1.1 WHAT IS AI?

It is a branch of Computer Science that pursues creating the computers or machines as intelligent as human beings.

It is the science and engineering of making intelligent machines, especially intelligent computer programs.

It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biological observable.

1.1.1 Introduction

Artificial intelligence (AI) is a relatively recent branch of science and engineering. Soon after World War II, work began in earnest, and the term was coined in 1956. In addition to molecular biology, AI is frequently mentioned by scientists from other fields as the "field I'd most like to be in."

A physics student may fairly believe that all of the good ideas have already been taken.

Galileo, Newton, and Einstein are three of the most famous scientists of all time.

Definition: Artificial Intelligence is the study of how to make computers do things, which, at the moment, people do better.
According to the father of Artificial Intelligence, John McCarthy, it is “The science and
engineering of making intelligent machines, especially intelligent computer programs”.

Artificial Intelligence is a way of making a computer, a computer-controlled robot, or a
software thinks intelligently, in the similar manner the intelligent humans think.

AI is accomplished by studying how human brain thinks and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

It has gained prominence recently due, in part, to big data, or the increase in speed, size and variety of data businesses are now collecting. AI can perform tasks such as identifying patterns in the data more efficiently than humans, enabling businesses to gain more insight out of their data.
From a business perspective AI is a set of very powerful tools, and methodologies for using those tools to solve business problems.
Intelligence

Because our intelligence is so vital to us, we call ourselves Homosapiens-man the wise. For thousands of years, scientists have attempted to

comprehend how we think: how a small amount of matter can see, comprehend, predict, and manage a world considerably larger and more sophisticated than itself. Artificial intelligence, or Al, is a field that goes even further.

1.2 FOUNDATIONS OF AI

Now we discuss the various disciplines that contribute ideas, viewpoints and techniques to AI.

Philosophy provide base to AI by providing theories of relationship between physical brain and mental mind, rules for drawing valid conclusions. It also provides information about knowledge origins and the knowledge needs to actions.

Mathematics gives strong base to AI to develop concrete and formal rules for drawing valid conclusions, various methods for date computation and techniques to deal with uncertain information.

Economics support AI to make decisions so as to maximum payoff and make decisions under certain circumstances.

Neuroscience gives information which is related to brain processing which helps AI to developed date processing theories.

Psychology provides strong concepts of how humans and animals act which helps AI for developing process of thinking and actions.

Historically there are four approaches to AI have been followed, each by different people with different methods. A rationalist approach involves a combination of mathematics and engineering. The various group have both disparaged and helped each other.

Intelligent Systems

In order to design intelligent systems, it is important to categorize them into four categories (Luger and Stubberfield 1993), (Russell and Norvig, 2003)

1. Systems that think like humans
2. Systems that think rationally
3. Systems that behave like humans
4. Systems that behave rationally

	Human-Like	**Rationally**
Think :	Cognitive Science Approach "Machines that think like humans"	Laws of thought Approach "Machines that think Rationally"
Act :	Turing Test Approach "Machines that behave like humans"	Rational Agent Approach "Machines that behave Rationally"

1.2.1 Acting Humanlay: The Turing Test Arrpoach

Turing test: a method of determining intellect. Turing Test was conceived by Alan Turing in 1950. He proposed a test based on common characteristics that can be matched to the most intelligent entity on the planet – humans.

Computer would need to process the following capabilities:

I) Natural language processing - In order for it to be able to communicate effectively in English.

II) Knowledge representation to store what it knows, what it hears.

III) Automated reasoning to make use of stored information to answer questions being asked and to draw conclusions.

IV) Machine learning to adapt to new circumstances and to detect and make new predictions by finding patterns.

V) Turing also proposed that the interrogator and the computers engage physically. The Turing test avoids this, but the Total Turing Assess includes a video signal to allow the interrogator to test the subject's perceptual abilities, as well as the ability to pass physical things "through the hatch."

VI) To pass total Turing test in addition, computer will need following capabilities.

VII) Computer vision to perceive objects.

VIII) Robotics to manipulate objects.

1.2.2 Thinking Rationally: The “Laws of Thought” Approach

Because we're claiming that the given software thinks like a human, we need to understand how humans think. The theory of human minds must be investigated in order to achieve this. There are two methods for doing so: introspection (trying to catch our own thoughts as they pass us by) and psychological experiments.

We can argue that some of the program's mechanisms are also operating in human mode if computer programmers’, input, output, and timing behaviors’ mirror similar human behaviors. Cognitive science is an interdisciplinary study that draws together computer models from AI and experimental approaches from psychology to try to build accurate and testable explanations of how the human mind works.

1.2.3 Thinking Rationally: The “Laws of Thought” Approach

“Right thinking” concept was introduced by Aristotle. Patterns for argument structures that always gives correct decisions when the premises are correct. It is known as the laws of thought approach.

"The study on mental faculties through the use of computational models. (Charmiakand McDemott, 1985)

"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)

Law of thought were supposed to govern the operation in the mind; their study initiated the field called Logic which can be implemented to create the system which is known as intelligent system.

1.2.4 Acting Rationally: The Rational Agent Approach

Something that acts is called an agent (Latin agre-to-do). Computer agents, on the other hand, are intended to have additional characteristics that separate them from "programmes," such as independent control, time perception, adaptability to change, and the ability to take on new goals. When there is uncertainty, a rational agent is required to act in such a way that the best possible outcome is achieved. The laws of thought emphasis on correct inference which should be incorporated in rational agent.

“Computational Intelligence is the study of the design of intelligent agents.” By Poole et at, 1998

1.2.5 Categorization of Intelligent Systems

There are various types and forms of AI. The various categories of AI can be based on the capacity of intelligent program or what the program is able to do. Consideration of the above factors there are three main categories:

1) Weak AI (Artificial Narrow Intelligence)
2) Strong AI (Artificial General Intelligence)
3) Artificial Super Intelligence

1) **Weak AI :** Weak AI is AI that focuses on a single task. It isn't an intellect that can be used in a variety of situations. Narrow intelligence or weak AI refers to an intelligent agent that is designed to solve a specific problem or perform a certain task. For example, it took years of AI research to beat the chess grandmaster, and humans still haven't beaten the machines at chess since then. But that's all it can do, and it does it exceptionally well.

2) **Strong AI :** Strong AI, often known as general AI, refers to machine intelligence proven in the performance of any cognitive task that a person can execute. It is far more difficult to construct powerful AI than it is to develop weak AI. Artificial general intelligence machines can display human qualities such as reasoning, planning, problem solving, grasping complicated ideas, learning from personal experiences, and so on by using artificial general intelligence. Many corporations and companies are working on developing general intelligence, but they have yet to finish it.

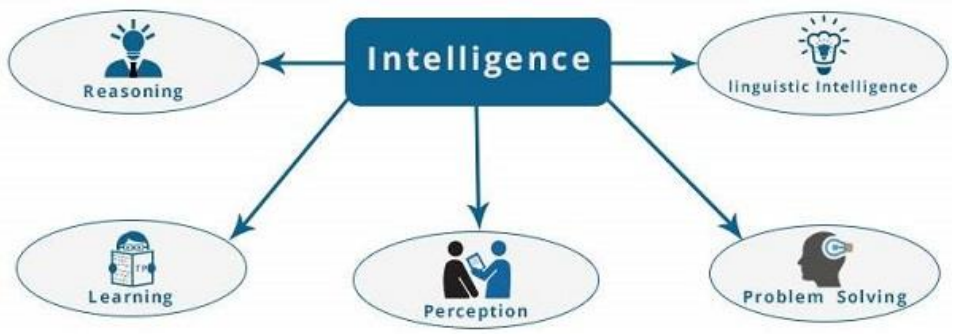
3) **Artificial Super-Intelligence :** AI thinker Nick Bostrom defined "Super intelligence is an intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills." Super intelligence ranges from a machine which is just a little smarter than a human to a machine that is trillion times smarter. Artificial super intelligence is the ultimate power of AI.

Weak AI	**Strong AI**
It is a narrow application with a limited scope.	It is a wider application with a more vast scope.
This application is good at specific tasks.	This application has an incredible human-level intelligence.
It uses supervised and unsupervised learning to process data.	It uses clustering and association to process data.
Example Siri, Alexa	Example Advanced Robotics

1.2.6 Components of AI

The intelligence is intangible. It is composed of −

- Reasoning
- Learning
- Problem Solving
- Perception
- Linguistic Intelligence



Let us go through all the components briefly −

- Reasoning − It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction. There are broadly two types −

Inductive Reasoning	Deductive Reasoning
It conducts specific observations to makes broad general statements.	It starts with a general statement and examines the possibilities to reach a specific, logical conclusion.
Even if all of the premises are true in a statement, inductive reasoning allows for the conclusion to be false.	If something is true of a class of things in general, it is also true for all members of that class.
Example − "Nita is a teacher. Nita is studious. Therefore, All teachers are studious."	Example − "All women of age above 60 years are grandmothers. Shalini is 65 years. Therefore, Shalini is a grandmother."

- Learning − It is the activity of gaining knowledge or skill by studying, practising, being taught, or experiencing something. Learning enhances the awareness of the subjects of the study.

  The ability of learning is possessed by humans, some animals, and AI-enabled systems. Learning is categorized as −

  - Auditory Learning − It is learning by listening and hearing. For example, students listening to recorded audio lectures.
  - Episodic Learning − To learn by remembering sequences of events that one has witnessed or experienced. This is linear and orderly.
  - Motor Learning − It is learning by precise movement of muscles. For example, picking objects, Writing, etc.
  - Observational Learning − To learn by watching and imitating others. For example, child tries to learn by mimicking her parent.
  - Perceptual Learning − It is learning to recognize stimuli that one has seen before. For example, identifying and classifying objects and situations.
  - Relational Learning − It involves learning to differentiate among various stimuli on the basis of relational properties, rather than absolute properties. For Example, Adding ‘little less’ salt at the time of cooking potatoes that came up salty last time, when cooked with adding say a tablespoon of salt.
  - Spatial Learning − It is learning through visual stimuli such as images, colors, maps, etc. For Example, A person can create roadmap in mind before actually following the road.

- Stimulus-Response Learning − It is learning to perform a particular behaviour when a certain stimulus is present. For example, a dog raises its ear on hearing doorbell.

- Problem Solving − It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.

  Problem solving also includes decision making, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.

- Perception − It is the process of acquiring, interpreting, selecting, and organizing sensory information.

  Perception presumes sensing. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.

- Linguistic Intelligence − It is one's ability to use, comprehend, speak, and write the verbal and written language. It is important in interpersonal communication.

1.2.7 Computational Intelligence (CI) Vs Artificial Intelligence (AI)

Computational Intelligence (CI)	Artificial Intelligence (AI)
Computational Intelligence is the study of the design of intelligent agents.	Artificial Intelligence is the study of making machines which can do things which at presents human do better.
Involvement of numbers and computations.	Involvement of designs and symbolic knowledge representations.
CI constructs the system starting from the bottom level computations, hence follows bottom-up approach.	AI analyses the overall structure of an intelligent system by following top down approach.
CI concentrates on low level cognitive function implementation.	AI concentrates on high level cognitive structure design.

1.3 HISTORY OF ARTIFICIAL INTELLIGENE

John McCarthy in 1955 introduced the term Artificial Intelligence.

The early work of Artificial Intelligence was done in the period 1943 to 1955. The first AI thoughts were formally put by McCulloch & Walter Pitts in the year 1943. They introduced with the concept of AI was based on different three theories. First theory is based on phycology i.e. Neuron functions in the brain. Second theory is based on formal analysis of

propositional logic and third theory is based on Turing's theory of computations.

1956-61

The first year of this period gave rise to the terminology 'Artificial Intelligence' proposed by McCarthy & supposed by the participants in the conference. In the same year Samuel developed a program for chess playing which performed better than its creator.

Around 1956-57, Chomsky's grammar in NLP i.e. linguistic model processing was a remarkable event. In 1958, McCarthy made a very significant contribution, development of LISP, an AI programming language and advice taker which combined the method of knowledge representation and resoning. Herbert Gelerriter at IBM in 1959 designed the first written AI program for geometry theorem proving in quick succession of time. In 1960, Window alone & then with Hoff developed networks called 'Adaline', based on the concepts of Hebbian learning. In 1956-57, logic theorist (LT), a program for automatic theorem proving was developed.

1962-67

At the beginning of this period Frank Rosen blatt proposed the concept of 'perception' in the line of Window's concept for artificial neural networks (ANN), a biological model to incorporate computational rationality. In 1963. McCarthy developed a general purpose logical reasoning method and it was enhanced by the Robinson's 'Resolution principle' (Robinson, 1965). The logical neural model of McCulloch and Pitts was enhanced by Winograd & Cowan in 1963. James Slage's program was developed for the interpretation of calculus in 1963. In 1965, Hearsay was developed at CMU for natural language interpretation of subset language.

1968-73

In this period, some AI program for practical use were developed. In 1967, David Bobrow developed 'STUDENT' to solve algebra story problems. The first knowledge-based expert system DENDRAL was developed by J. Lederber, Edward Feigenbaum and Carl Djerassi in 1968, although the work had started in 1965. The program discovered the molecular structure of an organic compound based on the mass spectral data. Simon stated that within 10 years a computer would be chess champion, & a significant mathematical theorem would be proved by machine. These predictions came true or approximately true within 40 years rather than 10.

The new back-propagation learning algorithms for multilayer networks that were to cause an enormous resurgence in neural-net research in the late 1980's were actually discovered first in 1969.

1974- 1980

In 1969 Minsky and Papert's book Perceptron's proved that perceptrons could represent vary little. Although their result did not apply to more

complex, multilayer networks, research funding for neural-net research soon dwindled to almost nothing.

In 1973 Professor S ir James Lightill mentioned the problem of combinatorial explosion or intractability which implied that many of AI's most successful algorithms would grind to a halt on real world problems and were only suitable for solving "toy" versions.

1981-1985

In this period many expert system shells, expert system tools and expert system programs were developed. During 1984-85 the expert system shells came into picture was EMYCIN by Buchanan, a rule-based diagnostic consultant based on LISP, EXPERT by Weiss and KAS by DUDE are the rule-based model for classification using FORTRAN; a semantic network-based system using LISP, others are knowledge crafts by GILMORE using object-oriented programming (OGP), KL-ONE by Brakeman using LISP for automatic inheritance. The most important development was PROLOG as AI programming language by Clockcin 1984.

1986-91

In this period significant developments occurred in ANN model in particular, the appearance of error back propagation algorithm formulated by Rumelhart and Hinton in parallel distributed processing. The probabilistic reasoning method in intelligent system appeared in 1988 by the work of Pearl. The distributed artificial intelligence concepts were formally incorporated in the multi-agent systems. The complete agent-based architecture was first implemented in a model SOAR, designed by Newel, Laired and Rosenbloom. Hidden Markov Model (HMM) was also conceptualized for speech processing and natural language processing during this period.

1992-97

In this period full swing of rise to the agent-based technology and multi-agent system (MAS). In 1992, Nawana brought the concept of autonomous agent, capable of acting independently with rationality. Different kinds of agent were defined. In 1994, Jennings Yoam introduced social and responsible agents, Yoam Shoham in 1993, described the concept of agent-oriented programming with different components and modalities. Belief, desire and intention (BDI) theory was introduced by Cohen (1995) during this period. The concept of cooperation, coordination and conflict resolution in MAS was introduced in this period.

In the NLP, a mean X-project was developed at Zurich by Nobel laureate Gerd Binning, who emphasized the use of word 'knowledge' to achieve comprehension. Gordon made a model language for representing strategies on standard AI planning techniques. The ABLE (Agent Building & Learning Environment) was developed by Joe Bigns, which focused on building hybrid intelligent agents for both reasoning and learning.