Unit I
Introduction to Artificial Intelligence

(6 Hours)

1.1 Introduction to AI, AI Perspectives: Acting and thinking humanly, Acting and thinking rationally

1.2 Scope of AI

1.2.1. Game Playing

1.2.2. Problem Solving:

1.2.3. Natural Language Processing

1.2.4. Robotics

1.2.5. Computer Vision

1.2.6. Expert Systems

1.3 Turing Machine and Turing Test

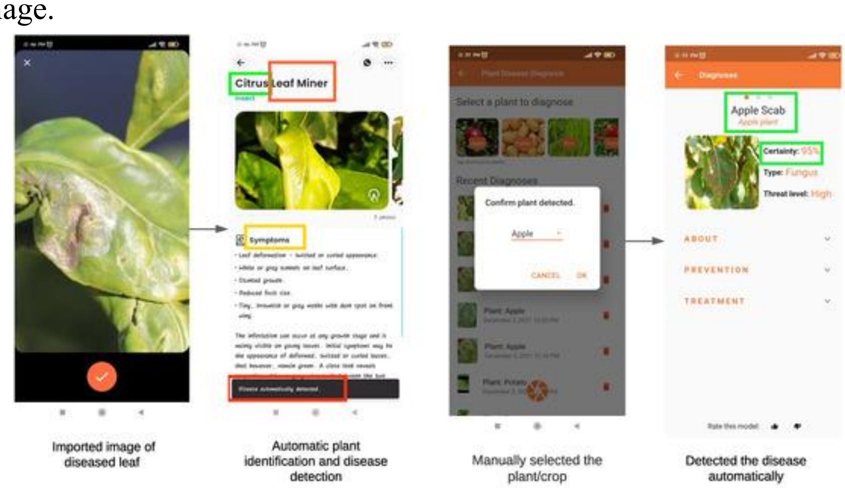
1.4. Intelligent Agents, Structure of Intelligent agent, Properties of Intelligent Agents

Case Example: "SmartFarm AI – Helping a Farmer with Artificial Intelligence"

1. Ramesh is a farmer in Nepal.
2. He grows tomatoes, potatoes, and rice on his small farm.
3. Every year, he faces problems with plant diseases.
4. Sometimes his crops get damaged before he even notices it.
5. He loses a lot of money due to late detection of crop disease.
6. He wishes he could get early warnings before his plants die.
7. One day, his friend tells him about **SmartFarm AI**, a mobile app that uses Artificial Intelligence.
8. The app can identify plant diseases from photos taken by the farmer.
9. Ramesh decides to try it out.
10. He opens the app and takes a photo of an infected tomato leaf.
11. The app immediately analyzes the photo.
12. It detects brown spots and discolored edges on the leaf.
13. Within a few seconds, it says:
14. "Your plant may have *Early Blight* disease."
15. It also shows what medicine to use and how to prevent it next time.
16. Ramesh is surprised and happy.
17. He realizes this is **Artificial Intelligence** at work.
18. But what exactly is happening inside the app?
19. Let's break it down to understand how AI helps Ramesh.

Part 1: How the AI Works

20. The app uses a **camera** (sensor) to capture the image.
21. The photo is sent to a computer model trained on thousands of leaf images(ML).
22. The model has learned from **past data** to recognize patterns of healthy and infected leaves.
23. The computer compares Ramesh's leaf with known examples in its database.
24. It uses a **machine learning algorithm** to predict the disease.
25. The algorithm gives a result: "Early Blight, 95% confidence."
26. It then generates suggestions and sends them back to Ramesh's phone.



(a) Plantix-your crop doctor (b) AgroAI-Plant Diseases Diagnosis (Early Access)

27. The app acts as an **intelligent agent** — it perceives, thinks, and acts.
28. The AI doesn't just see colors; it interprets meaning — like a human would.
29. It has learned from experience, not by being told every rule manually.
30. That's what makes it "intelligent."

Part 2: Difference Between Human and AI Thinking

31. If a human expert saw the leaf, he would:
32. Observe the color and texture.
33. Recall past experiences of plant diseases.
34. Think logically and emotionally ("I've seen this disease before").
35. Then decide which treatment to apply.
36. The AI system, on the other hand:
37. Doesn't have feelings or experience pain or stress.
38. It just processes the image mathematically.
39. It calculates similarity scores and probabilities.
40. It uses stored data and algorithms instead of emotions.
41. It works faster but only in the field it was trained for.
42. If the app is shown a banana leaf (not in its training data), it may fail.
43. So, humans are flexible and adaptive — AI is powerful but limited.

Part 3: Understanding AI Perspectives through this Case

1. Acting Humanly

44. The app acts like a human plant expert.
45. It observes the leaf, identifies the problem, and gives a solution.
46. Ramesh talks to it like a person — "What's wrong with my plant?"
47. The app responds naturally, like a conversation.
48. It passes the "acting humanly" test because Ramesh feels like he's talking to an expert.

2. Thinking Humanly

49. The AI "thinks" by simulating how a human reasons.
50. It doesn't just store pictures — it looks for patterns and causes.
51. For example, it identifies that brown spots usually mean fungus.
52. It has learned cause-and-effect relationships like humans do.
53. It "thinks" but without emotions or fatigue.

3. Acting Rationally

54. The AI tries to choose the best action for the situation.
55. It doesn't panic or guess randomly.
56. It analyzes data and selects the most effective disease treatment.
57. That's rational action — doing what maximizes success.
58. Humans might hesitate or delay, but AI acts immediately.

4. Thinking Rationally

59. The app uses logic and rules behind the scenes.
60. For example:

61. IF leaf has dark circular spots AND yellow edges, THEN disease = Early Blight.
62. These are logical rules that follow the "laws of thought."
63. It reasons step by step to reach a conclusion.

Part 4: Inside the Intelligent Agent

64. The app behaves as an **Intelligent Agent**.
65. It perceives the environment using its camera.
66. It reasons using algorithms and learned knowledge.
67. It acts by giving the user advice and actions.
68. It can even improve with feedback — a key property of learning agents.
69. Over time, as more farmers use the app, the model becomes smarter.

Agent Components:

70. **Sensor** → Camera (captures leaf image)
71. **Processor** → AI model (analyzes the data)
72. **Actuator** → App interface (shows diagnosis and advice)

Properties:

73. Autonomy — works on its own.
74. Reactivity — responds to user input quickly.
75. Proactiveness — gives preventive advice before diseases occur.
76. Rationality — chooses best solution with available information.
77. Learning — improves through continuous data updates.

Part 5: How AI Learns Like a Student

78. AI learning is similar to how a student studies for exams.
79. Suppose you show a student 100 pictures of diseased leaves.
80. The student learns to recognize patterns — shapes, colors, textures.
81. Then you test them with a new image.
82. If they recognize it correctly, they've learned.
83. Similarly, AI uses "training data" and "testing data."
84. The more examples it sees, the better it gets.
85. But unlike humans, AI can learn from **millions of examples** in minutes.

Part 6: Expanding AI in the Farm

86. SmartFarm AI doesn't stop at disease detection.
87. It also uses AI to predict **weather conditions**.
88. It combines data from satellites and local sensors.
89. The AI forecasts rainfall, temperature, and humidity.

90. It alerts Ramesh: "Heavy rain tomorrow, avoid spraying chemicals."
91. It helps him plan his work smarter.
92. The AI is like a "digital assistant farmer."

Part 7: How Humans and AI Work Together

93. Humans have **intuition** and **creativity**.
94. AI has **data and computation power**.
95. Together, they form a strong partnership.
96. Ramesh still decides what to do, but the AI helps him make better choices.
97. The AI learns patterns faster, but Ramesh knows his farm better.
98. So both intelligence types complement each other.

Part 8: Advantages of AI in this Case

99. Early detection of diseases.
100. Saves time and effort.
101. Reduces crop loss and increases productivity.
102. Provides consistent advice without fatigue.
103. Works 24/7 and improves continuously.

Part 9: Limitations of AI

104. Depends on quality of data and internet connection.
105. May fail if shown something completely new.
106. Cannot replace human judgment or creativity.
107. Needs updates and maintenance regularly.
108. May be costly for small farmers initially.

Part 10: Learning from the SmartFarm Example

109. Through this example, we can understand AI concepts easily.
110. It shows **AI is not magic**, it's logic and learning combined.
111. Machines are powerful because they follow rules without getting tired.
112. But they lack feelings and social understanding.
113. Humans, on the other hand, can feel empathy and make moral decisions.
114. The goal of AI is not to replace humans but to assist them.
115. AI augments human intelligence — not competes with it.

116. SmartFarm AI acts humanly — like an agricultural expert.
117. It thinks humanly — by recognizing disease patterns.
118. It acts rationally — choosing the best solution.
119. It thinks rationally — using logical rules.
120. It behaves like an intelligent agent with perception, reasoning, and action.
121. The Turing Test concept can be applied — if Ramesh can't tell if advice came from a person or AI, it's intelligent.
122. This is how AI makes real-world impact.
123. Farmers, doctors, teachers, and engineers can all use AI tools similarly.

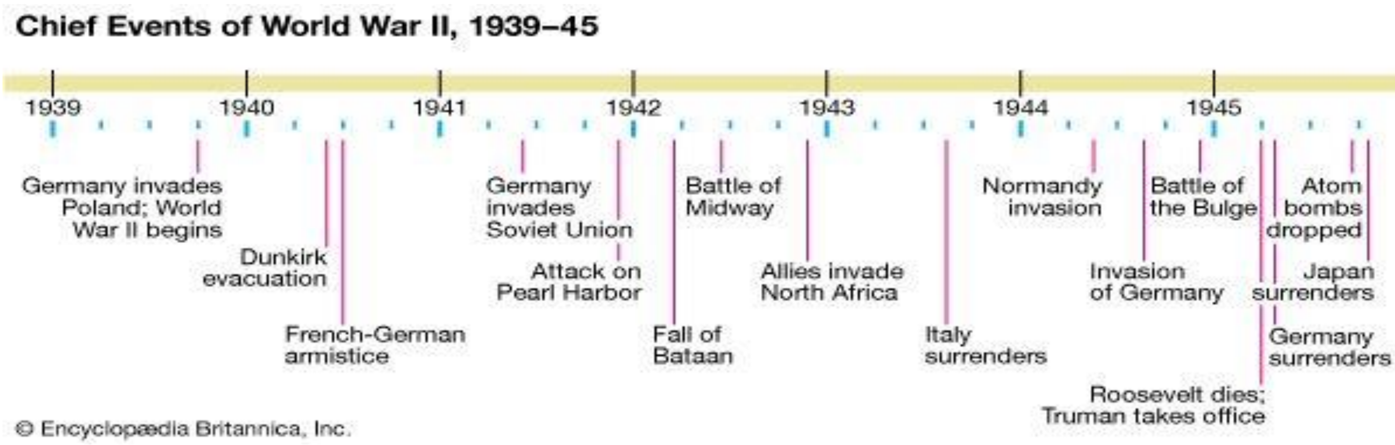
In Summary

124. Humans and AI are both intelligent in their own ways.
125. Humans are creative, emotional, and adaptive.
126. AI is logical, fast, and precise.
127. Together, they can solve big problems — like hunger, disease, and education.
128. Ramesh's SmartFarm AI shows how intelligence can be shared between man and machine.
129. Artificial Intelligence is not just technology — it's the next step in human innovation.
130. Understanding how AI works in simple examples helps us use it responsibly.

History of Artificial Intelligence

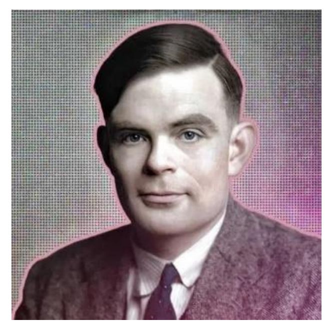
OR

Evolution of AI: From Alan Turing to Modern AI



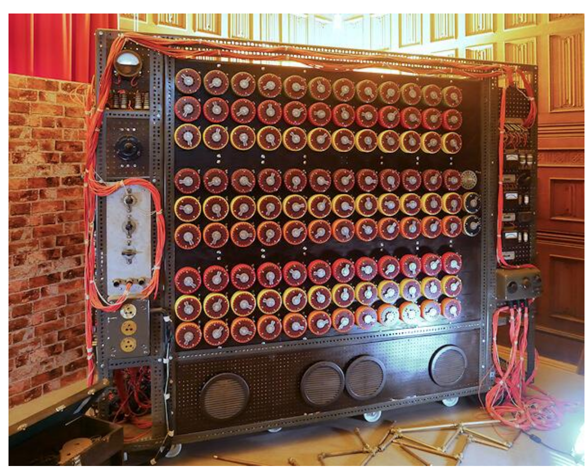
1. Early Foundations (1940s–1950s)

Alan Turing and the Birth of AI Thought

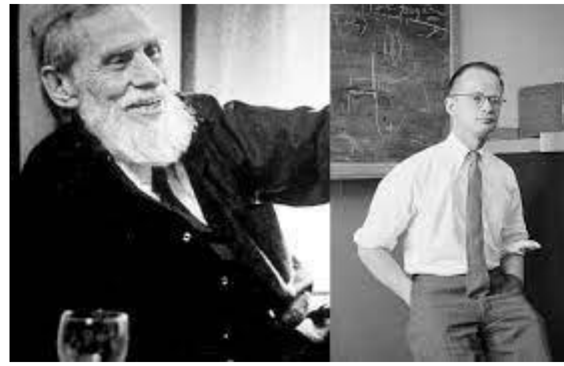


- **Alan Turing (1912–1954)** – British mathematician, considered the *Father of Theoretical Computer Science and AI.*
- During **World War II**, he worked at **Bletchley Park** to decrypt German codes.
- Built the **Bombe Machine**, which cracked the **Enigma cipher**, helping the Allies win the war.
- Proposed the concept of a **"Universal Machine" (Turing Machine)** in 1936 — a model for any computation.
- In 1950, introduced the **Turing Test** – a benchmark for whether a machine can *think like a human*.

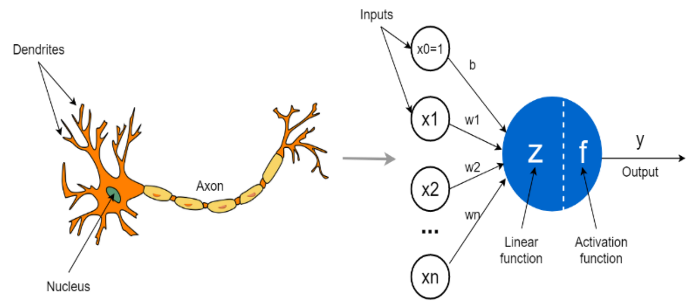
💡 *Turing's vision connected logic, computation, and cognition — laying the foundation of AI.*



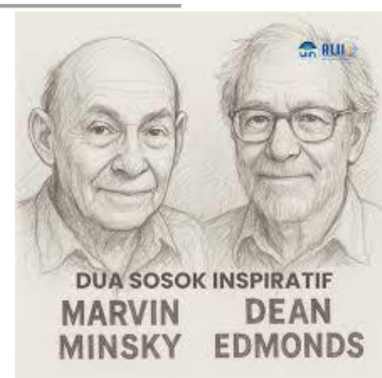
McCulloch and Pitts (1943)



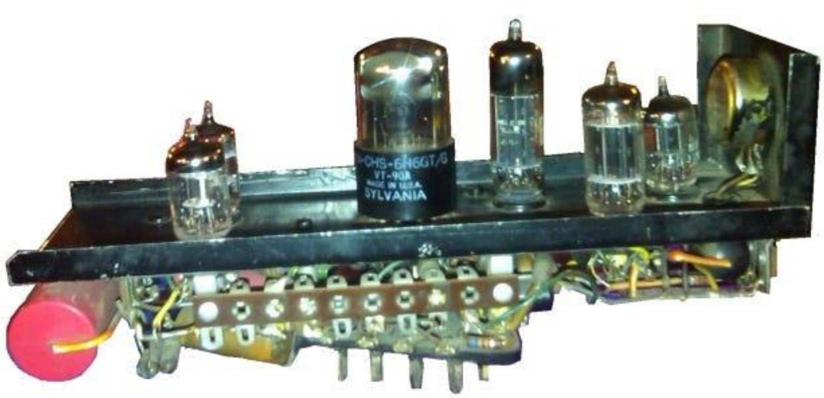
- **Warren McCulloch** and **Walter Pitts** published *"A Logical Calculus of the Ideas Immanent in Nervous Activity."*
- First mathematical model of **artificial neurons** — described how simple binary neurons could perform logical reasoning.
- Drew from **neurobiology**, **mathematical logic**, and **philosophy of mind**.
- Marked the beginning of the **neural-network concept** in AI.



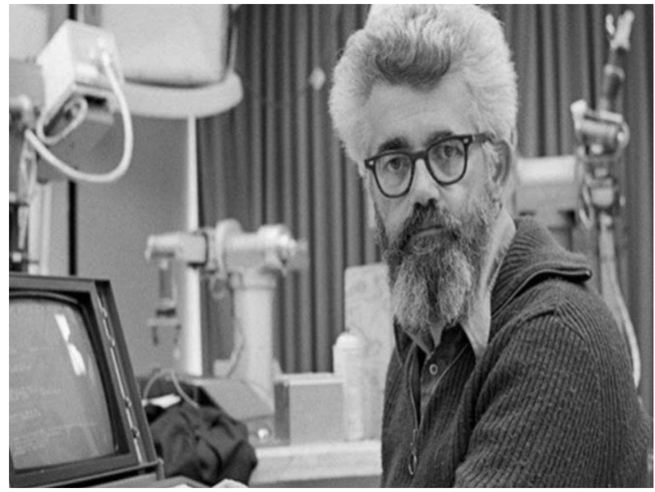
Marvin Minsky and Dean Edmonds – The SNARC (1951)



- Built **SNARC (Stochastic Neural Analog Reinforcement Calculator)** — the **first physical neural-network computer**.
- Simulated how a rat learns a maze using **reinforcement learning** and 3,000 vacuum tubes.
- Showed that machines could **learn from experience** — the first step toward **machine learning**.

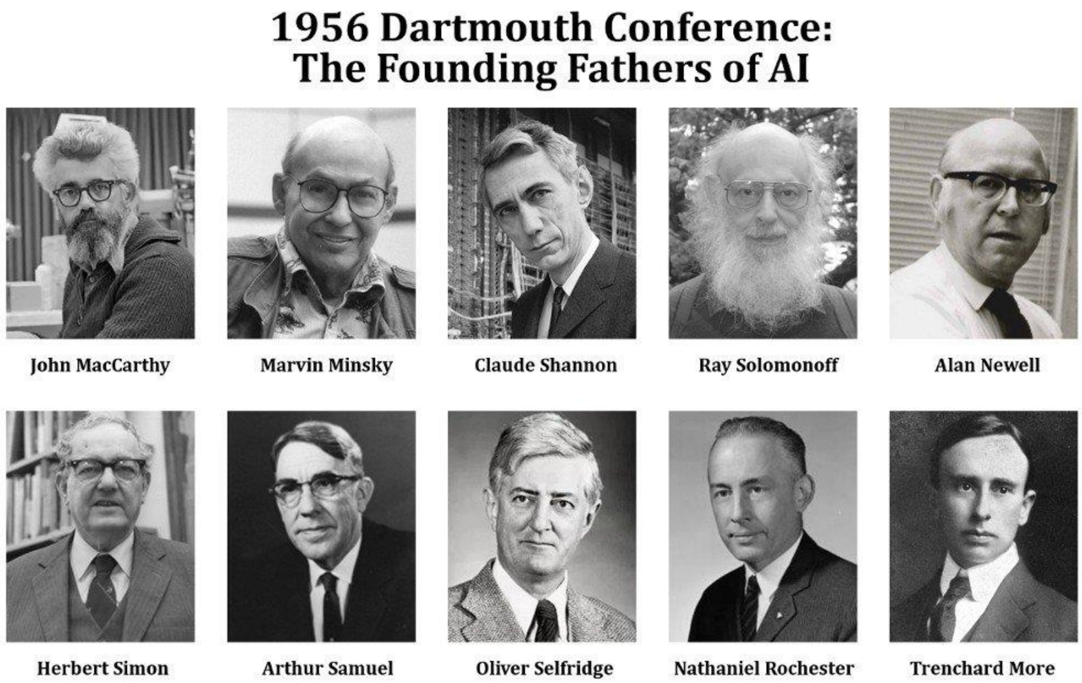


🔷 2. The Birth of AI as a Field (1956 – The Dartmouth Conference)



- **Year:** 1956 — considered the official **birth of Artificial Intelligence**.
- **Organizer: John McCarthy**, who coined the term **“Artificial Intelligence.”**
- **Event:** *Dartmouth Summer Research Project on AI* at Dartmouth College, New Hampshire.
- **Key Participants:** John McCarthy, Marvin Minsky, Claude Shannon, Nathaniel Rochester.
- **Goal:** To explore how machines could **simulate learning, reasoning, and understanding.**

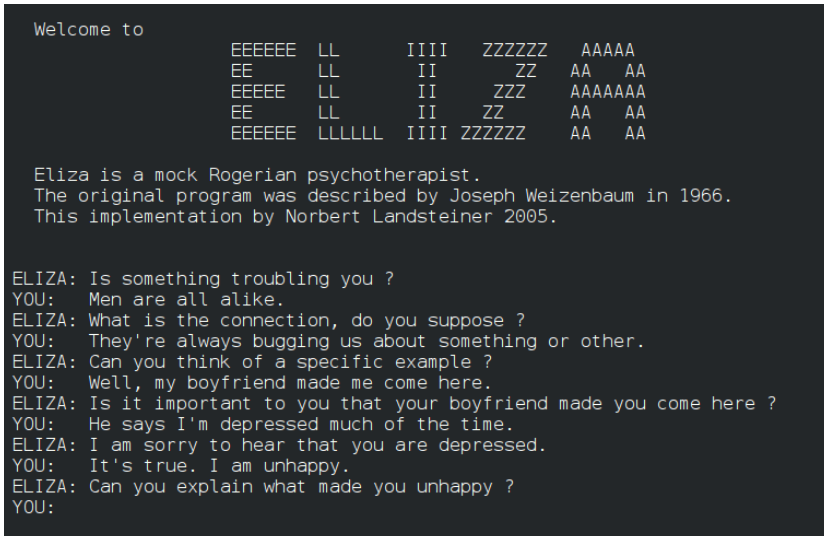
💬 *This conference made AI an academic discipline and inspired the creation of the first AI labs (MIT & Stanford).*

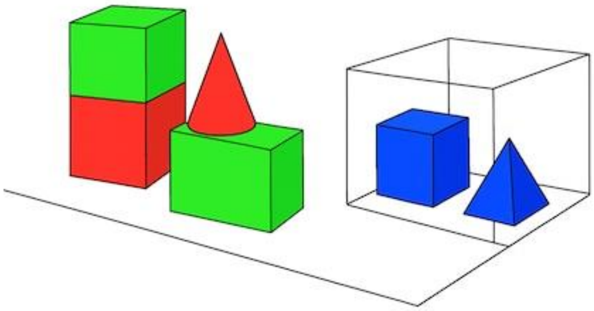


🔷 3. Early Growth and the First AI Winter (1960s–1970s)

- Early programs like **ELIZA** (chatbot), **SHRDLU** (language understanding), and **General Problem Solver** showed initial promise.
- However, **limited computing power** and **overhyped expectations** led to the **First AI Winter (1974–1980)**.
- **Lighthill Report (1973, UK)** criticized AI for lack of progress → funding cuts.

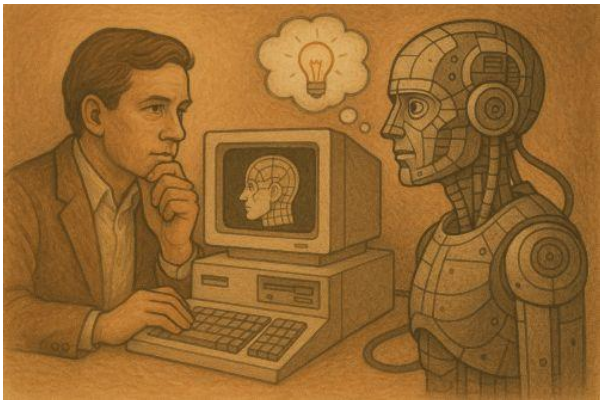
🧊 *AI enthusiasm cooled as projects failed to meet human-level expectations.*





🔷 4. AI Revival: Expert Systems Boom (1980s)

- AI regained popularity with **Expert Systems** — programs that simulated **human expert reasoning**.
- **Examples:**
  - **MYCIN** (medical diagnosis)
  - **DENDRAL** (chemical analysis)
  - **XCON** (Digital Equipment Corp., computer configuration)



- These systems used **if-then rules** and **knowledge bases** to make domain-specific decisions.
- Became profitable in business → major commercial adoption.

💡 *Expert systems marked the first industrial success of AI.*

🔷 5. The Second AI Winter (Late 1980s–1990s)

- **Causes:**
  - High maintenance cost of rule-based systems.
  - Lack of learning or adaptability.
  - Overhyped expectations and market collapse.
- Resulted in **loss of funding** and a second slowdown in AI research.

🧊 *AI progress slowed again — but new foundations in statistics, data, and algorithms were forming.*

🔷 6. Modern AI Milestones (1997–2018)

♟ 1997 – IBM Deep Blue Defeats Garry Kasparov

- IBM's **Deep Blue** beats world chess champion **Garry Kasparov**.
- Used massive parallel processing and search algorithms.
- First time a machine outperformed a human in strategic reasoning.

🚗 2005 – Stanford's "Stanley" Wins DARPA Grand Challenge

- **Stanford University** team built **"Stanley,"** an autonomous vehicle that completed a 132-mile desert course.
- Combined LIDAR, GPS, radar, and machine learning.
- Proved that **AI can navigate the real world** safely.

💬 **2011 – IBM Watson Wins *Jeopardy!* **

- IBM's **Watson** AI beat human quiz champions Ken Jennings and Brad Rutter.
- Used **Natural Language Processing** and **Machine Learning**.
- Demonstrated AI's ability to understand and answer human language.

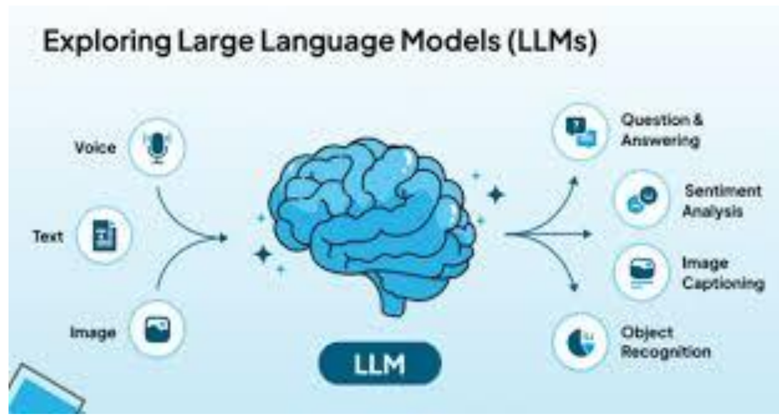
🧠 2015 – Deep Learning Breakthrough

- AI systems like **Google Inception v3** and **Microsoft ResNet** achieved **human-level accuracy** in image recognition.
- Error rate on ImageNet fell below 5%.
- Fueled by **neural networks, GPUs, and big data**.
- Sparked the **Deep Learning Revolution.**

🎯 2016 – AlphaGo Defeats Lee Sedol

- **Google DeepMind's AlphaGo** beat the 18-time world Go champion Lee Sedol.
- Used **Deep Reinforcement Learning and Monte Carlo Tree Search**.
- Showed AI could exceed human intuition and strategic creativity.

💬 2018 – OpenAI and Large Language Models

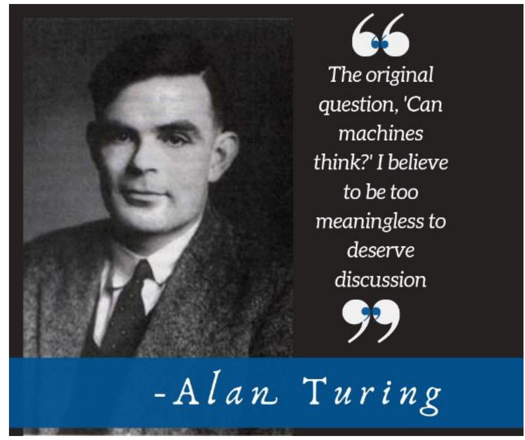


- **OpenAI** introduced **GPT (Generative Pre-trained Transformer)**, based on Google's 2017 Transformer architecture.
- Model could **generate human-like text, summaries, translations, and conversations.**
- Marked the rise of **Large Language Models (LLMs)** and modern AI assistants like ChatGPT.

Era / Year	**Milestone**	**Key Contribution**
1943	McCulloch & Pitts Neural Model	First mathematical model of neurons
1951	SNARC – Minsky & Edmonds	First neural-network computer
1956	Dartmouth Conference – John McCarthy	Birth of AI as a field; term coined
1974–1980	First AI Winter	Funding cuts, limited progress
1980s	Expert Systems	First commercial AI boom
Late 1980s–1990s	Second AI Winter	Decline due to brittle systems
1997	IBM Deep Blue	Machine defeats human in chess
2005	Stanford DARPA Challenge	Autonomous vehicle success
2011	IBM Watson	Natural language AI victory
2015	Deep Learning Breakthrough	Image recognition at human level
2016	AlphaGo (DeepMind)	Strategic self-learning AI

Era / Year	Milestone	Key Contribution
2018	OpenAI GPT	Rise of language intelligence

The Turing Test

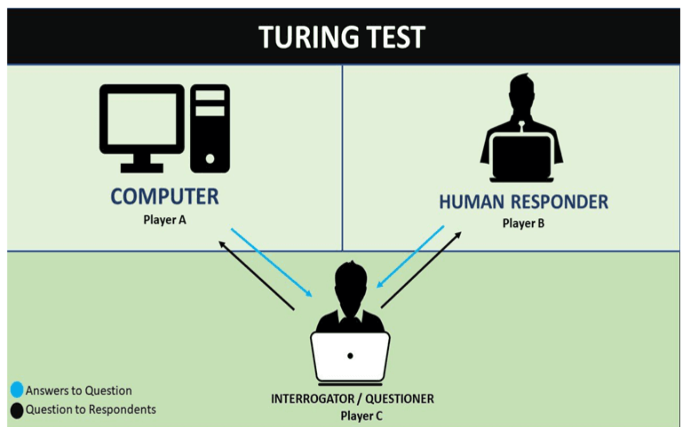


The **Turing Test** is one of the earliest and most influential ideas in Artificial Intelligence (AI). It was proposed by **Alan Turing (1950)** in his paper *"Computing Machinery and Intelligence"*.

Turing introduced a practical question:

"Can machines think?"

To answer it scientifically, he reframed it as an **"imitation game"** — a way to test whether a machine can **imitate human intelligence** convincingly enough to be indistinguishable from a human.



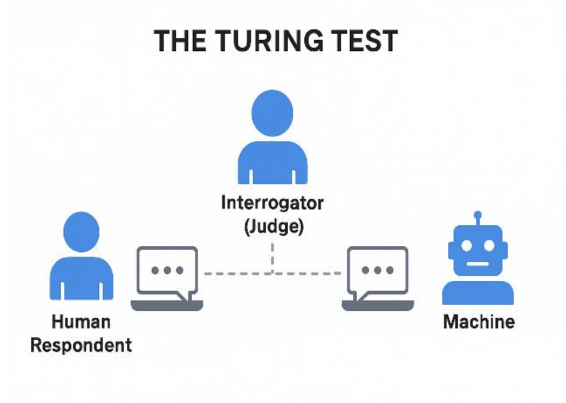
Concept of the Turing Test (The Imitation Game)

🎮 The Setup

- The test involves **three participants**:
    1. **A Human Interrogator (Judge)**
    2. **A Human Respondent**
    3. **A Machine (AI Program)**
- All participants communicate **through text only** (e.g., a chat terminal) — so that **appearance or voice** does not influence judgment.
- The **interrogator's task**: to ask any question and determine **which one is human** and **which is the machine**.

🧩 The Rule

If the **machine's answers** are so convincing that the human judge **cannot reliably distinguish** it from the human respondent,
then the machine is said to **have passed the Turing Test**.



Objective of the Test

- To measure a machine's **ability to exhibit intelligent, human-like behavior**.
- Focuses on **behavioral intelligence** rather than the internal process.
- The test does **not require consciousness or emotion** — only the *appearance* of understanding.

🔷 Example Scenario

Imagine a judge chatting with two unseen entities (A and B):

Judge: What do you like to do in your free time?

A: I enjoy reading books and sometimes coding small games.

B: I like watching cricket and chatting with friends.

*If **A** is a computer program and the judge **cannot tell**, then A has **passed the Turing Test**.*

Example	Description
ELIZA (1966)	A chatbot by *Joseph Weizenbaum* that simulated a psychotherapist. Many users thought it was human.
PARRY (1972)	Simulated a person with paranoid schizophrenia; passed limited Turing-style tests.
Eugene Goostman (2014)	A chatbot that simulated a 13-year-old boy; claimed to have fooled 33% of judges.
ChatGPT (2022–Present)	Modern large language model that produces highly human-like conversations — a near Turing-level AI.

💬 *While no system has perfectly passed the Turing Test under rigorous conditions, modern LLMs (like ChatGPT and GPT-4) come closest.*

Modern Relevance (Extra)

- The **Turing Test** remains a **symbolic milestone**, though AI today is measured differently — by performance in **tasks**, **learning ability**, and **generalization**.

- **ChatGPT**, **Google Bard**, and **Anthropic Claude** have reached conversation quality where many users cannot distinguish them from humans.
- AI now extends beyond imitation to **reasoning, self-learning, and creativity**, going beyond Turing's original vision.

AI Perspectives (Approaches to Building Intelligent Systems)

According to **Russell and Norvig (2021)**, AI perspectives can be categorized into **four main approaches**, depending on whether the system aims to **think** or **act**, and whether it models **human** or **rational** behavior.

1) **Acting Humanly (The Turing Test Approach)**
2) **Thinking Humanly (Cognitive Modeling Approach)**
3) **Acting Rationally (Rational Agent Approach)**
4) **Thinking Rationally (Laws of Thought Approach)**

Scenario:
Riya installs a **Smart Home AI Assistant** in her house.
This assistant can control lights, temperature, music, and security systems automatically.

It senses changes in the environment, learns from Riya's habits, and acts accordingly — just like an intelligent agent.

A. Acting Humanly (The Turing Test Approach)

- Focus: Systems that **behave like humans**.
- A machine is intelligent if it can **imitate human behavior** indistinguishably.
- AI behaves like a human — if people can't tell whether it's a human or a machine, it passes the Turing Test.
- Proposed by **Alan Turing (1950)** in his famous **Turing Test**.

Example:

- Chatbots like **ChatGPT**, **ELIZA**, or **Siri**, which can hold human-like conversations.

Goal:

- To replicate observable human behavior (speech, perception, reasoning).

Q: How does this bot show *acting humanly* behavior?
A: The chatbot responds naturally in conversation — greeting you, understanding your query, and replying politely — so well that you might not realize it's a machine.

🧠 B. Thinking Humanly (Cognitive Modeling Approach)

- Focus: Systems that **think like humans**.
- Attempts to **model human thought processes** and cognitive functions.
- AI tries to think the way humans think — by simulating how the human brain learns and solves problems.
- Based on psychology and neuroscience.

Example:

- *Neural networks* modeled after brain neurons, such as image recognition systems that "learn" patterns like humans.
- Cognitive AI systems that simulate human memory and learning — e.g., **ACT-R cognitive model**, **neural networks** modeled after the brain.

Goal:

- Understand how humans think and replicate that process in machines.

Q: How does this AI demonstrate *thinking humanly*?
A: It models human memory and learning patterns — repeating difficult words more often and simulating how the human brain learns through practice.

⚙️ C. Acting Rationally (Rational Agent Approach)

- Focus: Systems that **act to achieve the best outcome** based on logic and data.
- AI acts to achieve the best possible result or goal logically — not necessarily like a human, but optimally.
- Rational agents perceive their environment and act to maximize performance.
- Emphasizes **decision-making and goal achievement** rather than mimicry.

Example:

- **Autonomous drones** and **self-driving cars** making optimal navigation decisions.
- **AI trading bots** that act to maximize profit.

Goal:

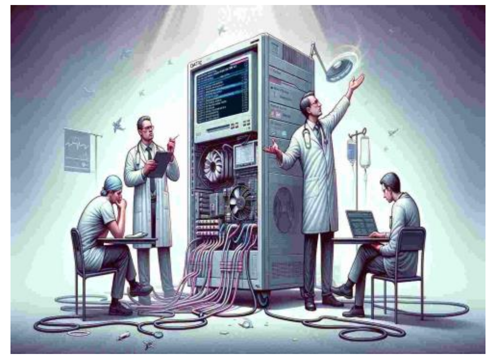
- Choose the best possible action for a given objective.

Q: How does it show *acting rationally*?
A: The car evaluates distance, speed, and safety — then decides logically whether to stop or proceed — aiming for the best, safest outcome.

📊 D. Thinking Rationally (Laws of Thought Approach)

- Focus: Systems that **reason logically** like mathematicians or philosophers.
- AI makes decisions based on logical reasoning — using facts and rules to reach conclusions.
- Uses formal logic to derive conclusions from facts and rules.
- Foundation of **expert systems** and **rule-based AI**.

Example:



- *Medical expert systems* that use "if–then" logic to suggest correct diagnoses or treatments.
- **MYCIN (1970s)** – Used logical rules to diagnose bacterial infections.
- **Modern knowledge-based reasoning systems** in medical and legal domains.

Goal:

- Develop machines that can reason correctly using formal rules of inference.

Q: How does it apply *thinking rationally*?
A: It uses logical "if–then" reasoning:

"If fever + sore throat → possible flu."
It applies formal rules and facts to reach a logical, explainable conclusion.
⚙️ *Example: Expert systems like MYCIN use rule-based reasoning for diagnosis.*

Introduction to Artificial Intelligence (AI)

Artificial Intelligence (AI) is a field of computer science that focuses on building systems capable of performing tasks that normally require **human intelligence** — such as **understanding language, recognizing patterns, learning from experience, reasoning, and making decisions.**

AI combines techniques from **mathematics, computer programming, data science, psychology, and neuroscience** to create machines that can think and act intelligently.

💡 **Examples**

- **Voice Assistants:** Siri, Alexa, and Google Assistant understand and respond to human speech.
- **Autonomous Vehicles:** Self-driving cars detect obstacles and make safe driving decisions.
- **Recommendation Systems:** Netflix and YouTube recommend content based on user behavior.
- **Chatbots:** AI systems like ChatGPT interact naturally with users.

Top 5 classic definitions of Artificial Intelligence (AI)

1 John McCarthy (1956) — *Father of Artificial Intelligence*

Definition: "Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs."

Meaning: AI combines science (understanding intelligence) and engineering (building systems that behave intelligently).
Focus: Building *intelligent behavior*, not just simulating it.

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2 Marvin Minsky (1968)

Definition: "Artificial Intelligence is the science of making machines do things that would require intelligence if done by humans."

Meaning: AI is measured by what humans consider "intelligent tasks" — reasoning, learning, problem-solving.
Focus: Human-like task performance.

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3 Elaine Rich (1983)

Definition: "Artificial Intelligence is the study of how to make computers do things at which, at the moment, people are better."

Meaning: AI's goal is to close the gap between human and machine capabilities.
Focus: Progressive improvement — machines learning from humans.

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4 Stuart Russell & Peter Norvig (1995, 2021)

Definition: "AI is the study of agents that receive percepts from the environment and perform actions to achieve their goals."

Meaning: AI systems act rationally — sensing, thinking, and acting to maximize success.
Focus: *Rational agent* behavior — the foundation of modern AI.

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5 Winston Patrick Henry (1992)

Definition: “Artificial Intelligence is concerned with computational understanding of intelligent behavior and the creation of machines that exhibit such behavior.”

Meaning: AI aims to both understand *how intelligence works* and build *systems that display it.*
Focus: Understanding and replication of intelligence.

Scope of Artificial Intelligence

The **scope of AI** refers to the **range of fields, functions, and real-world applications** where Artificial Intelligence can be applied to perform human-like tasks — including **learning, reasoning, decision-making, problem-solving, and perception.**

AI’s scope is vast and continues to grow across almost every domain of human life and industry.

🔷 1. Major Areas Covered by AI

Area	Description	Example
Machine Learning (ML)	AI learns from data and improves over time without being explicitly programmed.	Predicting stock prices, spam filters in Gmail.
Natural Language Processing (NLP)	Understanding and generating human language.	ChatGPT, Google Translate, Alexa.
Computer Vision	Interpreting and analyzing visual information from images or videos.	Face recognition, medical image diagnosis.
Robotics	AI-driven machines that perform physical tasks autonomously.	Industrial robots, autonomous drones.

Area	Description	Example
Expert Systems	Knowledge-based systems that mimic expert human reasoning.	Medical diagnosis systems like MYCIN.
Speech Recognition	Converting spoken language to text and understanding it.	Siri, Google Assistant.
Planning and Decision-Making	AI that analyzes options and selects optimal strategies.	GPS route optimization, airline scheduling.

🔷 2. Application Domains of AI

Domain	AI Application	Example
Healthcare	Disease prediction, drug discovery, medical imaging.	IBM Watson Health diagnosing cancer.
Education	Personalized learning and grading automation.	Coursera AI Tutor, Duolingo.
Agriculture	Crop monitoring, pest detection, yield prediction.	Drone-based smart farming systems.
Finance	Fraud detection, algorithmic trading, risk assessment.	PayPal fraud detection, AI stock trading bots.
Transportation	Autonomous vehicles, smart traffic control.	Tesla Autopilot, Google Waymo.
Security	Surveillance, anomaly detection.	AI-based CCTV analysis.
Entertainment	Recommendations, content creation.	Netflix AI recommendations, DALL·E image generation.
E-Commerce	Product suggestions, customer chatbots.	Amazon product recommendations.
Environment	Climate modeling, energy optimization.	Google DeepMind AI reducing data center energy.

🔷 **3. Emerging Fields in AI**

Emerging Area	Description	Example
Generative AI	Creates new content — text, music, art, code.	ChatGPT, DALL·E, Midjourney.
Quantum AI	Combines quantum computing with AI for faster data processing.	IBM Quantum-AI research.
Explainable AI (XAI)	Makes AI decisions transparent and understandable.	AI models that explain why they made a prediction.
AI Ethics and Governance	Ensures fairness, accountability, and privacy.	EU AI Act, responsible AI frameworks.
AI for Sustainability	Tackles environmental challenges.	AI predicting floods or optimizing energy use.

💬 **In short:**

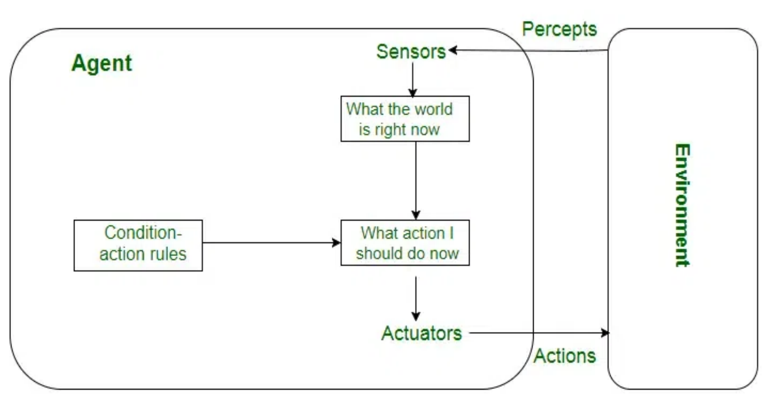
The scope of Artificial Intelligence spans from data-driven decision-making to human-like creativity — shaping smarter, faster, and more sustainable systems across every field.

Intelligent Agents, Structure of Intelligent agent, Properties of Intelligent Agents

Agent and Environment in Artificial Intelligence

Example 1: Case Scenario: Self-Driving Car (Autonomous Vehicle Agent)

*Imagine a **self-driving car** driving through city traffic. It uses **cameras, radar, GPS, and sensors** to perceive the world and **AI algorithms** to decide what to do — such as steering, braking, or changing lanes.*



Q1. What is the *Agent* here?

A:
The **agent** is the **AI system** inside the car that makes intelligent decisions.
It senses the world, interprets the situation, and decides what action to take next.

Example: The AI decides to slow down when it sees a red traffic light.

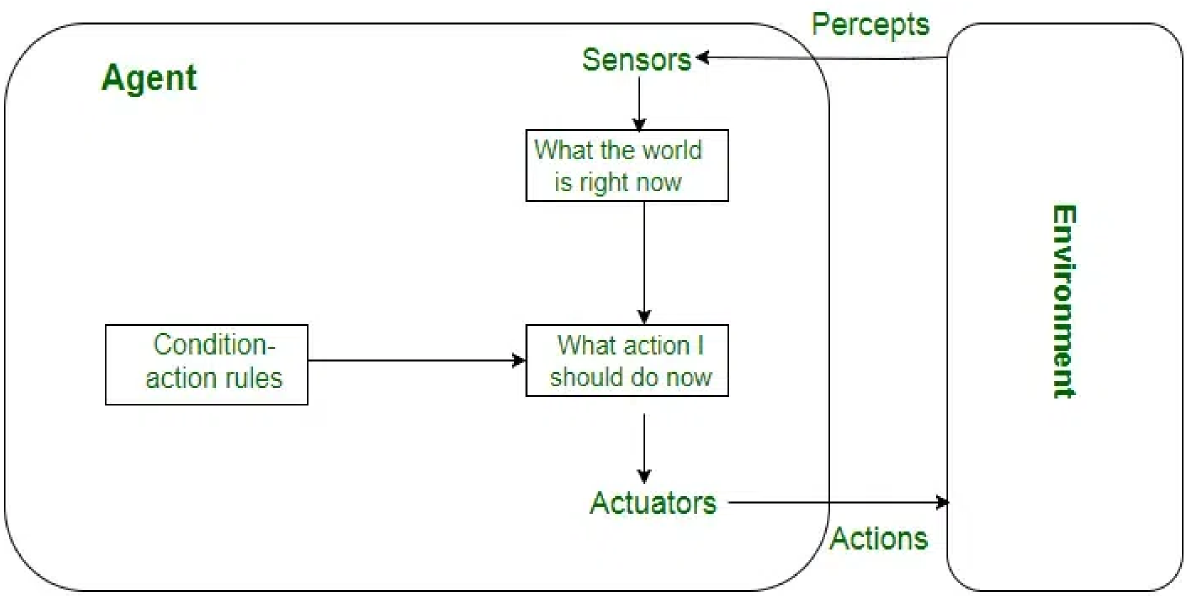
Q2. What is the *Environment*?

A:
The **environment** includes everything the car interacts with — roads, traffic lights, pedestrians, weather, and other vehicles.

The environment provides **inputs (percepts)** and responds to the car's **actions**.

Q3. What are the *Sensors* and *Actuators*?

Type	**Examples**	**Purpose**
Sensors	Cameras, radar, GPS, ultrasonic sensors	To perceive environment — detect cars, signals, lanes.
Actuators	Steering motor, brakes, accelerator	To act — move, turn, or stop the car.



Q4. What does "What the world is right now" mean?

A:
This part of the diagram represents the **percept** — the information sensed from the environment at that moment.

For example: "Red light ahead," "Pedestrian crossing," or "Speed limit 60 km/h."

Q5. What are *Condition–Action Rules*?

A:
These are the **if–then logic rules** that decide what the agent should do.

Example:

- *If traffic light = red → stop the car*
- *If road clear → move forward*
- *If obstacle → turn left*

The agent continuously uses such rules to decide its actions.

Q6. What are *Actions* and *Percepts* in this case?

A:

- **Percepts:** What the car senses (traffic signals, distance from other cars, speed).
- **Actions:** What the car does (accelerates, brakes, turns).

This creates a **continuous feedback loop** between **Agent** and **Environment**.

Key Components in the Case

Component	**Description**	**Example in Car**
Agent	AI control system that decides.	The car's onboard computer.
Environment	Everything external to the agent.	Roads, signals, traffic, weather.
Sensors	Devices that perceive environment.	Cameras, radar, GPS.
Actuators	Devices that act on environment.	Steering, brakes, engine.
Condition–Action Rules	Decision-making logic.	If obstacle → stop.
Percepts	Information sensed.	"Car ahead slowing."
Actions	Responses to percepts.	"Brake smoothly."

Example 2:

Imagine a medical AI system in a hospital that helps doctors diagnose diseases. It receives patient data (symptoms, test results, reports), analyses it using knowledge-based rules and AI models, and suggests the most probable diagnosis or treatment options.

Q1. What is the *Agent* here?

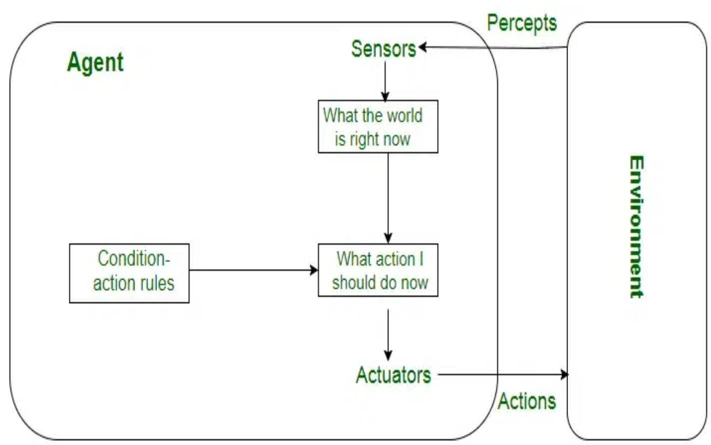
A:
The **AI diagnostic system** itself is the *agent*.
It processes patient data, applies reasoning or learning models, and outputs recommendations.

🧠 Example: The AI detects patterns in symptoms and predicts "possible diabetes" or "viral infection."

Q2. What is the *Environment*?

A:
The **environment** includes all external elements the system interacts with — patients, hospital database, electronic health records, lab test results, and doctors' feedback.

🌍 It provides the **input data (percepts)** and receives **recommendations (actions)** from the AI.



Q3. What are the *Sensors* and *Actuators*?

A:

Type	**Examples**	**Purpose**
Sensors	Input interfaces like medical record databases, lab results, wearable health trackers.	To gather patient data.
Actuators	Display systems, diagnostic reports, or recommendation dashboards.	To communicate diagnosis to doctors.

💡 *Sensors collect information; actuators present intelligent actions.*

Q4. What does "What the world is right now" represent?

A:
It represents the system's **current perception of the patient's health status** — what data it has received.

Example: Blood sugar = 250 mg/dL, fatigue = yes, temperature = 100°F.

The agent interprets this as *"patient may have a diabetic condition."*

Q5. What are the *Condition–Action Rules*?

A:
The AI uses **if–then medical reasoning rules** or **machine learning models** to make decisions.

Examples:

- *If high temperature + cough → possible infection.*
- *If high sugar + frequent urination → possible diabetes.*
- *If chest pain + irregular ECG → possible heart issue.*

Q6. What are *Percepts* and *Actions* here?

A:

- **Percepts:** Patient data (symptoms, reports, test values).
- **Actions:** Diagnosis suggestions or treatment recommendations.

🧩 Example: *Percept:* "High fever and fatigue." → *Action:* "Recommend dengue test."

```
┌──────────────────────────────────────┐
│              Environment             │
│  (Patients, records, test data)      │
└──────────────────────────────────────┘
                │
                │
           (Percepts)
                │
                ↓
┌──────────────────────────────────────┐
│                Agent                 │
│ Sensors → Condition–Action Rules → Act│
└──────────────────────────────────────┘
                │
                │
           (Actions)
                ↓
┌──────────────────────────────────────┐
│              Environment             │
│  (Updated records, doctor feedback)  │
└──────────────────────────────────────┘
```

🔷 Key Components in the Case

Component	**Description**	**Example in AI Doctor**
Agent	AI-based diagnosis system	IBM Watson Health, Clinical Decision Support System
Environment	Hospital data, patient information	EHR, lab reports
Sensors	Input from health databases	Test results, vitals, patient symptoms
Actuators	Output through dashboard/report	Suggests "Possible infection detected"
Condition–Action Rules	Decision-making logic	"If fever + rash → test for dengue"
Percepts	Input data sensed	High sugar, high BP
Actions	Diagnosis or recommendation	"Consult cardiologist"

Case Scenario: Smart Home Assistant (AI Agent)

A **Smart Home Assistant** is installed in a house.
It listens to user voice commands ("Turn on lights", "Play music", "What's the weather?"), processes them, and performs actions through connected devices such as lights, speakers, or thermostats.

The **Smart Home Assistant** shows how percepts and their history guide intelligent behavior. It senses inputs (voice, temperature), stores percept sequences (past data), applies an agent function (logic or learning model), and executes actions via an agent program.

💬 *This cycle — Perceive → Decide → Act → Learn — makes AI systems intelligent, adaptive, and useful in real life.*

🧠 1️⃣ Percept

Definition:

A **percept** is the **immediate input** that an agent receives from its environment through its **sensors** at a specific moment.

💬 *It is what the agent senses right now.*

In the Smart Home Case:

- The percept could be the **user's voice command** or the **current room condition**.
- Example percepts:
  - "Turn on the lights."
  - "Temperature is 30°C."
  - "Music playing: stopped."

🧩 2️⃣ Percept Sequence

Definition:

A **percept sequence** is the **complete history of all percepts** that an agent has received so far.
It helps the agent make better decisions by considering past inputs.

💬 *It's the memory of everything the agent has sensed until now.*

In the Smart Home Case:

- The system remembers a **series of previous interactions**, for example:
    1. "User said: Turn on lights."
    2. "Room brightness = low."
    3. "User said: Set temperature to 22°C."
    4. "User said: Play music."

The assistant can then predict future needs, e.g., *"User usually turns on lights and plays music at 7 PM."*

⚙️ 3 Agent Function

Definition:

An **Agent Function** is a **mathematical mapping** from the **percept sequence to an action**.

Formally:

$$f: P^* \to A$$

Where:

- P^*= set of all possible percept sequences
- A= set of all possible actions

💬 *It tells the agent what action to take based on what it has perceived so far.*

In the Smart Home Case:

Percept Sequence	Action (by Agent Function)
"User said: Turn on lights"	Switch on the connected lights.
"Temperature = 30°C"	Turn on air conditioner.
"User said: Play relaxing music"	Play selected playlist.
"User said: Good night"	Turn off all lights and lock doors.

Thus, the **agent function** maps *what the system hears/sees → what it should do next.*

💻 4 Agent Program

Definition:

An **Agent Program** is the **actual implementation (code)** of the agent function.
It runs on the **physical architecture** (like the Alexa device or a computer) and performs actions based on sensor input.

💬 *If the agent function is the plan, the agent program is the real code executing that plan.*

In the Smart Home Case:

- The **agent program** includes:
  - Speech recognition module (to detect voice commands).
  - **Logic rules** or AI models (to decide the meaning).
  - APIs to control devices (like lights, fans, or AC).

Example process:

1. **Input:** "Turn on the lights."
2. **Program:** Interprets intent → finds correct device → sends command.
3. **Action:** Lights turn on.
4. **Feedback:** Confirms — "Lights have been turned on."

🔷 Example Table (Summary of Smart Home Case)

Concept	Definition	Example from Smart Home Assistant
Percept	Current input received from environment.	"User says: Turn on the lights."
Percept Sequence	All percepts received till now (history).	"Turn on lights", "Set temperature", "Play music."
Agent Function	Maps percept sequence → action.	Maps "Hot room" → "Turn on AC."
Agent Program	Code that executes actions using sensors and actuators.	Software that receives voice command and activates devices.

🔷 Q&A Summary (for understanding)

Q1. What's the difference between Percept and Percept Sequence?

A:

- *Percept* = one-time input (current situation).
- *Percept Sequence* = memory of all inputs received so far.

Q2. What is the purpose of the Agent Function?

A:
To decide what action the agent should take next, given what it has perceived up to now.

Q3. How is the Agent Program related to the Agent Function?

A:
The **agent function** defines *what* to do, and the **agent program** defines *how* to do it (the real executable system).

🔷 Conclusion

The **Smart Home Assistant** shows how percepts and their history guide intelligent behavior.
It senses inputs (voice, temperature), stores percept sequences (past data), applies an agent function (logic or learning model), and executes actions via an agent program.

💬 *This cycle — Perceive → Decide → Act → Learn — makes AI systems intelligent, adaptive, and useful in real life.*

Intelligent Agents, Structure of Intelligent agent, Properties of Intelligent Agents

🤖 Intelligent Agents

🔷 1 Definition

An **Intelligent Agent (IA)** is an entity that can **perceive** its environment through **sensors**, **analyze** the situation, and **act** upon that environment using **actuators** to achieve specific goals intelligently.

💬 *In short: An Intelligent Agent "**senses → thinks → acts**" in its environment to accomplish objectives.*

🔷 2 Examples of Intelligent Agents

Type	Example
Software Agent	ChatGPT answering questions.
Robotic Agent	Self-driving car navigating roads.
Web Agent	Google Search crawler indexing sites.
Game Agent	AI player making strategic moves in chess or PUBG.

Type	Example
Medical Agent	AI diagnosis system analyzing X-rays.

🔷 3️⃣ Structure of an Intelligent Agent

An Intelligent Agent consists of three main components:

Component	Function	Example
Sensors	Gather data from the environment.	Camera, microphone, GPS.
Processing Unit (Brain)	Decides what action to take based on input data.	AI logic, neural network, algorithms.
Actuators	Carry out actions on the environment.	Motors, displays, speakers, or web actions.

⚙️ Block Diagram: Structure of an Intelligent Agent

```
┌─────────────────────────────┐
|         Environment         |
└─────────────┬───────────────┘
              |
         (Percepts)
              |
              ↓
┌─────────────────────────────┐
|           Agent             |
|  - Sensors                  |
|  - Decision/Processing Unit|
|  - Actuators                |
└─────────────┬───────────────┘
              |
         (Actions)
              ↓
┌─────────────────────────────┐
|         Environment         |
└─────────────────────────────┘
```

💡 How It Works:

1. **Sense** – The agent perceives the environment using sensors.

2. **Think / Decide** – The agent processes the input, applies rules or learning, and selects an appropriate action.
3. **Act** – The agent performs the chosen action via actuators, changing the environment.
4. **Feedback Loop** – New percepts are generated, and the cycle continues.

🔷 4 Properties of Intelligent Agents

Property	Description	Example
Autonomy	Works independently without human control.	Self-driving car controlling its route.
Reactivity	Responds to environmental changes.	Thermostat adjusting temperature automatically.
Proactiveness	Takes initiative toward goals.	AI assistant scheduling reminders.
Adaptability (Learning)	Learns and improves from experience.	Email spam filter improving with new data.
Rationality	Acts logically to achieve the best outcome.	GPS system finding the shortest route.
Goal-Oriented	Always directed toward achieving a purpose.	Game AI trying to win.
Social Ability	Can communicate with other agents or humans.	Chatbots interacting in natural language.

🔷 5 Example Case: Self-Driving Car

Component	Example in Self-Driving Car
Sensors	Cameras, radar, GPS detect road and traffic.
Processing Unit	AI analyzes sensor data and decides next action.
Actuators	Steering, brakes, and accelerator control movement.
Environment	Roads, pedestrians, signals, weather.
Action	Turns, stops, accelerates, or avoids obstacles.

AI Perspectives:

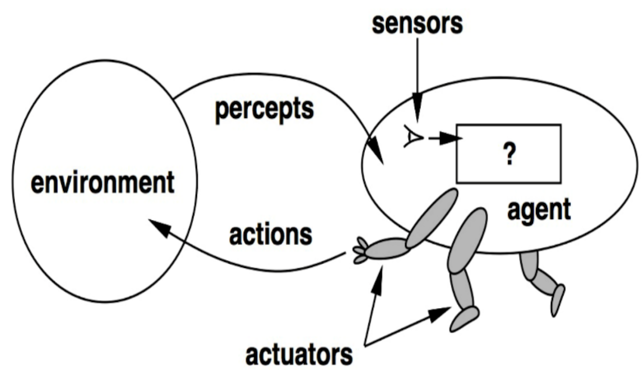
Acting and thinking humanly vs Acting and thinking rationally

🔷 1 What is Rationality in AI?

Definition:

In Artificial Intelligence, **rationality** refers to the ability of an agent to **make the best possible decision** to achieve its goals, based on:

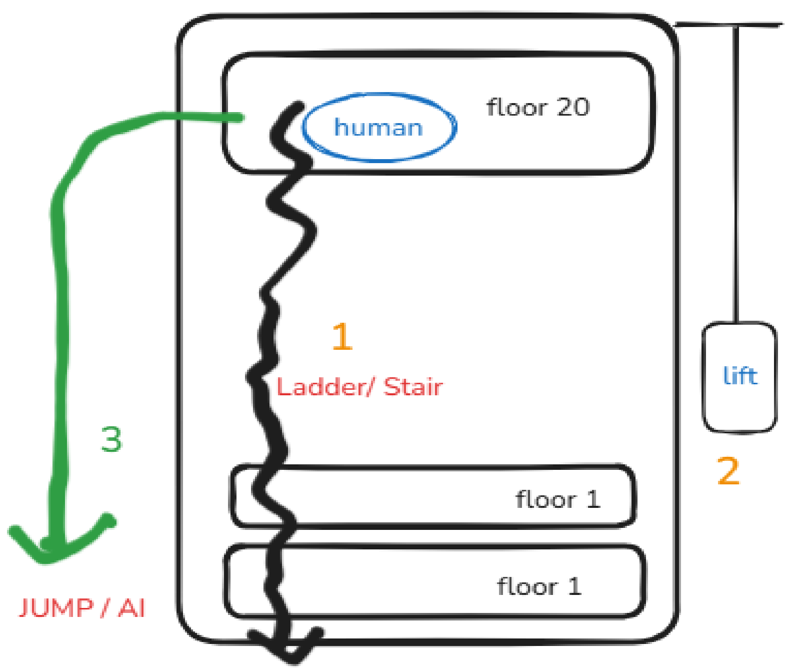
- The **knowledge** it has,
- The **percepts** it receives,
- The **actions** available, and
- The **performance measure** that defines success.



💬 *A rational agent is not necessarily perfect — it simply does the best it can given what it knows.*

Example:

A self-driving car (agent) stops when it sees a red light —
because, based on its knowledge and goals (safety, legality), that's the **most rational** decision.



🔷 2 Rational Agent

Definition:

A **Rational Agent** is one that **acts to achieve the best expected outcome** (or maximize performance) according to its percepts and knowledge.

🧩 *It always chooses the action that is expected to maximize its success.*

Characteristics of a Rational Agent

Characteristic	Description
Perception	Observes environment via sensors.
Reasoning	Decides best action logically.
Action	Performs chosen action via actuators.
Learning	Adapts behavior from feedback.
Goal-Oriented	Always acts to achieve specific objectives.

Real-World Examples

- **Google Maps AI:** Chooses the fastest route considering traffic — acts rationally.
- **Trading Bot:** Buys or sells stocks to maximize profit.
- **Autonomous Drone:** Takes shortest and safest flight path to destination.

🔷 3 Agent Selection and Decision Process

When deciding what to do, a rational agent follows these steps:

Step	Description	Example (Smart Delivery Drone)
1. Perceive	Collect information from sensors.	Detects wind speed, GPS location.
2. Think / Decide	Evaluate possible actions.	Choose path with least obstacles.
3. Act	Execute the best action.	Adjusts altitude and moves forward.
4. Learn	Analyze results and improve.	Learns best flight patterns for next trip.

🔷 4 Performance Measure

Definition:

A **performance measure** defines **what counts as success** for an agent in its environment.
It's a **quantitative or qualitative metric** used to evaluate how well an agent performs its task.

💬 *It answers the question: "How do we know the agent is doing well?"*

Examples of Performance Measures

Domain	Agent	Performance Measure
Self-driving car	Autonomous vehicle	Safety, smooth driving, travel time.
Medical diagnosis AI	Hospital AI system	Accuracy of diagnosis, speed of decision.
Game AI	Game-playing agent	Winning rate, score achieved.
Chatbot	Conversational agent	Relevance and helpfulness of responses.

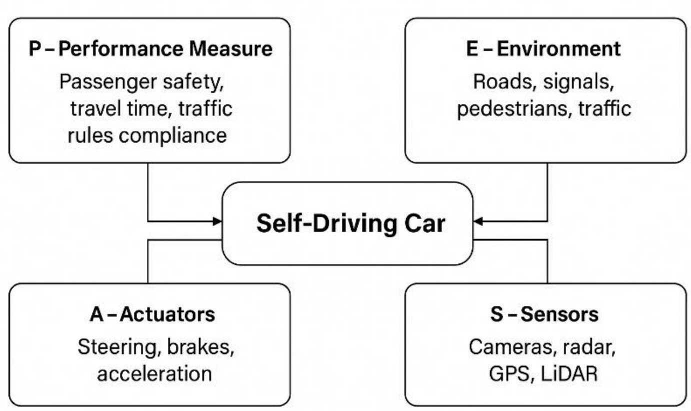
Designing a Good Performance Measure

A good performance measure should be:

Feature	Description
Aligned with Goals	Measures success according to actual objectives.
Objective and Quantifiable	Uses measurable results (accuracy, time, score).
Environment-Aware	Considers external factors (weather, traffic).
Encourages Rationality	Rewards correct, goal-achieving behavior.

⚙️ *For example, a self-driving car's performance measure might combine "safety score" and "trip efficiency" rather than just speed.*

🔷 5 Task Environment vs. Rational Agent



Task Environment:

The **Task Environment** defines **everything that surrounds and affects the agent's operation**.
It includes:

- **Performance Measure**

- **Environment**
- **Actuators**
- **Sensors**

This is called the **PEAS model** — a framework for designing intelligent agents.

Component	Description	Example (Autonomous Drone)
P – Performance Measure	Criteria for success.	Safe, on-time delivery.
E – Environment	Surroundings or context.	Airspace, weather, obstacles.
A – Actuators	Tools used to act.	Rotors, motors.
S – Sensors	Devices to perceive environment.	Camera, GPS, altimeter.

💬 *Rationality depends on how the agent interacts within its task environment.*

🧩 Case Scenario: Self-Driving Car (Rational Agent Example)

Scenario Description:

A **self-driving car** (agent) operates on city roads (environment).
It uses cameras, radar, and GPS to perceive surroundings, and makes driving decisions — such as braking, turning, or changing lanes — to reach its destination safely and efficiently.

Agent–Environment Table

Component	Example in Self-Driving Car
Agent	The AI driving system.
Environment	Roads, signals, pedestrians, traffic.
Sensors	Cameras, radar, GPS, LiDAR.
Actuators	Steering, brakes, acceleration.
Performance Measure	Passenger safety, travel time, traffic rules compliance.

Rational Behavior in This Case

- **Perceive:** Detects a red light ahead.
- **Decide:** Calculates that stopping avoids collision and penalty.

- **Act:** Brakes smoothly.
- **Evaluate:** Measures safety and compliance → positive performance feedback.

✅ The car's decision to **stop** is rational because it **maximizes performance** (safety, legality, passenger comfort).

💬 **Q&A Discussion**

Q1. What makes an agent rational?

A:
A rational agent selects the action that **maximizes expected performance**, given what it knows and perceives.

Q2. What is the difference between a rational and an omniscient agent?

A:

- **Rational Agent:** Acts optimally *based on available knowledge*.
- **Omniscient Agent:** Knows everything (ideal, impossible in real world).

💡 Rationality ≠ Perfection.

Rationality = Best possible action *with limited knowledge.*

Q3. What defines a good performance measure?

A:
A measure that correctly reflects the **goal success**, encourages **safe and efficient behavior**, and considers the **environment's constraints.**

Q4. How does task environment influence rationality?

A:
If the environment changes or becomes uncertain (like sudden rain for a self-driving car), the agent must adapt — rational behavior now includes adjusting speed and using sensors more carefully.

🔷 1 Introduction

Game Playing is one of the earliest and most important areas of AI research.
It involves designing **intelligent agents** that can play games and **make strategic decisions** like human players.

Game Playing in AI is about making intelligent, rational decisions in competitive environments — balancing strategy, prediction, and learning to achieve success.

💬 *In simple terms: Game Playing AI means teaching a computer how to "think ahead" and choose the best possible move.*

🔷 2 Why Study Game Playing in AI

- It provides a **controlled, rule-based environment** to test AI algorithms.
- Encourages **strategic thinking**, **planning**, and **learning from experience**.
- Serves as a **benchmark** for machine intelligence and problem-solving ability.

🎯 *Example: Chess and Go are used to measure how intelligent a machine's decision-making is.*

🔷 3 Components of a Game-Playing Agent

https://github.com/anuragjain-git/chess-ai

Component	Description	Example in Chess
Initial State	Starting configuration of the game.	Pieces arranged on board.
Players	Agents taking turns.	White (AI) and Black (human).
Actions	Legal moves possible.	Move pawn, bishop, knight.
Transition Model	Rules that define result of actions.	If move → new board layout.
Terminal State	End of game condition.	Checkmate or draw.

Component	Description	Example in Chess
Utility Function	Value assigned to outcomes.	+1 for win, 0 for draw, -1 for loss.

◆ 4 Types of Games in AI

Type	Description	Example
Deterministic	No randomness, predictable outcomes.	Chess, Checkers.
Stochastic	Involves randomness.	Ludo, Monopoly.
Perfect Information	All players see full game state.	Go, Chess.
Imperfect Information	Some information hidden.	Poker, Battleship.
Single-Agent	Only one player (AI).	Sudoku, Puzzle.
Multi-Agent	Two or more players.	Chess, Football, Dota 2.

◆ 5 Techniques Used in Game Playing

(a) Search Algorithms

AI explores possible moves and their outcomes.

Algorithm	Description	Example
Minimax	Chooses move that minimizes possible loss and maximizes gain.	Chess AI deciding optimal move.
Alpha–Beta Pruning	Optimized Minimax — skips irrelevant branches.	Speeds up search in Deep Blue.
Heuristic Search	Uses evaluation function to estimate good moves.	“Best move” prediction in Go.
Monte Carlo Tree Search (MCTS)	Random simulations to estimate best action.	AlphaGo using deep learning + MCTS.

◆ 6 Famous AI Game Systems

System	Year	Game	Key Achievement
IBM Deep Blue	1997	Chess	Defeated world champion Garry Kasparov.

System	Year	Game	Key Achievement
TD-Gammon	1992	Backgammon	Used reinforcement learning for expert play.
AlphaGo (DeepMind)	2016	Go	Beat Lee Sedol using deep learning + MCTS.
OpenAI Five	2019	Dota 2	Defeated professional esports team.
AlphaStar (DeepMind)	2019	StarCraft II	Learned real-time strategy using neural nets.

◆ 8 Importance of Game Playing in AI

Aspect	Importance
Testing Intelligence	Helps evaluate AI's reasoning ability.
Algorithm Development	Basis for search, learning, and strategy models.
Benchmarking	Games provide measurable, comparable results.
Human–AI Collaboration	AI helps humans learn strategies and skills.

Problem Solving in Artificial Intelligence

◆ 1 Introduction

Problem Solving in AI is the process of finding a **sequence of actions** that leads from an **initial state** to a **desired goal state**.
An AI agent must reason, plan, and choose actions to achieve the goal **efficiently** and **intelligently**.

In simple words: Problem solving in AI means teaching machines to "think" logically and find solutions like humans.

◆ 2 Characteristics of a Problem-Solving Agent

An **AI problem-solving agent**:

1. Identifies the problem from percepts.
2. Defines the **initial** and **goal states**.
3. Searches for a sequence of actions (path).
4. Chooses the **optimal** solution based on performance measures.

🔷 3 Components of an AI Problem

Component	Description	Example (8-Puzzle Problem)
Initial State	Starting situation.	Random arrangement of tiles.
Goal State	Desired outcome.	Tiles arranged in order 1–8.
Actions (Operators)	Possible moves to change state.	Move tile up, down, left, right.
State Space	All possible states from the initial to goal.	All 9! tile arrangements.
Path Cost	Cost (steps or time) to reach goal.	Number of moves.

🔷 4 Types of Problem-Solving Approaches

Approach	Description	Example
Uninformed (Blind) Search	No knowledge beyond problem definition.	BFS, DFS, Uniform Cost Search.
Informed (Heuristic) Search	Uses additional information to guide search.	A*, Best-First Search, Greedy Search.
Local Search	Focuses on single state; improves incrementally.	Hill Climbing, Simulated Annealing.
Adversarial Search	Two-player competitive problem solving.	Chess, Checkers.
Constraint Satisfaction	Satisfies a set of constraints.	Sudoku Solver.

🔷 5 Steps in Problem Solving Process

1. **Formulate the Problem**
   - Identify initial and goal states.
   - Define operators (valid actions).
2. **Search for a Solution**
   - Explore possible paths using algorithms.
3. **Execute the Solution**
   - Apply actions sequentially to reach goal.
4. **Evaluate and Learn**
   - Measure efficiency, update strategy if needed.

🔷 6 Search in Problem Solving

The **search process** is like exploring a map:

- Each **state** is a point on the map.
- Each **action** is a road to another point.
- The **goal** is reaching the destination efficiently.

💡 *AI search algorithms act like intelligent explorers navigating toward a target.*

Common AI Search Strategies

Category	Algorithm	Key Idea	Example Use
Uninformed Search	BFS (Breadth-First)	Explore all nodes level by level.	Shortest path in a maze.
	DFS (Depth-First)	Go deep into one branch first.	Solving puzzles recursively.
	Uniform Cost	Expands least-cost node first.	Route planning.
Informed Search	Best-First	Uses heuristic (estimated cost).	Google Maps route optimization.
	A* Search	Combines actual + heuristic cost.	Pathfinding in games.

🔷 7 Example Case: 8-Puzzle Problem

🧩 **Scenario:**

You have a 3×3 puzzle board with 8 numbered tiles and one empty space.
The goal is to move tiles one by one until they are in the correct order.

Initial State:

1 4 2

7 5 3

8 _ 6

Goal State:

1 2 3

4 5 6

7 8 _

How AI Solves It:

1. Defines each possible move (up, down, left, right).
2. Applies **search algorithms** to explore all possible sequences.

3. Uses **heuristic** (like number of misplaced tiles) to choose best move.
4. Repeats until goal state is reached.

🔷 8 Case 2: Route Planning Agent (Practical Example)

Scenario:

A GPS navigation system finds the shortest path between two locations.

Component	Example
Initial State	User's current location.
Goal State	Destination point.
Actions	Turn left/right, go straight.
Path Cost	Time or distance.
Algorithm	A* Search (using heuristic = estimated distance).

Agent Rationality:

- The AI selects the **route that minimizes travel time** while avoiding traffic → **rational and efficient** behavior.

🔷 9 Properties of Problem-Solving Agents

Property	Description	Example
Autonomy	Acts without human control.	GPS finds new route automatically.
Reactivity	Responds to environment changes.	Re-routes when traffic detected.
Proactiveness	Plans ahead for better results.	Predicts busy routes.
Learning	Improves over time using data.	Learns your preferred paths.

💬 Q&A Discussion

Q1. What is the difference between Problem Solving and Search?
A:
Problem solving defines *what to achieve*, while search defines *how to achieve it* through exploring possible solutions.

Q2. What is the role of heuristics?
A:
Heuristics guide the search toward the goal faster using experience-based rules (e.g., "move closer to target").

Q3. What makes an AI problem-solver rational?
A:
It chooses the action that **maximizes success** (best solution in least time/cost) given the information it has.

Q4. What are real-life examples of AI problem-solving systems?
A:

- Google Maps (route optimization)
- AI customer chatbots (troubleshooting)
- Medical diagnostic systems (finding correct diagnosis)
- Robotics (path planning and obstacle avoidance)

🔷 1🔟 Summary Table

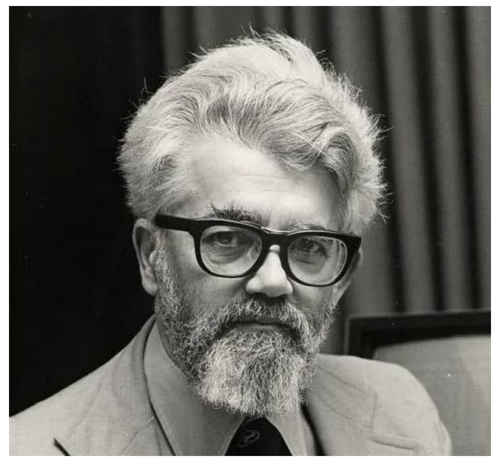
Concept	Definition	Example
Problem Solving	Finding sequence of actions to reach goal.	GPS route planning.
Initial State	Where agent starts.	Start location.
Goal State	Desired outcome.	Destination.
Search	Exploring possible actions.	BFS, A*.
Heuristic	Rule that improves search efficiency.	"Nearest to goal first."
Rational Solution	Best possible solution given constraints.	Fastest route chosen.

🧭 Conclusion

Problem solving is at the core of AI — enabling machines to think, plan, and act rationally.
By using **search strategies, heuristics, and learning**, AI systems can find efficient, optimal, and intelligent solutions to complex real-world problems.

Would you like me to now create a **diagram** showing the **AI problem-solving cycle**
(Initial State → Actions → Search → Goal State → Evaluation Loop)?

Introduction to Artificial Intelligence



Artificial Intelligence (AI) is a branch of computer science that focuses on creating machines capable of performing tasks that require human-like intelligence such as reasoning, learning, decision-making, perception, and understanding natural language.

Origin:
The term *Artificial Intelligence* was first introduced by **John McCarthy in 1956** during the Dartmouth Conference.

Objectives of AI:

- To build systems that can simulate human thinking and behavior.
- To design machines that can solve complex problems intelligently.
- To enable computers to learn from experience and adapt to new situations.
- To automate reasoning and improve human decision-making.

Examples of AI Applications:

- Virtual assistants (Siri, Alexa, Google Assistant)
- Self-driving cars
- Recommendation systems (Netflix, YouTube)
- Fraud detection in banking
- Smart home automation

Artificial Intelligence can be viewed from four main perspectives that describe how a system can behave or think intelligently.

1. Acting Humanly (The Turing Test Approach)

- Proposed by **Alan Turing (1950)**.
- Focuses on building systems that behave like humans.
- The **Turing Test** evaluates whether a machine can exhibit human-like behavior that is indistinguishable from a person.
- If a human evaluator cannot differentiate the machine's responses from a human's, the machine is said to possess intelligence.
- Example: Chatbots or virtual assistants that communicate naturally with humans.

Key Idea:
If a machine can *act* humanly, it can be considered intelligent.

2. Thinking Humanly (The Cognitive Modeling Approach)

- Tries to model how humans think and reason.
- Involves understanding the human brain and replicating its functions using computational models.
- Often data from cognitive psychology and neuroscience is used.
- Example: Neural networks and cognitive architectures that mimic brain processing.

Key Idea:
AI should *think* the same way humans do — by replicating mental processes like learning and memory.

3. Acting Rationally (The Rational Agent Approach)

- Focuses on designing intelligent agents that act to achieve the best possible outcome in any given situation.
- A **rational agent** perceives its environment and takes actions to maximize performance or success.
- Example: Self-driving cars choosing the safest and most efficient path.

Key Idea:
Intelligence means choosing and executing the *best possible action* based on goals and knowledge.

4. Thinking Rationally (The Laws of Thought Approach)

- Based on the use of logic and reasoning to make decisions.
- Derived from the principles of philosophy and mathematics (e.g., Aristotle's logic).
- AI systems are designed to *reason correctly* using logical rules and formal proofs.
- Example: Expert systems that use rule-based reasoning to diagnose diseases.

Key Idea:
AI should *think logically and rationally* — following correct principles of reasoning to reach conclusions.