CHAPTER THREE

Artificial Intelligence

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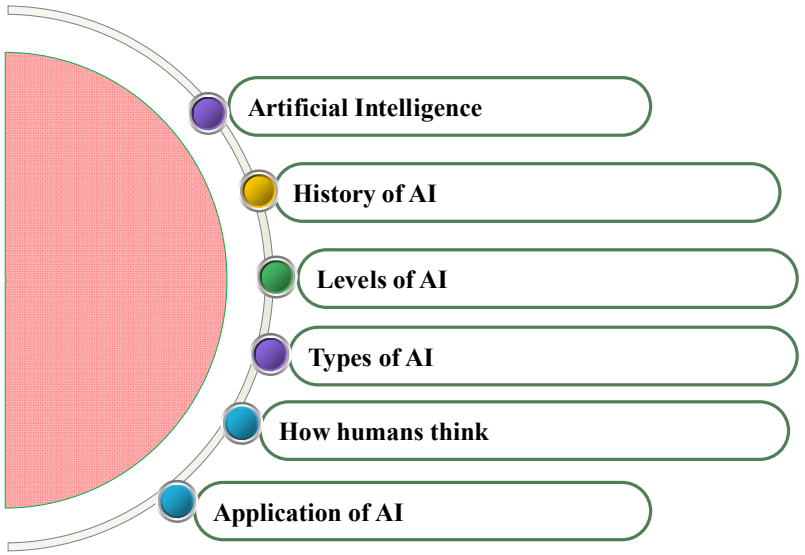
Contents



Artificial Intelligence (AI)

- **Artificial Intelligence** is composed of two words **Artificial** and **Intelligence**.
- Artificial defines "man-made," and intelligence defines "thinking power", or "the ability to learn and solve problems"
- Artificial Intelligence means "a man-made thinking power."
- Artificial Intelligence (AI) as the branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions.
- **Intelligence** is the ability to acquire and apply **knowledge**.

Artificial Intelligence (AI)

- **Knowledge** is the information acquired through experience.
- **Experience** is the knowledge gained through exposure (training).
- Therefore, 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."
- Artificial Intelligence exists when a machine can have human-based skills such as learning, reasoning, and solving problems.
- In 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.

Artificial Intelligence (AI)

- **Intelligence** is composed of:
  - Reasoning
  - Learning
  - Problem Solving
  - Perception and
  - Linguistic Intelligence
- **Artificial Intelligence system** is composed of
  - Agent and
  - Environment.

Artificial Intelligence (AI)

- **Artificial Intelligence system** is composed of **Agent** and its **Environment**.
  - An agent (e.g., human or robot) is anything that can perceive its environment through sensors and acts upon that environment through effectors.
  - Intelligent agents must be able to set goals and achieve them.
  - **Machine perception** is the ability to use input from sensors (such as cameras, microphones, sensors, etc.) to deduce aspects of the world. e.g., Computer Vision.

Artificial Intelligence (AI)

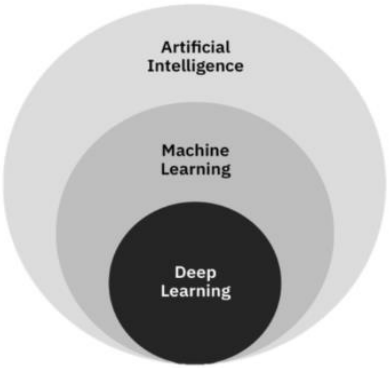
- **High-profile Examples of AI include**
  - Autonomous vehicles (such as drones and self-driving cars)
  - Medical diagnosis
  - Creating art (such as poetry)
  - Proving mathematical theorems
  - Playing games (such as Chess or Go)
  - Search engines (such as Google search)
  - Online assistants (such as Siri)
  - Image recognition in photographs
  - Spam filtering
  - Prediction of judicial decisions and
  - Online advertisements

Artificial Intelligence (AI)

- AI deals with the area of developing computing systems that are capable of performing tasks that humans are very good at.
  - Example: recognizing objects, recognizing and making sense of speech, and decision making in a constrained environment.
- **Machine Learning** is an advanced form of AI where the machine can learn as it goes rather than having every action programmed by humans.
- Machine learning, a fundamental concept of AI research since the field's inception, is the study of computer algorithms that improve automatically through experience.

Artificial Intelligence (AI)

- The term machine learning was introduced by Arthur Samuel in 1959.
- Neural networks are biologically inspired networks that extract features from the data in a hierarchical fashion.
- The field of neural networks with several hidden layers is called **deep learning.**



Need for Artificial Intelligence

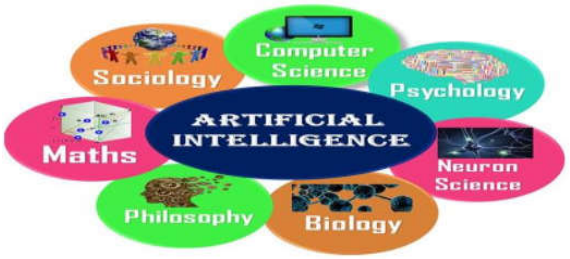
- **Why we need AI at this time?**
  1. To create expert systems that exhibit intelligent behavior with the capability to learn, demonstrate, explain and advice its users.
  2. Helping machines find solutions to complex problems like humans do and applying them as algorithms in a computer-friendly manner.

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.

What Comprises to Artificial Intelligence?

- To create the AI-first we should know that how intelligence is composed, so **Intelligence** is an intangible part of our brain which is a combination of Reasoning, learning, problem-solving, perception, language understanding, etc
- To achieve the above factors for a machine or software Artificial Intelligence requires the following **disciplines**



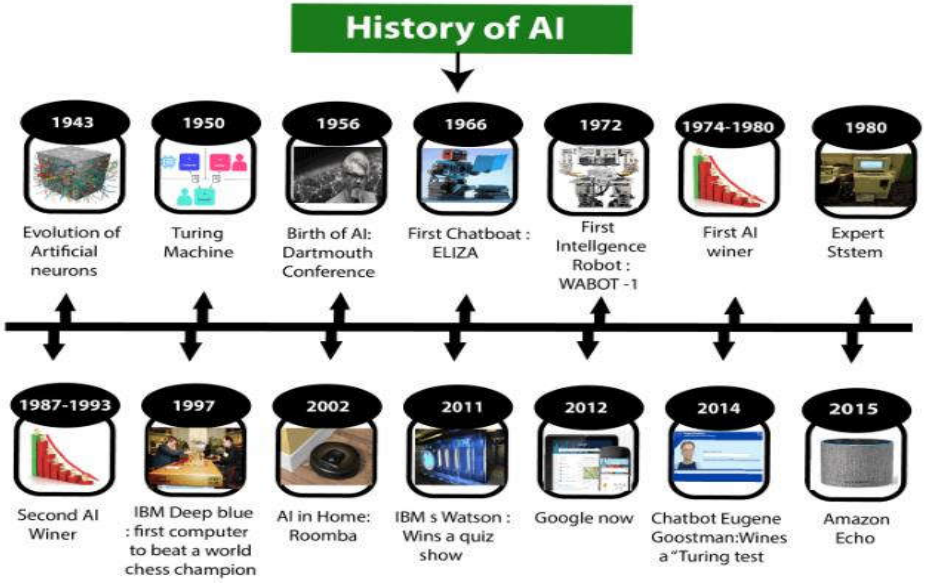
Advantages of Artificial Intelligence

- **High Accuracy with fewer errors:** AI machines or systems are prone to fewer 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 users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirements.
- **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 purposes, Natural language processing (for search engines, for spelling checker, for assistant like Siri, for translation like google translate), 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 humans, and may sometime be harmful for users if the proper care is not taken.
- **Increase dependence 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 AI [Reading Assignment]



History of AI

A. **Maturation of Artificial Intelligence (1943-1952)**

- **The 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.
- **The year 1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called Hebbian learning.
- **The 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 AI

B. The birth of Artificial Intelligence (1952-1956)

- **The year 1955:** An Allen Newell and Herbert A. Simon created the "first artificial intelligence program" Which was named "Logic Theorist". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- **The 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.

History of AI

C. The golden years-Early enthusiasm (1956-1974)

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

D. The first AI winter (1974-1980)

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

History of AI

E. A boom of AI (1980-1987)

- **The 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.

F. 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 due to high cost but not efficient results. The expert system such as XCON was very cost-effective.

History of AI

G. The emergence of intelligent agents (1993-2011)

- **The 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
- **The year 2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- **The year 2006:** AI came into the Business world until the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

History of AI

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

- **The year 2011:** In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve complex questions as well as riddles.
- Watson had proved that it could understand natural language and can solve tricky questions quickly.
- **The year 2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.

History of AI

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

- **The year 2014:** In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test"
- **The 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 hair dresser appointment on call, and the lady on the other side didn't notice that she was talking with the machine.

Levels of AI

- **Stage 1 – Rule-Based Systems**
  - Uses rules as the knowledge representation
  - Is a system that applies human-made rules to store, sort and manipulate data. In doing so, it mimics human intelligence.
  - It's a logical program that uses pre-defined rules to make deductions and choices to perform automated actions.
- **Stage 2 – Context Awareness and Retention**
  - Algorithms that develop information about the specific domain they are being applied in.
  - They are trained on the knowledge and experience of the best humans, and their knowledge base can be updated as new situations and queries arise.
  - Eg. chatbots and "robo advisors"

Levels of AI

- **Stage 3 – Domain-Specific Expertise**
  - **Expertise** and **Domain Specific Knowledge**.
  - These systems build up expertise in a specific context taking in massive volumes of information which they can use for decision making.
  - Eg. AlphaGo
- **Stage 4 – Reasoning Machines**
  - These algorithms have some ability to attribute mental states to themselves and others – they have a sense of beliefs, intentions, knowledge, and how their own logic works.
  - This means they could reason or negotiate with humans and other machines.
  - At the moment these algorithms are still in development, however, commercial applications are expected within the next few years

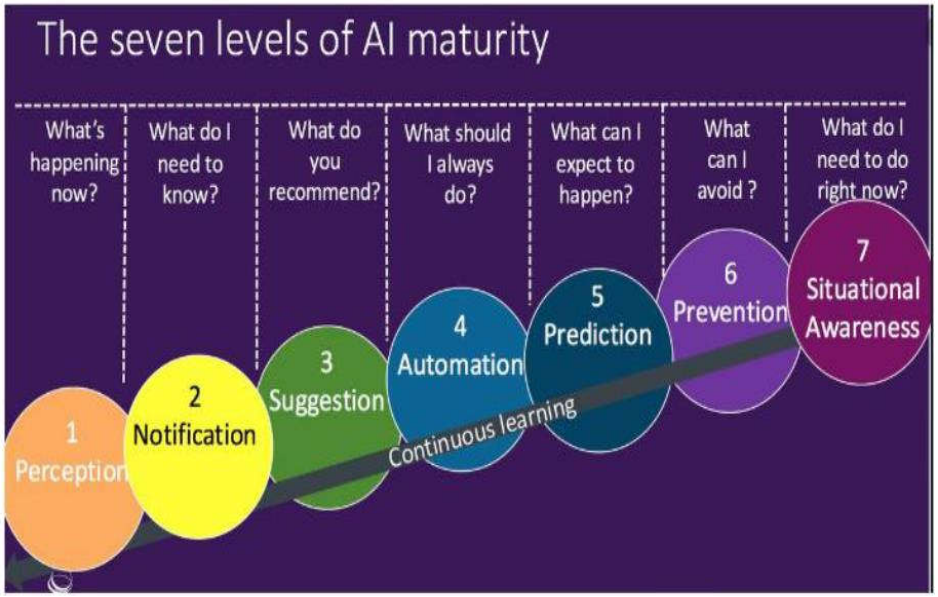
Levels of AI

- **Stage 5 – Self Aware Systems / Artificial General Intelligence (AGI)**
  - These systems have human-like intelligence
  - **AGI** is the **intelligence** of a machine that has the capacity to understand or learn any intellectual task that a human being can.
- **Stage 6 – Artificial Superintelligence (ASI)**
  - AI algorithms can outsmart even the most intelligent humans in every domain.
  - Logically it is difficult for humans to articulate what the capabilities might be, yet we would hope examples would include solving problems we have failed to so far, such as world hunger and dangerous environmental change.
  - A few experts who claim it can be realized by 2029.
  - Fiction has tackled this idea for a long time, for example in the film Ex Machina or Terminator.

Levels of AI

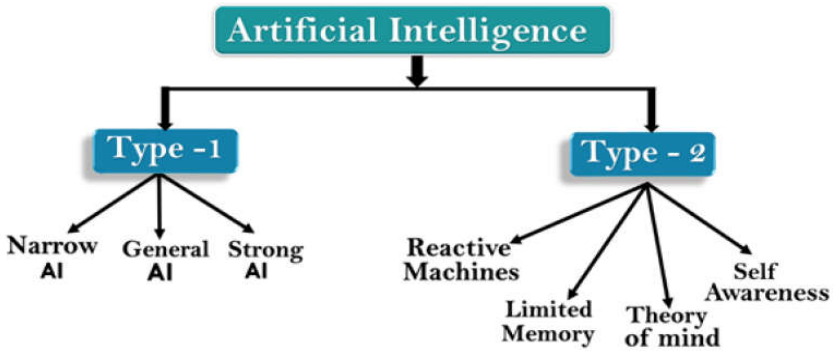
- **Stage 7 –Singularity and Transcendence**
  - This leads to a massive expansion in human capability.
  - Human augmentation could connect our brains to each other and to a future successor of the current internet, creating a "hive mind" that shares ideas, solves problems collectively, and even gives others access to our dreams as observers or participants.
  - Pushing this idea further, we might go beyond the limits of the human body and connect to other forms of intelligence on the planet – animals, plants, weather systems, and the natural environment.
  - Some proponents of singularity such as Ray Kurzweil, Google's Director of Engineering, suggest we could see it happen by 2045 as a result of exponential rates of progress across a range of science and technology disciplines.
  - The other side of the fence argues that singularity is impossible and human consciousness could never be digitized

Levels of AI



Types of AI

- Artificial Intelligence can be divided into various types, these are
  - **Based on Capabilities and**
  - **Based on Functionality**



Based on Capabilities

1. Weak AI or Narrow AI:

- Is a type of AI which is able to perform a dedicated task with intelligence.
- cannot perform beyond its field or limitations, as it is only trained for one specific task.
- Also called as **Weak AI.**
- Is the most common and currently available AI in the world
- Can fail in unpredictable ways if it goes beyond its limits.
- E.g. Apple Siri , IBM's Watson supercomputer ,Google translate, playing chess, purchasing suggestions on e-commerce sites, self-driving cars, speech recognition, and image recognition.

Based on Capabilities

2. General AI

- Is a type of intelligence that could perform any intellectual task with efficiency like a human.
- The idea behind the general AI to make such a system that could be smarter and think like a human on its own.
- Currently, there is no such system exists which could come under general AI and can perform any task as perfect as a human.
- As systems with general AI are still under research, and it will take lots of effort and time to develop such systems.

Based on Capabilities

3. Super AI

- Is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than a human with cognitive properties.
- This refers to aspects like general wisdom, problem solving and creativity.
- 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 on its own.
- Super AI is still a hypothetical concept of Artificial Intelligence.
- The development of such systems in real is still a world-changing task.

Based on Functionality

1. Reactive Machines:

- The most basic types of Artificial Intelligence
- Do not store memories or past experiences for future actions
- Only focus on current scenarios and react on it as per possible best action.
- Eg. IBM's Deep Blue system and Google's AlphaGo

Based on Functionality

2. Limited Memory

- 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.
- As the name suggests they have limited memory or short-lived memory
- Eg. **Self-driving cars** : can store the recent speed of nearby cars, the distance of other cars, speed limits, and other information to navigate the road.

Based on Functionality

3. Theory of Mind

- Understand human emotions, people, beliefs, and be able to interact socially like humans.
- Still not developed

4. Self Awareness

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

How Humans Think

- Intelligence or the cognitive process is composed of three main stages:
  - Observe and input the information or data in the brain.
  - Interpret and evaluate the input that is received from the surrounding environment.
  - Make decisions as a reaction towards what you received as input and interpreted and evaluated.

Mapping Human Thinking to AI Components

- Because AI is the science of simulating human thinking, it is possible to map the human thinking stages to the layers or components of AI systems.
- In the first stage, humans acquire information from their surrounding environments through human senses, such as sight, hearing, smell, taste, and touch, through human organs, such as eyes, ears, and other sensing organs, for example, the hands.
- In AI models, this stage is represented by the sensing layer, which perceives information from the surrounding environment.
- Eg: Sensors like voice recognition and visual imaging recognition

Influencers of Artificial Intelligence

- Influencers of AI includes:
  - **Big data:** Structured data versus unstructured data
  - **Advancements** in computer processing speed and **New chip** architectures
  - **Cloud computing and Application Program Interfaces**
    - Cloud computing is a general term that describes the delivery of on-demand services, usually through the internet, on a pay-per-use basis.
  - **The emergence of data science**
    - The goal of data science is to extract knowledge or insights from data in various forms, either structured or unstructured, which is like data mining.

Applications of Artificial Intelligence

- AI in agriculture
  - Very helpful for farmers
  - As agriculture robotics, solid and crop monitoring
- AI in Healthcare
  - to make a better and faster diagnosis than humans.
- AI in education
  - as a teaching assistant
  - Eg: chatbot
- AI in Finance and E-commerce
- AI in Gaming : eg chess
- AI in Social Media
  - To organize and manage massive amounts of data
- AI in Data Security
  - used to make your data more safe and secure.
- AI in Travel &Transport
  - Use chatbots which can make human-like interaction with customers
- AI in Robotics
- AI in Entertainment
- AI in the Automotive Industry

AI Tools and Platforms

- AI has developed a large number of tools to solve the most difficult problems in computer science, like:
  - Search and optimization
  - Logic
  - Probabilistic methods for uncertain reasoning
  - Classifiers and statistical learning methods
  - Neural networks
  - Control theory
  - Languages
- Most common artificial intelligence platforms include Microsoft AZURE Machine Learning, Google Cloud Prediction API, IBM Watson, TensorFlow, Infosys Nia, Wipro HOLMES, API.AI, Premonition, Rainbird, Ayasdi, MindMeld, and Meya.

Sample AI Application

- Commuting
  - Googles AI-powered predictions
  - Ridesharing Apps like Uber
- E-mail
  - Spam filters
  - Smart e-mail categorization
- AI in education
  - As a teaching assistant
  - Eg: chatbot
- Social Networking
  - Facebook
  - Instagram
- Online Shopping
  - Search (Amazon)
  - recommendations for products
- Mobile Use
  - Voice-to-text
  - Smart personal Assistants (Siri)

END OF CHAPTER THREE

Next: Chapter Four: IoT