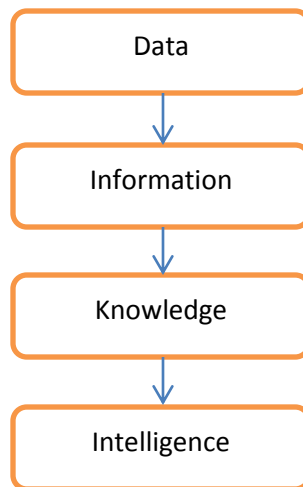# Unit-1   Artificial Intelligence

1.1   Introduction of AI

A branch of computer Science named Artificial Intelligence (AI) pursues creating the computer/machines as intelligent as human beings. John McCarthy the father of Artificial Intelligence described AI as, **"The science and engineering of making intelligent machines, especially intelligent computer programs".** Artificial Intelligence (AI) is a branch of computer science which deals with helping machines find solutions to complex problems in a more human-like fashion.

Artificial is defined in different approaches by researchers during its evolution, such as "Artificial Intelligence is the study of how to make computers do things which at the moment, people do better."

There are other possible definitions "like AI is a collection of hard problems which can be solved by humans and others living things, but for which we don't have good algorithms for Solving." e.g. understanding spoken natural language, medical diagnosis, circuit design, learning, self-adaptation , reasoning, chess playing, proving math theories, etc.

```
┌─────────────────────┐
│        Data         │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│     Information      │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│      Knowledge      │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│     Intelligence    │
└─────────────────────┘
```

- **Data:** Data is defined as symbols that present properties of objects events and their environment.
- **Information:** Information is massage that contain relevant meaning, implication, or input for decision and/or action.
- **Knowledge:** It is the (1) cognition or recognition (know-what), (2) capacity to   act (know-how), and(3) understanding (know -why)that resides or is contained within the mind or in the brain.

- **Intelligence:** It requires ability to sense the environment, to make decision, and to control action.

1.1.1 Concept:

Artificial intelligence is one of the emerging technologies that try to simulate human reasoning in AI systems The art and science of bringing learning, Adaptation and self-organization to the machine is the art of Artificial Intelligence is the ability of computer program to learn and think. Artificial Intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and reacts like humans. AI is built on these three important concepts

Machine learning: When you command your smartphone to call someone , or when you chat with customer service chatbot, you are interacting with software that run on AI. But this type of software actually is limited to what is has been programmed to do. However, we expect to soon have system that can learn new task without humans having to guide them. The idea is to give them a large amount of examples of any given chore, and they should be able to process each one and learn how to do it by the end of the activity.

Deep learning: The machine learning example I provide above is limited by the fact that humans still need to direct the AI's development. In deep learning the goal is for the software to use what it has learned in one area to solve problems in other areas. For examples ,a program that has learned how to distinguish images in a photograph might be able to use this learning to seek out patterns in complex graphs.

Neural network: This consist of computer programs that mimic the way the human brain process information. They specialize in clustering information and recognizing complex patterns , giving computers the ability to use more sophisticated processes to analyze dada.

1.1.2 Scope of AI:

The ultimate goal of artificial intelligence is to create computer programs that can solve problems and achieve goals like humans would. There is scope in developing machines in robotics, computer vision, language detection machine, game playing, expert systems, speech recognition machine and much more.

The following factors characterize a career in artificial intelligence:

- Automation
- Robotics

- The use of sophisticated computer software

Individuals considering pursuing a career in this field require specific education based on the foundation of math, technology, logic and engineering perspective. Apart from these, good communication skill(written and verbal) are imperative to convey how AI services and tools will help when employed within industry settings.

AI Aprroch:

The difference between and machine and human intelligence is that the human think /act rationally compare to machine . Historically, all four approaches to AI have been followed ,each by different people with different methods.

	Like Humans	Well
Think	GPS	Rational Agent
Act	Eliza	Heuristic systems

Think Well:

Develop formal models of knowledge representation, reasoning, learning, memory, problem solving that can be rendered in algorithms. There is often an emphasis on system that are provably correct, and guarantee finding an optional solution.

Act Well:

For given set of inputs, generate an appropriate output that is not necessarily correct but gets the job done.

- **A heuristic(heuristic rule, heuristic method) is rule of thumb, strategy ,trick,** simplification. Or any other kind of device which drastically limits search for solutions in large problem spaces.
- Heuristics do not guarantee optimal solution: in fact they do not guarantee any solution at all:
- All that can be said for useful heuristic is that is offers solutions which are good enough most of the time

Think like humans:

Cognitive science approach. Focus not just on behavior and I/O but also look at reasoning process.

The computational model should reflect "how" results were obtained. Provide a new language for expressing cognitive theories and new mechanisms for evaluating them.

GPS(General Problem Solver):Goal no just to produce human like behavior(like ELIZA),but to produce a sequence of steps of reasoning process that was similar to the steps followed by a person in solving the same task.

Act like humans:

Behaviorist approach-Not interested in how you get results, just the similarity to what women results are.

Examples: ELIZA: A program that simulated a psychotherapist interacting with patient and successfully passed the turning test. It was coded at MIT during 1964-1966 by Joel Weizenbaum. First script was DOCTOR. The script was a simple collection of syntactic patterns not unlike regular expressions. Each patterns had an associated reply which might include bits of the input (after simple transformation(my $\longrightarrow$ your) Weizenbaum was shocked at reactions: psychotherapist thought it had potential. People unequivocally anthropomorphized.

1.1.3 Components of AI

The core components and constituents of AI are derived from the concept of logic ,cognition and computation; and the compound components, built-up through core components are knowledge, reasoning, search, natural language processing, vision etc.

Level	Core	Compound	Coarse components
Logic	Introduction Proposition Tautology Model Logic	Knowledge Reasoning Control Search	Knowledge based systems Heuristic search Theorem Proving
Cognition	Temporal Learning Adaptation Self-organization	Belief Desire Intension	Multi Agent system Co-operation Co-ordination AI Programming
Functional	Memory		Vision

	Perception	Utterance	Natural language Speech Processing

The core entities are inseparable constituents of AI in that these concepts are fused at atomic level. The concepts derived from logic are propositional logic, tautology, predicate calculus, model and temporal logic. The concepts of cognitive science are two types: one is functional which includes learning , adaptation and self-organization, and the other is memory and perception which are physical entities. The physical entities generate some functions to make the compound components

The compound components are made of some combination of the logic and cognition stream. These are knowledge , reasoning and control generated from constituents of logic such as predicate calculus , induction and tautology and some from cognition (such as learning and adaptation). Similarly, belief ,desired and intention are models of mental states that are predominantly based on the cognitive components but less on logic. Vision, utterance (vocal)and expression(written) are combined effect of memory and perceiving organs or body sensors such as ear, eyes and vocal. The gross level contain the constituents at the third level which are knowledge-based systems (KBS),heuristics search, automatic theorem proving, multi agent system ,AI language processing(NLP).

AI Dimension: The philosophy of AI in three-dimension representation consists in logic, cognition and computation in the x-direction , knowledge , reasoning and interface in the y-direction. The x-y plane is the foundation of AI. The z-direction consists of correlated systems of physical origin such as language , vision and perception as shown in figure.1.1

The First Dimension (core)

The theory of logic, cognition and computation constitutes the fusion factors for the formation of one of the foundation on x-axis. Philosophy from its very inception of origin covered all the fact, direction and dimension of human thinking output. Aristotle's theory of syllogism, Descartes and kant's critic of pure reasoning and contribution of many other philosophers made knowledge-based on logic. It were Charles Babbage and Boole who demonstrated the power of computation logic. Although the modern philosopher such as Bertrand Russell correlated logic with mathematic but it was Turning who developed the theory of computation for mechanization . In the 1960, Marvin Minsky pushed the logical formation to integrate with knowledge.

Cognition

Computers has become so popular in short span of time due to the simple reason that they adapted and projected the information processing paradigm (IIP) of human beings: sensing organs as input, mechanical movement organs as output and the central nervous system (CNS) In brain as control and computing devices, short-term and long-term memory were not distinguished by computer scientists but, as a whole , it was in conjunction, termed memory.

In further deepening level, the interaction of stimuli with the stored information to produce new information requires the process of learning , adaptation and self-organization. These functionalities is the information processing at certain level of abstraction of brain activities demonstrate a state of mind which exhibits certain specific behavior to qualify as intelligence. Computational models were developed and incorporated in machines which mimicked the functionalities of human origin. The creation of such traits of human beings in the computing devices and processes originated the concept of intelligence in machine as virtual mechanism. These virtual machines were termed in due course of time artificial intelligent machines.

Computation

The theory of computation developed by Turing-finite state automation ----was turning point in mathematical model to logic computational. Chomsky's linguistic computational theory generated a model for syntactic a regular grammar.

The Second Dimension

The second dimension contains knowledge, reasoning interface which are the components of knowledge-based system (KBS). Knowledge can be logical, it may be processed as information which is subject to further computation. These means that any item on the y-axis is correlated with any item on the x-axis to make the foundation of any item on the z-axis knowledge and

reasoning are difficult to prioritize, which occurs first : whether knowledge is formed first and then reasoning is performed or as reasoning is present , knowledge is formed. Interface is means of communication between one domain to another. Here, it can notes a different concept then the user's interface. The formation of permeable membrane or transparent solid structure between two domains of different permittivity is termed interface. For examples in the industrial domains, the robot is an interface. A robot exhibits all traits of human intelligence in its course of action to perform mechanical work. In the KBS, the users interface is an example of the interface between computing machines and the users. Similarly, a program is an interface between the machine and the users. The interface may be between human and human , i.e. experts in one domain to experts in another domain. Human-to-machine is program and machine-to-machine is hardware. These interface are in the context of computation and AI methodology.
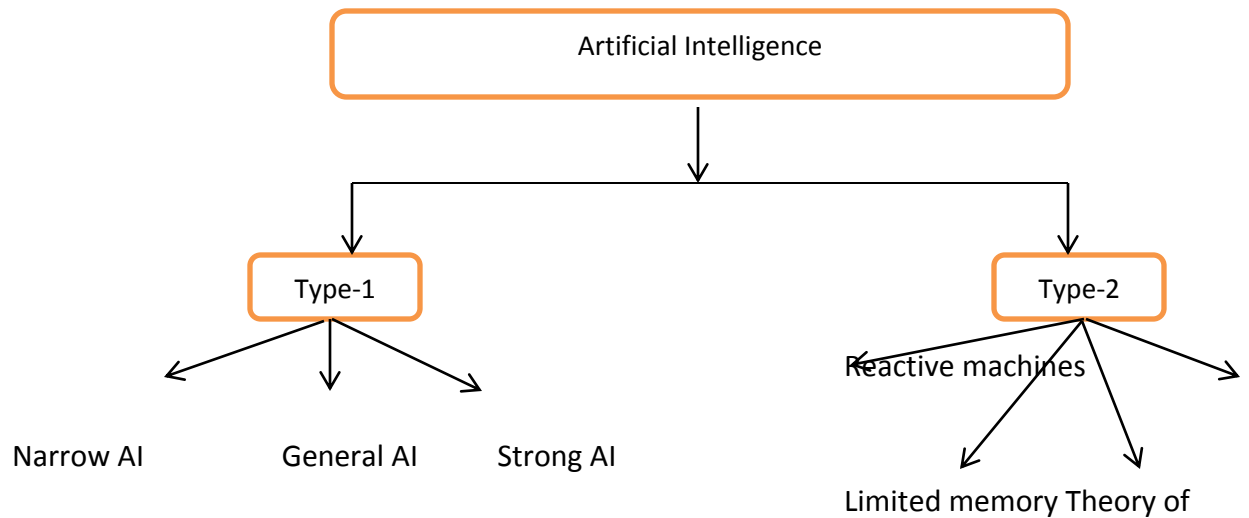
The Third Dimension

The third dimension leads to the orbital or peripheral entities, which are built on the foundation of x-y plane and revolve around these for development. The entities include an information system. NLP, for example, is formed on the basic of the linguistic computation theory of Chomsky and concepts of interface and knowledge on y-direction. Similarly, vision has its basic on some computational model such as clustering, pattern recognition computation models and image processing algorithms on the x-direction and knowledge of the domain on the y-direction.

The third dimension is basically the application domain. Here, if the entities are near the origin, more and more concepts are required from x-y plane. For examples, consider information and automation, these are far away from entities on z-direction, but contain some of the concepts of cognition and computation models respectively on x-direction and concepts knowledge (data), reasoning and interface on the y-direction. In general, any quantity in any dimension is correlated with some entities on the other dimension.

The implementation of the logical formalism was accelerated by the rapid growth in electronic technology, in general and multiprocessing parallelism in particular.

1.1.4 Types of AI

Artificial Intelligence can be divided in various type, there are mainly two types of main categorization which are based on capabilities and based on functionally of AI. Following is flow diagram which explain the type of AI.

```
                    ┌─────────────────────────────┐
                    │   Artificial Intelligence   │
                    └──────────────┬──────────────┘
                                   │
                    ┌──────────────┴──────────────┐
              ┌──────────┐                   ┌──────────┐
              │  Type-1  │                   │  Type-2  │
              └──────────┘                   └──────────┘
```

Narrow AI   General AI   Strong AI

Reactive machines

Limited memory Theory of

AI type-1: Based on Capabilities

1.Weak AI or Narrow AI:

- Narrow AI is type of AI which is able to perform a dedicated 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 limitation, 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.
- Apples Siriis a good example of narrow AI, but it operate with a limited pre-defined range of function.
- 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.

2. General AI

- General AI is type of intelligence which could perform any intellectual task with efficiency like 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.

3.Super AI:

- Super Ai is level of Intelligence of System at which machines could surpass human intelligence ,and can perform any 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 system in real is still world changing task.

Artificial Intelligence ype-2: Based on functionality

1.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.

2.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 best examples of Limited Memory systems. These cars can

Store recent speed of nearby cars, the distance of store cars, speed limit, and other information to navigate the road .

3.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.

4.Self-Awareness

- Self –awareness AI is the future of Artificial Intelligence .These machines will be super intelligent, and will have their own consciousness ,sentiment, 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.

1.1.5 Application of AI

AI has been dominant in various fiddles such as-

- **Gaming :** AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc. where machine can think of large number of possible positions based on heuristic knowledge.
- **Natural Language Processing:** In is possible to interact with the computer that understands natural language spoken by humans.
- **Expert Systems :** There are some applications which integrate machine ,software ,and special information to impart reasoning and advising . They provide explanation and advice to the users.
- **Vision systems:** These systems understand ,interpret, and comprehend visual input on the computer. For example,
  - A spying aeroplane takes photographs, which are used to figure out spatial information or map of the areas.
  - Doctor use clinic expert system to diagnose the patient.
  - Police use computer software that can recognize the face of the criminal with the stored portrait made by forensic artist.

- **Speech Recognition: some intelligent** system are capable of hearing and comprehending the languages in term of sentences and there meanings while a human talks to it. It can handle different accents, slang words , noise in the background , change in the human noise due to cold, etc.
- **Handwriting recognition:** The handwriting recognition software read the text written on paper by a pen or on screen by a stylus. It can recognize the shape of the latter and convert it into editable text.
- **Intelligent Robot:** Robots are able to performs the tasks given by human. They have sensors to detect physical data from the real word such as light, heat, temperature, movement, sound, bump and pressure. They have efficient processors, multiple sensor

and huge memory, to exhibit intelligence. In addition, they are capable of learning from there mistake and they can adapt to the new environment.

1.2 Concept of machine learning and deep learning
1.2.1 Machine Learning:

- Machine learning is branch of science that deals with programming with system in such way that they automatically learn and improve with experience. Here , learning means recognizing and understanding the input data and making wise decision based on the supplied data.

- It is very difficult to cater to all the decisions based on all possible inputs. To tackle this problem, algorithms are developed. These algorithms build knowledge from specific data and past experience with the principals of statistics ,probability theory , logic, combinatorial, search, reinforcement learning, and control theory.
The developed algorithms from the basic of various applications such as:

- Vision processing
- Language processing
- Forecasting (e.g., stock market trends)
- Pattern recognition
- Games
- Data mining
- Expert systems
- Robotics

Machine learning is a vast area and it is quit beyond the scope of this tutorial to cover all its features. There are several ways to implement machine learning techniques, however the most commonly used ones are **supervised** and **unsupervised learning.**

Supervised learning: Supervised leaning deals with learning a function from available training dada. A supervised learning algorithm analyzes the training dada and produces an inferred function, which can be used for mapping new examples. Common examples of supervised learning include:

- Classifying e-mails as span,
- Labeling webpages based on their content, and
- Voice recognition.

There are many supervised learning algorithms such as neural networks, supports vector machines (SVMs), and Naïve Bayes classifiers. Mahout implements Naive Bayes classifiers

Unsupervised Learning: unsupervised learning make sense of unlabeled data without having analyzing available data and look for patterns and trends. It is most commonly used for

clustering similar input into logical groups. Common approaches to unsupervised learning include:

- K-means
- Self-organizing maps, and
- Hierarchical clustering

1.2.2 Deep Learning

Deep leaning is subfield of machine learning where concerned algorithms are inspired by the structure and function of brain called artificial neural network .

All the value today of deep learning is through supervised learning or learning from labeled data and algorithms.

Each algorithm in deep learning goes through the same process. It includes a hierarchy of nonlinear transformation of input that can be used to generate a statistical model as output.

Consider a following steps that defined the machine learning and prepare them for analysis.

- Identifies the relevant data sets and prepare them for analysis.
- Choose the type of algorithm on the algorithm used.
- Trains the model on test data sets, revising its as needed.
- Runs the model to generate test scores.

Deep learning has evolved hand-in-hand with the digital era, which has brought about an explosion of data in all forms and from every region of the world. This dada, known simply as big data, Is drawn from source like a social media , internet search engines, e-commerce platforms, and online cinemas, among others. This enormous amount of dada is readily accessible and can be shared through fintech application like cloud computing.

However , the data which normally unstructured, is so vast that it could take decades for humans to comprehend it and extract relevant information .companies realize the incredible potential that can result from unraveling this wealth of information and are increasingly adapting to AI systems for automated supports.

Applications of Machine Learning and Deep Learning

- Computer vision which is used for facial recognition and attendance mark through fingerprints and vehicle identification through number plate.
- Information Retrieval from search engines like text search for image search.
- Automated email marketing with specified target identification.
- Medical diagnosis of cancer tumors or anomaly identification of any chronic disease.

- Natural languages processing for application like photo tagging. The best example to explain this scenario used in Facebook.
- Online advertising.