

Unit-1 Introduction

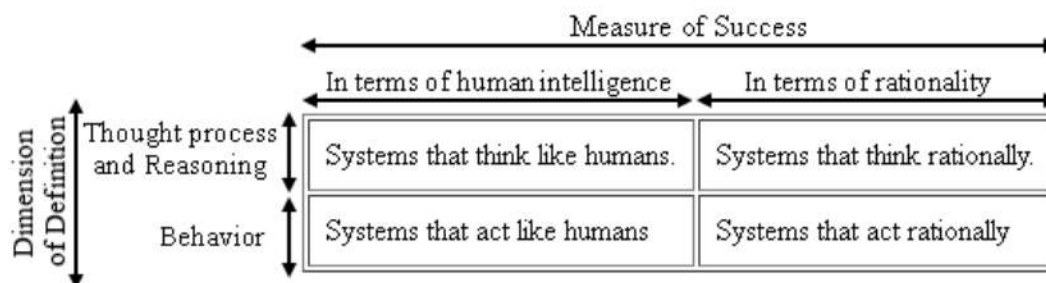
Artificial Intelligence (AI)

Artificial Intelligence is concerned with the design of intelligence in an artificial device. The term was coined by John McCarthy in 1956.

- **Intelligence** is the ability to reason, to understand, to create, to learn and to plan.

Artificial Intelligence (AI) is a branch of computer science which is concerned with study and creation of computer system that exhibit some form of intelligence or those characteristics which we associate with intelligence in human behavior.

Different definitions of AI are given by different books/writers. These definitions can be divided into four categories in two dimensions:

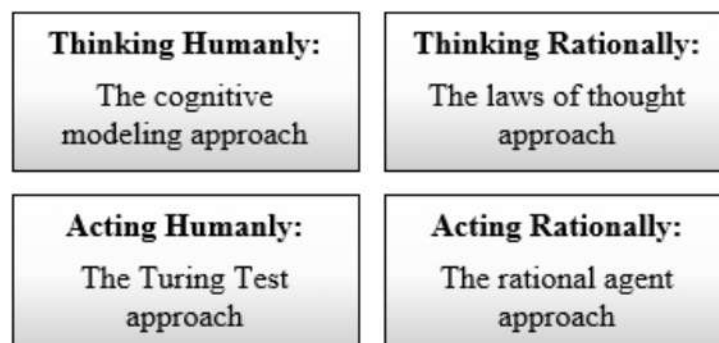


Goals of AI

- To improve computer functions which are related to human knowledge, for example, reasoning, learning, and problem solving.
 - *Reasoning*: judgment, making decisions, and prediction.
 - *Learning*: Learning enhances the awareness of the subjects of the study.
 - *Problem Solving*: Applying logic with decisions making concept.
- **To Create Expert Systems**: The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users.
- **To Implement Human Intelligence in Machines**: Creating systems that understand, think, learn, and behave like humans.

Approaches of AI

Four main approaches to AI:



1. Thinking Humanly: Cognitive modeling approach

This approach believes to make a machine which thinks like humans. In order to make machines think like human, we need to first understand how human think. There are three ways using which human's thinking pattern can be caught.

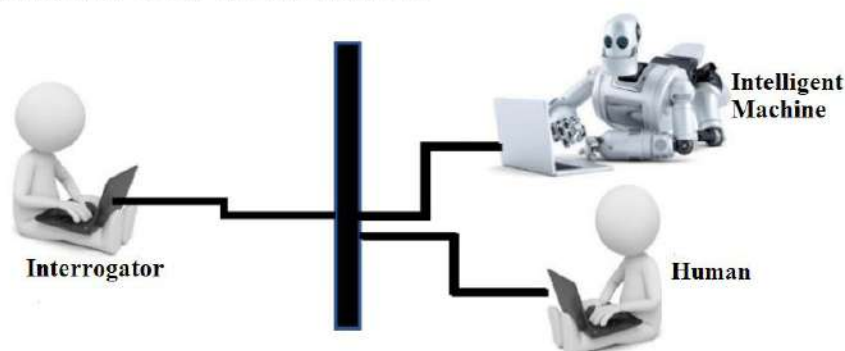
- a. Introspection:** Through which human can catch their own thoughts as they go by.
- b. Psychological experiments:** can be carried out by observing a person in action.
- c. Brain imaging** can be done by observing the brain in action.

By catching the human thinking pattern it can be implemented in Computer system as a program and if the program's input and output matches with that of human, then it can be claimed that the system can operate like humans.

2. Acting Humanly: The Turing Test Approach

This approach focuses on creating machines that can simulate human-like behavior and thought processes to the point where they are indistinguishable from humans.

The Turing Test approach is based on the idea that a machine can be considered intelligent if it can convincingly pass a test that was proposed by British mathematician and computer scientist *Alan Turing*. The **Turing test** involves an interrogator who interacts with one human and one machine. Within a given time the interrogator has to find out which of the two the human is, and which one the machine.



The machine passes the test if a human interrogator after posing some written questions, cannot tell whether the written response come from human or not.

To pass Turing test, a computer must have following capabilities:

1. **Natural Language Processing:** Must be able to communicate successfully in English.
2. **Knowledge Representation:** To store what it knows and hears.
3. **Automated Reasoning:** To draw conclusion from stored knowledge.
4. **Machine Learning:** Must be able to adapt in new circumstances.

The total Turing test includes video signals and manipulation capability so that the interrogator can test the subject's perceptual abilities and object manipulation ability. To pass the total Turing test computer must have following additional capabilities:

- **Computer Vision:** To perceive objects
- **Robotics:** To manipulate objects and move

3. Thinking rationally: The laws of thought approach

The laws of thought approach aims to develop AI systems that can reason logically and make decisions based on a set of predefined rules.

In the laws of thought approach, AI systems are designed to reason deductively, by starting with a set of premises and using logical rules to conclude. This approach is often used in expert systems, where a knowledge base of facts and rules is used to solve complex problems in a particular domain.

E.g. “Ram is man, all men are mortal. Therefore, Ram is mortal.”

4. Acting Rationally: The rational Agent approach

This approach focuses on creating *intelligent agents* that can act in the world to achieve their goals.

Acting rationally means acting to achieve one’s goals, given the available information and resources. An *intelligent agent* is one that does the right things and acts rationally so as to achieve the best outcome or, when there is uncertainty, the best expected outcome. In this approach the emphasis is given to correct inferences.

E.g. an agent that is designed to play a game should make moves that increase its chances of winning the game.

Challenges of AI

- **High Cost:** Developing and maintaining AI systems requires a significant investment. This includes costs for hardware, software, skilled personnel, and ongoing updates to keep the system effective.
- **Data Requirements:** AI models need a large amount of high-quality data to function effectively. Gathering, cleaning, and managing such data can be time-consuming and expensive.
- **Lack of Skilled Professionals:** The demand for AI experts exceeds the supply, making it difficult for organizations to find skilled professionals to design, develop, and manage AI systems.
- **Ethical Issues:** AI systems may inherit biases present in the data or algorithms, leading to unfair decisions. There are also concerns about privacy, especially in sensitive applications.
- **Security Risks:** AI systems can be vulnerable to hacking and misuse. For example, attackers could manipulate an AI model to produce incorrect outputs or use AI for harmful purposes.
- **Job Displacement:** As AI automates repetitive tasks, it can replace human workers in various industries, leading to unemployment and social challenges.
- **Energy Consumption:** Training and running AI models, especially large ones, consume vast amounts of computational resources and energy, raising environmental concerns.
- **Integration Issues:** Integrating AI systems with existing technologies or workflows can be complex, requiring additional time, cost, and expertise.
- **Unpredictable Behavior:** AI systems may behave unpredictably in unfamiliar situations, which can lead to errors, safety concerns, or unintended outcomes.

AI Techniques

Artificial Intelligence (AI) techniques are methods and algorithms that develop intelligent systems to perform tasks that require human-like intelligence.

Some AI techniques include:

1. **Search Techniques:** AI uses search methods to find solutions to problems by exploring possibilities.
 - ***Uninformed Search:*** Uninformed Search techniques do not use domain-specific knowledge. For example, Breadth-First Search (BFS), Depth-First Search (DFS).
 - ***Informed Search:*** Informed Search techniques make use of domain-specific knowledge to guide the search process towards the goal more efficiently. For example, A* and Greedy Search.
2. **Machine Learning:** Machine learning involves the building of algorithms to learn patterns in data and make predictions based on it.
 - ***Supervised Learning:*** Trains on labeled data to classify or predict outcomes.
 - ***Unsupervised Learning:*** Discovers patterns in unlabeled data, such as clustering.
 - ***Reinforcement Learning:*** Learns by trial and error, using rewards and punishments to optimize decisions.
3. **Natural Language Processing (NLP):** Natural Language Processing (NLP) focuses on how computers and human language interact. It bridges the gap between human communication and digital data processing by enabling machines to understand, interpret, and generate human languages in a meaningful and practical way. Examples include chatbots, speech recognition, and language translation systems.
4. **Robotics:** Combines AI with mechanical systems to create machines capable of performing tasks autonomously, such as robots used in manufacturing or self-driving cars.
5. **Computer Vision:** Computer Vision focuses on enabling machines to see, interpret, and understand the visual world, just like humans. It involves processing and analyzing images or videos to extract meaningful information. For example, in facial recognition systems, computer vision identifies and matches a person's face from a photo or video. Other examples include object detection in autonomous vehicles and medical image analysis for detecting diseases in X-rays or MRIs.
6. **Fuzzy Logic:** Fuzzy Logic deals with reasoning that is approximate rather than fixed and exact, allowing AI to handle vague or imprecise information. Unlike traditional binary logic, where values are either true or false, fuzzy logic uses degrees of truth, ranging between 0 and 1.
7. **Data Mining:** Data mining is the process of extracting knowledge or insights from large amounts of data using various statistical and computational techniques. The data can be structured, semi-structured, or unstructured, and can be stored in various forms such as databases, data warehouses etc.

The primary goal of data mining is to discover hidden patterns and relationships in the data that can be used to make informed decisions or predictions.

Artificial Intelligence vs. Human Intelligence

<i>Artificial Intelligence</i>	<i>Human Intelligence</i>
Develops intelligent outputs using fed and updated data.	Learns and develops continuously without external input.
Depends entirely on data provided to it.	Relies on brainpower and cognitive abilities.
Works much faster and more efficiently.	Takes time to learn and perform tasks.
Struggles with problems outside its training data.	Adapts to new situations and solves new problems.
Learns only when new data is provided.	Learns continuously using memory, reasoning, and abstraction.
Makes decisions based on data and programming.	Decisions are influenced by emotions, intuition, gaps in knowledge and biases.
Lacks emotions and empathy.	Capable of feeling emotions and empathy.
Limited creativity and imagination.	Capable of creativity, imagination, and innovation.
Operates in a structured environment with clear rules.	Can handle unstructured, ambiguous situations effectively.
Can work tirelessly without fatigue.	Requires rest and energy to function effectively.
Requires significant setup and maintenance costs.	Needs only basic physical needs like food and rest.
Cannot possess moral values or ethics on its own.	Operates based on personal morals and societal ethics.

Advantages of Artificial Intelligence

- **Efficiency and Speed:** AI can process and analyze large amounts of data much faster than humans, saving time and effort.
- **Accuracy and Precision:** AI reduces human error, especially in repetitive tasks like calculations, data entry, or quality checks.
- **24/7 Availability:** AI systems can work continuously without fatigue, unlike humans who need rest.
- **Automation of Repetitive Tasks:** AI can automate boring and repetitive tasks, freeing humans to focus on creative and strategic work.
- **Cost Savings:** By automating tasks, AI reduces operational costs over time, especially in industries like manufacturing and customer service.
- **Enhanced Decision-Making:** AI uses data to provide insights, helping in making better and faster decisions. For example, businesses use AI to predict market trends.
- **Personalization:** AI tailors experiences based on user preferences, such as recommending movies on Netflix or products on Amazon.
- **Risk Management:** AI can perform dangerous tasks, such as working in hazardous environments or disarming bombs, reducing risks to human life.
- **Improved Customer Service:** AI-powered chatbots provide instant responses to customer queries, improving satisfaction.

Necessary Characteristics of an Intelligent System

- **Learning Ability:** An intelligent system should be able to learn from experience and improve its performance over time.
- **Reasoning and Problem-Solving:** It should use logic to analyze information, make decisions, and solve problems, even in unfamiliar situations.
- **Interaction:** The system should interact naturally with users or other systems, such as responding to voice commands or exchanging data with other devices.
- **Perception:** An intelligent system should perceive and interpret its surroundings using sensors or data, such as detecting objects in autonomous vehicles or recognizing faces in photos.
- **Adaptability:** The system should adapt to new environments or changing conditions without needing constant reprogramming.
- **Knowledge Representation:** It should store and manage knowledge effectively, using it to understand situations and make decisions.
- **Autonomy:** An intelligent system should perform tasks independently, without human intervention, like robots in manufacturing.
- **Efficiency:** It should perform tasks quickly and accurately, saving time and resources.
- **Decision-Making:** Intelligent systems should make decisions that align with ethical guidelines, ensuring fairness and safety, such as in healthcare applications.

Applications of AI

AI has been dominant in various fields such as:

- **E-commerce:** AI helps to make appropriate suggestions and recommendations as per the user search history and view preferences. There are also AI chatbots that are used to provide customer support instantly.
- **Healthcare:** AI is used for diagnosing diseases, predicting patient outcomes, and personalized treatment plans.
- **Education:** AI powers personalized learning platforms, virtual tutors, and automated grading systems, enhancing the teaching and learning experience.
- **Business:** AI helps in customer support (chatbots), fraud detection, demand forecasting, and optimizing supply chains.
- **Entertainment:** AI drives content recommendations on platforms like Netflix and Spotify, creating personalized user experiences.
- **Finance:** It is used in stock market predictions, credit risk analysis, fraud detection, and automating customer service through chatbots.
- **Transportation:** AI enables autonomous vehicles, traffic management systems, and navigation tools like Google Maps.
- **Gaming:** AI plays vital role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.

- **Natural Language Processing (NLP):** Enables applications like virtual assistants (e.g., Alexa, Siri), real-time language translation, and automated content generation.
- **Agriculture:** AI is used in agriculture to monitor soil conditions, such as water, moisture, and nutrient levels, and detect where the weeds are growing, where the soil is infertile, etc. It also helps in crop monitoring, pest detection, and optimizing irrigation systems, improving productivity and efficiency.
- **Social Media:** Some social media platform such as Facebook, Instagram, etc uses AI to show relevant content to the user. It uses the search history and view history of a user to show relevant content.
- **Cybersecurity:** AI helps detect and respond to cyber threats by identifying unusual patterns and predicting potential attacks.