UNIT-1

Introduction to Artificial Intelligence: What is AI, Foundations of AI, Goals of AI, and Applications of AI.

Q) Define AI. Describe the organization of AI Definition.

John McCarthy in mid-1950'scoined the term "Artificial Intelligence" which he would define as "**the science and engineering of making intelligent machines**" AI is about teaching the machines to learn, to act, and think as humans would do. We can organize AI definition into 4 categories:

- The definitions on top are concerned with thought processes and reasoning, whereas the ones on the bottom address behavior.
- The definitions on the left measure success in terms of conformity to human performance whereas the ones on the right measure against an ideal performance measure called rationality.
- A system is rational if it does the "right thing," given what it knows.
- Historically, all four approaches to AI have been followed, each by different people with different methods.
- A human-centered approach must be in part an empirical science, involving observations and hypotheses about human behavior.
- A rationalist's approach involves a combination of mathematics and engineering. The various groups have both disparaged and helped each other. Let us look at the four approaches in more detail.

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computersthink machines with minds, in thefull and literal sense." (Haugeland, 1985) "[The automation of] activities that weassociate with human thinking, activitiessuch as decision-making, problem solving,learning." (Bellman, 1978)	"The study of mental faculties through theuse of computational models."(Charniak and McDermott, 1985) "The study of the computations that makeit possible to perceive, reason, and act."(Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that performfunctions that require intelligencewhen performed by people." (Kurzweil,1990) "The study of how to make computers dothings at which, at the moment, people arebetter." (Rich and Knight, 1991)	"Computational Intelligence is the studyof the design of intelligent agents." (Pooleet al., 1998) "AI is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Thinking humanly: The cognitive modeling approach

If we are going to say that a given program thinks like a human, we must have some way ofdetermining how humans think. We need to get *inside* the actual workings of human minds.

There are three ways to do this:

1. through introspection-trying to catch our own thoughts as they go by
2. through psychological experiments—observing a person in action; and
3. through brain imaging—observing the brain in action.

Acting humanly: The Turing Test approach

- The **Turing Test**, proposed by Alan Turing (1950), was designed to provide a satisfactoryoperational definition of intelligence.
- A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.
- This test is used to evaluate a computer acting like humanly.

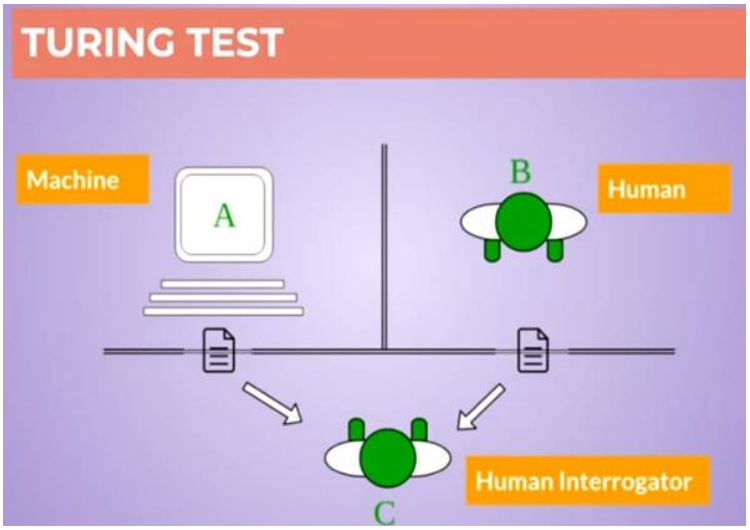

Fig.Illustrating Turing test.

- For current scenarios the computer would need to possess the following capabilities:
    - **natural language processing** to enable it to communicate successfully in English
    - **knowledge representation** to store what it knows or hears;
    - **automated reasoning** to use the stored information to answer questions and to draw new conclusions
    - **machine learning** to adapt to new circumstances and to detect and the patterns.
- **Total Turing Test** includes a video signal so that the interrogator can test thesubject's perceptual abilities, as well as the opportunity for the interrogator to pass physicalobjects "through the hatch."
- To pass the total Turing Test, the computer will need
    - **computer vision** to perceive objects, and
    - **robotics**to manipulate objects and move about.

These six disciplines compose most ofAI.

Thinking rationally: The "laws of thought" approach

Aristotle was one of the first to attempt to codify "right thinking," that is, irrefutable reasoning processes.

His **syllogisms** provided patterns for argument structuresthat always yielded correct conclusions when given correct premises.

Eg.

Socratesis a man;

all men are mortal;

therefore, Socrates is mortal." -- logic

There are two main obstacles to this approach.

1. it is not easy to take informalknowledge and state it in the formal terms required by logical notation, particularly whenthe knowledge is less than 100% certain.
2. Second, there is a big difference between solvinga problem "in principle" and solving it in practice.

Acting rationally: The rational agent approach

- An **agent** is just something that acts.
- All computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, and adapt to change, and create and pursue goals.
- A **rational agent** is one that acts so as to achieve thebest outcome or, when there is uncertainty, the best expected outcome.
- In the "laws of thought" approach to AI, the emphasis was on correct inferences.
- On the other hand, correct inference is not all of rationality; in some situations, there is no provably correct thing to do, but something must still be done.
- For example, recoiling from a hot stove is a reflex action that is usually more successful than a slower action taken after careful deliberation.

Q) Explain different types of AI with examples.

1. **Weak AI:** Weak AI is also known as narrow AI. It is an AI system that is designed and trained for a specific type of task.
   Eg.IBM's Watson,Siri and Alexa are weak AI. This categorization happens with the help of unsupervised programming.

2. **Strong AI:** Strong AI is more like the human brain and is also known as **artificial general intelligence**. It has cognitive abilities that help to perform unfamiliar tasks and commands. It can find the solution to a problem and works beyond a preprogrammed algorithm.
   Eg. Visual perception, speech recognition, decision making, and translations between languages.

3. **Super AI:** Super AI is AI that to go beyond in excellencethan human intelligence and ability. It's also known as artificial superintelligence (ASI) or superintelligence.
   Eg. It's the best at everything — maths, science, medicine, hobbies, you name it.

Q) What are goal of AI? Explain advantages and disadvantages of AI.
Goals of AI:

- **To Create Expert Systems** – The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users in particular domain.
- **To Implement Human Intelligence in Machines** – Creating systems that understand, think, learn on own, and behave like humans

Advantages of Artificial Intelligence

Artificial Intelligence is difficult for beginners yet it offer great opportunities for developing intelligent machines that can transform computer science on its head.

- Reduce human errors and perform various tasks with greater efficiency by using intelligent systems.
- Intelligent systems can perform hard tasks that are beyond human reach. Eg.exploring ocean, performing various hard laborious task with ease.
- Lot of applications has been developed using artificial intelligence. iPhoneSiri and Microsoftcortana developed on the phenomenon of artificial intelligence. These are interactive robots that help you access Smart phones.
- Use artificial intelligence and improve productivity, efficiency and accuracy of your products.

Disadvantages of Artificial Intelligence

Artificial Intelligence looks promising and it's quite futuristic. It's being implemented slowly in many fields. There are many drawbacks of artificial intelligence that are:

- Artificial intelligence is slowly making its way into real time applications. AI offers great prospects but it's really expensive. Small organizations can't afford High end machines, software, resources required for implementing AI.
- Artificial intelligent systems might replace humans in performing task in terms of productivity, but they can't take decisions. Robots can't decide what is right or what is wrong.
- With intelligent systems, you won't get creative with everyday experience. Humans tend to show creative ideas with every day experience.
- Replacing humans with intelligent systems might increase unemployment that lead to poor GDP.

Q) Briefly explain about expert systems.

The expert systems are the computer applications developed to solve complex problems in a particular domain.

Characteristics of Expert System

- High Performance: The expert system provides high performance for solving any type of complex problem of a specific domain with high efficiency and accuracy.
- Understandable: It responds in a way that can be easily understandable by the user. It can take input in human language and provides the output in the same way.
- Reliable: It is much reliable for generating an efficient and accurate output.
- Highly responsive: ES provides the result for any complex query within a very short period of time.

The components of ES include –

- Knowledge Base
- Inference Engine
- User Interface

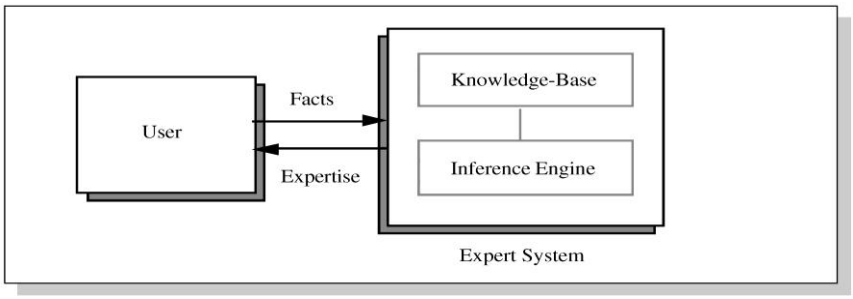

Fig.Basic Functions of Expert System.

1. **User Interface**

With the help of a user interface, the expert system interacts with the user, takes queries as an input in a readable format, and passes it to the inference engine. After getting the response from the inference engine, it displays the output to the user. In other words, it is an interface that helps a non-expert user to communicate with the expert system to find a solution.

2. **Inference Engine(Rules of Engine)**

- The inference engine is known as the brain of the expert system as it is the main processing unit of the system. It applies inference rules to the knowledge base to derive a conclusion or deduce new information. It helps in deriving an error-free solution of queries asked by the user.
- With the help of an inference engine, the system extracts the knowledge from the knowledge base.
- There are two types of inference engine:

- **Deterministic Inference engine**: The conclusions drawn from this type of inference engine are assumed to be true. It is based on facts and rules.
- **Probabilistic Inference engine**: This type of inference engine contains uncertainty in conclusions, and based on the probability.

- Inference engine uses the below modes to derive the solutions:
  - **Forward Chaining**: It starts from the known facts and rules, and applies the inference rules to add their conclusion to the known facts.
  - **Backward Chaining**: It is a backward reasoning method that starts from the goal and works backward to prove the known facts.

3. **Knowledge Base**

- The knowledgebase is a type of storage that stores knowledge acquired from the different experts of the particular domain. It is considered as big storage of knowledge. The more the knowledge base, the more precise will be the Expert System.
- It is similar to a database that contains information and rules of a particular domain or subject.
- One can also view the knowledge base as collections of objects and their attributes. Such as a Lion is an object and its attributes are it is a mammal, it is not a domestic animal, etc.

Knowledge Representation: It is used to formalize the knowledge stored in the knowledge base using the If-else rules.

- The knowledge of an expert system can be represented in a number of ways, including IF-THEN rules:

  IF you are hungry THEN eat

Knowledge Acquisitions: It is the process of extracting, organizing, and structuring the domain knowledge, specifying the rules to acquire the knowledge from various experts, and store that knowledge into the knowledge base.

Components of Knowledge Base

- Factual Knowledge: The knowledge which is based on facts and accepted by knowledge engineers comes under factual knowledge.
- Heuristic Knowledge: This knowledge is based on practice, the ability to guess, evaluation, and experiences.

Advantages of Expert System

- These systems are highly reproducible.
- They can be used for risky places where the human presence is not safe.
- Error possibilities are less if the KB contains correct knowledge.
- The performance of these systems remains steady as it is not affected by emotions, tension, or fatigue.
- They provide a very high speed to respond to a particular query.

Limitations of Expert System

- The response of the expert system may get wrong if the knowledge base contains the wrong information.
- Like a human being, it cannot produce a creative output for different scenarios.
- Its maintenance and development costs are very high.
- Knowledge acquisition for designing is much difficult.
- For each domain, we require a specific ES, which is one of the big limitations.
- It cannot learn from itself and hence requires manual updates.

Applications of Expert System: refer to applications question.

Some Expert Systems:

- DENDRAL – used in chemical mass spectroscopy to identify chemical constituents
- MYCIN – medical diagnosis of illness
- DIPMETER – geological data analysis for oil
- PROSPECTOR – geological data analysis for minerals
- XCON/R1 – configuring computer systems
- CaDeT: The CaDet expert system is a diagnostic support system that can detect cancer at early stages.
- PXDES: It is an expert system that is used to determine the type and level of lung cancer.

Q) **Differentiate Conventional programming and Expert System.**

Characteristic	Conventional Program	Expert System
Program Design	Structured Design	Little or no structure
Problem solving	Algorithm	Rules
Input	Assumed correct	Incomplete. incorrect
Unexpected input	Difficult to deal	Very responsive
Control by ...	Statement order	Inference engine
Control Strength	Strong	Weak
Execution	Generally sequential	Opportunistic rules
Output	Always correct	Varies with the problem

Q) Briefly explain Foundation of AI.

A brief history of the disciplines that contributed ideas, viewpoints, and techniques to AI are as follows:

1. **Philosophy**(the study of the fundamental nature of knowledge):

   - Can formal rules be used to draw valid conclusions?
   - How does the mind arise from a physical brain?

- Where does knowledge come from?
- How does knowledge lead to action?

- Aristotle (384–322 B.C.), was the first to formulate a precise set of laws governing the rational part of the mind. He developed an informal system of syllogisms for proper reasoning, which in principle allowed one to generate conclusions mechanically, given initial premises.

Eg.

all dogs are animals;
all animals have four legs;
therefore all dogs have four legs

- Thomas Hobbes (1588–1679) proposed that reasoning was like numerical computation that "we add and subtract in our silent thoughts."
- Rene Descartes (1596–1650) gave the first clear discussion of the distinction between mind and matter and of the problems that arise.
- The empiricism movement, starting with Francis Bacon's (1561— 1626).
- The confirmation theory of Carnap and Carl Hempel (1905-1997) attempted to analyze the acquisition of knowledge from experience.
- Carnap's book The Logical Structure of the World (1928) defined an explicit computational procedure for extracting knowledge from elementary experiences. It was probably the first theory of mind as a computational process.
- The final element in the philosophical picture of the mind is the connection between knowledge and action. This question is vital to Al because intelligence requires action as well as reasoning.

2. Mathematics

- What are the formal rules to draw valid conclusions?
- What can be computed?

Formal science required a level of mathematical formalization in three fundamental areas: **logic, computation**, and **probability**.

Logic:

George Boole (1815–1864), who worked out the details of propositional, or Boolean, logic.

In 1879, Gottlob Frege (1848–1925) extended Boole's logic to include objects and relations, creating the firstorder logic that is used today.

First order logic – Contains predicates, quantifiers and variables

E.g. Philosopher(a) ⇒ Scholar(a)

$\forall x$, effect_carona(x) ⇒ quarantine(x)

$\forall x$, King(x) ^ Greedy (x) ⇒ Evil (x)

Alfred Tarski (1902–1983) introduced a theory of reference that shows how to relate the objects in a logic to objects in the real world.

Logic and Computation: The first nontrivial algorithm is thought to be Euclid's algorithm for computing greatest common divisors(GCD).

- Beside logic and computation, the third great contribution of mathematics to AI is the **probability**. The Italian Gerolamo Cardanao (1501-1576) first framed the idea of probability, describing it in terms of the possible outcomes of gambling events.
- Thomas Bayes (1702-1761) proposed a rule for updating probabilities in the light of new evidence. Baye's rule underlies most modern approaches to uncertain reasoning in AI systems.

3. **Economics**

- How should we make decisions so as to maximize payoff?
- How should we do this when the payoff may be far in the future?

- The science of economics got its start in 1776, when Scottish philosopher Adam Smith treat it as a science, using the idea that economies can be thought of as consisting of individual agents maximizing their own economic well being.
- **Decision theory,** which combines probability theory with utility theory, provides a formal and complete framework for decisions (economic or otherwise) made under uncertainty— that is, in cases where probabilistic descriptions appropriately capture the decision maker's environment.
- Von Neumann and Morgenstern's development of **game theory** included the surprising result that, for some games, a rational agent should adopt policies that are randomized. Unlike decision theory, game theory does not offer an unambiguous prescription for selecting actions.

4. **Neuroscience:** How do brain process information?

- Neuroscience is the study of the nervous system, particularly the brain.
- 335 B.C. Aristotle wrote, "Of all the animals, man has the largest brain in proportion to his size."
- Nicolas Rashevsky (1936, 1938) was the first to apply mathematical models to the study of the nervous system.

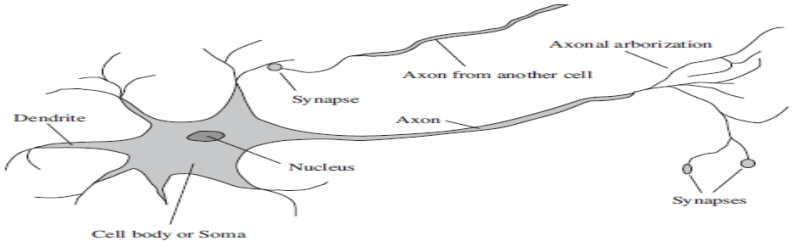

Fig. A neuron cell of human brain.

- The measurement of intact brain activity began in 1929 with the invention by Hans Berger of the electroencephalograph (EEG).
- The recent development of functional magnetic resonance imaging (fMRI) (Ogawa et al., 1990; Cabeza and Nyberg, 2001) is giving neuroscientists unprecedentedly detailed images of brain activity, enabling measurements that correspond in interesting ways to ongoing cognitive processes.

5. **Psychology:** How do humans and animals think and act?

    - Behaviorism movement, led by John Watson(1878-1958). Behaviorists insisted on studying only objective measures of the percepts(stimulus) given to an animal and its resulting actions(or response). Behaviorism discovered a lot about rats and pigeons but had less success at understanding human.
    - Cognitive psychology, views the brain as an information processing device. Common view among psychologist that a cognitive theory should be like a computer program.(Anderson 1980) i.e. It should describe a detailed information processing mechanism whereby some cognitive function might be implemented.

6. **Computer engineering:** How can we build an efficient computer?

    - For artificial intelligence to succeed, we need two things: intelligence and an artifact. The computer has been the artifact(object) of choice.
    - The first operational computer was the electromechanical Heath Robinson, built in 1940 by Alan Turing's team for a single purpose: deciphering German messages.
    - The first operational programmable computer was the Z-3, the invention of KonradZuse in Germany in 1941.
    - The first electronic computer, the ABC, was assembled by John Atanasoff and his student Clifford Berry between 1940 and 1942 at Iowa State University.
    - The first programmable machine was a loom, devised in 1805 by Joseph Marie Jacquard (1752-1834) that used punched cards to store instructions for the pattern to be woven.

7. **Control theory and cybernetics:** How can artifacts operate under their own control?

    - Ktesibios of Alexandria (c. 250 B.C.) built the first self-controlling machine: a water clock with a regulator that maintained a constant flow rate. This invention changed the definition of what an artifact could do.
    - Modern control theory, especially the branch known as stochastic optimal control, has as its goal the design of systems that maximize an

objective function over time. This roughly OBJECTIVE FUNCTION matches our view of Al: designing systems that behave optimally.

- Calculus and matrix algebra- the tools of control theory
  The tools of logical inference and computation allowed AI researchers to consider problems such as language, vision, and planning that fell completely outside the control theorist's purview.

8. **Linguistics:** How does language relate to thought?

- In 1957, B. F. Skinner published Verbal Behavior. This was a comprehensive, detailed account of the behaviorist approach to language learning, written by the foremost expert in the field.
- Noam Chomsky, who had just published a book on his own theory, Syntactic Structures.Chomsky pointed out that the behaviorist theory did not address the notion of creativity in language.
- Modern linguistics and AI were "born" at about the same time, and grew up together, intersecting in a hybrid field called computational linguistics or natural language processing.
- The problem of understanding language soon turned out to be considerably morecomplex than it seemed in 1957. Understanding language requires an understanding of the subject matter and context, not just an understanding of the structure of sentences.
- knowledge representation (the study of how to put knowledge into a form that a computer can reason with)- tied to language and informed by research in linguistics.

Q) Explain different applications of AI

1. **Neural networks (NN),** also known as artificial neural networks (ANN), are computational models that mimic human brain, have a unique ability to extract meaning from imprecise or complex data by passing input through various layers of the neural network.

   NN are used in various applications such as:

- **Banking:** Credit card attrition, credit and loan application evaluation, fraud and riskevaluation, and loan delinquencies.
- **Business Analytics**: Customer behaviour modelling, customer segmentation, fraudpropensity, market research, market mix, market structure, and models for attrition, default, purchase, and renewals
- **Defense:** Counterterrorism, facial recognition, feature extraction, noise suppression,object discrimination, sensors, sonar, radar and image signal processing, signal/image identification, target tracking, and weapon steering
- **Education:** Adaptive learning software, dynamic forecasting, education systemanalysis and forecasting, student performance modeling, and personality profiling

- **Financial:** Corporate bond ratings, corporate financial analysis, credit line use analysis, currency price prediction, loan advising, mortgage screening, real estate appraisal, and portfolio trading
- **Medical:** Cancer cell analysis, ECG and EEG analysis, emergency room test advisement, expense reduction and quality improvement for hospital systems, transplant process optimization, and prosthesis design
- **Securities:** Automatic bond rating, market analysis, and stock trading advisory systems
- **Transportation:** Routing systems, truck brake diagnosis systems, and vehicle scheduling.

2. **Fuzzy Logic:** Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1 both inclusive. By contrast, in Boolean logic, the truth values of variables may only be the integer values 0 or 1.

Fuzzy logic is used in various applications such as:

Medicine

- Controlling arterial pressure when providing anaesthesia to patients
- Used in diagnostic radiology and diagnostic support systems
- Diagnosis of prostate cancer and diabetes

Transportation systems

- Handling underground train operations
- Controlling train schedules
- Braking and stopping vehicles based on parameters, such as car speed, acceleration and wheel speed

Defence

- Locating and recognizing targets underwater
- Supports naval decision making
- Using thermal infrared images for target recognition
- Used for controlling hypervelocity interceptors

Industry

- Controlling water purification plants
- Handling problems in constraint satisfaction in structural design
- Pattern analysis for quality assurance
- Fuzzy Logic is used for tackling sludge wastewater treatment

Naval control

- Selecting the optimal or best possible routes for reaching a destination
- Autopilot is based on Fuzzy Logic
- Autonomous underwater vehicles are controlled using Fuzzy Logic

Washing systems powered by Fuzzy Logic

Modern washing machines powered by Fuzzy Logic are becoming popular these days. They have sensors that continuously track variations in temperature. It adjusts the controls and operations accordingly. These systems perform well, and are productive and cost efficient.

3. **Expert Systems:** Expert Systemsis an interactive and reliable computer-based decision-making system which uses both facts and heuristics to solve complex decision-making problems.
   It is considered at the highest level of human intelligence and expertise. The purpose of an expert system is to solve the most complex issues in a specific domain.

- **Hospitals and medical facilities**: Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations on humans.
- **Employee performance evaluation**: To evaluate employees based on various key parameters.
- **Virus detection:** To predict virus based on the activities performed.
- **Stock market trading**: to predict stock market price
- **Process monitoring and control:**Controlling a physical process based on monitoring.
- **In designing and manufacturing domain:** It can be broadly used for designing and manufacturing physical devices such as camera lenses and automobiles.
- **In the finance domain:** In the finance industries, it is used to detect any type of possible fraud, suspicious activity, and advise bankers that if they should provide loans for business or not.
- **Planning and Scheduling:** The expert systems can also be used for planning and scheduling some particular tasks for achieving the goal of that task.

4. **NLP**: NLP stands for **Natural Language Processing**, which is a part of **Computer Science, Human language,** and **Artificial Intelligence**. It is the technology that is used by machines to understand, analyse, manipulate, and interpret human's languages.

   Applications of NLP:

- **Question Answering:** Question Answering focuses on building systems that automatically answer the questions asked by humans in a natural language.
- **Spam Detection:** Spam detection is used to detect unwanted e-mails getting to a user's inbox.
- **Sentiment Analysis:** Sentiment Analysis is also known as **opinion mining**. It is used on the web to analyse the attitude, behaviour, and emotional state of the sender. This application is implemented through a combination of NLP (Natural Language Processing) and statistics by assigning the values to the text (positive, negative, or natural), identify the mood of the context (happy, sad, angry, etc.)
- **Machine Translation:** Machine translation is used to translate text or speech from one natural language to another natural language.
- **Spelling correction:** Microsoft Corporation provides word processor software like MS-word, PowerPoint for the spelling correction.
- **Speech Recognition:** Speech recognition is used for converting spoken words into text. It is used in applications, such as mobile, home automation, video recovery, dictating to Microsoft Word, voice biometrics, voice user interface, and so on.
- **Chatbot:** Implementing the Chatbot is one of the important applications of NLP. It is used by many companies to provide the customer's chat services.

- **Information extraction:** Information extraction is one of the most important applications of NLP. It is used for extracting structured information from unstructured or semi-structured machine-readable documents.

Other Applications:

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.

Vision Systems: These systems understand, interpret, and comprehend visual input on the computer.

Eg.

- A spying aeroplane takes photographs which are used to figure out spatial information or map of the areas.
- Doctors use clinical expert system to diagnose the patient.
- Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

Speech Recognition: Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

Handwriting Recognition: The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

Self-driving cars: It enables your car to steer, accelerate and brake automatically within its lane. It requires sensors like camera for object detection.

Intelligent Robots: Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.