UNIT-6

Applications of AI

⊛. Expert System:

An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert. It performs this by extracting knowledge from it's knowledge base using the reasoning and inference rules according to the user queries. The system helps in decision making for complex problems using both facts and heuristics like a human expert. The performance of an expert system is based on the expert's knowledge stored in it's knowledge base.

Heuristic meaning informative or instructional

Expert systems are used by most of the larger or medium sized organization as a major tool for improving productivity and quality. These systems are designed for a specific domain, such as medicine, science etc. One of the common example of expert system is a suggestion of spelling errors while typing in the Google search box. Expert systems hold the characteristics like high performance, understandable, reliable, and highly responsive.

⊛. Components of Expert System:

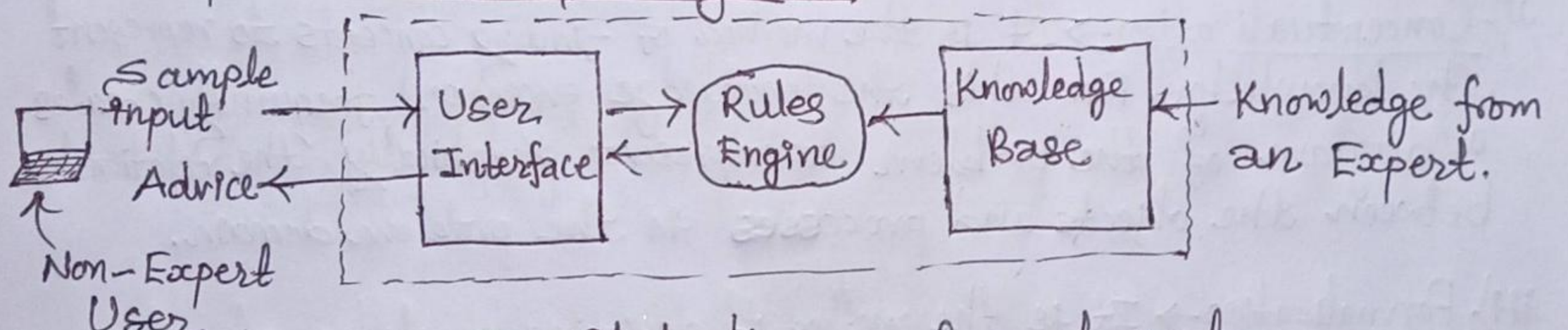


Fig: Block diagram of expert system.

An expert system mainly consists of following three components:

1) User Interface → With the help of 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 (or rules engine). After getting response from the inference engine, it displays the output to the user.

iii) Inference Engine (Rules of Engine) → The inference engine is known as brain of 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.

iii) Knowledge Base → The knowledge base is a type of storage that stores knowledge acquired from different experts of the particular domain. 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.

⊛. Development of Expert Systems:

An expert system typically is developed and refined over a period of several years. Following are the stages of expert system development that provide us some insight into the ways in which expert systems are developed.

i) Identification → It is the method of determining the characteristics of the problem. It helps to determine the exact nature of the problem instead to feel that the system would be helpful in certain situation.

ii) Conceptualization → It is the method of finding concepts to represent the knowledge. For this the knowledge engineer frequently creates a diagram of the problem to represent graphically, the relationship between the objects and processes in the problem domain.

iii) Formalization → It is the method of designing knowledge structure using knowledge representation techniques. During formalization, it is important that the knowledge engineer be familiar with the various techniques of the knowledge representation and the expert system tools.

iv) Implementation → It is the method of creating prototyes of expert system. Many scientists actually consider the first prototype to be a "throw-away" system, useful for evaluating progress but hardly a usable expert system.

v) Testing → It is the method of validating the implemented expert system. Testing provides opportunities to identify the weakness in the structure and implementation of the system and to make the appropriate corrections.

⊛. Features of an Expert System:

→ It should be able to respond to simple questions.
→ It should be able to learn new knowledge.
→ It should be easily modified.
→ It should be adaptive and flexible.
→ It should be able to explain its advice.
→ It should be goal oriented.

Q. Explain knowledge engineering with a block diagram.

Ans: Knowledge engineering is a field of AI that creates rules to apply data in order to imitate the thought process of human expert. Knowledge engineering attempts to take challanges and solve problems that would usually require a high level of human expertise to solve.

In general, knowledge engineering is the process of understanding and representing a human knowledge in a computer as a program. Knowledge engineering includes:

i) Knowledge acquisition.
ii) Knowledge representation.
iii) Inferencing.
iv) Explanation and justification.

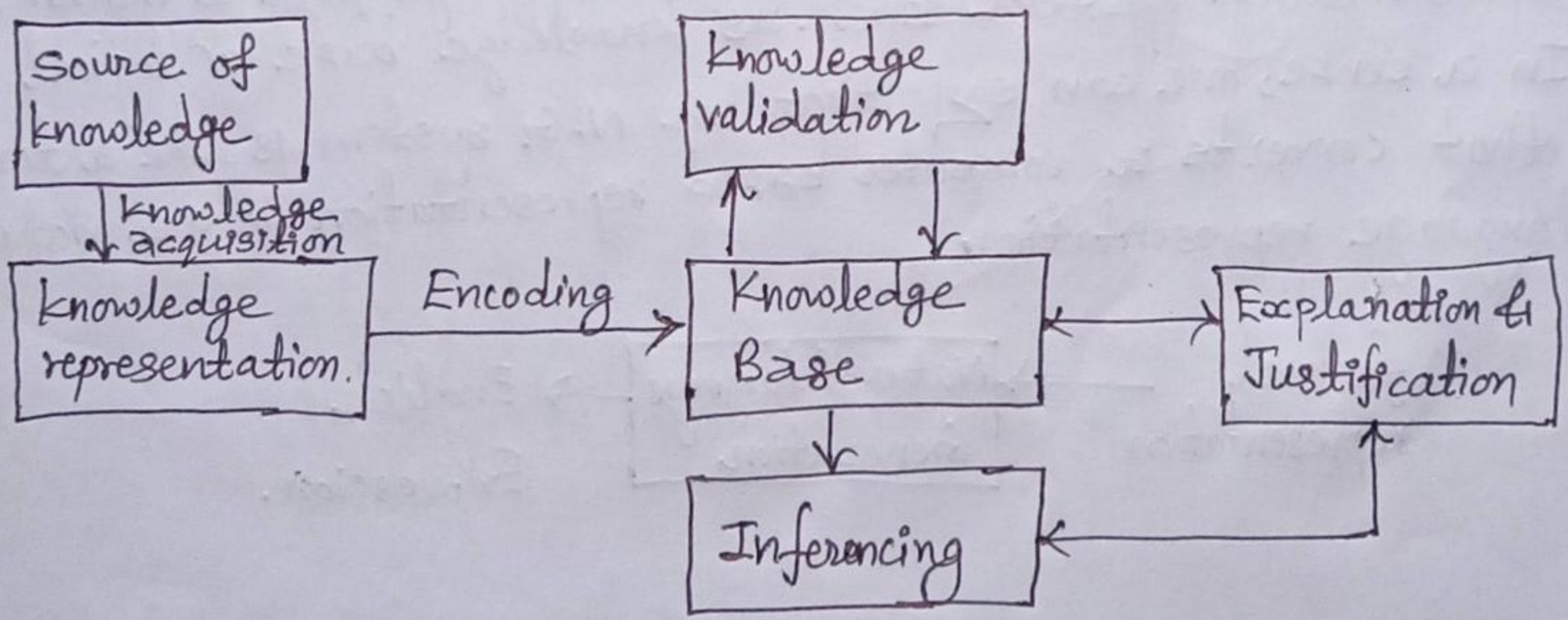
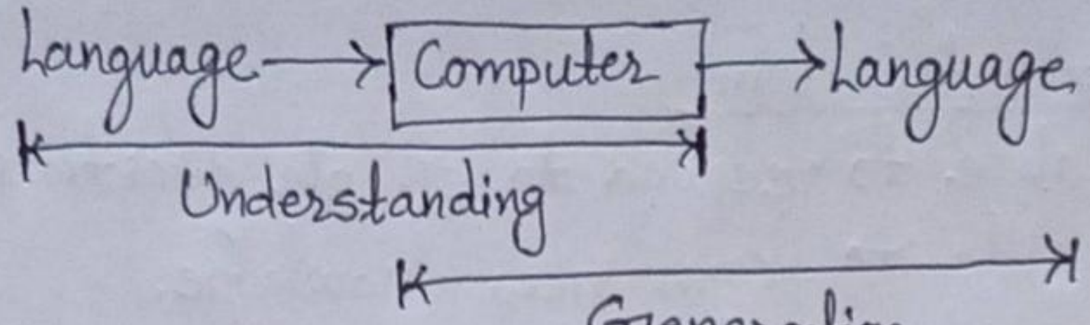


Fig: Knowledge Engineering process.

⊛ Natural Language Processing (NLP):

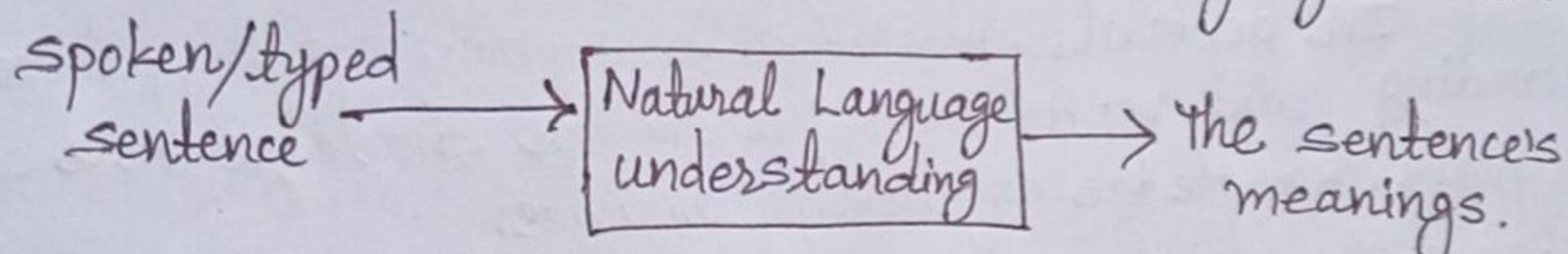
Natural language processing is a technology which involves converting spoken or written language into a form which can be processed by computers and vice-versa.



Voice recognition software, Text-to-speech synthesizers, Grammer checkers, Machine translation systems etc. are some of the better-known applications of NLP language. NLP is composed of two parts: NLU (Natural language understanding) and NLG (Natural language generation).

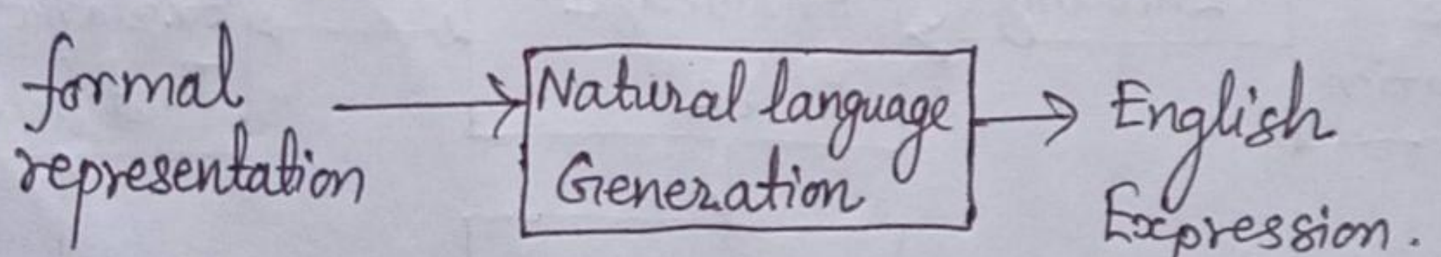
⊛ Natural language Understanding (NLU):

It is the process of mapping the given inputs in natural language into useful representation and analyzing different aspects of the language. Developing programs that understand a natural language is a difficult problem. Natural languages are large.



⊛ Natural Language Generation (NLG):

It is the process of producing meaningful phrases and sentences in the form of natural language from a machine representation system such as knowledge base or logical form. In a sense, one can say that an NLG system is like a translator that converts a computer based representation into a natural language representation.

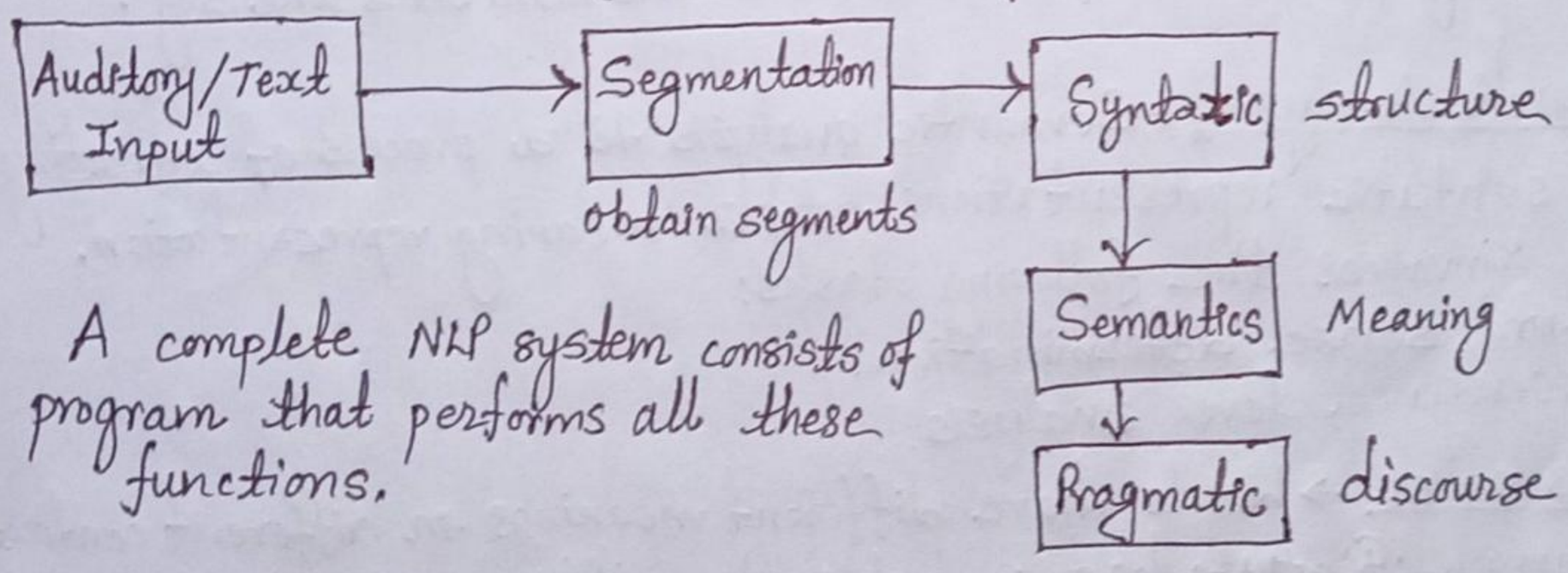


⊛. NLU vs. NLG:

NLU	NLG
i) NLU is taking some spoken/typed sentence and working out what it means.	i) NLG is taking some formal representation of what we want to say & working out a way to express it in a natural language.
ii) In NLU the system needs to disambiguate the input sentence to produce the machine representation language.	ii) In NLG the system needs to make decisions about how to put a concept into words.
iii) Different levels of analysis required: morpological analysis, syntatic analysis, semantic analysis.	iii) Different levels of synthesis required: deep learning, syntatic generation.
iv) NLU is most harder than NLG.	iv) NLG is less harder than NLU.

or Process

⊛ Steps of Natural Language Processing: (OR Parameters in NLP)



A complete NLP system consists of program that performs all these functions.

i) Input/source → The input of a NLP system can be written text or speech. Quality of input decides the possible errors in language processing that is high quality input leads to correct language understanding.

ii) Segmentation → The text inputs are divided into segments (chunks) and the meaning of individual segments are analyzed.

⇒ Syntatic Analysis → Syntatic analysis takes an input sentence and produces a representation of its grammatical structure. A grammar describes the valid parts of speech of a language and how to combine them into phrases.

A computer grammar specifies which sentences are in a language and their parase tree. A parase tree is a hierarchical structure that shows how the grammar applies to the input. Each level of the tree corresponds to the application of one grammar rule.

Example: Parse tree

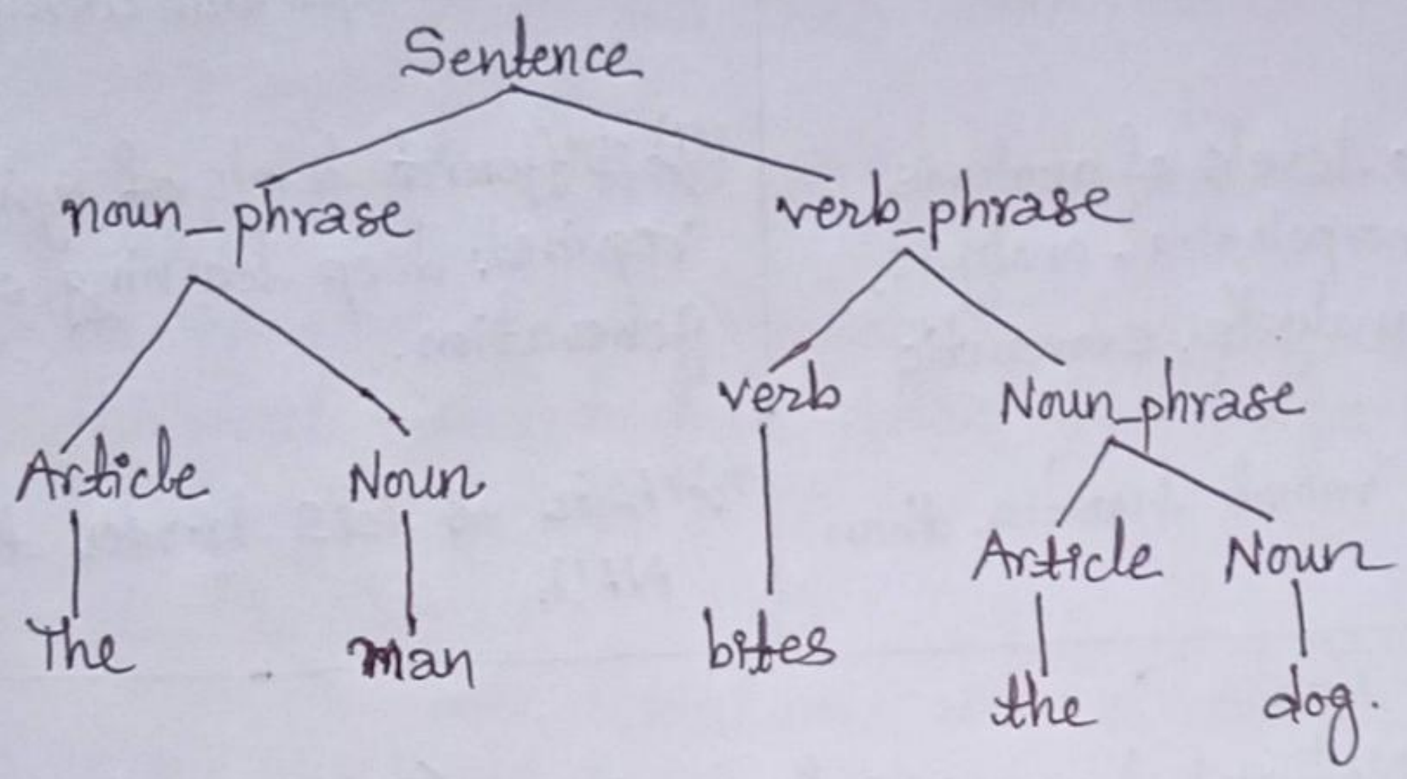


Fig: parse tree for the sentence "The man bites the dog".

⇒ Semantic Analysis → Semantic analysis is a process of converting the syntatic representations into a meaning representation. This involves the following tasks:

→ word sense determination.
→ sentence level analysis.

Word sense → Words have different meanings in different contexts.

Example: Susmita had a bat in her office.

bat = "a baseball thing"
bat = "a flying mammal".

Sentence level analysis → Once the words are understood, the sentence must be assigned some meaning.

Example: I saw an astronomer with a telescope.

v) Pragmatic Analysis → It deals with using and understanding sentences in different situations and how the interpretation of the sentence is affected. The main focus is on what was said is reinterpreted on what it actually means.

Morphology → It is the process of recognizing the suffixes and prefixes that have been attached to a word.
For example: adjective + ly → adverb [e.g, Friend + ly = friendly].

⊛. Importance of NLP:

→ NLP helps to make communication eaiser between the user and computer system.
→ It helps to understand large social data available in the internet.
→ It improves the efficiency and accuracy of documentation and identify the most relevent information from large database.

⊛. Machine Translation:-

The term "machine translation" (MT) is used in the sense of translation of one language to other. The ideal aim of machine translation system is to produce the best possible translation without human assistance. An example of machine translation is "Google Translator" which can translate english language to other languages like nepali, hindi and vice-versa.

The translation quality of the machine translation systems can be improved by pre-editing and post-editing in MT. Pre-editing means adjusting the input by making prefixes, suffixes, clause boundries etc. Post-editing means controlling the vocabulary to the output of the MT.

⊛ Types of machine translations:

There are four types of machine translations which are as follows:

i) Rule based machine translation (RBMT) → It translates on the basis of grammatical rules. It conducts a grammatical analysis of the source language and the target language to generate the translated sentence. It can translate the source language

directly to the target language.

ii) Statistical machine translation (SMT) → It offers good solution to ambiguity problem. SMT are robust and work well even if there are errors and the presence of new data. SMT aims to determine the correspondence between a word from the source language and a word from the target language.

iii) Hybrid machine translation (HMT) → It is the blend of RBMT and SMT. It holds a translation memory, making it far more effective in terms of quality. However, even HMT has its drawbacks, the main drawback is the need for extensive editing.

iv) Neural machine translation (NMT) → It depends on neural network models (based on human brain) to develop statical models for the purpose of translation. The primary benefit of NMT is that it provides a single system that can be trained to decode the source and target text.

⑧. Machine Vision Concepts :-

Machine vision is the ability of a computer to "see". A machine vision system employs one or more video cameras, analog-to-digital conversion, and digital signal processing. The resulting data goes to a computer or robot controller. It uses different components to visually analyze an operation or activity.

Two important specifications in any vision system are the sensitivity and the resolution. Sensitivity is the ability of a machine to see in dim light, or to detect weak impulses at invisible wavelengths. Resolution is the extent to which a machine can differentiate between objects. Machine vision systems have two primary hardware elements the camera, which serves as the eye of the system and a computer video analyzer,

Components: A typical machine vision system will consist of the following components:

→ One or more digital or analog cameras with suitable optics for acquiring images, such as lenses to focus the desired field of view. It also consists image sensor which is responsible for analysing captured images or presence of defects.

→ Input/Output hardware (e.g, digital I/O) or communication links (e.g, network connection or RS-232) to report result.

→ A synchronizing sensor for part detection to trigger image acquisition and processing and some form of actuators to sort, route or reject defective parts.

→ A program to process images and detect relevent features.

Applications:

→ Electronic component analysis
→ Signature identification.
→ Optical character recognition.
→ Handwriting recognition.
→ Object recognization
→ Pattern recognization.
→ Materials inspection.
→ Medical image analysis.

⊛. Robotics:

Robotics is a branch of engineering and science that includes electronics engineering, mechanical engineering, computer science and so on. This branch deals with the design, construction, sensory feedback and information processing. These robots are designed to be for any purpose like bomb detection, industrial use and many more. Robots can take any form but many of them have given the human appearance.

The advantage of using robots is they can get information that a human can't. They can perform tasks without any mistake and efficiently as well as fast. The disadvantage of using robot is that people working in factories may loose their jobs and they need high maintenance.

Robot Hardware:- A robot hardware generally consists of 5 basic components as follows:

i) **Controller** → Every robot is connected to a computer controller, which regulates the components of the arm and keeps them working together. Almost all robots are pre-programmed but in future controllers with AI could allow robots to think on their own, even program themselves.

ii) **Arm** → The arm is the part of the robot that positions the end-effector and sensors to do their pre-programmed business. Many are built to resemble human arms and work like human arms.

iii) **Drive** → The links (the sections between the joints) are moved into their desired position by the drive. Typically a drive is powered by hydraulic pressure or electricity.

iv) **End-Effector** → The end-effector could be thought of as the "hand" on the end of robotic arm. There are many possible end-effectors like gripper, vaccum pump, welder, spray gun etc. that help it to do its job.

v) **Sensor** → The sensors give the robot controller information about its surroundings and lets it to know the exact position of the arm, or the state of world around it. Robot sensors can detect infrared radiation to "see" in the dark.

Robotic Perceptions:- Robotic perception is related to many applications in robotics where sensory data and artificial intelligence/machine learning techniques are involved. Examples of such applications are object detection, environment representation, scene understanding, activity recognition etc. It contains the algorithms and techniques that empower robots ~~from~~ to learn from sensory data and, based on learned models, to react and take decisions accordingly. Robotic perception Systems are evolving in a way that new applications and tasks are becoming a reality.