# 1 Why to Study Artificial Intelligence?

The human brain is a biological computer which has an estimated $10^{11}$ tiny units called **neurons**. These neurons are interconnected with an estimated $10^{15}$ links. Here the most significant fact is, as the number of neurons increases, the number of possible interconnections grows exponentially. Artificial Intelligence is designed to identify and understand the thought processes of mind. In one word AI strategy is based upon emulation of the intelligence which is exhibited by the human mind.

Human brains have some limitations in computing, a large computation cannot be done in a fraction of second by human brain, and also it will not guarantee correctness. Forgetfulness is another negative aspect of human brain. Sometimes thought process of human brain is become biased. Huge amount of knowledge-base does not exist in human brain i.e. human brain has very limited knowledge base and nature of thought process is serial. Serial knowledge processing of brain leads to very slow progress of knowledge processing with compared with computers. These aspects of human brains lead the way to design a mechanism which will attempt to unify all human thought process along with precision, un-biasness.

Artificial Intelligence performs intelligent calculations with an enormous speed and accuracy. Now, the question is which computations are intelligent and which are not? The term intelligent itself is vague. It is difficult to define human intelligence but in terms of computation we can easily distinguish. For example, purely numeric computations, such as adding and multiplying numbers with incredible speed, are not intelligent computations i.e. it is not an AI. A computer performing symbolic integration of $\text{Sin}^2x\, e^x$ is intelligent, because some predefined knowledge; assumptions are used to evaluate it. The calculations that require knowledge, inference, prediction, classification, optimization, and learning are part of intelligent computation. There is no such fixed implementation technique for these types. Some of the calculation is based on pure inference or on assumption of uncertainty whereas others are based on biological processes to reach a solution. ***Neural Networks, Genetic Algorithms, Fuzzy Systems*** are some of the computational models that require intelligent computations. Some quantization and mapping techniques such as ***Rough Sets*** and nonlinear, deterministic dynamical system like ***Chaos*** are also require intelligent computations to execute.

Artificial Intelligence is influencing the technology and our economy. AI support for practical applications of rules, medical diagnosis, research support, manufacturing control, and so on. For these applications we need some programs, which are universal in nature. They can be copied to other machines (only constraints are that we have to follow intellectual property rights) and uniformity in views is maintained and also AI is automating human effort and paper works.

Basically our main aim was to develop a conception such as artificial intelligence that can deal with physical randomness and indeterminism, vagueness, ignorance.

## 1.1 Role of AI in Engineering

Creativity implies the ability to produce novel solutions which are better than previous solutions. We have some AI driven computational tools that assist designers to be more creative should also have intelligence built into them and they should be able to use expert knowledge of the problem domain for decision making. AI and expert systems technology along with tools such as Genetic Algorithms (GAs) and Artificial Neural Nets (ANN) provide techniques for simulating intelligence in decision making, evolution and learning in computers. Like design, activities such as planning and management also can be improved with the use of intelligent tools.

Different AI-based search techniques can also be employed for generating designs. Some techniques generate just one solution at a time, whereas some other techniques simultaneously generate many feasible solutions. Mathematical optimization techniques and rule-based expert systems generate just one solution for evaluation. GAs and design synthesis can generate many feasible solutions, resulting in a choice of design solutions for the designers to select from.

## 1.2 AI in Daily Life

AI systems are in everyday use for identifying credit card fraud, for advising doctors, for recognizing speech and in helping complex planning tasks. Recognizing speech is very difficult because voices have specific characteristics that are hard to translate or decrypt. AI components are embedded in numerous devices e.g. in copy machines for automatic correction of operation for copy quality improvement. Then there are intelligent tutoring systems that provide students with personalized attention. In modern washing machines, fuzzy logic is embedded to achieve better performance. AI has increased understanding of the nature of human intelligence and reasoning. It has also helped us understand the complexity of modeling human reasoning. The automatic vacuum gadget can actually learn and map the logistics of a leaving area. This vacuum cleaner is a devise that learns coordinates based on hitting the walls and furniture's of the home. Once the vacuum cleaner has mapped the room, it can clean the room without even hitting any obstracle.

## 1.3 Intelligence and Artificial intelligence

Intelligence can be defined as a capability of human brain to process information and communicate it properly, effectively which can be achieved by learning. Basically two key components of human intelligence are *Communication* and *Learning*. The use of intuition, commonsense, judgment, creativity, and reasoning are other

important aspects of human intelligence. Basically, human beings and some animals are intelligent to some extent, as they show some property of being intelligent i.e. they can react, move in the environment, sense the surroundings, reproduce. Apart from these basic aspects of intelligence, it requires language to express intellectual behavior, expert knowledge to take decisions; proper interpretation by good communication is also part of intelligence as message synthesis with skill requires determination of proper context and exact representation. Organizing knowl3edge by proper learning is a significant aspect of intelligence, learning also require3s proper accumulation of knowledge to create a framework which is helpful in storing experience, which in turns makes human being intelligence.

The Concept of Artificial intelligence (AI) is between psychology and computer science. This is due to the fact that researchers are working in this field from past 40 years, to understand how the human brain works, and also simulate or model this concept on computer. Generally stem of human thinking is goal-oriented line of action i.e. starting from a problem and trying to find the most optimal solution. Simple imitation how human brain does the solution is not an AI technique. AI is used to employ optimal intelligent solution to the problem, which means rather than employing a fixed method (as for example Predicate logic), AI with its fixed goal, by creating intelligent agent, derives as much solution as possible. In 1956, McCarthy defines Artificial Intelligence as:

***"Artificial Intelligence is concerned with the design of intelligence in an artificial device".***

Idea behind this definition is, ***Intelligence*** and ***Artificial devices*** are two basic components of Artificial Intelligence (AI) concept. Ability to learn about, learn from, comprehend relationships, understand, solve problem, and interact with one's environment, together will form ***Intelligence.***

***Artificial devices*** should have the property of intelligence as human beings i.e. it acts like a human, think like a human. Those devices must understand how to imitate the human thought process. For example computer with large memory, that can save long text and retrieve it on demand, shows intelligent capabilities. Sometimes quick calculation of long digits also shows higher processing capabilities. Computers with these higher intellectual processing capabilities like humans, can be considered as an Artificial Device from these concepts definitions of artificial Intelligence can be derived:

*Artificial Intelligence is*

***The study of the computations that make it possible to perceive, reason, and act. [WINSTON 1992]***

***The study of how to make computers do things at which, at the moment, people are better.[RICH & KNIGHT 2003]***

We expect that AI could perform some "common place tasks" as well as "Expert Tasks". Basically, *Recognizing* people, objects, Communicating (through *natural language*). *Navigating* around obstacles on the streets all are common place tasks. These tasks are done matter of emphatically and routinely by people and some other animals. Expert tasks include: Medical diagnosis. Mathematical problem solving Playing games like chess, these tasks can only be performed by skilled specialists.

On the other hand it is hard to make computer systems perform many routine tasks that all humans and a lot of animals can do. Examples of such tasks are navigating our way without running into things, catching victim and avoiding predators. Humans and animals are also capable of interpreting complex sensory information. We are able to recognize objects and people from the visual image that we receive. We are also able to perform complex social functions.

### 1.3.1 Components of Artificial Intelligence

The picture shown below gives a pictorial representation of different components of Artificial Intelligence. These components are discussed at a later stage in this book. Basically Artificial Intelligence is defined by all of these components.

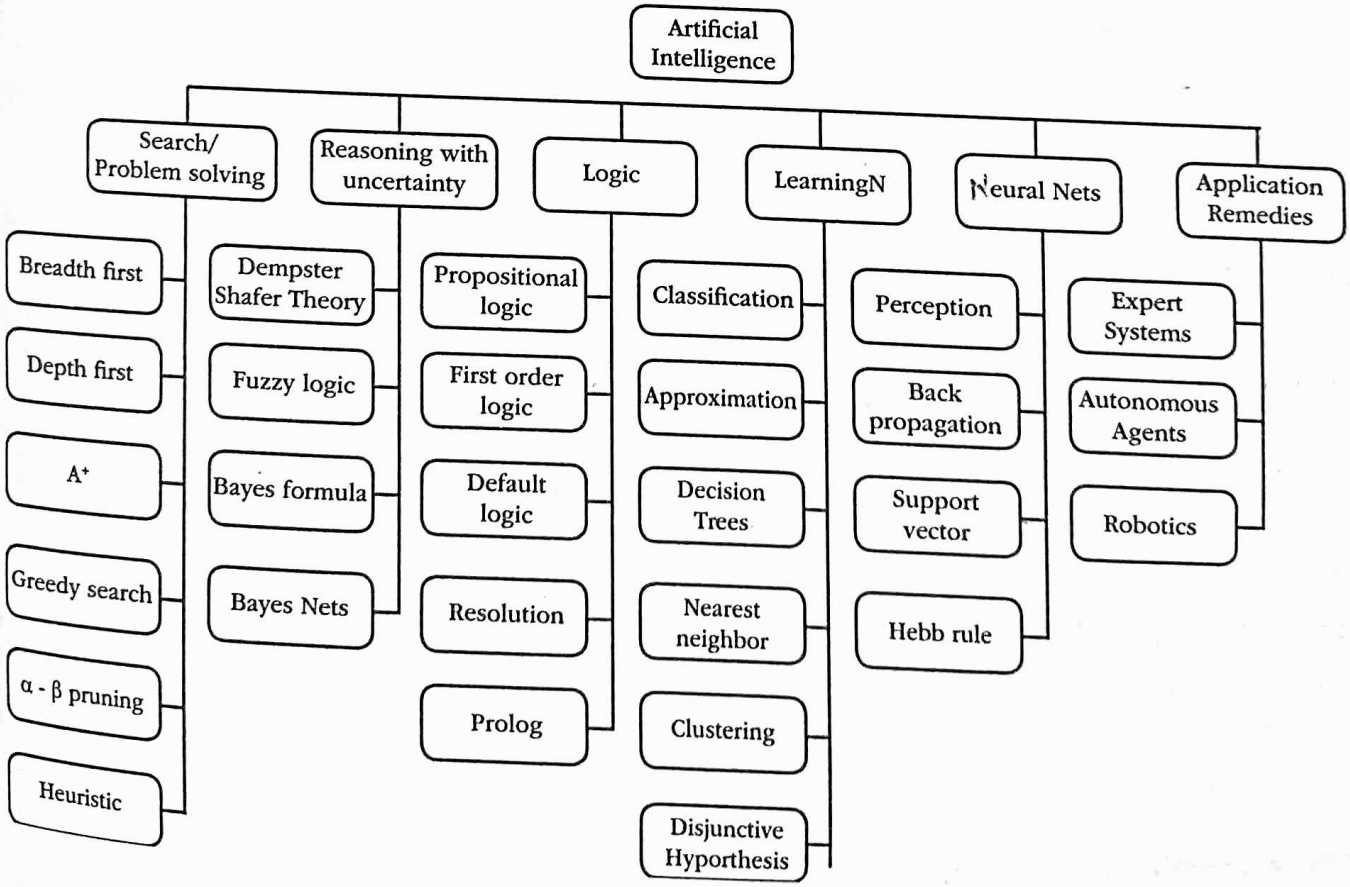


*Figure 1.1: Components of Artificial Intelligence*

### 1.3.2 Different categories of AI

There are two different major approaches in the field of AI. One is often termed traditional symbolic AI, which has been historically dominant and characterized by a high level of perception. Knowledge engineering systems and logic programming fall in this category. Symbolic AI covers areas such as knowledge based systems, logical reasoning, symbolic machine learning, search techniques, and natural language processing.

The second approach is based on low level, microscopic biological models, similar to the emphasis of physiology or genetics. Neural networks and genetic algorithms are the prime examples of this approach. These biological models do not necessarily resemble their original biological counterparts.

In addition to the two major categories mentioned above, there are relatively new AI techniques which include fuzzy systems, rough set theory, and chaotic systems or disorder for short. Fuzzy systems and rough set theory can be employed for symbolic as well as numeric applications, often dealing with incomplete or imprecise data.

### 1.3.3 Approaches to AI

Artificial Intelligence is a vast concept. Application of AI, sometimes is problem specific. There exist different wide-ranging classes into which the problems fall. These classes are coupled with a generic control strategy that is suitable for solving the problem. Depending upon the granularity at which we categorize the problems and strategies for control to apply the concept of Artificial Intelligence, we may have the following approaches:

**Strong AI:** Presently technology is nowhere near such highly functional AI, that can think freely is classified as *strong AI* as seen in movies such as "iRobot" and "Terminator." Strong AI will possess human traits such as consciousness, sentience (ability to feel, perceive or be conscious), sapience, self- awareness and son on. Basically *strong AI* aims to build machines that can truly reason and solve problems. These machines should be self aware and their overall intellectual ability needs to be identical from that of a human being.

Strong AI is practically not feasible as of now because the simulated brain reaches a fundamental criticism which is derived from personified reasoning where human embodiment is considered as an essential aspect of human intelligence. Many researchers believe that embodiment is necessary to come to a meaning by the AI. If this view is correct, any fully fictional brain model will need to include more than just the neurons.

**Weak AI:** Weak AI refers to the technology that is able to manipulate predetermined

rules and apply the rules to reach a well defined goal [Bethell 2006]. This type of AI is presently used in large industries and also incorporated into society. Factories, for example uses programs that allow different machines to work independently without their operator for hours. Also voice recognition software can be considered as a weak artificial intelligence as voices have specific characteristics that are hard to decode. Weak AI deals with the creation of some form of computer-based artificial intelligence that cannot truly reason and solve problems, but can act as if it were intelligent. Weak AI holds that suitably programmed machines can simulate human reasoning.

**Applied AI:** This type of approach produces commercially feasible system - "well-groomed or smart" systems. Such as, a security system that is able to identify the faces of people who are permitted to enter a particular building. Applied AI has already enjoyed considerable success.

**Cognitive AI:** "Interdisciplinary study about mind and its working functionality is known as cognitive science." The main aim of AI i.e. imitating human behaviors and perception are incorporated inside the cognitive AI concept as it deals with "what human reasoning is?" "what is does?" and "how it does?". Cognitive AI mainly focuses on how information is presented, processed and transformed (such as language, emotion, memory reasoning etc.) within nervous systems. Basically, in this approach, computers are used to test theories about how the human mind works, for example, theories about how we distinguish faces and other objects, or about how we solve abstract problems.

While studying the typical range of tasks that we might expect an "intelligent entity" to perform, we need to consider both "common-place" tasks as well as expert tasks.

## 1.4 Different task domains of AI

Artificial Intelligence can execute intelligent behaviors like Perception involving image recognition and computer vision , reasoning, learning, understanding language involving natural language processing, speech processing, solving problems, which include some typical range tasks. It is also predictable that an intelligent entity will perform these tasks such as recognizing people, communicating through natural language, navigating around obstacles in the street along with that some skilled tasks are also expected such as medical diagnosis, strategic game playing like chess, mathematical problem solving and so on. The former tasks i.e. the "common place tasks" does not require same proficiency as the later "expert tasks". Examples of common-place tasks include recognizing people, objects, communicating (through natural language), navigating around obstacles on the streets.

There must be a classification of jobs performed by the system, because not all jobs can performed with same ease and skills. Generally, the expert tasks require

expertise knowledge and skill. Categorization of tasks will provide a clear cut margin of complexity i.e. with this classification we can now understand which tasks are easy and which one is hard. The basic classifications of artificial intelligence are described in the figure 1.2.

**Mundane Task:** Repetitive and monotonous tasks are usually referred to as mundane tasks. In artificial Intelligence, mundane task refers to the common things that generally human does every day. For an instance vision, speech, natural language processing (NLP), generation of Natural language, understanding natural language, and reasoning are the basic mundane tasks in AI.

**Formal task:** It refers to the tasks where logic and constraints are considered. For an instance board game, playing chess, checkers, logic, calculus, algebra, verification, theorem proving is addressed as the basic formal tasks in AI.

**Expert Task:** The tasks that may assign to a professional and which require predefine knowledge, skill about the specific domain, special expertise. For an instance design engineering graphics, art creativity, financial analysis, medical consulting are commonly known formal tasks.

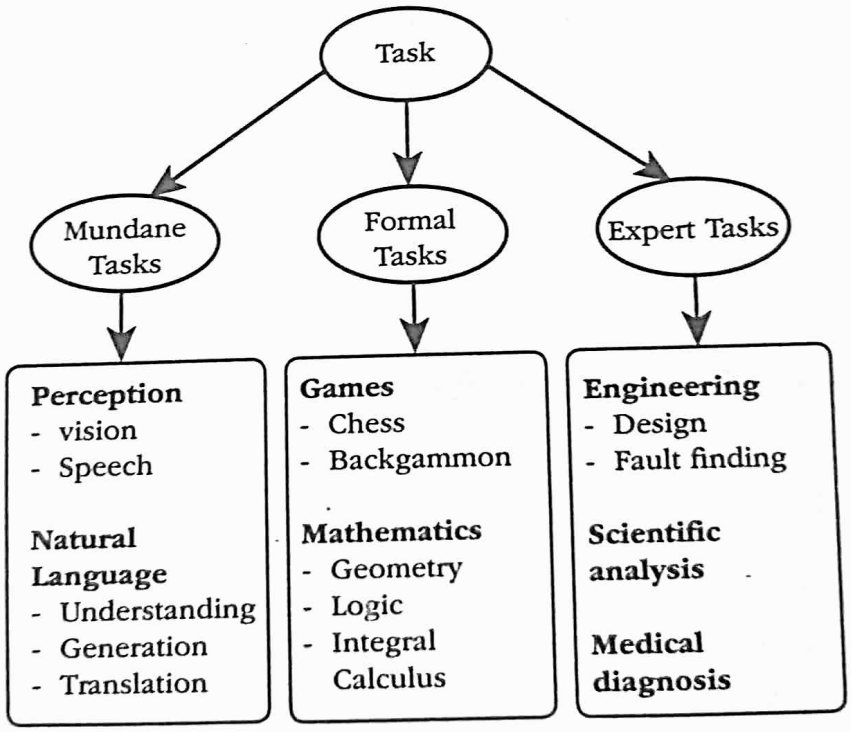


*Figure 1.2: Task Domains of Artificial Intelligence*

## 1.5 History and Early Works of AI

How human being can solve a problem is a secondary concept in Artificial intelligence. The foremost aim of AI is to provide an optimal intelligent solution to a problem. The concept of AI exists from twentieth century and day by day it is improving by different scientific inventions, tests in stages. Some of the stages are mentioned below: