

## Week - 2

- **Application Areas of AI**
  - Expert Systems
  - Natural Language Processing (NLP)
  - Computer Vision
  - Speech Recognition And Generation
  - Robotics
  - Neural Network
  - Virtual Reality

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### APPLICATION AREAS OF ARTIFICIAL INTELLIGENCE

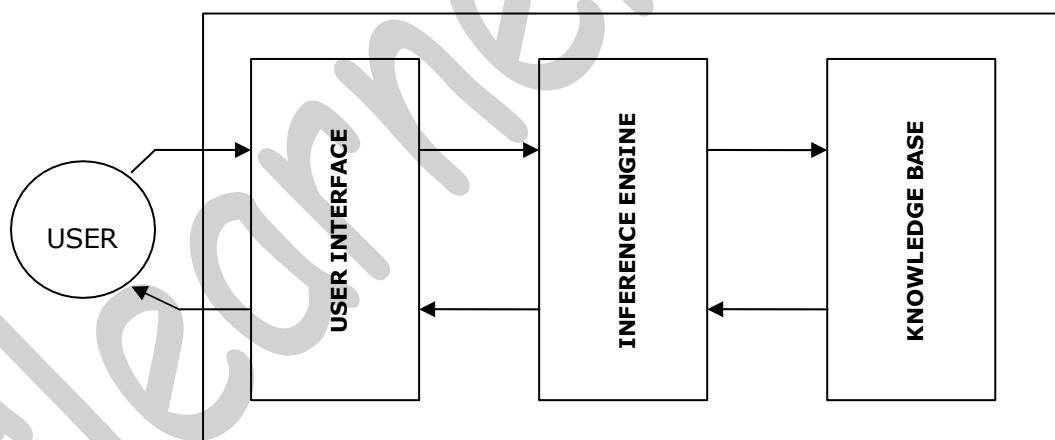
Artificial intelligence is divided into different branches which are mentioned below:

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#### EXPERT SYSTEMS

These are AI programs that act as intelligent advisor or consultants. An experts system permits the knowledge and experience of one or more experts to be captured and stored in computer. This knowledge then can be used by anyone requiring it.

An expert system is a computer program designed to act as an expert in a particular domain (area of expertise). Also known as a knowledge based system, an expert system typically includes a sizeable knowledge base, consisting of facts about the domain and heuristics (rules) fir applying those facts.



**GENERAL BLOCK DIAGRAM OF EXPERT SYSTEM**

The purpose of expert system is not to replace the experts, but simply to make their knowledge and experience more widely available. Typically there are more problems to solve than there are experts available to handle them. The expert system permits others to increase their productivity, improve the quality of their decisions, or simply to solve problems when an expert is not available.

Expert systems are ideal when it is necessary for an individual to select the best alternative from a long list of choices. Based on the criteria supplied to it, the expert system can choose the best option. For example there are expert systems that will help you to select one of the many places to invest your money based on your own financial conditions, goals, and personality traits.

Expert systems technology is the first AI technology to have a widespread impact on business and industry.

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## NATURAL LANGUAGE PROCESSING (NLP)

The second widely used AI application is natural language processing (NLP). NLP programs use artificial intelligence techniques to permit a computer to understand and generate natural language. It has been said that the key to intelligence is the understanding of language.

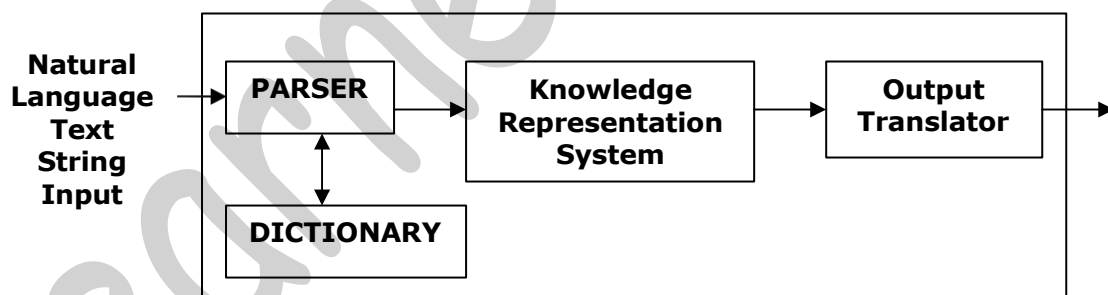
These programs attempt to identify the syntax, semantics, and context contained within the sentence to extract meaning from the natural language input. **For example:** the computer could initiate the commands specified by the user.

Natural language understanding programs can also be used for language translation. Such program might read an Urdu language text; understand it, and produce an accurate English translation.

### HOW NLP SYSTEMS WORK?

The idea is to understand the words and sentences entered. That is, the NLP software has to extract the meanings from the input. For this purpose, most NLP systems have three basic parts:

- **Parser**
- **Knowledge representation system**
- **Output translator**



### COMPONENTS OF NLP SYSTEM

The **parser** takes the natural language input sentence and breaks it down into the various parts of grammar (nouns, verbs, adjectives, prepositions, etc.). This is the first step in determining the function of each word in the sentence and the way the words related to one another. This analysis usually results in construction of parse tree.

A **dictionary** associated with the parser helps determine word meaning, but it often has a limited vocabulary. It can't know everything. So, like expert systems and other AI programs, NLP systems are usually limited or dedicated to a specific subject area or application.

The **knowledge system** then analyzes the parsed output to determine meaning. Based on knowledge, the NLP system tries to understand the input so it can take some appropriate action.

Finally, the **output translator** takes the interpretation of knowledge system and initiates some action. It may respond with natural language reply or create special outputs that match other computer programs.

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## SPEECH RECOGNITION AND GENERATION

AI software also can be created to allow a computer respond to voice input. Voice or speech recognition uses an electronic process of converting voice input to microphone into electronic signals that can be understood and used by the NLP system. Voice recognition is typically a hardware process, but some advance systems use AI software techniques.

The output of the voice recognizer can be used to drive a natural language processing system so that a computer can be operated by voice. Instead of typing, you have to speak into a microphone. The voice recognition equipment converts the sound waves into electronic signals that a natural language interface can understand. Then NLP takes over and interprets what is said and causes other actions to take place.

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## NEURAL NETWORKS

Definitions...

### 1. According to the DARPA Neural Network Study (1988, AFCEA International Press):

... A neural network is a system composed of many simple processing elements operating in parallel whose function is determined by network structure, connection strengths, and the processing performed at computing elements or nodes.

### 2. According to Haykin, S. (1994), *Neural Networks: A Comprehensive Foundation*, NY: Macmillan:

A neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects:

- ☞ Knowledge is acquired by the network through a learning process.
- ☞ Interneuron connection strengths known as synaptic weights are used to store the knowledge.

ANNs have been applied to an increasing number of real-world problems of considerable complexity. Their most important advantage is in solving problems that are too complex for conventional technologies -- problems that do not have an algorithmic solution or for which an algorithmic solution is too complex to be found. In general, because of their abstraction from the biological brain, ANNs are well suited to problems that people are good at solving, but for which computers are not. These problems include pattern recognition and forecasting (which requires the recognition of trends in data).

### Why Use Neural Networks

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. This expert can then be used to provide projections given new situations of interest and answer "what if" questions. Other advantages include:

1. **ADAPTIVE LEARNING:** An ability to learn how to do tasks based on the data given for training or initial experience.
2. **SELF-ORGANIZATION:** An ANN can create its own organization or representation of the information it receives during learning time.

3. **REAL TIME OPERATION:** ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.

Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

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## VIRTUAL REALITY

The use of specialized computers, software, and other gear to construct computer-generated environments. A user wears a headset that blocks out vision of the physical world and projects these computer-generated environments onto a screen near the eyes. He also uses a computer-connected "glove" or other hand-held device to manipulate the images in the virtual environment. Virtual reality is now transitioning from experimental applications to applications in business, health care, and mass entertainment.

[usinfo.state.gov/products/pubs/archive/telecomm/glossary.htm](http://usinfo.state.gov/products/pubs/archive/telecomm/glossary.htm)

An artificial environment created with computer hardware and software and presented to the user in such a way that it appears and feels like a real environment. To "enter" a virtual reality, a user dons special gloves, earphones, and goggles, all of which receive their input from the computer system. In this way, at least three of the five senses are controlled by the computer. In addition to feeding sensory input to the user, the devices also monitor the user's actions. The goggles, for example, track how the eyes move and respond accordingly by sending new video input. To date, virtual reality systems require extremely expensive hardware and software and are confined mostly to research laboratories. The term virtual reality is sometimes used more generally to refer to any virtual world represented in a computer, even if it's just a text-based or graphical representation.

[www.rustybrick.com/definitions.php](http://www.rustybrick.com/definitions.php)

A computer simulation of a real 3-dimensional world, often supplemented by sound effects. One early example allowed you to drive through a city, turn at any street intersection, and see what you would see out of a car window. Another let you learn a ship's layout by moving throughout all of its decks. Modern games let you fly an airplane or spaceship in combat or explore a dungeon and kill its monsters. Educational applications let you learn through experience for many types of simulated tasks or interact with professors and class members at a distance. See VRML.

[www.walthowe.com/glossary/v.html](http://www.walthowe.com/glossary/v.html)

### Different Images of VR Devices



The BOOM (Binocular Omni-Orientation Monitor)

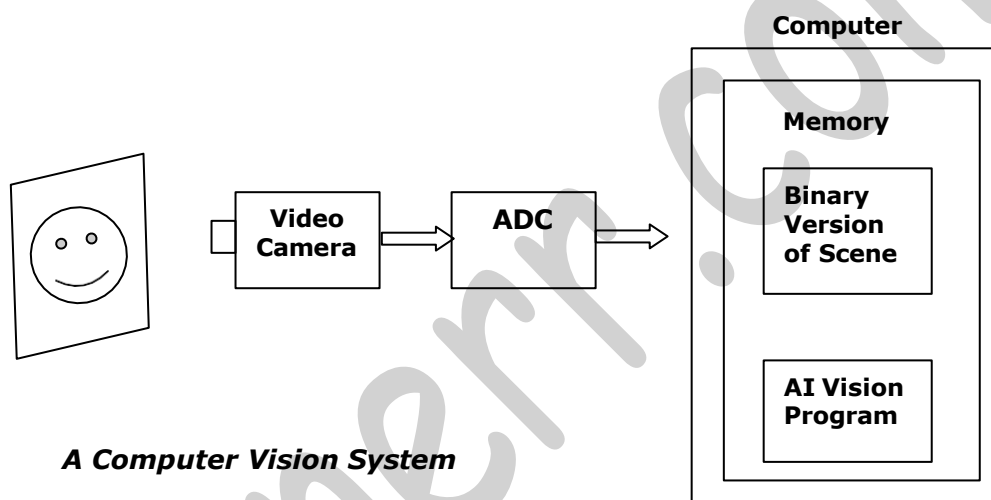


## COMPUTER VISION

Computer vision is the use of a computer to analyze and evaluate visual information. AI techniques allow the computer to examine a picture or real life scene to identify particular objects, features, or patterns.

By using search and pattern-matching techniques, a computer can pick out key features and search and identify information that a human eye may miss. Computer vision software attempts to extract knowledge from visual information to help a user solve a problem or make a decision.

For a computer to perform AI operations on visual inputs, the picture or real life scene must first be converted into digital signals compatible with the computer. A typical system is shown below:



**A Computer Vision System**

A video camera is pointed at the picture or scene and a video signal is generated. A high speed analog-to-digital converter (ADC) changes the analog video signal into binary numbers that are stored in the computer memory. The AI software then uses this input data for its content analysis.

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## ROBOTICS

Robotics is that field of engineering devoted to duplicating the physical capabilities of human beings, a natural complement of field of AI which attempts to mimic human mental abilities.

Robots are machines or manipulators capable of carrying out limited physical functions, the typical robot is a manipulator arm that can be used to pick up and place parts in a manufacturing operation, weld, and paint, attach and screw, and perform other intricate mechanical manipulations.

Robotic manipulator arms are operated by special electronic controllers or in some cases a computer. The controller or computer supplies commands to the robot and causes it to move the way it has been programmed to move.

Robots cannot respond to unusual or changing conditions. They cannot make their own decisions. However, if a robot is controlled by a computer, then it can be given artificial intelligence software which can make it more powerful and flexible. Instead of blindly carrying out a

preprogrammed sequence of operations, the robot may decide to change the order or its process, eliminate some steps, or otherwise modify its operation to fit situation.

To use AI software, however, a robot must receive input about its environment. This means that it must use sensors to detect the position of its arm and other conditions in its surroundings. The sensors can be pressure sensors, temperature sensors, light sensors etc. The most useful sensor is visual input from a video camera.

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