

Time: 3 Hours

Total Marks: 100

Note: Attempt all questions.

Q. 1. Attempt any four parts of the following. (5 × 4 = 20)

(a) What is AI? Explain any five applications of AI in short.

Ans. AI is developing computer programs to solve complex problems by applications of processes that are analogous to human reasoning process. It is a branch of computer science concerned with the study and creation of computer systems that exhibit some form of intelligence: Systems that can learn new concepts and tasks, system that can reason and draw useful conclusions about the world around us, system that can understand natural language etc.

Application of AI

- 1. Games:** Ex. Chess, Tic-tac-toe that display intelligences we can easily play these games with computer system.
- 2. Problem Solving:** There are several problems like water jug problem, Tower of Hanoi, Travelling salesman problem (TSP) etc. can be solved with the help of AI techniques.
- 3. Robotics:** It is developing a computer system that can perform ability to move and act in the world, responding to new perceptions.
- 4. Natural language processing:** Computer system that can understand natural language must know how to generate, understand, translate to the language by using different techniques like encoding, decoding, parsing translating and AI ideas about structures for representing contextual knowledge.
- 5. Visual Perception:** We perceive our environment through sight, sound, touch,

taste etc. Accurate machine vision opens a new realm for computer applications such as mobile robot navigation, computer manufacturing tasks, etc.

Q. 1(b) What is heuristic search? Explain with example. Also write heuristic function for:

(i) Hill climbing problem:

Ans. Hill climbing problem: A heuristic is a technique that improves the efficiency of a search process possibly by sacrificing claims of completions. It is a method that might not always find best solution but is guaranteed to find a good solution in reasonable time. Using good heuristics, we can get good solutions to hard problems such as traveling sales man problem etc. One example of a good general purpose heuristics is nearest neighbour heuristics that is useful for a variety of combinatorial problem. A heuristics function is a function that maps from problem state descriptions to measures of desirability usually represented as numbers. Its purpose is to guide the search process in the most profitable direction by suggesting which path to follow first when more than one path is available.

Heuristic function for Hill climbing problem - Hill climbing algorithm also called discrete optimization algorithm uses Heuristics functions.

Amount of distance the node is from goal.

(ii) Tic Tac Toe

Ans. Heuristics function for Tic-Tac-Toe-

1. For each row in which we could win and in which we already have one piece plus 2 for each row in which we have two pieces.

Q. 1(c) Differentiate between strong AI and weak AI

Ans. Strong AI: Strong AI makes bold claim that computers can be made to think on a level at least equal to humans. Strong AI research deals with the creation of some form of computer based AI that can truly reason and solve problem. In strong AI, the programs are themselves the explanations

Weak AI-IT simple states that some "thinking like" features can be added to computer to make them more useful tool. Weak AI research deals with reaction of some form of computer based AI which can reason and solve problems in a limited domain. "We have already started reaching the objectives of weak AI (e.g expert system) but objectives of strong AI are still to be reached".

Q. 1(d) Prove the Breadth first search and depth first search are special cases of best first search.

Ans. A search strategy that uses a cost function $C(x) = f(h(x)) + g(x)$ to select the next E-node would always choose for its next E-node a level node with least $C(\cdot)$. Hence such a search strategy is called best first search. BFS and DFS (Breadth first search and depth first search) is special case of Best first search. If we use

$\hat{g}(x) = 0$ and $f(h(x)) = \text{level of node } x$ then best first search generates nodes by levels. This is essentially same as breadth first search.

If $f(h(x)) \cong 0$ and $\hat{g}(x) \geq \hat{g}(y)$ whenever y is child of x then search is essentially a depth first search. $\hat{g}(x)$ is estimate of additional effort needed to reach an answer node from x .

Node x is assigned a rank using a function $\hat{c}(x)$. $h(x)$ is cost reaching x from root $f(\cdot)$ -any non decreasing function.

Q. 1(e) Describe how Branch and Board techniques could be used to find the shortest path solution path solution to a travelling salesman problem.

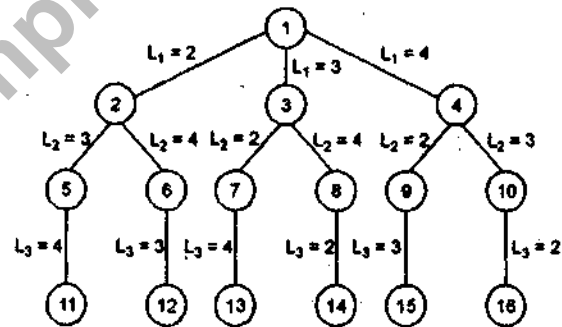
Ans. Let $G = (V, E)$ be a directed graph defining an instance of traveling salesman problem. Let C_{ij} equal cost of edge (ij) , $C_{ij} = \infty$ if $(i, j) \notin E$ and Let $|V| = n$.

To use least cost breach bound (LCBB) to search the traveling salesperson state space tree, we need to define a cost function (C) and two other functions $\hat{c}(\cdot)$ and $u(\cdot)$ such that

$$\hat{c}(r) \leq c(r) \leq u(r) \text{ For all nodes.}$$

The cost $C(\cdot)$ is such that solution node with least $C(\cdot)$ corresponds to a shortest tour in C_1 . One choice for $C(\cdot)$ is

$C(a) = \text{Length of defined by path from root to } A$, if A is a leaf cost of a minium cost leaf in the subtree A , if A is not a leaf



State space tree of TSP with $n = 4$ and $i_0 = L_1 = 1$

A simple $\hat{c}(\cdot)$ such that $\hat{c}(A) \leq c(A)$ for all A is obtained by defining $\hat{c}(A)$ to be the length of path defined at node A . For example, the path defined at node 6 for fig. is $i_0, i_1, i_2 = 1, 2, 4$. It consists of edges $(1, 2)$ and $(2, 4)$. The better $\hat{c}(\cdot)$ can be obtained by using reduced cost matrix

$$G = \begin{bmatrix} \infty & 20 & 30 & 10 & 11 \\ 15 & \infty & 16 & 4 & 2 \\ 3 & 5 & \infty & 2 & 4 \\ 19 & 6 & 18 & \infty & 3 \\ 16 & 9 & 7 & 16 & \infty \end{bmatrix} \quad \begin{bmatrix} \infty & 10 & 17 & 0 & 1 \\ 12 & \infty & 11 & 2 & 0 \\ 0 & 3 & \infty & 0 & 2 \\ 15 & 3 & 12 & \infty & 0 \\ 11 & 0 & 0 & 12 & \infty \end{bmatrix}$$

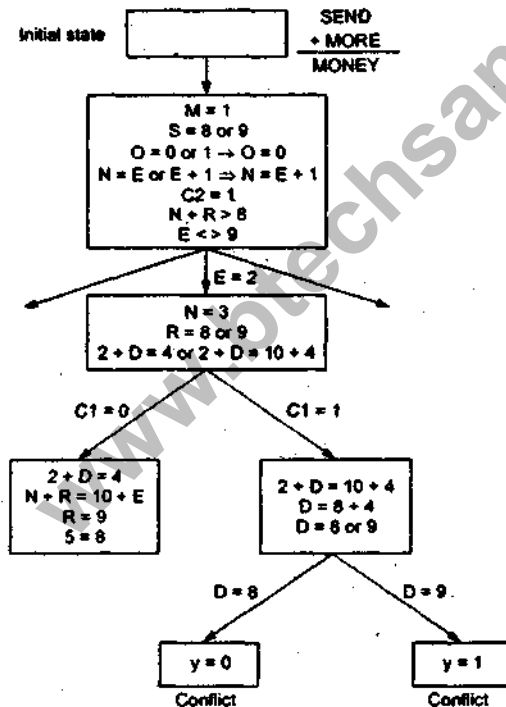
Cost Matrix Reduced cost matrix

For example, after using reduced cost matrix method, LCBB algorithm terminates with (1, 4, 2, 5, 3, 1) as the shortest length tour

Q. 1(f) Solve the following cryptarithmic problem.

$$\begin{array}{r} \text{SEND} \\ + \text{MORE} \\ \hline \text{MONEY} \end{array}$$

Ans.



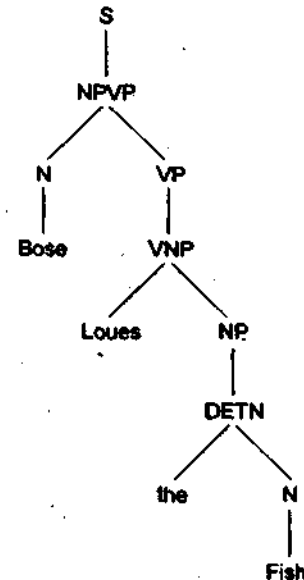
Q. 2 Attempt any four parts of the following
(5 × 4 = 20)

Q. 2 (a) Derive the parse tree for the sentence "Bose Loues the fish" where following rewrite rules are used:

$S \rightarrow \text{NPVP}$, $\text{NP} \rightarrow \text{N}$, $\text{NP} \rightarrow \text{DET N}$
 $\text{VP} \rightarrow \text{VNP}$, $\text{DEBT} \rightarrow \text{the}$, $\text{V} \rightarrow \text{Loues}$
 $\text{N} \rightarrow \text{Bose/fish}$

Ans.

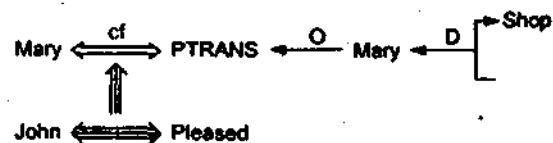
$S \rightarrow \text{NPVP}$
 $S \rightarrow \text{NVP}$ [Using $\text{NP} \rightarrow \text{N}$]
 $S \rightarrow \text{NVNP}$ [Using $\text{Vp} \rightarrow \text{VNP}$]
 $S \rightarrow \text{Bose VNP}$ [$\text{N} \rightarrow \text{Bose}$]
 $S \rightarrow \text{Bose Loues NP}$ [Using $\text{V} \rightarrow \text{Loues}$]
 $S \rightarrow \text{Bose Loues DETN}$ [Using $\text{NP} \rightarrow \text{DET N}$]
 $S \rightarrow \text{Bose Loues the N}$ [Using $\text{DET} \rightarrow \text{the}$]
 $S \rightarrow \text{Bose Loues the fish}$ [Using $\text{N} \rightarrow \text{fish}$]



Q. 2(b) Draw a conceptual dependency diagram for following sentence:

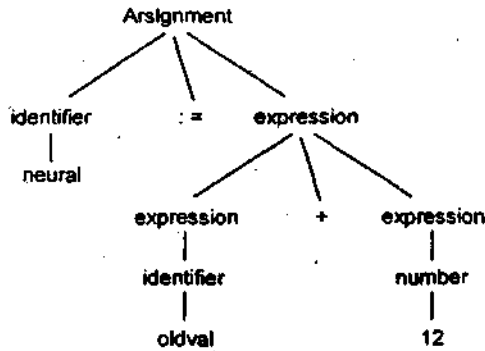
"John wanted Mary to go to shop"

Ans.



Q. 2(c) Explain syntactic analysis in short.

Ans. A syntax analyzer creates the syntactic structure (generally a parse tree) of the given program. Syntax analyzer is also called a parser. A parse tree describes a syntactic structures in which all terminals are at leaves. All inner nodes are non terminals in a context free grammar



- Syntax of languages is specified by a context free grammar (CFG).
- Rules in a CFG are mostly recursive.
- Syntax analyzer check whether a given program satisfies the rules implied by a CFG or not.
- If it satisfies, syntax analyzer creates a parse tree for given program.

Q. 2(d) Explain the Transition Networks with help of suitable example.

Ans. It is a method used to represent formal and natural languages structure. They are based on application of digraphs and finite state automata. A transition network consists of a number of nodes and labelled arcs. The nodes represent different states in traversing a sentence, and the arcs represent rules or test conditions required to make the transition from one state to next. If a transition network can be successfully traversed, it will have recognized a permissible sentence structure eg. a

network used to recognize a sentence consisting of determiners a, noun and a verb is represented by following graph.



We can derive the sentence from above network like "The child runs".

This type of network is very limited since it will only recognize simple sentences of the form DETVV. So we can have network like

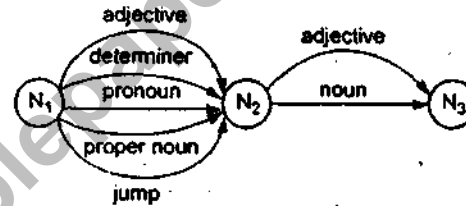


Fig. A noun Phrase segment of a Transition network

Q. 2(e) What is sentence level processing? Explain with an example.

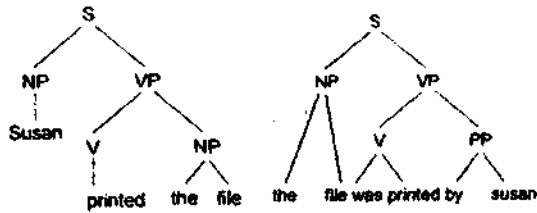
Ans. Several approaches to the problem of creating semantic representation of a sentence have been developed including the following.

1. Semantic grammar which combine syntactic, semantic and programmatic knowledge into a single set of rules in the form of a grammar. The result of parsing with such a grammar is semantic grammar.

Ex- I want to print Bill's in it file. In the sentences

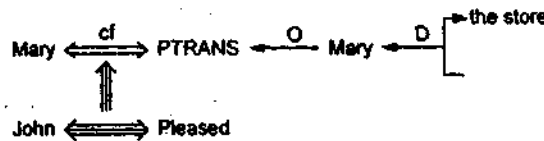
"I want to" - ACTION.

2. Care grammar is one in which structure that is built by the parsers contains some semantic information



Susan printed the file the file was printed by Susan
 Syntactic Parser of an active and a passive sentence.

3. Conceptual parsing is one in which syntactic and semantic knowledge are combined into a single interpretation system that is driven by semantic knowledge.



4. Approximately composition semantic interpretation - is one in which semantic processing is applied to the result of performing a syntactic parse.

Q. 2(f) Explain various terms used in sentence generation.

Ans. Sentence generation system must not only decide what to say but also how to say it. A sentence generation system must decide which form is better (active or passive), which words and structures best express what we want to communicate and when to say what. The study of languages generation falls naturally into three areas:

- (i) **Content Determination:** It is concerned with what details to include in an explanation, a request, a question or argument. It means that speaker must know that the hearer already knows, what hearer needs to know and what hearer wants to know.
- (ii) **Text Planning:** It is a process of organizing the content to be communicated so as to best achieve the goals of the speaker.

(iii) **Realization:** It is the process of mapping organized content to actual text.

Typical stages of natural language generation system are

1. **Content determination:** Determination of salient feature that are being said.
2. **Discourse planning:** Overall organization of information to be conveyed.
3. **Sentence aggregation:** Merging of similar sentences to improve readability and naturalness.
4. **Lexicalization:** Putting words to concepts.
5. **Referring expression generation:** Linking words in the sentences by introducing pronouns and other types of means of reference.
6. **Syntactic and morphological realization:** It is used to produce surface string.
7. **Orthographic realization:** Matters like casing, punctuation and formatting are resolved.

Q. 3 Attempt any two part of the following:

Q. 3(a) What is Minsky Frames System Theory?

Ans. Frames were first introduced by Marvin Minsky (1975) as a data structure to represent a mental model of a stereotypical situation such as driving a car, attending a meeting or eating in a restaurant. Knowledge about an object or event is stored together in memory as a unit. Then, when a new situation is encountered, an appropriate frame is selected from memory for use in reasoning about the situation.

Frames are general record like structure consists of a collection of slots and slots values. The slots may be of any size and type. Slots typically have names and values or subfields called facts. Facts may also have names and any number of values

<Frame name>

<slot 1> <facet 1> <Value 1> ... (Value k₁)>

<facet 2> <Value 1> ... (Value k₂)>

<slot 2> <facet 1> <Value 1> ... (Value k_n)>

A general frame structure

eg. a simple frame for Bob is shown in following

fig.

```
(bob
 (PROFESSION (VALUES professor))
 (AGE (VALUE 42))
 (WIFE (VALUE sandy))
 (CHILDREN (VALUE sue joe))
 (ADDRESS (STREET (VALUES 100 elm))
           (CITY (VALUES dallas))
           (STATE (VALUE tx))
           (ZIP (VALUES 75000))))
```

A simple instantiated person frame

Q. 3 (b) Describe semantic net and frames with suitable example.

Ans. Frames: AI languages such as LISP use frame based representation. They typically have functions to create, access, modify, update and display frames. For example a function which defines frame might be called with

```
(fdefine f-name <parents><slots>)
```

Where

f define is a frame definition

f-name is name assigned to a new frame.

<parents> is a list of all parent frames to which new frame is linked.

<slots> is a list of slot names and initial values using function *f*define to create a train frame we might provide following details.

```
(fdefine general-train land-transport
```

```
(types (VALUES passengers))
```

```
(class (VALUES first-class, second-class, sleepers))
```

```
(food (restaurant (VALUES hot-meals))
```

```
(fast food (VALUES cold-snacks))
```

Semantic net: The main idea behind semantic nets is that meaning of concepts comes from ways

in which it is connected to other concepts. It consists of two basic primitive.

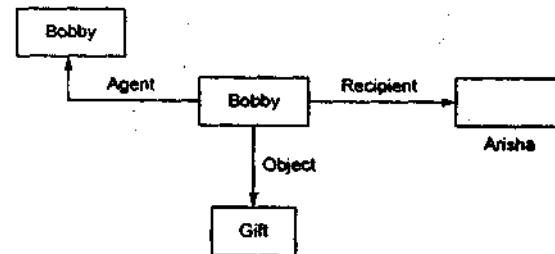
Nodes: It corresponds to objects or classes of objects in the world

Arcs: It corresponds to relationship between these objects.

- Semantic nets or networks is used as a graphical notation for representing knowledge in pattern of interconnected nodes and arcs.
- The node in a semantic net stand for "Objects, concepts, and events".
- Area can be defined in a variety of ways, depending on kind of knowledge being represented.
- In natural language processing, arcs are represented by "Agents, objects, recipients etc."

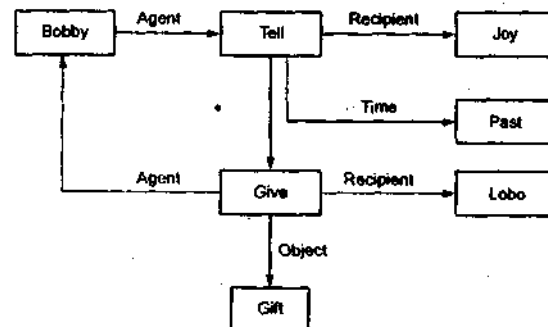
ex- BOBBY gives Arisha a gift"

It is semantic network



ex- Krishan told Bobby that he give Arisha a gift

Its semantic network



Q. 3(c) Convert following sentence into predicate logic and then its clause form:

Ans. Marcus was a Man

Predicate logic : Man(Marcus)

Clause form: Man (Marcus)

Ans. (ii) Ceaser was ruler.

Predicates logic: Rules (ceaser)

Clase form: Ruler (ceaser)

Ans. (iii) Everyone in loyal to someone.

Predicate logic: $\exists x : \exists y : \text{loyal to}(x, y)$

Clause form : $\forall x : \rightarrow y : \text{loyal to}(x, y)$

Ans. (iv) Marcus try to assassinate Ceaser.

Predicate logic: try assassinate (Marcus, ceaser)

Clause form: tryassassinatic (Marcus, Ceaser)

Q. 4 Attempt any two parts of the following:

(10 × 2 = 20)

Q. 4(a) Explain the working of DENDRAL expert system.

Ans. The first expert system to be completed was DENDRAL, developed at stanford University in 1960's. This system was capable of determining the structure of chemical compounds given a specification of compound's constituent elements and mass spectrometry data obtained from samples of the compound.

DENDRAL used heuristic knowledge obtained from experienced chemists to help constrain the problem and thereby reduce the search space. During tests, DENDRAL discovered a number of structure previously unknown to expert chemists.

Working of DENDRAL: At the starting of the session, the planning program is used. The spectrum available from the test is fed into the program and various groups in the compound are identified. The output of this planning program consists of two list.: One is GOODLIST and other is BADLIST, These lists helps in the formation of structure of the compound.

The elements of GOODLIST act as indicators to identify the rules which have that group as an antecedent. In this fashion, the system forward chains to identify very specific compounds.

The planner's production rules help in pricing the number of alternate structure in the compound. If this planning component is missing, it is certain that there will be combinations explosion of states which will be highly unmanageable. The outputs of planner are sent to the structure generator to give chemical structure of the compound. DENDRAL is supposed to be a milestone in the development of expert system because for the first time it proved capacity of achieving expert performance in a very constracted domain.

DENDRAL's Processes

Operation	Component (Programs)	Input	Output
Planning	Molion Planner	Mass spectrum Planning rules	Ion constraints Other constraints Super atoms
Generating	Congen Genoa Stereo	Constraints	Candidate molecular structures
Testing	Predictor Ms prune	Candidate Molecular structures Mass Spectrometry rules Reaction chemistry rules	Most plausible Structure Structures consistent with spectrum Structures consistent with known relations.

Q. 4(b) What is knowledge and Meta knowledge? Explain in detail.

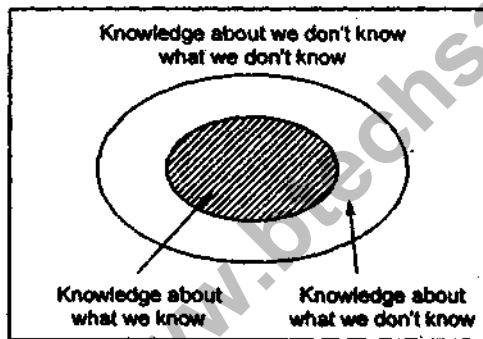
Ans. Knowledge is a collection of specialized fact, Procedures and judgement rules knowledge sources can be

- Documented (books, manuals etc)
- Undocumented (in peoples minds)
- From people, from machines
- Knowledge acquisition from data bases
- Knowledge acquisition via the internet
- Professionals who elicit knowledge from experts
- Empathetic patient.
- Broad range of understanding, capabilities
- Integrate knowledge from various sources
- Creates and edits code
- Operates tools
- Build knowledge base
- Validates information
- Trains users.

knowledge acquisition is the extraction of knowledge from source of expertise and its transfer to the knowledge base and sometimes to the inference engine. It is a method of learning, first proposed by Aristate in his seminar work "organon". He proposed that mind at birth is a blank state, or *tabula rasa*. As a blank state, it contains no knowledge of the objective, empirical universe nor of itself.

Meta Knowledge is knowledge about the knowledge. It is knowledge about what to know and what we don't know. This implies at an individual as well as at an organization level. At the individual level, there are three levels of meta knowledge best represented by a diagrams of shape like a boiled egg.

1. The yalk part represents the knowledge that we know, what we know.
Ex. I know I have the knowledge that how to ride bike.
2. The white part of egg is the knowledge that we know what we don't know.
Ex- I know that I don't know what will be my salary in future but I know that, it will possible for me to acquire knowledge in future
3. The rest of universe, the empty space outside the egg is the knowledge that we don't know what we don't's know



Meta knowledge

Q. 4(c) Write short notes on:

Ans. (i) Limitation of Expert System (ES):

- (a) Present day ES focus on very specific topics like computer faults, diagnostic skills etc. The major reason being the difficulty in extracting knowledge, building and maintaining large knowledge bases.

- (b) Lack of proper knowledge representation mechanism hamper progress in expert system development.
- (c) There is no flexibility for user to state the problem. Users describe the problem in strictly defined formal language which every user might not be able to do.
- (d) All AI system lack understanding" about underlying concepts and exactly repeat for what they have been programmed.
- (e) The construction process of ES is laborious one.
- (f) Present day ES are fragile at the boundaries of their domain. The main reason is systems do not possess knowledge whether the problem falls with in domain or not.
- (g) Though some of the system have the facility of knowledge acquisition by directly interacting with the experts, for majority of the system, there is a dire need for a knowledge engineer.
- (i) Presents day ES do not have any common sense knowledge.

Ans. (ii) Self Explanation system: Most expert system have self explaining facility i.e why it asked certain questions, how it arrived as its answers etc. Most of these answers are provided by explanation module. It provide the user with an explanation of reasoning process when requested.

To respond to how query, explanation module traces the chain of rules fired during a consultation with answer.

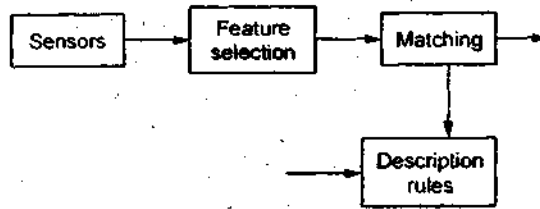
The sequence of rules that led to the conclusion is then printed for the user in an easy to understand human language style.

To respond to why query, the explanation module must be able to explain why certain information is needed by the inference engine to complete a step in reasoning process before it can proceed

Q. 5 Attempt any two part of the following:

Q. 5(a) (i) Explain approaches for pattern recognition techniques.

Ans. Pattern recognition aims to classify data (patterns) based on either a priori knowledge or on statistical information extracted from the patterns. Pattern recognition process have following steps



There are two basic approaches to pattern recognition problem:

1. Decision Theoretic classification (statistical Description)
2. Syntactic Description (Structural Descriptions)

Statistical Description: It is based on the use of decision functions to classify object. A decision functions maps pattern vector X into decision regions of D . A problem can be stated as

1. Given a universe of objects $O = \{O_1, O_2, \dots, O_n\}$. Let each O_i has k observable attributes and relations express able as vector $V = (V_1, V_2, \dots, V_k)$
2. Determine (a) A subset of $m \leq k$ of V_i , say $X = (X_1, X_2, \dots, X_m)$ whose values unequely characterize the O_i and b) $C \geq 2$ grouping or classifications of O_i which exhibit high interclass and low interclass stimulates. Determining feature attribute and decision regions requires stipulating of learning mapping from the measurement space M to the features space F and then a mapping F to the classification or decision space D ,

$$M \rightarrow F \rightarrow D$$

Syntactic description

It is based on the uniqueness of syntactic "Structure" among objects classes. It is based on structural interrelationships of features. A wide range of algorithms can be applied for pattern recognition, classifications of text into several categories like spam/non e-mail messages.

(ii) What are the problems associated with speech recognition?

Ans. When medium is speech, prediction step is called speech recognition. Speech is ability to communicate directly with programs and it offers several advantages.

- (i) It eliminates the need for keyboard entries.
- (ii) It speeds up the interchange of information between user and system.
- (iii) With speech as a communication medium, users are also free to perform other tasks concurrently with the computer interchange.
- (iv) Untrained personal can also use computer in a variety of applications.

Major design issues or problems that are associated with speech recognition are:

1. Speaker dependence versus speaker independence

A speaker independent system can listen to any speaker and translate the sounds in written text. Speaker independence system is hard to achieve because of wide variation in pitch and accent.

2. Continuous versus Isolated work speech: Interpreting isolated word speech, in which speaker pauses between each words is easier than interpreting continuous speech. This is because boundary effects cause words to be pronounced differently in different contexts.

3. Real time versus offline processing: Highly interactive applications require that a sentence be translated into text as it is being spoken, while in other situations, it is permissible to spend time in computation.

4. **Large versus small vocabulary:** System that are confined to small vocabulary is easier than working with large vocabulary
5. **Broad versus Narrow Grammar:** The narrower the grammar, the smallest the search space for recognition will be.

Q. 5(b)(i) Write a function in LISP that computes prime number between 1 to 20

Ans. The lisp function
 (define prime (n)
 (and
 (> n 1)
 (for all (nums 2 (floor (sqrt n)))
 #' (lambda (divisor) (not (= (mod n divisor) 0))
))))

This expression yields all the prime number in the range 1...20

(2 3 5 7 11 13 17 19)

Q. 5(b)(ii) Write down the main features of PROLOG language.

Ans. PROLOG (Programming in logic)-PROLOG uses the syntax of predicate logic to perform symbolic, logical computations. Programming in PROLOG is accomplished by creating a data base of facts and rules about objects, their properties and their relationships to other objects. Queries can then be posted about the objects and valid conclusions will be determined and returned by the program.

Facts: There are declared with predicate and constants written in lower case letters. Some facts are:

Sister (Sue, bill)

It means that sue is the sister of bill.

Rules: There are composed of a condition of "if" part and a conclusion or "then" part separated by the symbol.

ex-Grandfather (X,Z): parent (X, Y), parent (Y, Z), male (X)

It means that for all X, Y, Z. is grandfather of Z. If X is parent of Z and X is the male.

Given a database of facts and rules, we make queries by typing after the query symbol "?"

? - Parent (X, sam)

X = aa nn).

Q. 5(c) (i) Write short notes on following

Ans. (i) Computer vision: Computer vision is one way for a computer system to reach beyond the data. It is given and find out about the real world. The human visual system makes scene interpretation seem easy. We can look out of a window and can make sense of even a very complex scene. This process is difficult of the machine. The orientation and position of an object changes its appearance as does different lighting or color.

Phase of computer vision:

1. **Digitization:** The analogues wide signal is converted into a digital image.
2. **Signal processing:** Low level processing of the digital image in order to enhance significant features for human consumption or as input to another program.
3. **Edge and region detection:** finding low level features in digital image.
4. **Three dimensional or two dimensional objects recognition:** building lines and regions into objects.
5. **Pattern recognition:** classification objects into a category drawn from a finite set of possibilities.
6. **Image understanding:** Making sufficient sense of image to use it.

Ans. (ii) Machine perception: Perception involves interpreting signals, sound, smells and touch. Machine perception is the process by which machine maps sensor measurement into internal representation of the environment. Good internal representation for machine perception should have three properties.

- (i) They should contain enough information for the machine to make the right decisions.

- (ii) They should be structured such that they can be updated effectively.
- (iii) They should be natural in the sense that internal variables corresponds to natural state variables in the physical world.

As the amount of digital storage capacities doubling every year and bandwidth in both wired and wireless networks increases at faster rate, So there is a need for tolls that can assists us in exploring huge quantitative of data and can extract knowledge burried in bits. This can be done by machine perception. Machine perception concerns itself with estimating decision relevant quantities from sensor data. Probabilistic filtering algorithms such as kolman filters and particle filters are useful for machine perception.