Semester:I

Course Code: 24BTPHY106

Course: Fundamentals of AI and ML

Module-1
Introduction and Intelligent Agents

What is AI? — The Foundations of Artificial Intelligence — The History of Artificial Intelligence — The State of the Art — Risks and Benefits of AI

Agents and Environments — Good Behavior: The Concept of Rationality— The Nature of Environments — The Structure of Agents

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

- John McCarthy who has coined the word "Artificial Intelligence" in 1956, has defined Al as "the science and engineering of making ***intelligent machines***", especially intelligent computer programs.
- Artificial Intelligence (AI) is relevant to any intellectual task where the machine needs to take some decision or choose the next action based on the current state of the system, in short act intelligently or rationally. As it has a very wide range of applications, it is truly a universal field.
- In simple words, Artificial Intelligent System works like a Human Brain, where a machine or software shows intelligence while performing given tasks; such systems are called intelligent systems or expert systems. You can say that these systems can "think" while generating output!!!
- Al is one of the newest fields in science and engineering and has a wide variety of application fields. Al applications range from the general fields like learning, perception and prediction to the specific field, such as writing stories, proving mathematical theorems, driving a bus on a crowded street, diagnosing diseases, and playing chess.
- Al is the study of how to make machines do thing which at the moment people do better.

Why Artificial Intelligence?

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

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

Goals of Artificial Intelligence

Following are the main goals of Artificial Intelligence:

1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:
    - Proving a theorem
    - Playing chess
    - Plan some surgical operation
    - Driving a car in traffic
5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

Approaches of AI

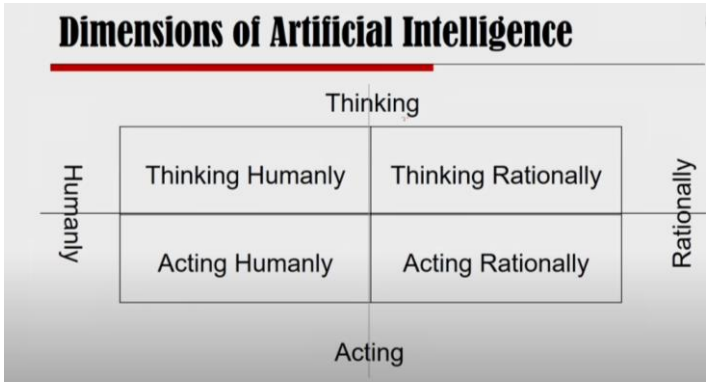


Fig: Dimensions of Artificial Intelligence

The “approach of AI” refers to the general philosophy or strategy that is used to build and design artificial intelligence (AI) systems. There are several different approaches to AI, each with its own goals and methodologies. The four main approaches to AI are:

1. Thinking Humanly
2. Acting Humanly
3. Thinking Rationally
4. Acting Rationally

Now we will discuss them one by one.

1. **Thinking Humanly: The Cognitive Modelling Approach**

- This approach focuses on building artificial intelligence systems that can think like a human. The goal is to create systems that can understand human language, emotions, and culture and can interact with humans in a natural way.
- This approach is mainly used in the development of conversational AI systems, such as chatbots and virtual assistants, that need to understand and respond to natural language input from humans.
- In order to make machines think like human, we need to first understand how human think. Research showed that there are three ways using which human's thinking pattern can be caught.
  i) Introspection through which human can catch their own thoughts as they go by.
  ii) Psychological experiments can be carried out by observing a person in action.
  iii) Brain imaging can be done by observing the brain in action.

Examples:

a. Siri, Alexa, and Google Assistant: Virtual assistants that can understand and respond to natural language input from users.
b. Chatbots: AI systems that can have conversations with humans using natural language processing techniques.
c. Emotion recognition systems: AI systems that can detect emotions in human speech and facial expressions.

2. **Acting Humanly**: **The Turing Test Approach**

- This approach focuses on building artificial intelligence systems that can act like humans.
- The goal is to create systems that can perform tasks such as recognizing speech, recognizing images, and controlling robots in a human-like manner.
- This approach is mainly used in computer vision and robotics, where the goal is to create systems that can perceive and interact with the physical world in a human-like manner.

Examples:

a. Self-driving cars: AI systems that can control a vehicle and navigate roads, traffic, and obstacles in a human-like manner.
b. Facial recognition systems: AI systems that can identify individuals based on their facial features.
c. Gesture-based human-computer interfaces: AI systems that can interpret and respond to gestures made by a user.

- To judge whether the system can act like a human, Sir Alan Turing had designed a test known as Turing test. As shown in below Fig, in Turing test, a computer needs to interact with a human interrogator by answering his questions in written format. Computer passes the test if a human 'interrogator, cannot identify whether the written responses are from a person or a computer. Turing test is valid even after 60 year of research.

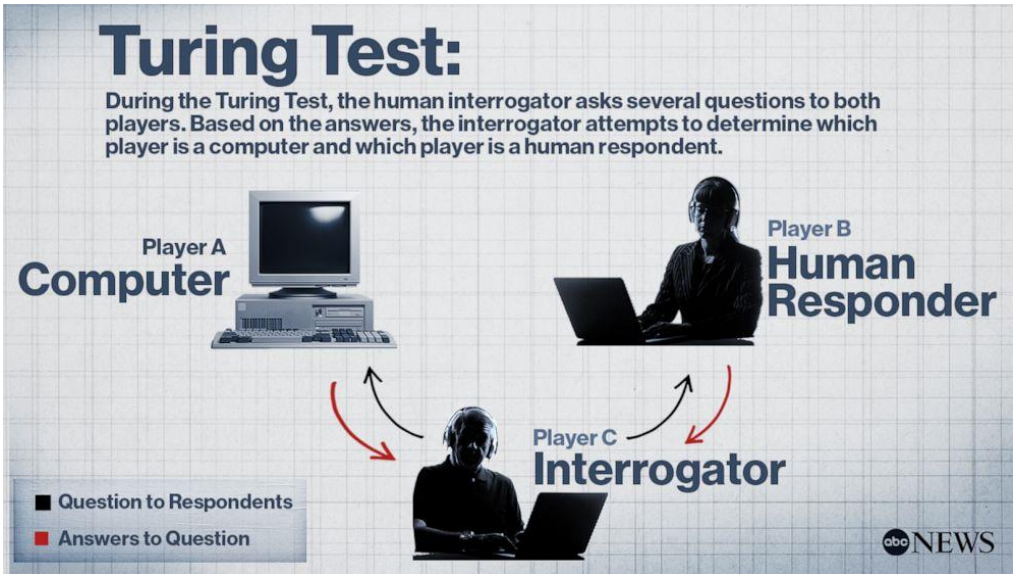


Fig: Turing Test

- For this test, the computer would need to possess the following capabilities:
- Natural Language Processing (NLP) : This unit enables computer to interpret the English language and communicate successfully.
- Knowledge Representation : This unit is used to store knowledge gathered by the system through input
- Automated Reasoning : This unit enables to analyze the knowledge stored in the system and makes new inferences to answer questions.
- Machine Learning : This unit learns new knowledge by taking current input from the environment and adapts to new circumstances, there by enhancing the knowledge base of the system.
- Computer vision: This unit is required to perceive objects from the environment
- Robotics: This unit is required to manipulate those objects.

3. **Thinking Rationally**: **The "Laws of Thought" Approach**

- This approach focuses on building artificial intelligence systems that can reason logically and make decisions based on information and rules.
- The goal is to create systems that can solve problems and make decisions in a way that is consistent with the principles of rational thinking.
- This approach is used in a wide range of applications, including decision-making, planning, and problem-solving

Examples:
a. Expert systems: AI systems that can make decisions and provide advice based on a set of rules and knowledge.

b. Recommendation systems: AI systems that can provide personalized recommendations to users based on their preferences and behavior.

c. Optimization algorithms: AI systems that can find the best solution to a problem by considering multiple factors and constraints.

4. **Acting Rationally: The Rational Agent Approach**

- This approach focuses on building artificial intelligence systems that can act rationally. The goal is to create systems that can make decisions and take actions that are consistent with the principles of rational thinking and that achieve their goals efficiently and effectively.
- This approach is mainly used in artificial intelligence systems that need to make decisions and take actions to achieve their goals in a rational and efficient manner.

Examples:
a. Autonomous agents: AI systems that can make decisions and take actions to achieve their goals in an efficient and effective manner.

b. Reinforcement learning algorithms: AI systems that can learn to take actions in an environment by receiving rewards and punishments based on their decisions.

c. Game AI: AI systems that can play games such as chess, Go, or poker and make decisions based on the rules and objectives of the game

The two approaches namely, thinking humanly and thinking rationally are based on the reasoning expected from intelligent systems while; the other two acting humanly and acting rationally are based on the intelligent behaviour expected from them.

Components of AI

Al is a vast field for research and it has got applications in almost all possible domains. By keeping this in mind, components of Al can be identified as follows :

- Perception
- Knowledge representation
- Learning
- Reasoning
- Problem Solving
- Natural Language Processing (language-understanding).

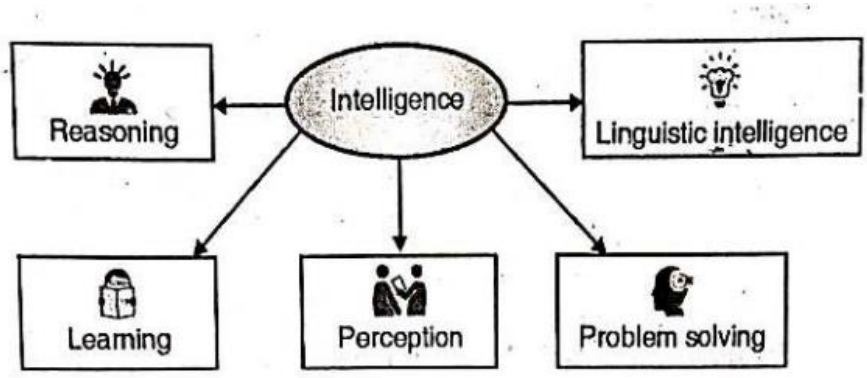


Fig: Components of AI

Perception:

In order to work in the environment, intelligent agents need to scan the environment and the various objects in it. Agent scans the environment using various sense organs like camera, temperature sensor, etc. This is called as perception. After capturing various scenes, perceiver analyses the different objects in it and extracts their features and relationships among them.

Knowledge representation:

The information obtained from environment through sensors may not be in the format required by the system. Hence, it need to be represented in standard formats for further processing like learning various patterns, deducing inference, comparing with past objects, etc. There are various knowledge representation techniques like Prepositional logic and first order logic

Learning

Learning is a very essential part of Al and it happens in various forms. The simplest form of learning is by trial and error. In this form the program remembers the action that has given desired output and discards the other trial actions and learns by itself. It is also called as unsupervised learning. In case of rote learning, the program simply remembers the problem solution pairs or individual items. In other case, solution to few of the problems is given as input to the system, basis on which the system or program needs to generate solutions for new problems. This is known as supervised learning

Reasoning

Reasoning is also called as logic or generating inferences form the given set of facts. Reasoning is carried out based on strict rule of validity to perform a specified task. Reasoning can be of two types, deductive or inductive. The deductive reasoning is in which the truth of the premises guarantees the truth of the conclusion while, in case of inductive reasoning, the truth of the premises supports the conclusion, but it cannot be fully dependent on the premises. In programming logic generally deductive inferences are used. Reasoning involves drawing inferences that are relevant to the given problem or situation.

Problem-solving

Al addresses huge variety of problems. For example, finding out winning moves on the board games, planning action's in order to achieve the defined task, identifying various objects from given images, etc. As per the types of problem, there is variety of problem solving strategies in Al. Problem solving methods are mainly divided into general purpose methods and special purpose methods. General purpose methods are applicable to wide range of problems while, special purpose methods are customized to solve particular type of problems

Natural Language Processing

Natural Language Processing, involves machines or robots to understand and process the language that human speak, and infer knowledge from the speech input. It also involves the active participation from machine in the form of dialog i.e. NLP aims at the text or verbal output from the machine or robot. The input and output of an NLP system can be speech and written text respectively

Applications of Artificial Intelligence:

You must have seen use of Artificial Intelligence in many SCI-FI movies. To name a few we have I Robot, Wall-E, The Matrix Trilogy, Star Wars, etc. movies. Many a times these movies show positive potential of using Al and sometimes also emphasize the dangers of using Al. Also there are games based on such movies, which show us many probable applications of Al.

Artificial intelligence is commonly used for problem solving by analyzing or/and predicting output for a system. Alcan provide solutions for constraint satisfaction problems. It is used in wide range of fields for example in diagnosing diseases, in business, in education, in controlling a robots, in entertainment field, etc.

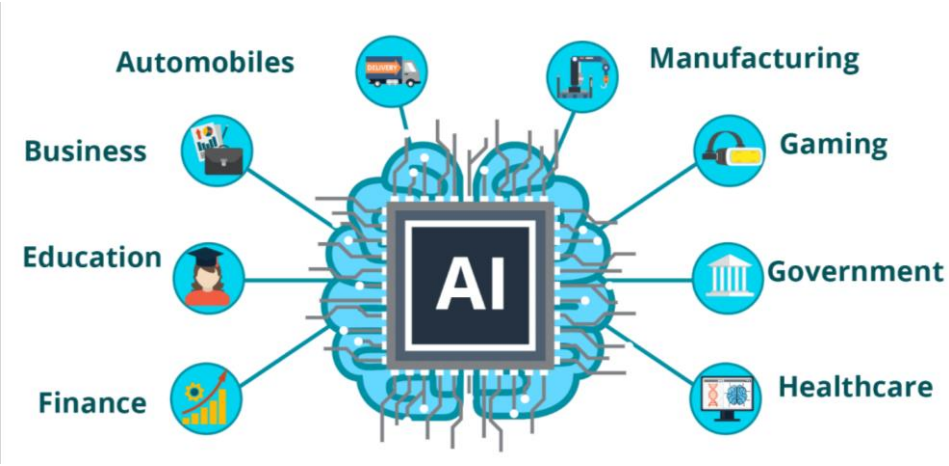


Fig: Applications of AI

Education:

Training simulators can be built using artificial intelligence techniques. Software for pre-school children are developed to enable learning with fun games. Automated grading, Interactive tutoring, instructional theory are the current areas of application.

Entertainment:

Many movies, games, robots are designed to play as a character. In games they can play as an opponent when human player is not available or not desirable.

Medical:

Al has applications in the field of cardiology (CRG), Neurology (MRI), Embryology (Sonography), complex operations of internal organs, etc. It can be also used in organizing bed schedules, managing staff rotations, store and retrieve information of patient. Many expert systems are enabled to predict the decease and can provide with medical prescriptions.

Military

Training simulators can be used in military applications. Also areas where human cannot reach or in life stacking conditions, robots can be very well used to do the required jobs. When decisions have to be made quickly taking into account an enormous amount of information, and when lives are at stake,

artificial intelligence can provide crucial assistance. From developing intricate flight plans to implementing complex supply systems or creating training simulation exercises,Al is a natural partner in the modern military.

Business and Manufacturing

Latest generation of robots are equipped well with the performance advances, growing integration of vision and an enlarging capability to transform manufacturing

Automated planning and scheduling

Intelligent planners are available with Al systems, which can process large datasets and can consider all the constraints to design plans satisfying all of them.

Voice Technology

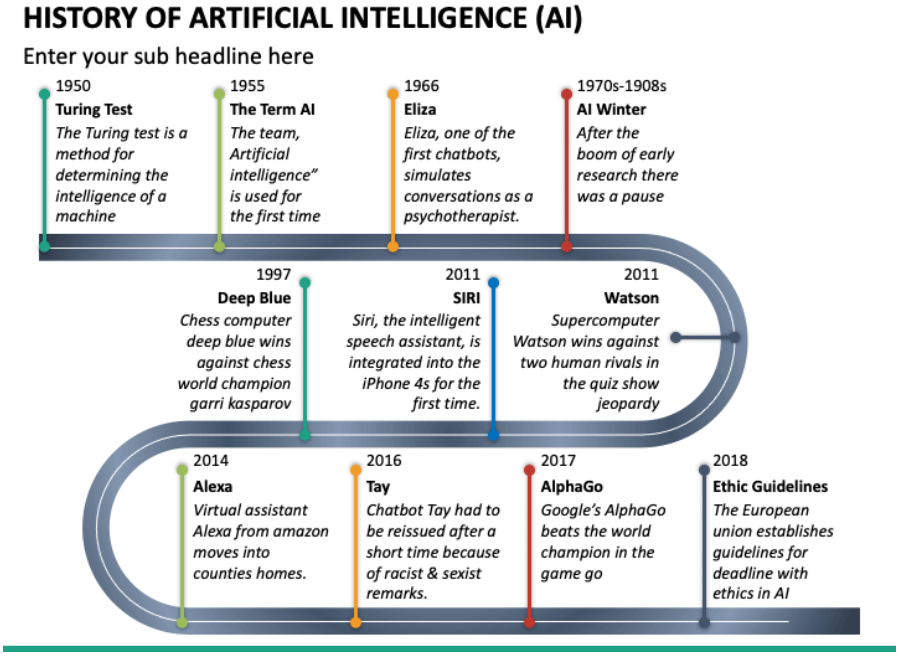
Voice recognition is improved a lot with AI. Systems are designed to take voice inputs which are very much applicable in case of handicaps. Also scientists are developing an intelligent machine to emulate activities of a skillful musician. Composition, performance, sound processing, music theory are some of the major areas of research.

Heavy Industry

Huge machines involve risk in operating and maintainíng them. Human robots are better replacing human operators. These robots are safe and efficient. Robot are proven to be effective as compare to human in the jobs of repetitive nature, human may fail due to lack of continuous attention or laziness.

HISTORY OF ARTIFICIAL INTELLIGENCE

- Artificial Intelligence is not a new word and not a new technology for researchers. This technology is much older than you would imagine. Following are some milestones in the history of AI which defines the journey from the AI generation to till date development.



Maturation of Artificial Intelligence (1943-1952)

Between 1943 and 1952, there was notable progress in the expansion of artificial intelligence (AI). Throughout this period, AI transitioned from a mere concept to tangible experiments and practical applications. Here are some key events that happened during this period:

- **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of **artificial neurons**.
- **Year 1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called Hebbian learning.
- **Year 1950:** The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes **"Computing Machinery and Intelligence"** in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a **Turing test**.
- **Year 1951:** Marvin Minsky and Dean Edmonds created the initial artificial neural network (ANN) named SNARC. They utilized 3,000 vaccum tubes to mimic a network of 40 neurons.

The birth of Artificial Intelligence (1952-1956)

From 1952 to 1956, AI surfaced as a unique domain of investigation. During this period, pioneers and forward-thinkers commenced the groundwork for what would ultimately transform into a revolutionary technological domain. Here are notable occurrences from this era:

- **Year 1952:** Arthur Samuel pioneered the creation of the Samuel Checkers-Playing Program, which marked the world's first self-learning program for playing games.
- **Year 1955:** An Allen Newell and Herbert A. Simon created the "first artificial intelligence program"Which was named as **"Logic Theorist"**. This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- **Year 1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI coined as an academic field.

  At that time high-level computer languages such as FORTRAN, LISP, or COBOL were invented. And the enthusiasm for AI was very high at that time.

The golden years-Early enthusiasm (1956-1974)

The period from 1956 to 1974 is commonly known as the "Golden Age" of artificial intelligence (AI). In this timeframe, AI researchers and innovators were filled with enthusiasm and achieved remarkable advancements in the field. Here are some notable events from this era:

Year 1958: During this period, Frank Rosenblatt introduced the perceptron, one of the early artificial neural networks with the ability to learn from data. This invention laid the foundation for modern neural networks.

Year 1959: Arthur Samuel is credited with introducing the phrase "machine learning" in a pivotal paper in which he proposed that computers could be programmed to surpass their creators in performance.

Year 1969: Arthur Bryson and Yu-Chi Ho outlined a learning algorithm known as backpropagation, which enabled the development of multilayer artificial neural networks.

Year 1972: The first intelligent humanoid robot was built in Japan, which was named WABOT-1.

The first AI winter (1974-1980)

The initial AI winter, occurring from 1974 to 1980, is known as a tough period for artificial intelligence (AI). During this time, there was a substantial decrease in research funding, and AI faced a sense of letdown.

A boom of AI (1980-1987)

- In 1980, the first national conference of the American Association of Artificial Intelligence was held at Stanford University.
- **Year 1981:** Danny Hillis created parallel computers tailored for AI and various computational functions, featuring an architecture akin to contemporary GPUs.

The second AI winter (1987-1993)

- The duration between the years 1987 to 1993 was the second AI Winter duration.
- Again Investors and government stopped in funding for AI research as due to high cost but not efficient result.

The emergence of intelligent agents (1993-2011)

During this era, AI professionals shifted their emphasis from attempting to match human intelligence to crafting pragmatic, ingenious software tailored to specific tasks.

Year 1997: In 1997, IBM's Deep Blue achieved a historic milestone by defeating world chess champion Gary Kasparov, marking the first time a computer triumphed over a reigning world chess champion.

- **Year 2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.

- **Year 2006:** AI came into the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

Deep learning, big data and artificial general intelligence (2011-present)

Year 2011: In 2011, IBM's Watson won Jeopardy, a quiz show where it had to solve complex questions as well as riddles

Year 2012: Google launched an Android app feature, "Google Now", which was able to provide information to the user as a prediction

Year 2021: OpenAI unveiled the Dall-E multimodal AI system, capable of producing images based on textual prompts.

Year 2022: In November, OpenAI launched ChatGPT, offering a chat-oriented interface to its GPT-3.5 LLM.

The State of the Art-What can AI Do today?

What can AI do today? A concise answer is difficult because there are so many activities in so many subfields. Here we sample a few applications

Robotic vehicles: A driverless robotic car named STANLEY sped through the rough terrain of the Mojave dessert at 22 mph, finishing the 132-mile course first to win the 2005 DARPA Grand Challenge. STANLEY is a Volkswagen Touareg outfitted with cameras, radar, and laser rangefinders to sense the environment and onboard software to command the steering, braking, and acceleration (Thrun, 2006)

Speech recognition: A traveler calling United Airlines to book a flight can have the entire conversation guided by an automated speech recognition and dialog management system.

Autonomous planning and scheduling: A hundred million miles from Earth, NASA's Remote Agent program became the first on-board autonomous planning program to control the scheduling of operations for a spacecraft (Jonsson et al., 2000). REMOTE AGENT generated plans from high-level goals specified from the ground and monitored the execution of those plans—detecting, diagnosing, and recovering from problems as they occurred.

Game playing: IBM's DEEP BLUE became the first computer program to defeat the world champion in a chess match when it bested Garry Kasparov by a score of 3.5 to 2.5 in an exhibition match (Goodman and Keene, 1997).

Spam fighting: Each day, learning algorithms classify over a billion messages as spam, saving the recipient from having to waste time deleting what, for many users, could comprise 80% or 90% of all messages, if not classified away by algorithms.

Logistics planning: During the Persian Gulf crisis of 1991, U.S. forces deployed a Dynamic Analysis and Replanning Tool, DART (Cross and Walker, 1994), to do automated logistics planning and scheduling for transportation.

Robotics: The iRobot Corporation has sold over two million Roomba robotic vacuum cleaners for home use.

Machine Translation: A computer program automatically translates from Arabic to English

Risks of Artificial Intelligence

As the world witnesses unprecedented growth in artificial intelligence (AI) technologies, it's essential to consider the potential risks and challenges associated with their widespread adoption. AI does present some significant dangers — from job displacement to security and privacy concerns.

Here are the biggest risks of artificial intelligence:

1. Lack of Transparency

Lack of transparency in AI systems, particularly in deep learning models that can be complex and difficult to interpret, is a pressing issue. This opaqueness obscures the decision-making processes and underlying logic of these technologies.

When people can’t comprehend how an AI system arrives at its conclusions, it can lead to distrust and resistance to adopting these technologies.

2. Bias and Discrimination

AI systems can inadvertently perpetuate or amplify societal biases due to biased training data or algorithmic design. To minimize discrimination and ensure fairness, it is crucial to invest in the development of unbiased algorithms and diverse training data sets.

3. Privacy Concerns

AI technologies often collect and analyze large amounts of personal data, raising issues related to data privacy and security. To mitigate privacy risks, we must advocate for strict data protection regulations and safe data handling practices.

4. Ethical Dilemmas

Instilling moral and ethical values in AI systems, especially in decision-making contexts with significant consequences, presents a considerable challenge. Researchers and developers must prioritize the ethical implications of AI technologies to avoid negative societal impacts.

5. Security Risks

As AI technologies become increasingly sophisticated, the security risks associated with their use and the potential for misuse also increase. Hackers and malicious actors can harness the power of AI to develop more advanced cyberattacks, bypass security measures, and exploit vulnerabilities in systems.

The rise of AI-driven autonomous weaponry also raises concerns about the dangers of rogue states or non-state actors using this technology — especially when we consider the potential loss of human control in critical decision-making processes. To mitigate these security risks, governments and organizations need to develop best practices for secure AI development and deployment and foster international cooperation to establish global norms and regulations that protect against AI security threats.

6. Concentration of Power

The risk of AI development being dominated by a small number of large corporations and governments could exacerbate inequality and limit diversity in AI applications. Encouraging decentralized and collaborative AI development is key to avoiding a concentration of power.

7. Dependence on AI

Overreliance on AI systems may lead to a loss of creativity, critical thinking skills, and human intuition. Striking a balance between AI-assisted decision-making and human input is vital to preserving our cognitive abilities.

8. Job Displacement

AI-driven automation has the potential to lead to job losses across various industries, particularly for low-skilled workers (although there is evidence that AI and other emerging technologies will *create* more jobs than it *eliminates*).

As AI technologies continue to develop and become more efficient, the workforce must adapt and acquire new skills to remain relevant in the changing landscape. This is especially true for lower-skilled workers in the current labor force.

9. Economic Inequality

AI has the potential to contribute to economic inequality by disproportionally benefiting wealthy individuals and corporations. As we talked about above, job losses due to AI-driven automation are more likely to affect low-skilled workers, leading to a growing income gap and reduced opportunities for social mobility.

The concentration of AI development and ownership within a small number of large corporations and governments can exacerbate this inequality as they accumulate wealth and power while smaller businesses struggle to compete. Policies and initiatives that promote economic equity—like reskilling

programs, social safety nets, and inclusive AI development that ensures a more balanced distribution of opportunities — can help combat economic inequality.

10. Legal and Regulatory Challenges

It's crucial to develop new legal frameworks and regulations to address the unique issues arising from AI technologies, including liability and intellectual property rights. Legal systems must evolve to keep pace with technological advancements and protect the rights of everyone.

11. AI Arms Race

The risk of countries engaging in an AI arms race could lead to the rapid development of AI technologies with potentially harmful consequences.

Recently, more than a thousand technology researchers and leaders, including Apple co-founder Steve Wozniak, have urged intelligence labs to pause the development of advanced AI systems. The letter states that AI tools present "profound risks to society and humanity.

12. Loss of Human Connection

Increasing reliance on AI-driven communication and interactions could lead to diminished empathy, social skills, and human connections. To preserve the essence of our social nature, we must strive to maintain a balance between technology and human interaction.

13. Misinformation and Manipulation

AI-generated content, such as deepfakes, contributes to the spread of false information and the manipulation of public opinion. Efforts to detect and combat AI-generated misinformation are critical in preserving the integrity of information in the digital age.

14. Unintended Consequences

AI systems, due to their complexity and lack of human oversight, might exhibit unexpected behaviors or make decisions with unforeseen consequences. This unpredictability can result in outcomes that negatively impact individuals, businesses, or society as a whole.

Robust testing, validation, and monitoring processes can help developers and researchers identify and fix these types of issues before they escalate.

15. Existential Risks

The development of artificial general intelligence (AGI) that surpasses human intelligence raises long-term concerns for humanity. The prospect of AGI could lead to unintended and potentially catastrophic consequences, as these advanced AI systems may not be aligned with human values or priorities.

To mitigate these risks, the AI research community needs to actively engage in safety research, collaborate on ethical guidelines, and promote transparency in AGI development. Ensuring that AGI serves the best interests of humanity and does not pose a threat to our existence is paramount.

Benefits of Artificial Intelligence

AI offers numerous benefits across various domains, revolutionizing how we live, work, and interact with technology. Here are some of the key benefits:

1.Reduction in Human Error:

The phrase "human error" was born because humans make mistakes from time to time. Computers, however, do not make these mistakes if they are programmed properly. With Artificial intelligence, the decisions are taken from the previously gathered information applying a certain set of algorithms. So errors are reduced and the chance of reaching accuracy with a greater degree of precision is a possibility.

Example : In Weather Forecasting using Ai they have reduced the majority of human error.

2. Takes risks instead of Humans :

This is one of the biggest advantages of Artificial intelligence. We can overcome many risky limitations of humans by developing an AI Robot which in turn can do the risky things for us. Let it be going to mars, defuse a bomb, explore the deepest parts of oceans, mining for coal and oil, it can be used effectively in any kind of natural or man-made disasters.

Example : Have you heard about the Chernobyl nuclear power plant explosion in Ukraine? At that time there were no Al-powered rot robots that can help us to minimize the effect of radiation by controlling the fire in early stages, as any human went close to the core was dead in a matter of minutes. They eventually poured sand and boron from helicopters from a mere distance

AI Robots can be used in such situations where intervention can be hazardous.

3. Available 24 x 7:

An Average human will work for 4-6 hours a day excluding the breaks. Humans are built in such a way to get some time out for refreshing themselves and get ready for a new day of work and they even have weekly offed to stay intact with their work-life and personal life. But using Al we can make machines work 24 x7 without any breaks and they don't even get bored, unlike humans.

Example : Educational Institutes and Helpline centers are getting many queries and issues which can be handled effectively using Al.

4. Helping in Repetitive Jobs:

In our day-tó- day work, we will be performing many repetitive works like sending a thanking mail, verifying certain documents for errors and many more things. Using artificial intelligence we can productively automate these mundane tasks and can even remove "boring"tasks for humans and free them up to be increasingly creative.

Example : In banks, we often see many verifications of documents to get a loan which is a repetitive task for the owner of the bank. Using Al Cognitive Automation the owner can speed up the process of verifying the documents by which both the customers and the owner will be benefited.

5. Digital Assistance:

Some of the highly advanced organizations use digital assistants to interact with users which saves the need for human resources. The digital assistants alsó used in many websites to provide things that users want. We can chat with them about what we are looking for. Some chat bots are designed in such a way that it's become hard to determine that we're chatting with a chatbot or a human being.

Example : We all know that organizations have a customer support team that needs to clarify the doubts and queries of the customers. Using Al the organizations can set up a Voice bot or Chatbot which can help customers with all their queries. We can see many organizations already started using them on their websites and mobile applications.

6. Faster Decisions :

Using Al alongside other technologies we can make machine stake decisions faster than a human and carry out actions quicker. While taking a decision human will analyze many factors both emotionally and practically but Al-powered machine works on what it is programmed and delivers the results in a faster way

Example :We all have played Chess games in Windows. It is nearly impossible to beat CPU in the hard mode because of the Al behind that game. It will take the best possible step in a very short time according to the algorithms used behind it.

7. Daily Applications:

Daily applications such as Apple's Siri, Window's Cortana, Goggle's OK Google are frequently used in our daily routinè whether it is for searching a location, taking a selfie, making a phone call, replying to a mail and many more.

Example : Around 20 years ago, when we are planning to go somewhere we used to ask a person who already went there for the directions. But now all we have to do is say "OK Google where is Visakhapatnam". It will show you Visakhapatnam's location on google map and the best path between you and Visakhapatnam.

8. New Inventions:

Al is powering many inventions in almost every domaín which will help humans solve the majority of complex problems.

Example ; Recently doctors can predict breast cancer in the woman at earlier stages using advanced Al based technologies.

INTELLIGENT AGENTS

AGENTS AND ENVIRONMENT

- An AI system can be defined as the study of the rational agent and its environment.
- The agents sense the environment through sensors and act on their environment through actuators.
- An AI agent can have mental properties such as knowledge, belief, intention, etc.

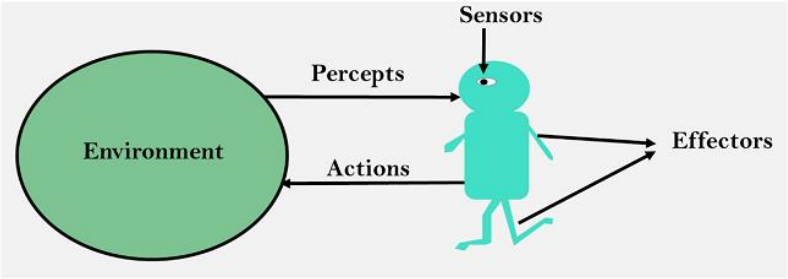
What is an Agent?

An agent can be anything that perceives environment through sensors and act upon that environment through actuators. An Agent runs in the cycle of perceiving**,** thinking**,** and acting. An agent can be:

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

Sensors, effectors, and actuators.

- **Sensor:** Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.
- **Actuators:** Actuators are the component of machines that converts energy into motion. The actuators are only responsible for moving and controlling a system. An actuator can be an electric motor, gears, rails, etc.
- **Effectors:** Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.



Intelligent Agents:

An intelligent agent is an autonomous entity which act upon an environment using sensors and actuators for achieving goals. An intelligent agent may learn from the environment to achieve their goals. A thermostat is an example of an intelligent agent.

Following are the main four rules for an AI agent:

- **Rule 1:** An AI agent must have the ability to perceive the environment.
- **Rule 2:** The observation must be used to make decisions.
- **Rule 3:** Decision should result in an action.
- **Rule 4:** The action taken by an AI agent must be a rational action.

PEAS Representation:

PEAS is a type of model on which an AI agent works upon. When we define an AI agent or rational agent, then we can group its properties under PEAS representation model. It is made up of four words:

- **P:** Performance measure
- **E:** Environment
- **A:** Actuators
- **S:** Sensors

1. **Performance Measure:** Performance measure is the unit to define the success of an agent. Performance varies with agents based on their different precepts.
2. **Environment**: Environment is the surrounding of an agent at every instant.
3. **Actuator**: An actuator is a part of the agent that delivers the output of action to the environment.
4. **Sensor**: Sensors are the receptive parts of an agent that takes in the input for the agent.

Agent	Performance Measure	Environment	Actuators	Sensors
Medical Diagnose	• Healthy patient • Minimized Cost	• Patient • Hospital • Staff	• Tests • Treatment	Keyboard(Entry of symptoms)
Vacuum Cleaner	• Claenliness • Efficiency • Battery Life • Security	• Room • Table • Floor • Obstacles • Carpet	• Wheels • Brushes • Vacuum Extractor	• Camera • Dirt Detection Sensor • Cliff Sensor • Bumb sensor • Infrared wall sensor
Part picking Robot	• Percentage of parts in correct bins	• Conveyor belt with parts • Bin	• Joint arm • Hand	• Camera • Joint angle sensor
Taxi Driver	• Safe • Fast • Legal • Comfortable trip • Maximize profit	• Road • Other Traffic • Pedestrian • Customer	• Steering • Accelerator • Brake • Signal • Horn • Display	• Camera • Sonar • Engine Sensor • Speedometer • GPS • Accelerometer
Refinery Controller	• Purity • Yield • Safety	• Refinery • Operators	• Valve • Pump • Heater • Display	• Temperature sensor • Pressure Sensor • Chemical sensor
Subject tutoring	• Maximum score	• Classroom • Desk • Chair • Board • Staff	• Smart display	• Eye • Ear • Notebook

Rational Agent:

- A rational agent is an agent which has clear preference, models uncertainty, and acts in a way to maximize its performance measure with all possible actions.
- A rational agent is the one that does the right thing. AI is about creating rational agents to use for game theory and decision theory for various real-world scenarios.

Rationality:

The rationality of an agent is measured by its performance measure. Rationality can be judged on the basis of following points:

- Performance measure which defines the success criterion.
- Agent prior knowledge of its environment.
- Best possible actions that an agent can perform.
- The sequence of percepts.

What are AI agents?

- Fundamentally, an AI agent is a computer program capable of performing tasks autonomously by making decisions based on its environment, inputs, and predefined goals. These agents represent a leap from traditional automation, as they are not just designed to follow a set of instructions but to think, adapt, and act independently.
- In practice, AI agents can range from simple programs performing single tasks to complex systems

Structure of an AI Agent

- To understand the structure of Intelligent Agents, we should be familiar with *Architecture* and *Agent* programs
- Architecture is the machinery that the agent executes on. It is a device with sensors and actuators, for example, a robotic car, a camera, and a PC.
- An agent program is an implementation of an agent function. An agent function is a map from the percept sequence(history of all that an agent has perceived to date) to an action.

  - Agent = Architecture + Agent program

Examples of agents in artificial intelligence:

Autonomous robots: These are agents that are designed to operate autonomously in the physical world.

Gaming agents: These are agents that are designed to play games, either against human opponents or other agents.

Fraud detection agents: These are agents that are designed to detect fraudulent behaviour in financial transactions

Types of Agents

- Simple Reflex Agents
- Model-Based Reflex Agents
- Goal-Based Agents
- Utility-Based Agents
- Learning Agent
- Multi-agent systems
- Hierarchical agents

Simple Reflex Agents

These agents function on the principle of condition-action rules. They respond directly to their immediate perceptions, lacking an internal model of the world. Simple reflex agents are straightforward and efficient for environments where the agent's next action depends solely on the current percept. Their simplicity, however, limits their effectiveness in complex, unstructured environments.

Model-based reflex agents

These agents possess an internal model of the world, allowing them to keep track of parts of the environment that are not immediately perceptible. This model helps the agent handle partially observable environments by inferring missing information. They decide actions based on their current percept and internal model, making them more adaptable than simple reflex agents.

Goal-based agents

Goal-based agents go a step further by considering the future consequences of their actions. They have goals and make decisions based on how likely actions will achieve these goals. This foresight enables them to plan and choose actions that lead to desired outcomes, making them suitable for complex decision-making tasks.

Utility-based agents

These agents assess the desirability of different states using a utility function. They strive to achieve a goal and maximize their performance based on a given utility measure. This approach is beneficial in

scenarios with multiple possible actions or outcomes, and the agent needs to decide the best course based on a preference.

Learning agents

These agents improve their performance over time based on experience. They are particularly advantageous in dynamic environments where they adapt and evolve their strategies. For instance, a learning agent could continuously refine its understanding of customer preferences to optimize ad placements.

Multi-agent systems (MAS)

In MAS, multiple agents interact and work towards common or individual goals. MAS is used for complex tasks involving multiple agents working together where coordination is key. These systems can be seen in supply chain management, where different agents represent various components of the supply chain, working in unison to optimize the overall process.

Hierarchical agents

These agents are structured in a hierarchical manner, where higher-level agents manage and direct lower-level agents. Each level in the hierarchy has specific roles and responsibilities, contributing to the overall goal. Hierarchical agents benefit large-scale systems where tasks must be broken down and managed at different levels.

Agent Environment in AI

An environment is everything in the world which surrounds the agent, but it is not a part of an agent itself. An environment can be described as a situation in which an agent is present.

Features of Environment

As per Russell and Norvig, an environment can have various features from the point of view of an agent:

1. Fully observable vs Partially Observable
2. Static vs Dynamic
3. Discrete vs Continuous
4. Deterministic vs Stochastic
5. Single-agent vs Multi-agent
6. Episodic vs sequential
7. Known vs Unknown
8. Accessible vs Inaccessible

1. **Fully observable vs Partially Observable:**

- If an agent sensor can sense or access the complete state of an environment at each point in time then it is a fully observable environment
- An agent with no sensors in all environments then such an environment is called unobservable.

2. Deterministic vs Stochastic:

- If an agent's current state and selected action can completely determine the next state of the environment, then such an environment is called a deterministic environment. Chess is a classic example of a deterministic environment.
- A stochastic environment is random and cannot be determined completely by an agent. For reference, The stock market is an example of a stochastic environment.

3. Episodic vs Sequential:

- In an episodic environment, there is a series of one-shot actions, and only the current percept is required for the action. For example, Tic-Tac-Toe is a classic example of an episodic environment.
- However, in a Sequential environment, an agent requires memory of past actions to determine the next best actions.
- For example, Chess is an example of a sequential environment.

4. Single-agent vs Multi-agent

- If only one agent is involved in an environment, and operating by itself then such an environment is called a single-agent environment.
- However, if multiple agents are operating in an environment, then such an environment is called a multi-agent environment.

5. Static vs Dynamic:

- If the environment can change itself while an agent is deliberating then such an environment is called a dynamic environment it is called a static environment.
- However, for a dynamic environment, agents need to keep looking at the world at each action.
- For reference, Taxi driving is an example of a dynamic environment.
- When you're driving a taxi, the environment is constantly changing. The road conditions, traffic, pedestrians, and other vehicles all contribute to the dynamic nature of this environment.

6. Discrete vs Continuous:

- If in an environment, there are a finite number of percepts and actions that can be performed within it, then such an environment is called a discrete environment

- Chess is an example of a discrete environment. In chess, there are a finite number of distinct chess pieces (e.g., pawns, rooks, knights) and a finite number of squares on the chessboard.
- Controlling a robotic arm to perform precise movements in a factory setting is an example of a continuous environment

7. Known vs Unknown

- In a known environment, the results of all actions are known to the agent. While in an unknown environment, an agent needs to learn how it works in order to perform an action.
- The opening theory in chess can be considered as a known environment for experienced chess players.
- Imagine a scenario where a rover or drone is sent to explore an alien planet with no prior knowledge or maps of the terrain can be considered as unknown environment

8. Accessible vs Inaccessible

- If an agent can obtain complete and accurate information about the state's environment, then such an environment is called an Accessible environment
- For example, Imagine an empty room equipped with highly accurate temperature sensors. These sensors can provide real-time temperature measurements at any point within the room. An agent placed in this room can obtain complete and accurate information about the temperature at different locations
- For example, Consider a scenario where a satellite in space is tasked with monitoring a specific event taking place on Earth, such as a natural disaster or a remote area's condition. While the satellite can capture images and data from space, it cannot access fine-grained information about the event's details.