Artificial Intelligence (AI)

CHAPTER THREE



3. Artificial Intelligence

Topics Covered

- Overview for Artificial Intelligence
  - Definition of Artificial Intelligence
  - Why Artificial Intelligence
  - Advantages and Disadvantages
  - Components of AI System
- History of AI
- Types of AI
  - How humans think
  - Mapping human thinking to artificial intelligence components
- Influencers of artificial intelligence
- Applications of AI

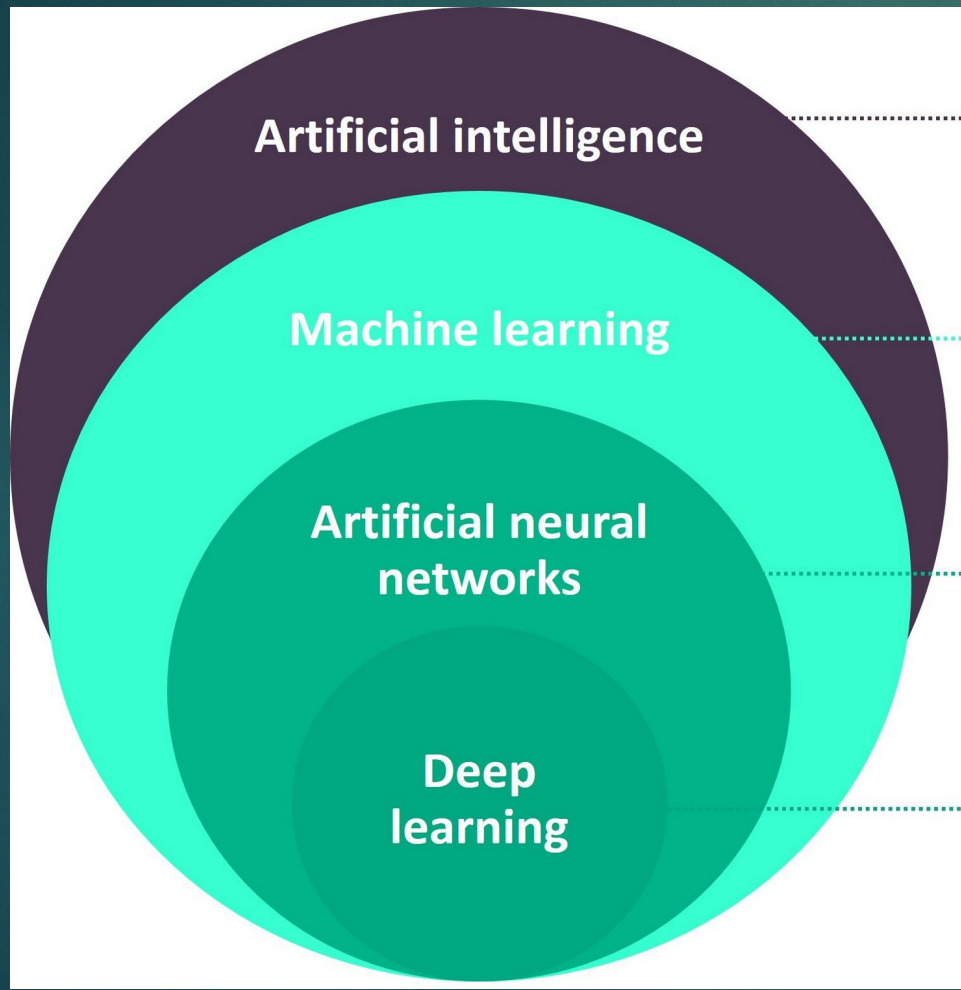
Introduction

- Artificial Intelligence is composed of two words Artificial and Intelligence
  - Artificial means "man-made," and
  - Intelligence defines "thinking power", or “the ability to learn and solve problems”
- Hence Artificial Intelligence means "a man-made thinking power."
- It is the imitation of human thinking to solve problems

Artificial Intelligence

- Artificial intelligence comprises integration of several technologies such as machine learning, natural language processing, reasoning, and perception
- 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.
- Generally , AI is the field of CS that is associated with the concept of machines “thinking like human” to perform tasks such as learning , problem solving , planning, reason and identifying patterns.

Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL)



Artificial intelligence (AI)
Any techniques that enable machines to solve a task in a way like humans do

Machine learning (ML)
Algorithms that allow computers to learn from examples without being explicitly programmed

Artificial neural networks (ANN)
Brain-inspired machine learning models

Deep learning (DL)
A subset of ML which uses deep artificial neural networks as models and automatically builds a hierarchy of data representations

Need for Artificial Intelligence

- To create expert systems that exhibit intelligent behavior
  - capability to learn, demonstrate, explain and advice its users.
- To find solutions to complex problems
- To automate the routine work
- To automates repetitive learning and discovery through data.
- To adapts through progressive learning algorithms
- To achieves incredible accuracy through deep neural networks

Goals of Artificial Intelligence

- The main goals of Artificial Intelligence:
  - Replicate human intelligence
  - Solve Knowledge-intensive tasks
  - 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, etc

What Comprises to Artificial Intelligence ?

- 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, AI requires the following disciplines:
  - Mathematics
  - Biology
  - Psychology
  - Sociology
  - Computer Science
  - Neurons Study
  - Statistics

Advantages of Artificial Intelligence

- Following are some main 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.

Advantages of Artificial Intelligence

- Following are some main advantages of Artificial Intelligence
  - **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

- Create a superintelligence that can threaten human existence.
- **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.

Components of AI system

1. **Applications**: Image recognition, Speech recognition, Chatbots, Natural language generation, and Sentiment analysis.
2. **Types of Models**: Deep learning, Machine learning, and Neural Networks.
3. **Software/Hardware for training and running models**: Graphic Processing Units (GPUs), Parallel processing tools (like Spark), Cloud data storage and computer platforms.
4. **Programming languages for building models**: Python, TensorFlow, Java, and C/C^{++}, etc.

History of AI

- Myths of Mechanical men in Ancient Greek and Egyptian Myths
- 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.
  - **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 hairdresser 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** : A rule-based system (e.g., production system, expert system) uses rules as the knowledge representation. These rules are coded into the system in the form of if-then-else statements. The main idea of a rule-based system is to capture the knowledge of a human expert in a specialized domain and embody it within a computer system. That's it. No more, no less. Hence, knowledge is encoded as rules.
- **Stage 2 – Context Awareness and Retention** : Algorithms that develop information about the specific domain they are being applied in. e.g. chatbots and "roboadvisors".
- **Context awareness** is the ability of a system or system component to gather information about its environment at any given time and adapt behaviors accordingly. **Contextual** or **context-aware** computing uses software and hardware to automatically collect and analyze data to guide responses.

Levels of AI

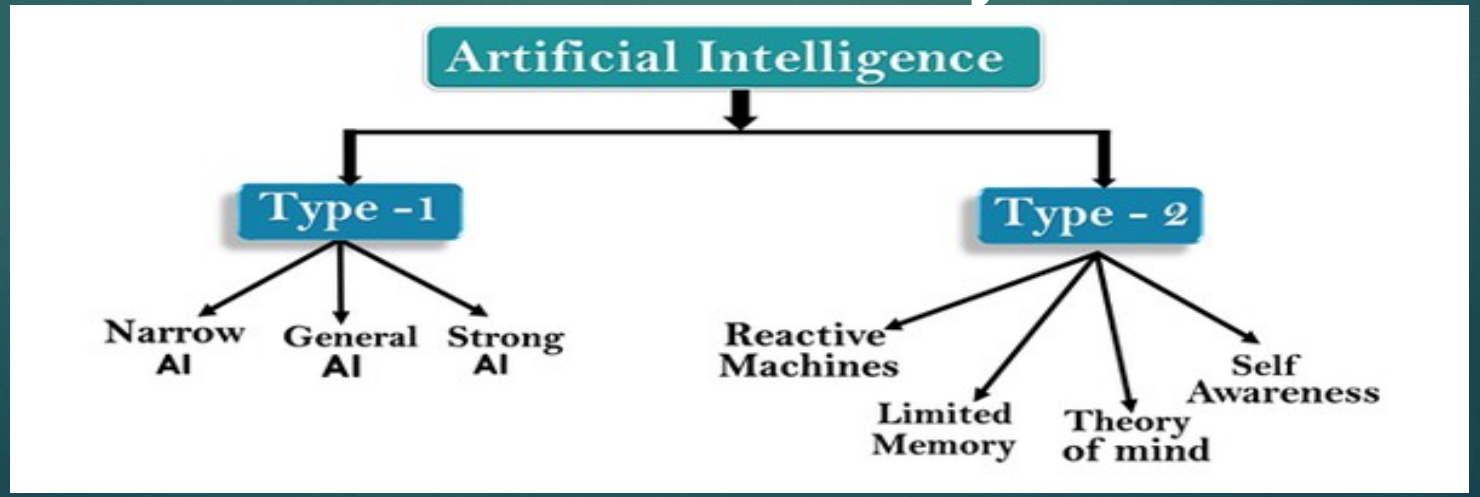
- **Stage 3 – Domain-Specific Expertise** : **Expertise** and **Domain Specific Knowledge**. An expert is a person with extensive **knowledge** about **a particular** subject matter or area of **expertise**. Much problem solving involves **domain-specific knowledge.**
- These systems build up expertise in a specific context taking in massive volumes of information which they can use for decision making. E.g. AlphaGo.
- **Stage 4 – Reasoning Machines** : **Machine reasoning** (MR) systems generate conclusions from available knowledge by using logical techniques like deduction and induction. They have a sense of beliefs, intentions, knowledge, and how their own logic works.

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. Experts claim it can be realized by 2029.
- **Stage 7 – Singularity and Transcendence** : is a hypothetical future point in time at which technological growth becomes uncontrollable and irreversible, resulting in unforeseeable changes to human civilization. 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.

Types of AI

- Artificial Intelligence can be divided into various types, there are mainly
  - Based on Capabilities
  - Based on the functionality



Based on Capabilities

1. **Weak AI or Narrow AI**: Narrow artificial intelligence is a specific type of AI that is used to perform a narrow task.
   - They are also called as Weak AI. Programmed to perform a single task, they lack the self-awareness, consciousness to perform Intelligent tasks.
   - The most common and currently available
   - 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:** These are the types that can impersonate human intelligence. They can think and perform tasks on their own just like a human being.
- They are self-aware and conscious to take decisions.
- General AI is a type of intelligence that could perform any intellectual task with efficiency like a human
- 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.

Super AI



Based on the functionality

- Based on functionalities there are 4 types:
  1. **Reactive Machines** : Reactive Artificial Intelligence is one of the basic forms of AI. They don’t have past memory or historic data to use and to make current decisions. Such machines work on the present, to perform a task that is right in front of them. **Example:** IBM chess program that beat Garry Kasparov
  2. **Limited Memory** : These AI systems can use past experiences to take future decisions. As the name suggests they have limited memory or short-lived memory. **Example:** self-driving cars

Based on the functionality

- **3. Theory of Mind AI:** Simply thinking like a human. This type of AI understands human emotions, thoughts and is able to interact socially.

- 4. **Self-Aware AI:** In this type of artificial intelligence the machines are self-conscious, and self-aware like humans. This can be a future of robots, though how pleasant will it be for humans will be an interesting thing to find out.

How humans think

- Achieving this goal might require many more years.
- 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.

There are sensing agents such as voice recognition for sensing voice and visual imaging recognition for sensing images

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- The second stage is related to interpreting and evaluating the input data.

In AI, this stage is represented by the **interpretation layer**, that is, reasoning and thinking about the gathered input that is acquired by the sensing layer.

- The third stage is related to taking action or making decisions.

After evaluating the input data, the interacting layer performs the necessary tasks. speech generation is example of function that is implemented in the interacting layer.

Influencers of artificial intelligence

- The following influencers of AI are described in this section:
  - Big data: Structured data versus unstructured data
  - Advancements in computer processing speed and new chip architectures
  - Cloud computing and APIs
  - The emergence of data science

Big Data

- Big data refers to huge amounts of data.
- Big data requires innovative forms of information processing to draw insights, automate processes, and help decision making.
- Big data can be structured data that corresponds to a formal pattern, such as traditional data sets and databases

Applications of AI

- AI in agriculture
- AI in Healthcare
- AI in education
- AI in Finance and E-commerce
- AI in Gaming
- AI in Social Media
- AI in Data Security
- AI in Travel &Transport
- 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

Sample AI application

- Email (Spam filtering)
- Social Networking
- Online Shopping
- Mobile Use

End of Chapter THREE !!!