B.TECH. TIT-702

SEVENTH SEMESTER EXAMINATION, 2008-2009

ARTIFICIAL INTELLIGENCE

Time: 3 Hours *Total Marks:* 100

Note: (*i*) *Attempt all questions.*
(*ii*) *All questions carry equal marks.*
(*iii*) Be precise in your answer.
(*iv*) No second answer book will be provided.

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

1. (*a*) What is Artificial Intelligence and Natural Intelligence?

Ans. Artificial Intelligence: "AI is developing computer programs to solve complex problems by applications of processes that are analogous to human reasoning processes."

OR

"AI is a branch of computer science concerned with the study and creation of computer systems that exhibit some form of intelligence : systems that learn new concepts and tasks, systems that can reason and draw useful conclusions about the world around us, systems that can understand a natural language and system that perform other types of feats that require human types of intelligence."

Natural Intelligence: It is the ability to reason, to trigger new thoughts. It is natural rather than being programmed by human beings. It increases with both experience and hereditary. This intelligence increases by supervised or unsupervised teaching. There is always a better solution provided by another human being. It is highly refined and no electricity from outside is required to generate output unlike in artificial intelligence where computer systems need electricity to generate output.

1. (*b*) Differentiate between strong AI and weak AI.

Ans.

Strong AI	Weak AI
1. Makes the bold claim that computers can be made to think on a level at least equal to humans.	1. It simply states that some "thinking - like" feature can be added to computers to make them more useful tool.
2. Strong AI research deals with the creation of some form of computer based AI that can truly reason and solve problems.	2. Weak AI research deals with the creation of some form of computer-based AI which can reason and solve problems in a limited domain.
3. In strong AI, the programs are themselves the explanations.	3. In weak AI, this is not the case
4. Objectives of strong AI are still to be reached.	4. We have already started reaching the objectives of weak AI (e.g. expert systems).

1. (c) What are the different branches of Artificial Intelligence (AI)?

Ans. Branches of AI:

1. Natural Language Processing (NLP): Processing and (perhaps) understanding human "natural" language.

2. Knowledge engineering/representation: Turning what we know about a particular domain into a form in which a computer can understand it.

3. Planning: Given a set of actions, a goal state, a present state, decide which actions must be taken so that the present state is turned into the goal state.

4. Machine learning: Programs that learn from experience.

5. Pattern Recognition: When a program makes observations of some kind, it is often programmed to compare what it sees with a pattern.

6. Speech Recognition: Conversion of speech into text.

7. Search: The finding of a path from a start state to a goal state.

8. Representation: Facts about the world have to be represented in some way, usually mathematical logics are used.

9. Inference: From some facts, others can be inferred. For e.g. when we hear of a bird, we may infer that it can fly.

10. Learning from experience: Programs do that. The approaches to AI based on connectionism and neural nets specialize in that.

11. Epistemology: This is a study of kinds of knowledge that are required for solving problems in the world.

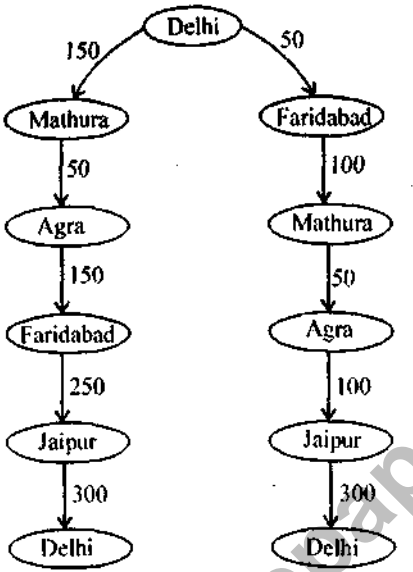
12. Heuristics: A heuristic is a way of trying to discover something or an idea embedded in a program.

13. Neutral Networks: The study of programs that function in a similar manner as animal brain does.

1. (d) Give an instance of the travelling salesman problem for which the nearest neighbour strategy fails to find an optimal path. Suggest another heuristic for this problem.

Ans. Instance of TSP:

	Delhi	Faridabad	Mathura	Agra	Jaipur
Delhi	—	50	150	200	300
Faridabad	50	—	100	150	250
Mathura	150	100	—	50	150
Agra	200	150	50	—	100
Jaipur	300	250	150	100	—



The another approach is solution guaranteed approach.

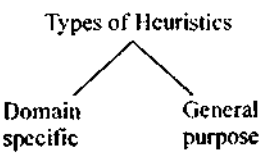
1. (e) Explain various hardware and software components of AI system.

Ans. Hardware and software components of AI system:

Software	*Architecture*	*A.I. Concepts*
Machine language	Uniprocessor	Numerical processing
Assembly language	Array processor	Symbolic processing
High level language	Special purpose chips	General problem solving
LISP, PROLOG	Super Computers	Logic
4th Generation Language	Parallel Computers	Heuristic Search
Object-oriented language	VLSI Array Processor	Computational Linguistics
Distributed Languages	Parallel Distributed Processing	Natural Language Processing
Natural Language		Knowledge Representation
		Expert systems
		Hidden Markov Model
		Artificial Neural networks

1. (f) Explain various types of heuristic.

Ans.



Domain Specific: Here more knowledge of the problem is incorporated. This can be done in two ways – when domain-specific knowledge can incorporated into a rule-based search procedure:

— In the rule themselves. For e.g., the rules for a chess-playing system might describe not simply the set of legal moves but rather a set of sensible moves, as determined by rule writer.

— As a heuristic function which evaluates individual problem, states and determines how desirable they are.

General Purpose: Heuristics are useful for a variety of problems. One example of general purpose heuristics is for Travelling Salesman Problem (TSP). TSM involving combinatorial explosion is the Nearest Neighbour heuristic procedure, which works by selecting the locally superior alternative at each step.

Another strategy is Branch and Bound. It generates one path at a time, keeping track of the best circuit found so far.

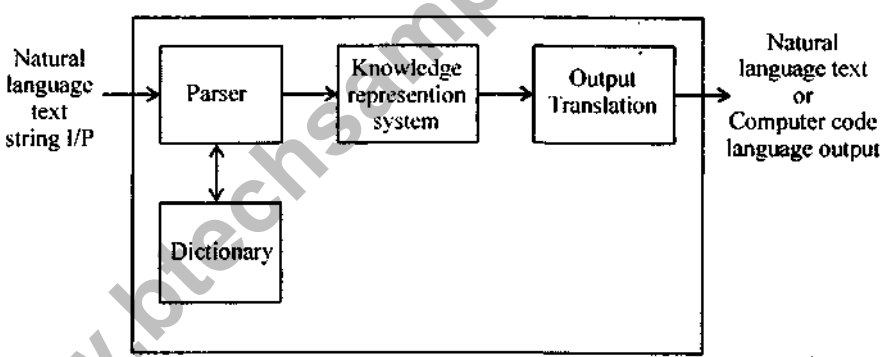
Q.2. Attempt any FOUR parts of the following: **(5×4=20)**

2. (*a*) What is natural language processing?

Ans. Natural Language Processing: "Natural language processing is the engineering of systems that process or analyze written or spoken natural language".

OR

"Natural language processing can be defined as the automatic processing of human language."



(The major components of a natural language processing system.)

It consists of two things natural language understanding and then language generation.

2. (*b*) Derive the parse tree for the sentence "Base Loues the fish", where the following rewrite rules are used:

S → NPVP, NP → N, NP → DETN, VP → VNP, DET → the, V → loues, N → Bose/fish

Ans. To derive a tree for the given sentence.

"Base Loues the fish"

Given rules are:

S → NPVP, NP → N, NP → DETN

V → VNP, DET → The, V → Loues

N → Bose/fish

By using leftmost derivation:

$S \rightarrow NPVP$

$\rightarrow NVP$ ($\because NP \rightarrow N$)

$\rightarrow$ Bose VP ($\because N \rightarrow$ Bose)

$\rightarrow$ Bose VNP ($\because VP \rightarrow VNP$)

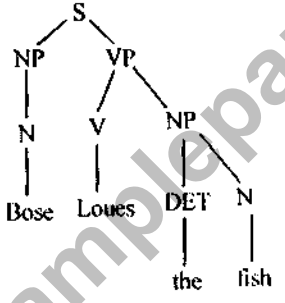
$\rightarrow$ Bose Loues NP ($\because V \rightarrow$ Loues)

$\rightarrow$ Bose Loues DET N ($\because NP \rightarrow DETN$)

$\rightarrow$ Bose Loues the N ($\because DET \rightarrow$ the)

$\rightarrow$ Bose Loues the fish ($\because N \rightarrow$ fish)

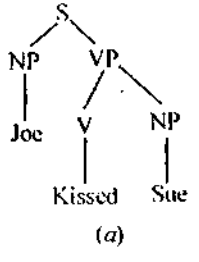
Parse tree



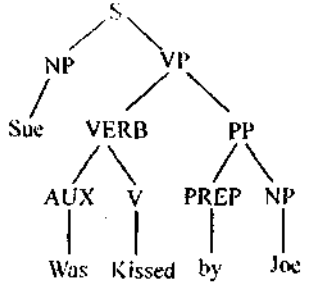
2. (c) Describe the Transformational Grammars with suitable examples.

Ans. Transformational Grammars: The generative grammars generally produce different structures for sentences having different syntactical forms eventhough they may have the same semantic content.

E.g. The active and passive forms of a sentence will result in two different syntactic tree. The sentences "Joe kissed Sue" (active voice), "Sue was Kissed by Joe" (passive voice) have the two different structures obtaining different structures from sentences having the same meaning is undesirable in language understanding systems. To repair these shortcomings in generative grammars, Chomsky extended them by incorporating two additional components to the basic syntactic component. The added components provide a mechanism to produce single representation for sentences having the same meaning through a series of transformations. This extended grammar is called transformation generative grammar.



(a)



(b)

2. (d) What is the basic process for building conceptual dependency structure?

Ans. Basic process for building conceptual dependency structures are:

Step 1. Obtain the next lexical item.

Step 2. Access the lexical entry for the item and obtain the association tests and actions.

Step 3. Perform the specified actions given with the entry.

Three types of tests are performed:

Test type 1. If a certain laxical entry is found, the indicated action is performed. This corresponds to true.

Test type 2. Specific word odering are checked as the structure is being built and actions initialized as a result of the oderings.

Test type 3. Checks are made for specific words or phrases and if found, specific actions are taking. For above tests, four types of actions are taken:

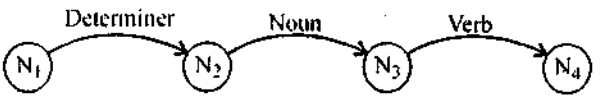
1. Adding additional structure to a partially built conceptual dependency.
2. Filling a slot with substructure.
3. Activating another action.
4. Deactivating an action.

These actions build up the conceptual dependency structure as the input string is passed.

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

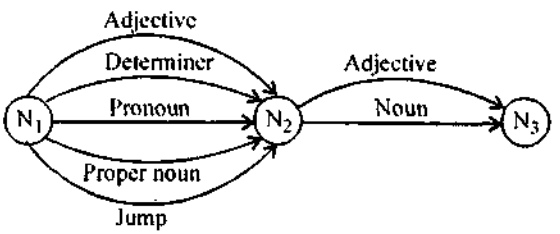
Ans. Transition Networks: It is a method used to represent formal and natural languages structures. They are based on the application of diagraphs and finite state automata. A transaction network consists of a number of nodes and labelled arcs. The nodes represent different states in traversing a sentence,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

E.g. A network uses to recognize a sentence consisting of a determiner, a noun and a verb, is represented by the following graph:



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

This type of network is very limited since it will only recognize simple sentences of the form DETNV. The utility of network such as this can be increased if more than a single choice is permitted at some of the nodes.



A noun phrase segment of Transition network

To move from N_1 to N_2 in this network, it is necessary to first find an adjective, a determiner, a pronoun, a proper noun or none of these by jumping directly to N_2.

E.g. It will recognize following noun phrases:

Big White Clouds

Large green leaves

A beautiful girl.

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

Ans. The various terms used in sentence generation includes various areas:

***(i)* Content determination:** It is concerned with what details to include in an explantion. This means that the speaker must know what the hearer already knows, what the hearer needs to know, and what he 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 the organized content to actual text. This requires that specific words and phrases be choosen and formulated into a syntactic structure.

The typical stages in a natural language generation system are:

1. Content determination: Determination of the salient features that are worth being said.

2. Discourse planning: Overall organization of the information to be conveyed.

3. Sentence aggregation: Merging of similar sentences to improve readability and naturalness. For example, the sentences "The next train is the Dehradoon Express" and "The next train leaves Delhi at 10 am" can be aggregated to form "The next train, which leaves at 10 am, is the Dehradoon Express".

4. Lexicalization: Putting words to the 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: These are applied to produce the surface string.

7. Orthographic realization: Matters like casing, punctuation and formatting are resolved.

Q.3. Attempt any TWO parts of the following: **(10×2=20)**

3. *(a)* Describe meaning of knowledge representation and knowledge acquisition.

Ans. Knowledge Representation: After giving the fact that knowledge is important and in fact essential for intelligent behaviour, the representation of knowledge has become of AI's top research priorities. It can be represented in different forms:

— as a medium for efficient computation

— as a medium for human expressions

— as mental images in one's thoughts

— as spoken or written words in some language

— as graphical or other pictures.

First order Predicate Logic (FOPL): FOPL or predicate calculus has assumed one of the most important role in AI for the representation of knowledge. In FOPL statements from a natural

language like English are translated into symbolic structures comprised of predicates, functions, variables, constants, quantifiers and logical connectives.

Syntax for FOPL:

1. Connectives: There are five connective symbols

~ not or negation

& and or conjunction

V or i.e. A or B

→ implication

↔ equivalence or if and only if

2. Quantifiers: There are two quantifiers symbols:

∃ (Essust_ntial quantification) and

∀ (Universal quantification)

$(\exists x)$ means for some x or there is an x, $(\forall)x$ means for all x.

3. Constants: Constants are fixed value terms that belong to a given domain e.g., *a, b, c,* 5, 3, ... 21 Flight-102.

4. Variables: Variables are terms that can assume different values over a given domain e.g. *x, y, z.*

5. Functions: Function symbols denote relations defined on a domain D. They map n elements $(n \geq 0)$ to a single element of the domain An n place function is written as $f(f_1 \ldots f_n)$ where f_i are terms (constants, variables or functions) defined over some domain.

6. Predicates: Predicate symbols denote relations or functional mappings from the elements of a domain D to the values true or false. Capital letters and capitalized words such as P, Q, R, EQUAL are used to represent predicates like function predicates may have $n(n \geq 0)$ terms for arguments written as $P(f_1, f_2, \ldots, f_n)$ where f_i are defined over some domain.

Knowledge Acquisition: One of the most difficult tasks in building knowledge based systems is in the acquisition of encoding of the requisite domain knowledge. Knowledge for expert systems must be derived for expert sources like formal, articles, texts, reports, database etc. Much effort has been denoted to move effective methodology acquisition. Knowledge acquisition itself includes many different activities. Simple storing of computed information is simplest form of this.

The acquisition problem has also stimulated much research in machine learning systems.

3. (b) What is Minskey Frames System Theory?

Ans. Minskey Frames: Frames were first introduced by Marium 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 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 situatioin.

Frames in general are record-like structures which 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 facets.

Farcets may also have names and any number of values.

[<framenam>

(<slot1> (<facet 1><value 1> .... <value K_1>)

(<facet 2><value 1> .... <value K_2>)

⋮

(<slot2> (<facet 1><value 1> .... <value K_n>)

⋮) (A general frame structure)

E.g. A simple frame for : Bob is shown.

(bob)

(PROFESSION (VALUE professor))

(AGE (VALUE NO))

(WIFE (VALUE LINDA))

(ADDRESS (STREET (VALUE 100CL)))

(CITY(VALUE BERIN))

(ZIP(VALUE 226016))

A simple instantiated person frame

3. (c) What is Semantic Nets? Explain the properties of Semantic nets.

Ans. Semantic Nets: In a semantic net information is represented as a set of nodes connected to each other by a set of labeled arcs, which represent relationship among the nodes. This is a natural way to represent relationships that would appear as ground instances of binary predicates in predicate logic.

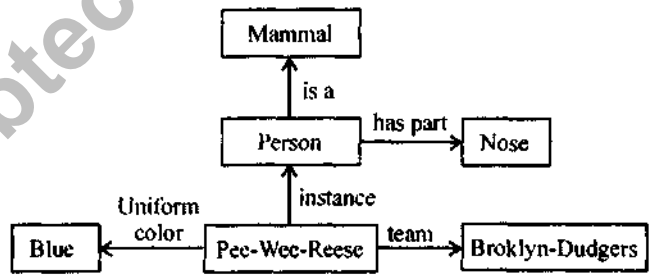


Fig. *A Semantic Network*

For example, some of the arcs from the above figure could be represented in logic as:

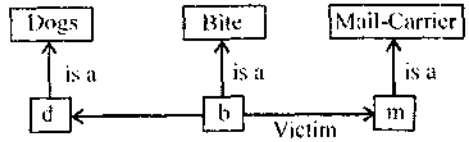
is a (Person, Mammal)

instance (Pee-Wee-Reese, Person)

team (Pee-Wee-Reese, Brooklyn-Dodgers)

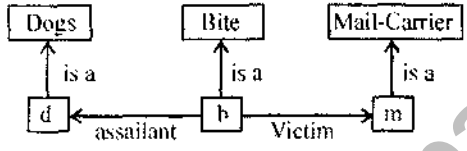
Uniform-Color (Pee-Wee-Reese, Blue)

This technique is particularly useful for representing the contents of a typical declarative sentence that describe several aspects of a particular event. The sentence "The dog bit the mail carrier" can be represented by the following semantic net.



Partitioned Semantic Nets: Suppose we want to represent simple quantified expressions in a semantic nets. One way to do this is to partition the semantic net into a hierarchical set of spaces, each of which corresponds to scope of one or more vaiables. Let us consider the semantic net for the following sentence:

The dog bit the mail carrier



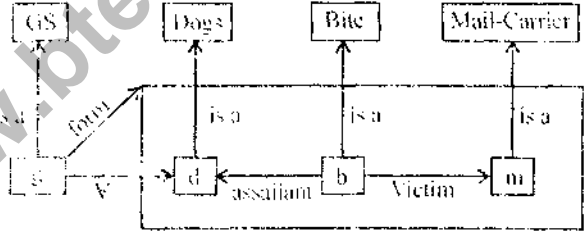
The nodes Dogs, Bite and carrier represent the classes of dogs, bitings and mail carriers respectively while the nodes d, b and m represent a particular dog, a particular biting mail carrier. This fact can easily be represented by a single net with no partitioning.

But now suppose that we want to represent the fact.

Every dog has bitten a mail carrier.

or $\forall x : \text{Dog}(x) \rightarrow \exists y$: Mail-Carrier $(y) \wedge$ Bite (x, y)

It represents this fact it is necessary to encode the scope of the universally quantified variable x. This can be done using partitioning as shown in the figure.



Node g is an instance of the special class GS of general statements about the world. Every element of GS has at least two attributes : a form which states the relation that is being asserted and one or more V connections, one for each of the universally quantified. In the example there is only one variable *d*, which can stand for any element of the class Dogs. The other two variables in the form, *b* and *m* are understood to be esistentially quantified.

Q.4. Attempt any TWO parts of the following: **(10×2=20)**

4. (a) What is expert system? Explain the architecture of an expert system.

Ans. An expert system is basically an AI program which use knowledge to solve problem which would normally reuqire a human expert. The knowledge collected from human experts and

secondary knowledge sources, such as books is represented in some form – logic, production rules, emantic rules, frames or scripts. Once a sufficient amount of expert knowledge has been acquired, it must be encoded in some form, loaded into a knowledge base, then tested and refined continually throughout the life of the expert system. The system includes a reasoning mechanism as well as heuristics, for making choices and navigating around the search space for possible solutions.

It also includes a mechanism for passing information to and from the user. Expert systems have process to be effective in a number of problems, domains which normally require the kind of intelligence by human expert.

Basic Architecture of an Expert System: An expert system consists of the following main components:

(*a*) Knowledge base

(*b*) Inference engine — a reasoning mechanism and heuristics for problem solving (search techniques).

(*c*) Explanatory component

(*d*) Human-machine interface.

The knowledge base is separate from the interference engine on Control Components. It contains the export knowledge coded in some form such as production rules, networks or frames or other representation schemes. The inference engine manipulates the knowledge structure in the knowledge base to perform a type of symbolic reasoning and draw useful conclusion relating to the current task. The human machine (or user) interface provides the means for dialog between the user and system. The user inputs commands, queries and responses to system messages. The system, in turn, produces various messages for the user. In addition to these three components, most system have an explanation module which provides the user with explanations of how a conclusion was reached or why a piece of knowledge is needed. Another feature that may be present in an editor for use in creating and modifying the knowledge base structure. These basic components are shown in figure

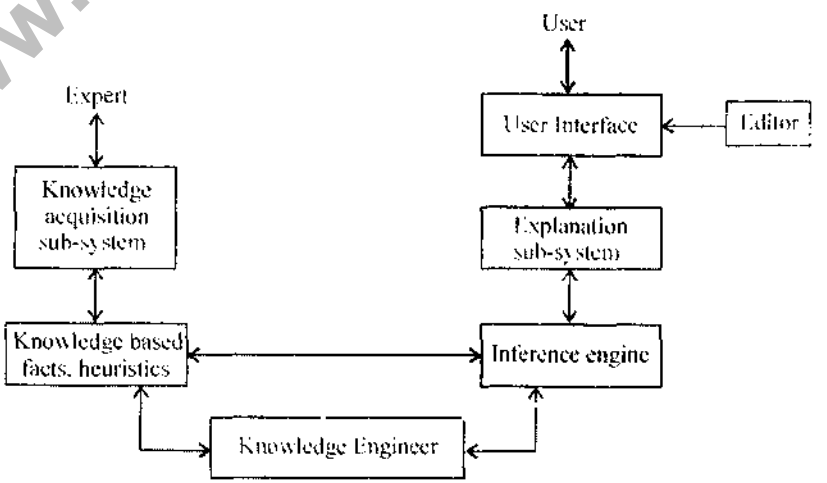


Fig. *Basic Components of an expert system*

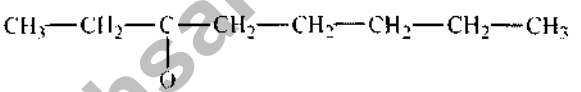
4. (b) Write a short note on DENDRAL.

Ans. Dendral is one of the great classic application program. To see what it does, suppose that an organic chemist wants to know the chemical nature of some substance newly created in the test tube. The first step is to determine the number of atoms of various kinds in one molecule of the stuff. This step determines the chemical formula, such as $C_8H_{16}O$. The notation indicates that each molecule has eight atoms of carbon 16 of hydrogen and one of oxygen.

Once a sample's chemical formula is known, the chemist may use the sample's mass spectogram to work out the way the atoms are arranged in chemical's structure thus identifying the isomer of the chemical.

The spectgram machine bombards a sample with high energy electrons, causing the molecules to break up into charged chunks of various sizes. Then the machine shorts the chunks by passing through a magnetic field which deflect the high charge, low weight onces more than it does the low-charge, highweighted ones. It is now possible to get an estimate of the masses of these particles. This is called a mass spectogram. Though it is not possible to get all possible masses yet by knowing these rules and by knowing the masses, it is possible to guess how the atoms of a single molecule at the unknown substance are put together. This is what Dendral does.

Mass/Change: The purpose of Dendral is to work life knowledgeable chemist. From a chemical formula and spectogram a deduced structure is produced like the chemical structure as shown below:



The DENDRAL program works out structures from chemical formula and mass spectograms using the generate and test method. The generator consists of a structure enumeration and a synthesizer, which produces a synthetic mass spectogram by simulating the action of a real mass spectrometer on each enumerated structure.

The structure enumerator ensures that the overall generator is complete and non-redundant because the structure enumerator uses complete and non-redundant structure – enumeration procedure. The overall generator is also informed, because the structure enumerator uses the chemical formula and knowledge about necessary and forbidden substructures.

4. (c) Write a short note on limitations of experts systems.

Ans. Although expert systems lack the robust and general intelligence of human beings. They can provide benefits to organisation if their limitations are well understood. Only certain classes of problems can be solved using expert system. Many expert systems require large, lengthy and expensive development efforts. Moreover, expert systems lack the breadth and the understanding of fundamental principles of human expert.Their knowledge base are quite narrow, shallow and brittle. They typically perform limited tasks which can be performed by professional, in a few minutes and hours. Hiring on training more experts may be less expensive than building an expert system.

We can say that the four major problems facing current expert system are:

1. Brittleness: As expert system only have access to highly specific domain knowledge, they cannot fall back on more general knowledge.

2. Lack of meta-knowledge: Expert systems do not have any sophisticated knowledge about their own operation. They typically cannot reason about their own scope and limitations.

3. Knowledge acquisition: Despite the development of various tools for knowledge acquisition, it still remains a major bottleneck in applying expert systems technology to new domains.

4. Validation: Measuring the performance of an expert system is difficult because we do not know how to quantify the use of knowledge. Certainly it is impossible to present formal proof of correctness of expert system.

Q.5. Attempt at.y FOUR parts of the following: **(5×4=20)**

5. (*a*) Explain approaches for pattern recognition techniques.

Ans. Approaches to Pattern Recognition Techniques:

1. Structured Description (Syntactic Pattern Recognition)
2. Statistical Description

1. Structured Description: Syntactic pattern regionition is a form of pattern recognition, where items are presented in pattern structure which can take into account more complex interrelatioinship between features. In statistical classification simple numerical feature vectors are used.

Syntactic pattern recognition can be used if there is clear structure in the pattern. One way to present such structures is string of formal language. The difference in the structure are encoded as different grammars. Another way to represent relations are graphs where nodes are connected if corresponding subpattern are related. An item can be labelled as belonging to a class if its graph representation is isomorphic.

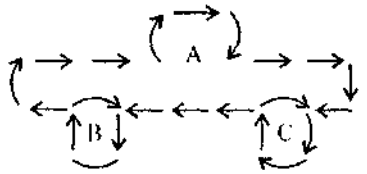
Patterns are constructed from subpatterns. This helps in dividing the task into easier subtask of first identifying subpattern and then only the actual patterns.

Example: Let grammar $G(V_n, V_t, P, S)$ define following objects where the terminal V_t consist of the following shape primitive,

V_T: $a =$ → $b =$ ↑ $c =$ ← $d =$ ↓

$e =$ ↘ $f =$ ↗ $g =$ ↙ $h =$ ↖ $i =$ ↖

Now the object



A = aafagaadceccceefc
B = eghf
C = eghf

2. Statistical Classification: Statistical classification is a statistical procedure in which individual objects are placed into groups based on quantitative information on one or more characteristics inherent in the objects.

Statistical Classification Techniques: Decision Theoretic classification — The decision theoretic classification approach is based on the use of decision function to classify object. A decision funtion maps pattern vector X into decision regions of D. In general this problem can be stated as follows:

1. Given a universe of objects $O = \{O_1, O_2, \ldots O_n\}$. Let each O_i has K observable attributes and relations expressable as a vector $V = (V_1, V_2, \ldots V_k)$.

2. Determine (*a*) a subset $M \leq K$ of the V_i; say $X = (X_1, X_2 \ldots X_n)$ whose values uniquely characterize the O_i, and

(*b*) $C \geq 2$ grouping or classifications of the O_i which exhibit high interclass and low interclass similarities such that a decision function $d(X)$ can be found which partitions D into C disjoint regions. The regions are used to classify each O_i as belonging to atmost one C classes.

Detrmining the feature attributes and decision regions requires stipulating of bearing mappings from the measurement space M to the feature space F and then a mapping from F to the classification or decision space D.

$$M \rightarrow F \rightarrow D$$

When there are only two classes, say C_1 & C_2 the value of the objects pattern vector may tend to cluster into two disjoint groups. In this case, a linear functions $d(X)$ can often be used to determine an object's class.

5. (*b*) What are the problems associated with speech recognition?

Ans. Problems associated with speech recognition:

1. Hard to achieve-speaker Independence: Speaker independence is hard to achieve. A speaker independent system can listen to any speaker and translate the sounds into written text.

2. Hard to implement continuous speech systems: Interpreting isolated-word speech, in which the speaker pauses between each word, is eaier than interpreting continuous speech.

3. Hard to implemen' Real time system: Highly interactive applications require that a sentence be translated into text as it is being spoken, while in other situation, it is permissible to spend minutes in computation.

Real Time speeds are hard to achieve, especially when higher-level knowledge is involved.

4. Hard to implement large vocabulary: Recognizing utterances that are confined to small vocabularies (e.g. 20 words) is easier than working with large vocabularies (e.g. 20000 words). A small vocabulary helps to limit the number of words candidates use for a given speech segment.

5. Broad grammar is harder to implement: An example of a narrow grammar is the one for phone numbers : S → XXX – XXXX, where X is any number between zero and nine. Syntactic and semantic constraints for unrestricted English are much lrarder to represent. The narrower the grammar is, the smaller the search space for recognition will be.

5. (*c*) Write a LISP program to convert Centrigrade temperature to Fahrenheit.

Ans. Celsius to Fahrenheit conversions is done by

$$F = \frac{9C}{5} + 32$$

The Lisps code implementing this conversion equation is

→ Define (C → FC)

(+ (1(* 9C)5)32)

ivocation by the call:

→ (C → F 37)

yields the expected result 98.6.

5. (*d*) Define a function balled first element that takes a list as its argument and returns the first top element of the list.

Ans. Function is

(DEFUN First-Element (L)

(FIRST'(l)))

This function defines a function first – Element that takes an argument L and return first element of it.

5. (*e*) Trace the search sequence PROLOG follows in satisfying the following goal:

? - member (C, [a, b, c, d])

Ans. The number function is a built is predicate in prolog. It search an element in the list and return "yes" or "no".

The Head of the list is the first element and the Tail is the remaining elements.

The member can be defined as —

Member (X, [X | T]).

Member (X, [H | T]): – Member (X, T):

This definition tells that that member is a recursive function and it returns true if *X* is head as first rule says or it is present in tail.

The given program is

? — member (C, [a, b, c. d]) will execute in following sequence:

1. Member checks 'C' in head according to first rule and match does not occur. So according to Recursive definition Now member would work on [b. c, d] and the intermediate form can be thought of as ?-member (C, [b, c, d]).

2. Now 'C' would be checked against 'b' and the second rule would now generate ?-member (C, [c, d]).

3. Here 'C' is in capitals and the 'C' in list is in small. So no match found according to first rule and second rule will generate ? - member (C, [d]).

4. Here c & d are different so the 2nd rule would generate. ? - member (C, [ ])

5. Here [ ] is an empty list and it cannot be further divided in head and tail and the answer returned is 'no'.

5. (*f*) Differentiate between pattern recognition and speech recognition.

Ans. Pattern Recognition: Pattern recognition aims to classify data (patterns) based on either a priori knowledge or on statistical information extracted from the patterns. The patterns to be classified are usually groups of measurements or observations, defining points in an appropriate multidimensional space. A complete pattern recognition system consists of a sensor that gathers the observations to be classified or described. A feature extraction mechanism that

computes numeric or symbolic information from the observations and a classification or description scheme that does the actual job of classifying or describing observations, relying on the extracted features.

The classification or description scheme is usually based on the availability of a set of patterns that have already been classified or described. This set of patterns is termed the training set and the resulting leaving strategy is characterized as supervised learning. Learning can also be unsupervised, in the sense that the system is not given as a priori labelling of patterns, instead it establishes the classes itself based on the statistical regularities of the patterns.

Speech recognition: Speech recognition is the process of converting a speech signal to a sequence of words, by means of an algorithm implemented as a computer program. Speech is one of our most expedient and natural forms of communication, and so understandably, it is a capability we would like AI system to process. The ability to communicate directly with programs offers several advantages. It eliminates the need of keyboard and speeds up the interchange of information between user and system. The recognition of continuous waveform patterns such as speech begins with sampling and digitizing the waveform.

There are different approaches for the statistical speech recognition:

1. Hidden Markov Model (HMM) based speech recognition.
2. Neural network based speech recognition.
3. Dynamic Time Wraping (DTW) based speech recognition.