

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (AI)

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Learning Outcomes:-

- Artificial Intelligence Introduction,
- Future of Artificial Intelligence,
- Definition of AI,
- History and Types of AI,
- AI ethics and limitations
- Artificial Intelligence Areas
- Expert Systems,
- Natural Language Processing,
- Neural Networks,
- Robotics,
- Fuzzy Logic Systems
- AI applications in various industries (healthcare, finance, manufacturing, etc.)

INTRODUCTION TO AI

- ❑ AI is one of the fascinating and universal fields of Computer science which has a great scope in future. AI holds a tendency to cause a machine to work as a human.
- ❑ **Artificial Intelligence is composed of two words Artificial and Intelligence, where Artificial defines "man-made," and intelligence defines "thinking power", hence AI means "a man-made thinking power."**
- ❑ Artificial Intelligence exists when a machine can have human based skills such as learning, reasoning, and solving problems.
- ❑ With Artificial Intelligence you do not need to preprogram a machine to do some work, despite that you can create a machine with programmed algorithms which can work with own intelligence, and that is the awesomeness of AI.
- ❑ **It is the ability of machines or computer-controlled robot to perform task that are associated with intelligence."**

INTRODUCTION TO AI

- ❑ **Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and act like humans.**
- ❑ It involves the development of algorithms and computer programs that can perform tasks that typically require human intelligence such as visual perception, speech recognition, decision-making, and language translation.
- ❑ **Artificial Intelligence is a method of making a computer, a computer-controlled robot, or a software think intelligently like the human mind.**
- ❑ AI is accomplished by studying the patterns of the human brain and by analyzing the cognitive process. The outcome of these studies develops intelligent software and systems.

INTRODUCTION TO AI

- ❑ **Intelligence: The ability to learn and solve problems. This definition is taken from Webster's Dictionary.**
- ❑ If the computers can, somehow, solve real-world problems, by improving on their own from past experiences, they would be called "intelligent".
- ❑ Thus, the AI systems are more generic (rather than specific), can "think" and are more flexible.
- ❑ Intelligence, as we know, is the ability to acquire and apply knowledge. Knowledge is the information acquired through experience. Experience is the knowledge gained through exposure (training).
- ❑ **artificial intelligence as the "copy of something natural (i.e., human beings) 'WHO' is capable of acquiring and applying the information it has gained through exposure."**

INTRODUCTION TO AI

❑ Intelligence is composed of:

❑ Reasoning

❑ Learning

❑ Problem-Solving

❑ Perception

❑ Linguistic Intelligence

❑ The main focus of artificial intelligence is towards understanding human behavior and performance. This can be done by creating computers with human-like intelligence and capabilities. This includes natural language processing, facial analysis and robotics.

Why Artificial Intelligence?

- ❑ 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.

Uses of Artificial Intelligence :

- ❑ **Healthcare:** AI is used for medical diagnosis, drug discovery, and predictive analysis of diseases.
- ❑ **Finance:** AI helps in credit scoring, fraud detection, and financial forecasting.
- ❑ **Retail:** AI is used for product recommendations, price optimization, and supply chain management.
- ❑ **Manufacturing:** AI helps in quality control, predictive maintenance, and production optimization.
- ❑ **Transportation:** AI is used for autonomous vehicles, traffic prediction, and route optimization.
- ❑ **Customer service:** AI-powered chatbots are used for customer support, answering frequently asked questions, and handling simple requests.
- ❑ **Security:** AI is used for facial recognition, intrusion detection, and cybersecurity threat analysis.
- ❑ **Marketing:** AI is used for targeted advertising, customer segmentation, and sentiment analysis.

Techniques and Approaches of Artificial Intelligence :

- ❑ **Machine Learning:** A subset of AI that involves the use of algorithms to enable computers to learn from and make predictions or decisions based on data.
- ❑ **Deep Learning:** A subfield of machine learning that involves neural networks with many layers (deep neural networks). It has shown exceptional performance in tasks such as image and speech recognition.
- ❑ **Natural Language Processing (NLP):** A branch of AI that focuses on enabling computers to understand, interpret, and generate human language. Chatbots and language translation are examples of NLP applications.
- ❑ **Computer Vision:** The field of AI that enables computers to interpret and understand visual information from the world, such as images and videos.
- ❑ **Robotics:** Integrating AI with physical machines to create robots that can perform tasks autonomously or semi-autonomously.
- ❑ **Expert Systems:** AI systems that mimic the decision-making abilities of human experts in a specific domain.

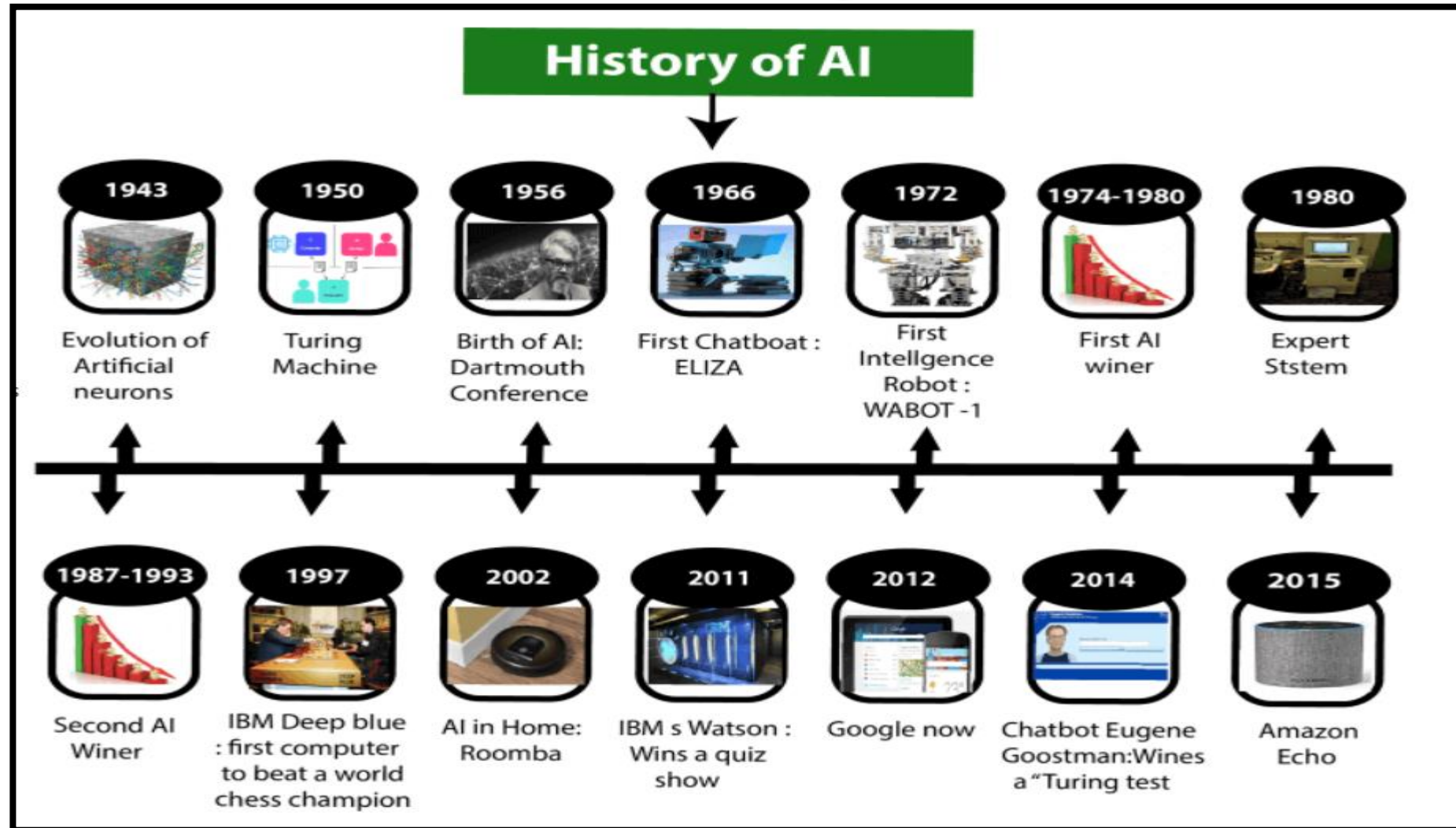
Advantages of Artificial Intelligence

- ❑ **High Accuracy with less errors:** AI machines or systems are prone to less errors and high accuracy as it takes decisions as per pre-experience or information.
- ❑ **High-Speed:** AI systems can be of very high-speed and fast-decision making, because of that AI systems can beat a chess champion in the Chess game.
- ❑ **High reliability:** AI machines are highly reliable and can perform the same action multiple times with high accuracy.
- ❑ **Useful for risky areas:** AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.
- ❑ **Digital Assistant:** AI can be very useful to provide digital assistant to the users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirement.
- ❑ **Useful as a public utility:** AI can be very useful for public utilities such as a self-driving car which can make our journey safer and hassle-free, facial recognition for security purpose, Natural language processing to communicate with the human in human-language, etc.

Disadvantages of Artificial Intelligence

- ❑ **High Cost:** The hardware and software requirement of AI is very costly as it requires lots of maintenance to meet current world requirements.
- ❑ **Can't think out of the box:** Even we are making smarter machines with AI, but still they cannot work out of the box, as the robot will only do that work for which they are trained, or programmed.
- ❑ **No feelings and emotions:** AI machines can be an outstanding performer, but still it does not have the feeling so it cannot make any kind of emotional attachment with human, and may sometime be harmful for users if the proper care is not taken.
- ❑ **Increase dependency on machines:** With the increment of technology, people are getting more dependent on devices and hence they are losing their mental capabilities.
- ❑ **No Original Creativity:** As humans are so creative and can imagine some new ideas but still AI machines cannot beat this power of human intelligence and cannot be creative and imaginative.

History of Artificial Intelligence



History of Artificial Intelligence

Maturation of Artificial Intelligence (1943-1952):-

- ❑ **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter Pitts 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**.

History of Artificial Intelligence

The birth of Artificial Intelligence (1952-1956):-

- ❑ **Year 1955:** 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 found 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.

The golden years-Early enthusiasm (1956-1974):-

- ❑ **Year 1966:** The researchers emphasized developing algorithms which can solve mathematical problems. Joseph Weizenbaum created the first **chatbot** in 1966, which was named as ELIZA.
- ❑ **Year 1972:** The first intelligent humanoid robot was built in Japan which was named as WABOT-1.

History of Artificial Intelligence

The first AI winter (1974-1980):-

- ❑ The duration between years 1974 to 1980 was the first AI winter duration. AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches.
- ❑ During AI winters, an interest of publicity on artificial intelligence was decreased.

A boom of AI (1980-1987):-

- ❑ **Year 1980:** After AI winter duration, AI came back with "Expert System". Expert systems were programmed that emulate the decision-making ability of a human expert.
- ❑ In the Year 1980, the first national conference of the American Association of Artificial Intelligence was held at Stanford University.

The second AI winter (1987-1993):-

- ❑ The duration between the years 1987 to 1993 was the second AI Winter duration.

History of Artificial Intelligence

The emergence of intelligent agents (1993-2011):-

- ❑ **Year 1997:** In the year 1997, IBM Deep Blue beats world chess champion, Gary Kasparov, and became the first computer to beat a 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 in the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

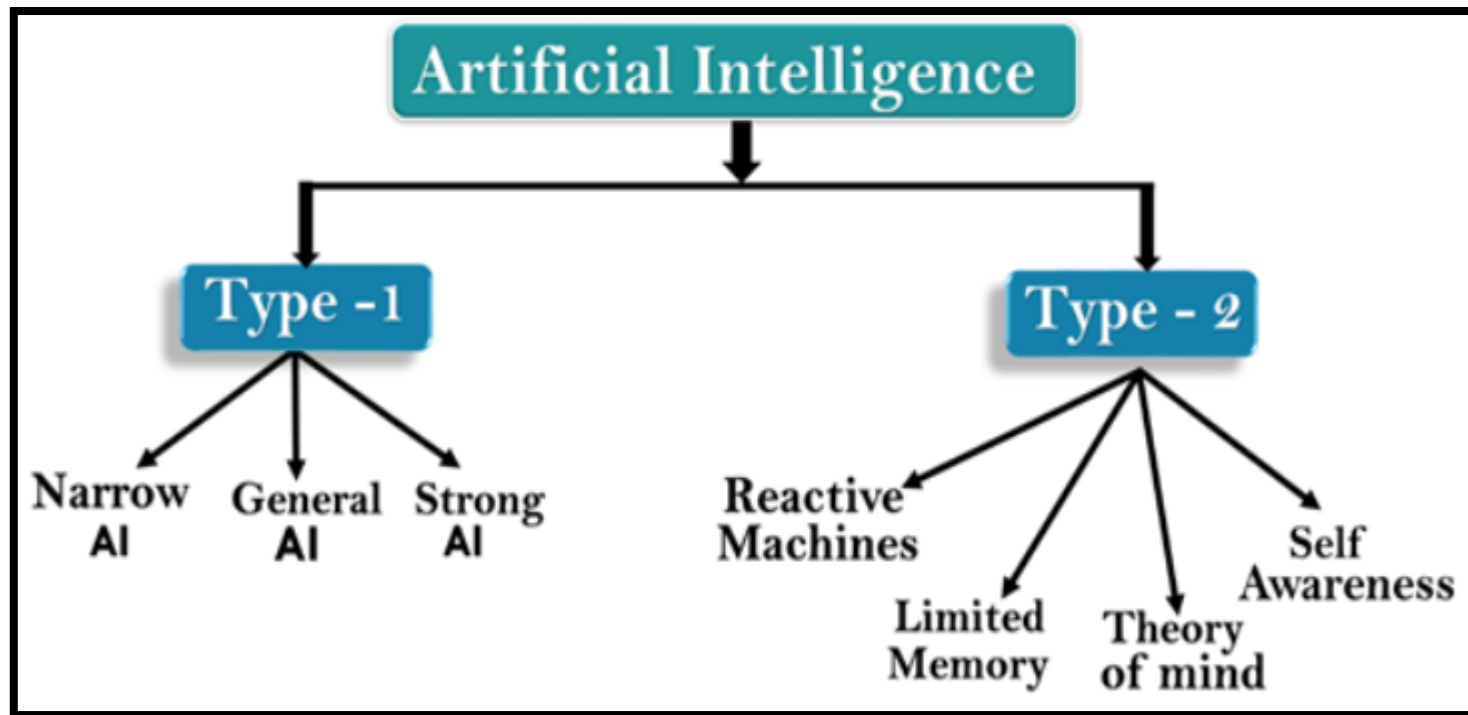
History of Artificial Intelligence

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

- ❑ **Year 2011:** In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve the complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.
- ❑ **Year 2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- ❑ **Year 2014:** In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test."
- ❑ **Year 2018:** The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.
- ❑ Google has demonstrated an AI program "Duplex" which was a virtual assistant and which had taken hairdresser appointment on call, and lady on other side didn't notice that she was talking with the machine.

Types of Artificial Intelligence

- Artificial Intelligence can be divided in various types, there are mainly two types of main categorization which are based on capabilities and based on functionally of AI.



Types of Artificial Intelligence

❑ AI type-1: Based on Capabilities:-

Weak AI or Narrow AI:

- ❑ **Narrow AI** is a type of AI which is able to perform a dedicated task with intelligence.
- ❑ The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.
- ❑ Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as **weak AI**. Narrow AI can fail in unpredictable ways if it goes beyond its limits.
- ❑ Apple Siri is a good example of Narrow AI, but it operates with a limited pre-defined range of functions.
- ❑ IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.
- ❑ Some Examples of Narrow AI are playing chess, purchasing suggestions on e-commerce site, self-driving cars, speech recognition, and image recognition.

Types of Artificial Intelligence

❑ AI type-1: Based on Capabilities:-

General AI:

- ❑ **General AI** is a type of intelligence which could perform any intellectual task with efficiency like a human.
- ❑ The idea behind the general AI to make such a system which could be smarter and think like a human by its own.
- ❑ Currently, there is no such system exist which could come under general AI and can perform any task as perfect as a human.
- ❑ The worldwide researchers are now focused on developing machines with General AI.
- ❑ As systems with general AI are still under research, and it will take lots of efforts and time to develop such systems.

Types of Artificial Intelligence

❑ AI type-1: Based on Capabilities:-

Super AI:

- ❑ **Super AI** is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than human with cognitive properties.
- ❑ It is an outcome of general AI.
- ❑ Some key characteristics of strong AI include capability include the ability to think, to reason, solve the puzzle, make judgments, plan, learn, and communicate by its own.
- ❑ Super AI is still a hypothetical concept of Artificial Intelligence.
- ❑ Development of such systems in real is still world changing task.

Types of Artificial Intelligence

❑ AI type-2: Based on functionality:-

Reactive Machines:

- ❑ Purely reactive machines are the most basic types of Artificial Intelligence.
- ❑ Such AI systems do not store memories or past experiences for future actions.
- ❑ These machines only focus on current scenarios and react on it as per possible best action.
- ❑ IBM's Deep Blue system is an example of reactive machines.
- ❑ Google's AlphaGo is also an example of reactive machines.

Types of Artificial Intelligence

❑ AI type-2: Based on functionality:-

Limited Memory:

- ❑ Limited memory machines can store past experiences or some data for a short period of time.
- ❑ These machines can use stored data for a limited time period only.
- ❑ Self-driving cars are one of the best examples of Limited Memory systems.
- ❑ These cars can store recent speed of nearby cars, the distance of other cars, speed limit, and other information to navigate the road.

Types of Artificial Intelligence

❑ AI type-2: Based on functionality:-

Theory of Mind:

- ❑ Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans.
- ❑ This type of AI machines are still not developed, but researchers are making lots of efforts and improvement for developing such AI machines.

Self-Awareness:-

- ❑ Self-awareness AI is the future of Artificial Intelligence. These machines will be super intelligent, and will have their own consciousness, sentiments, and self-awareness.
- ❑ These machines will be smarter than human mind.
- ❑ Self-Awareness AI does not exist in reality still and it is a hypothetical concept.

Artificial Intelligence Ethics

- ❑ AI ethics is a system of moral principles and techniques intended to inform the development and responsible use of artificial intelligence technology.
- ❑ As AI has become integral to products and services, organizations are starting to develop AI codes of ethics.
- ❑ Ethics in AI are also referred to as machine ethics or computational ethics. As an emerging discipline, it is often unclear what constitutes “good” or “bad” behavior for AI algorithms.

Principles for AI Ethics:-

- ❑ Principles for AI ethics are a set of rules and guidelines that are meant to help protect society from the negative effects of Artificial Intelligence. These principles aim to protect people, the environment, and the economy.

Artificial Intelligence Ethics

- ❑ AI ethics revolves around four main areas:
- ❑ **Safety:**
- ❑ This refers to how well an AI can avoid harming humans. This includes things like not causing physical harm or using offensive language.
- ❑ It also includes things like protecting intellectual property rights and privacy.
- ❑ **Security:**
- ❑ This refers to how well an AI can prevent other systems from attacking it or taking advantage of it in some way.
- ❑ It also refers to how well an AI can protect itself from being hacked or manipulated by humans who want to use it for nefarious means (like stealing money).

Artificial Intelligence Ethics

❑ Privacy:

- ❑ This refers to how much information an AI system knows about you, where it gets its data from, how it stores that information, what kind of analysis tools it uses with that data, etc.
- ❑ Basically, everything related to your personal information is being used/shared by any technology company!

❑ Fairness:

- ❑ This refers to whether or not your rights as a consumer are being protected when interacting with a company's services/products.

Artificial Intelligence Ethics

Principles of AI Ethics:-

- ❑ AI systems should be designed and operated to be safe, secure, and private. The designers and builders of intelligent autonomous systems must:
- ❑ Ensure that they are robust, reliable, and trustworthy.
- ❑ Incorporate mechanisms that reflect societal values and aims as they interact with people outside their immediate purview.
- ❑ Ensure that their creations are adaptive so that they can learn from experience over time to improve their performance and capabilities.
- ❑ Consider the full range of human needs in their design, for example, by promoting safety, privacy, trustworthiness, fairness, transparency, accountability, and inclusion in society through AI technologies.”
- ❑ Ensure that they can explain how decisions are made by their creations so that people can understand them and take action to correct any mistakes that are made.
- ❑ Consider the impact on society when developing these technologies.

Future of Artificial Intelligence

- ❑ At the current stage, AI is known as Narrow AI or Weak AI, which can only perform dedicated tasks. For example, self-driving cars, speech recognition, etc.
- ❑ **Advanced AI Technologies:** AI will continue to advance, with improvements in machine learning algorithms, neural networks, and natural language processing. This will lead to AI systems that are more capable, adaptable, and efficient.
- ❑ **AI in Everyday Life:** AI will become even more integrated into our daily lives. We'll see AI in smart homes, virtual assistants, healthcare diagnostics, personalized education, and more.
- ❑ **Autonomous Systems:** Autonomous vehicles, drones, and robots will continue to develop, with AI at their core. This could revolutionize industries such as transportation, delivery, and manufacturing.
- ❑ **AI in Healthcare:** AI will play an increasingly vital role in healthcare, assisting with diagnostics, drug discovery, treatment optimization, and even robotic surgery.
- ❑ **AI in Business:** AI will continue to transform businesses through automation, data analytics, and enhanced decision-making. It will impact various industries, from finance and marketing to supply chain management.

Future of Artificial Intelligence

- ❑ **AI and Privacy:** There will be growing concerns about AI and privacy, leading to the development of privacy-preserving AI techniques and regulations to protect individual data.
- ❑ **AI in Education:** AI-powered personalized learning will become more widespread, helping students receive tailored educational experiences.
- ❑ **AI in Research:** AI will assist scientists in making breakthroughs in various fields, from climate science to drug discovery.
- ❑ **AI and Jobs:** The impact of AI on employment will vary by industry, but there will be a growing need for individuals with AI-related skills to develop, manage, and maintain AI systems.
- ❑ **AI in Cyber security:** AI will be used both by cybercriminals and cybersecurity experts, leading to a continuous arms race in the digital realm.
- ❑ **AI in Climate Change:** AI will play a role in addressing environmental challenges by optimizing energy use, predicting climate patterns, and aiding in climate modeling.
- ❑ **Risk with AI:-**
 - ❑ AI is programmed to do something destructive:
 - ❑ Misalignment between our goals and machines:

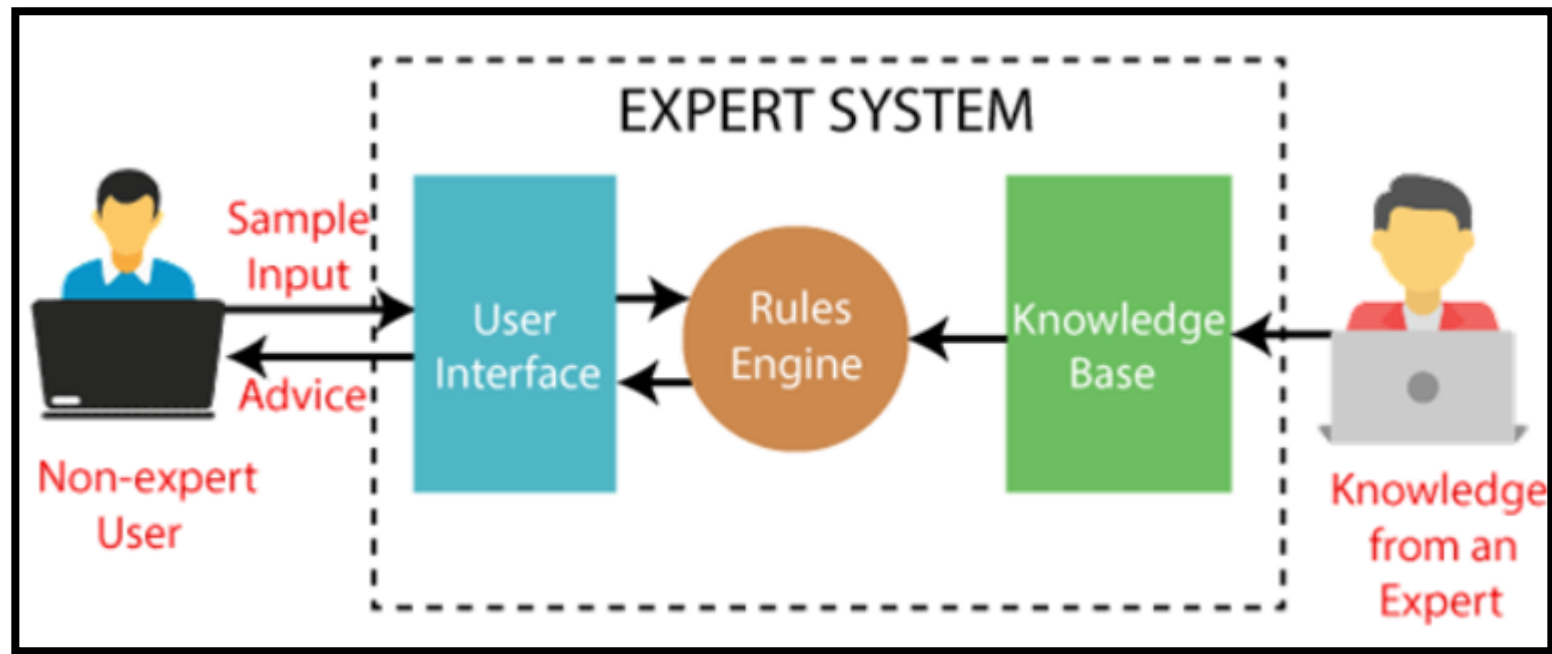
Artificial Intelligence Areas:

❑ Expert Systems:-

- ❑ Expert Systems are AI programs designed to mimic the decision-making abilities of a human expert in a particular domain.
- ❑ They use a knowledge base of facts and rules to make inferences and provide expert-level advice.
- ❑ Expert Systems are a specific subfield of Artificial Intelligence (AI) that focuses on creating computer systems capable of emulating the decision-making abilities of a human expert in a particular domain or field.
- ❑ These systems are designed to store, represent, and apply expert knowledge to solve complex problems or make informed decisions.
- ❑ The performance of an expert system is based on the expert's knowledge stored in its knowledge base. The more knowledge stored in the KB, the more that system improves its performance.
- ❑ One of the common examples of an ES is a suggestion of spelling errors while typing in the Google search box.

AI Areas: Expert Systems

- ❑ Here are key components and characteristics of expert systems:
- ❑ **User Interface**
- ❑ **Interface Engine**
- ❑ **Knowledge Base**



Artificial Intelligence Areas:

Examples of Expert Systems:-

- ❑ **MYCIN:** An expert system for diagnosing bacterial infections.
- ❑ **Dendral:** An early expert system used for chemical analysis.
- ❑ **TurboTax:** Uses expert system techniques for guiding users through tax-related decisions.
- ❑ **CaDeT:** The CaDet expert system is a diagnostic support system that can detect cancer at early stages.

Limitations:

- ❑ Expert systems have limitations, such as difficulty handling novel or unforeseen situations, their reliance on the quality of the knowledge base, and the challenge of acquiring and maintaining expert knowledge.

Applications:

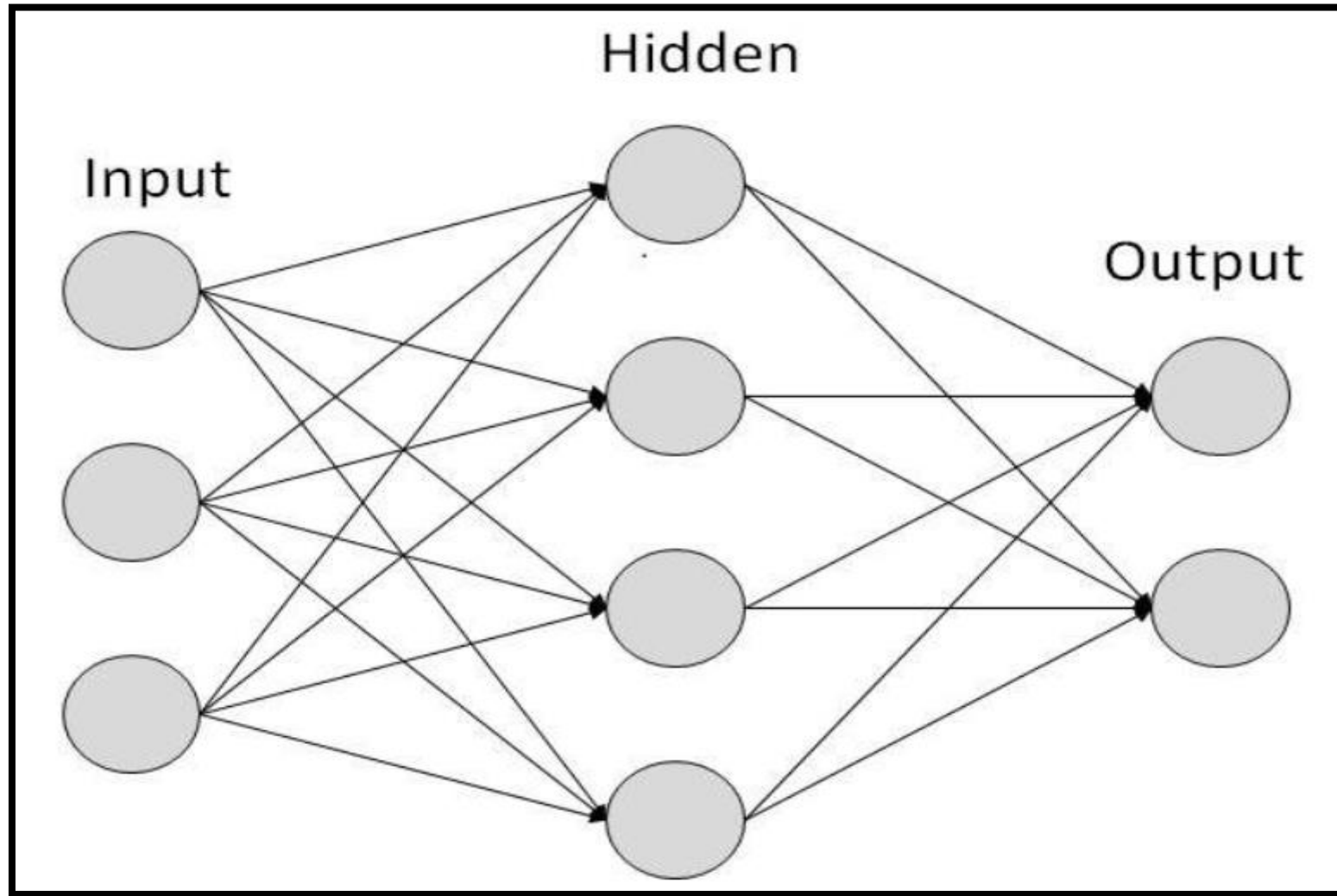
- ❑ Expert systems have been applied in various fields, including healthcare (medical diagnosis), finance (investment advising), manufacturing (quality control), customer support (troubleshooting), and more.

Artificial Intelligence Areas:

❑ **Neural Networks:-**

- ❑ A neural network is a method in artificial intelligence that teaches computers to process data in a way that is inspired by the human brain.
- ❑ It is a type of machine learning process, called deep learning, that uses interconnected nodes or neurons in a layered structure that resembles the human brain.
- ❑ It creates an adaptive system that computers use to learn from their mistakes and improve continuously.
- ❑ Thus, artificial neural networks attempt to solve complicated problems, like summarizing documents or recognizing faces, with greater accuracy.

Artificial Intelligence Areas:



Artificial Intelligence Areas:

❑ **Neural Networks:-**

- ❑ **Neurons and Layers:** A neural network consists of artificial neurons (also called nodes or units) organized into layers. Typically, neural networks have an input layer, one or more hidden layers, and an output layer. Each neuron in a layer is connected to every neuron in the adjacent layers.
- ❑ **Weights and Connections:** The connections between neurons are associated with weights that represent the strength of the connection. These weights are learned during the training process, allowing the network to adapt and optimize its performance on a specific task.
- ❑ **Activation Functions:** Neurons apply an activation function to their input, transforming it into an output. Common activation functions include sigmoid, ReLU (Rectified Linear Unit), and tanh. These functions introduce non-linearity, enabling neural networks to learn complex patterns and relationships.