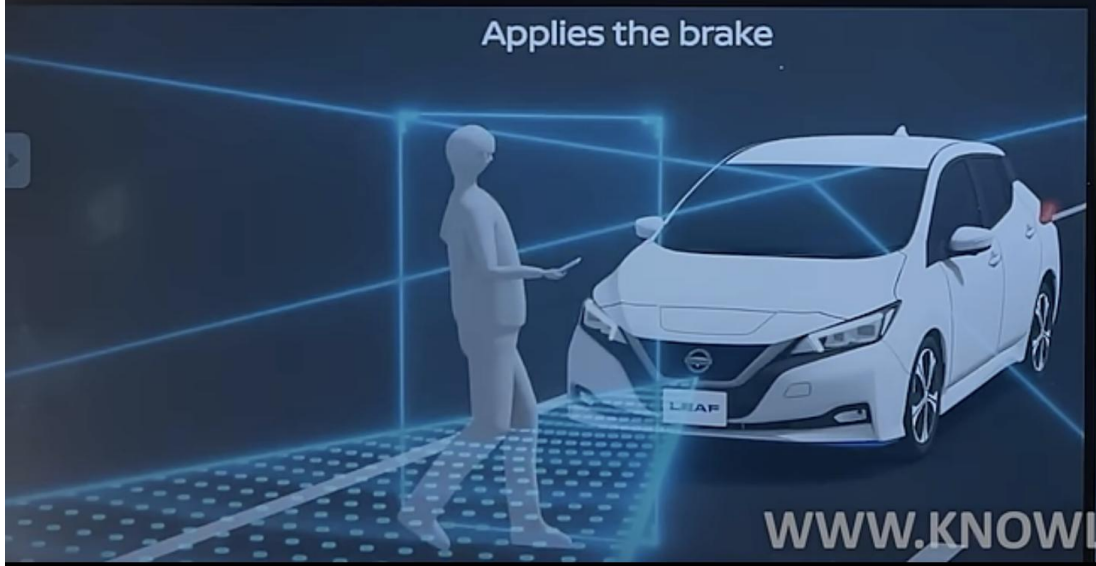
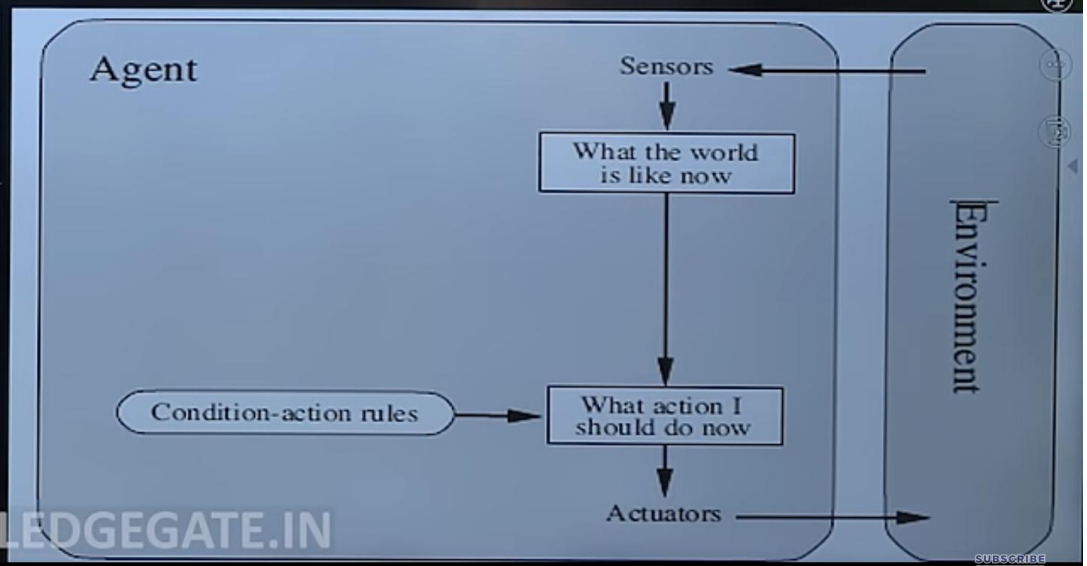
# Simple reflex agents

- **Basic Functioning:** Simple reflex agents act based on current percepts, ignoring historical percepts.
- **Condition-Action Rule:** These agents follow "if-then" rules, like "if someone is in front of the car then initiate-braking."
- **Simplicity and Limitations:** While such agents are simple to design do not perform complex calculation, their intelligence and memory is limited.
- **Problems with Unobservability:** Issues arise if all necessary information isn't observable, like different configurations of car lights.

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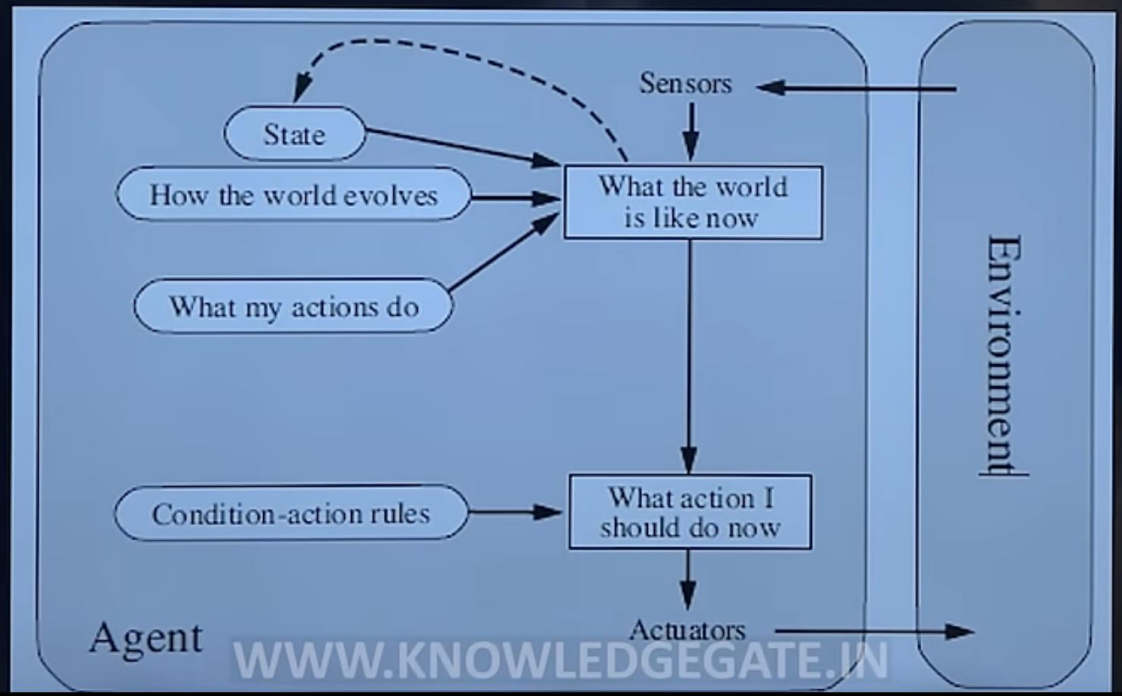
# Model-based reflex agents

- **Handling Partial Observability:** Model-based agents is designed to work in partially observable environment.
- **Internal State:** These agents maintain an internal state that reflects unobserved aspects environment, based on percept history.
- **Updating Internal State:** This process requires knowledge of how the world evolves independently of the agent and how the agent's actions affect the world.

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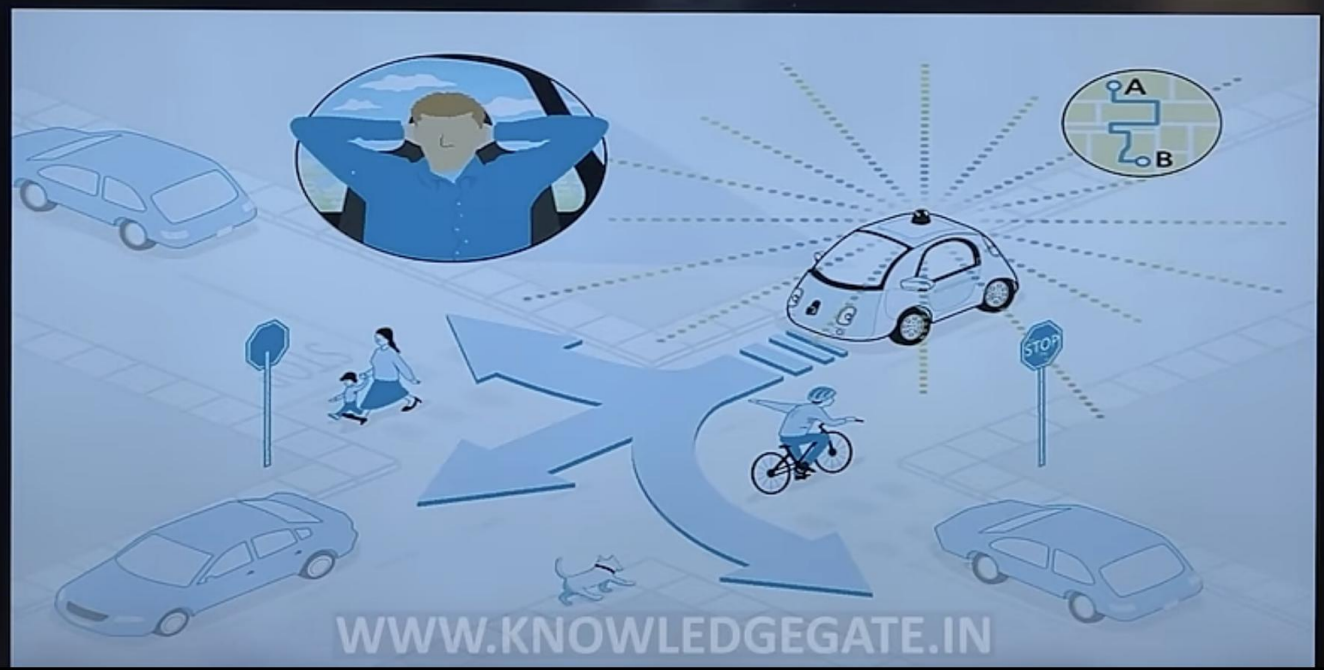
- **Internal Model**: The car has a map of the roads, traffic rules, and typical traffic patterns.
- **Sensors**: Uses cameras and sensors to perceive traffic lights, road signs, other vehicles, pedestrians, and road conditions.
- **Updating Knowledge**: It updates its model in real-time as it drives, learning current traffic conditions, construction work, or detours.
- **Decision Making**: If the car approaches a red light, it stops. When the light turns green and the path is clear, it proceeds.
- **Learning Over Time**: The car refines its internal model to improve predictions, like estimating the time it will take to reach destinations considering the current traffic.

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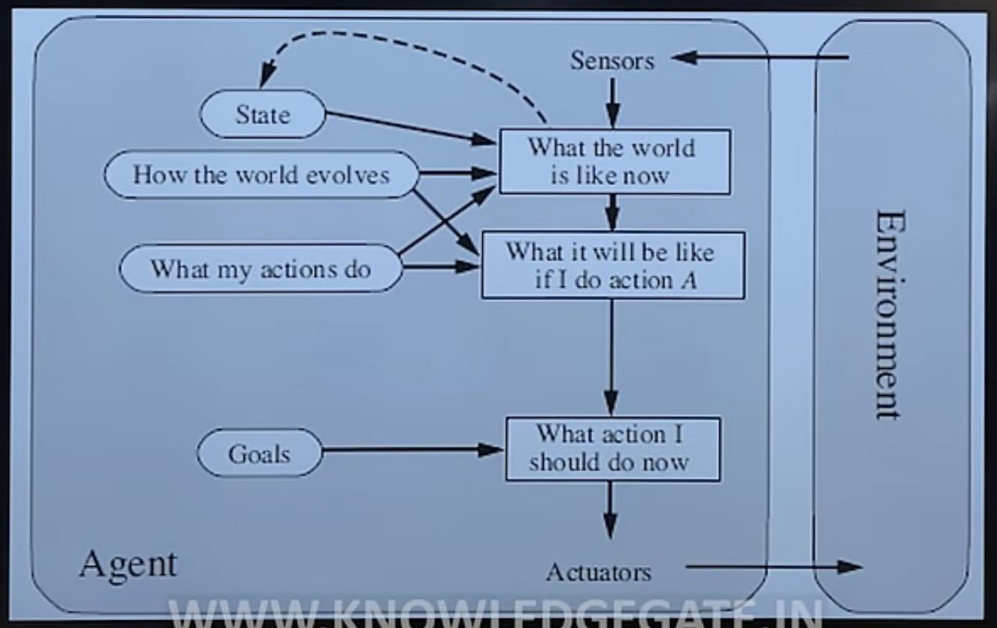
# Goal-based agents

- **Goal Information:** It is an extension of model based reflex agent, here we have a goal information that describes desirable situations, guiding their actions.
- **Action Decision:** These agents use their internal model and goal information to decide actions. For example, a taxi at a junction chooses a direction based on its destination.
- **Action Selection:** Goal-based agents may need to consider sequences of actions to achieve the goal. This can be straightforward or complex depending on the goal.

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Chapter-1 (INTRODUCTION)

**Example**: Automated Vacuum Cleaner

**Goal**:- Clean the entire floor area.

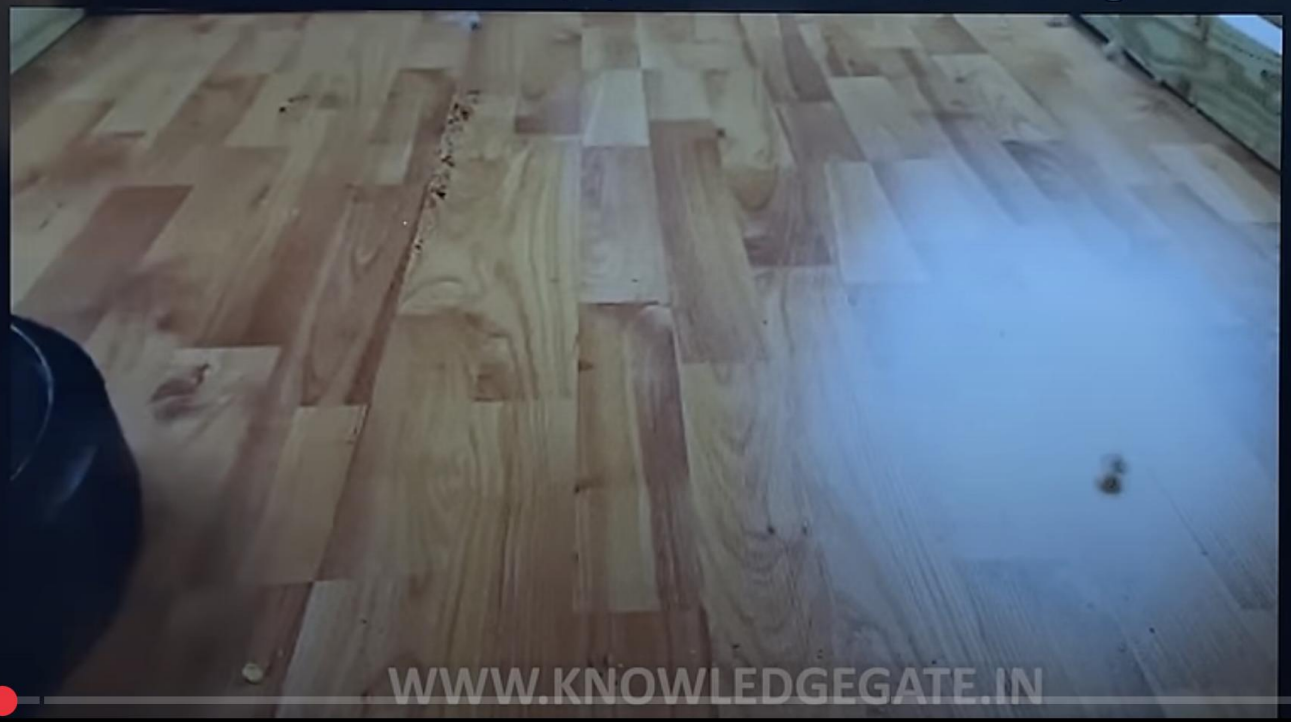
**Perception**:- Detects location and whether a spot is clean or dirty.

**Act**

- ** Changes position to cover the floor.
- **C** Activates vacuum on dirty spots.

**Decis naking**:- Chooses actions based on its goal and what it perceives (e.g., cleans dirty spots, moves to new area rent is clean).

**Go vement**:- Stops operating once no dirty spots are detected, indicating the floor is clean.



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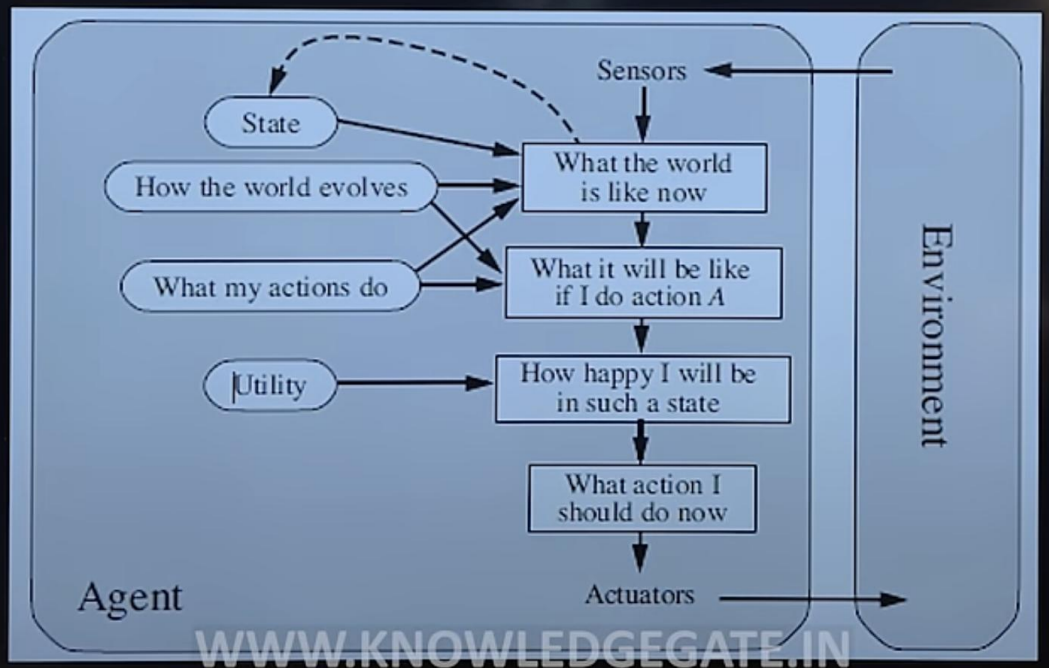
# Utility-based agents

- **Performance Measure:** Beyond having a goal, utility-based agents have a performance measure that compares different world states based on how "desirable" they are.
- **Utility:** To sound more scientific, the term "utility" is used to denote how happy or satisfied an agent is with a state.
- **Example:** Many routes can get a taxi to its destination, but some are quicker, safer, or cheaper. Utility allows the agent to distinguish between these routes.

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## Example: Smart Thermostat

**Goal**:

- Maintain comfortable home temperature.

**Perception**:

- Senses current temperature and occupant preferences.

**Actions**:

- **Heat**, **Cool**, or **Maintain** temperature.

**Utility Calculation**:

- Balances occupant comfort with energy efficiency

**Decision-making**:

- Chooses action to maximize comfort while minimizing energy use.

**Utility Achievement**:

- Adjusts temperature to keep high utility, considering both comfort and efficiency.

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## Key characteristics of a learning agent

- Adaptability
- Memory
- Feedback Sensitivity
- Decision-Making Ability
- Exploration and Exploitation
- Generalization
- Performance Improvement Over Time
- Problem-Solving Skills

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