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Internal Assessment Test III – Nov. 2019

Sub:	ARTIFICIAL INTELLIGENCE					Sub Code:	17CS562	Branch:	OPEN ELECTIVE (ISE V)
Date:	18/11/2019	Duration:	90 min's	Max Marks:	50	Sem / Sec:	V (A&B)		OBE

Answer any five full questions

PART -1

		MARKS	CO	RBT
1 (a)	What is learning? Explain different techniques of learning.	[10]	CO4	L2

Ans

Learning is an important area in AI, a goal of AI is to enable computers that can be taught rather than programmed. Learning is an area of AI that focusses on processes of self-improvement. Information processes that improve their performance or enlarge their knowledge bases are said to learn.

Different techniques of learning:

- **Skill refinement** -- one can learn by practicing, e.g playing the piano.
- **Knowledge acquisition** -- one can learn by experience and by storing the experience in a knowledge base. One basic example of this type is rote learning.
- **Taking advice** -- Similar to rote learning although the knowledge that is input may need to be transformed (or operationalised) in order to be used effectively.
- **Problem Solving** -- if we solve a problem one may learn from this experience. The next time we see a similar problem we can solve it more efficiently. This does not usually involve gathering new knowledge but may involve reorganisation of data or remembering how to achieve the solution.
- **Induction** -- One can learn from examples. Humans often classify things in the world without knowing explicit rules. Usually involves a teacher or trainer to aid the classification.
- **Discovery** -- Here one learns knowledge without the aid of a teacher.
- **Analogy** -- If a system can recognise similarities in information already stored then it may be able to transfer some knowledge to improve to solution of the task in hand.

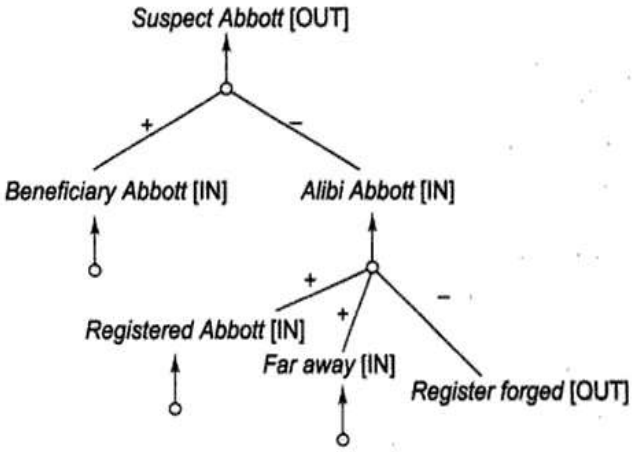
2 (a)	Explain Justification based Truth Maintenance System (JTMS)? What are the two critical criterion that must be met during labelling of JTMS nodes and illustrate with suitable example.	[10]	CO3	L3

Ans

: JTMS allows assertion to be connected via a spreadsheet-like network of dependencies serving as a bookkeeper. Purely syntactic , domain independent way to represent beliefs and change it consistently.

Two critical criterion:

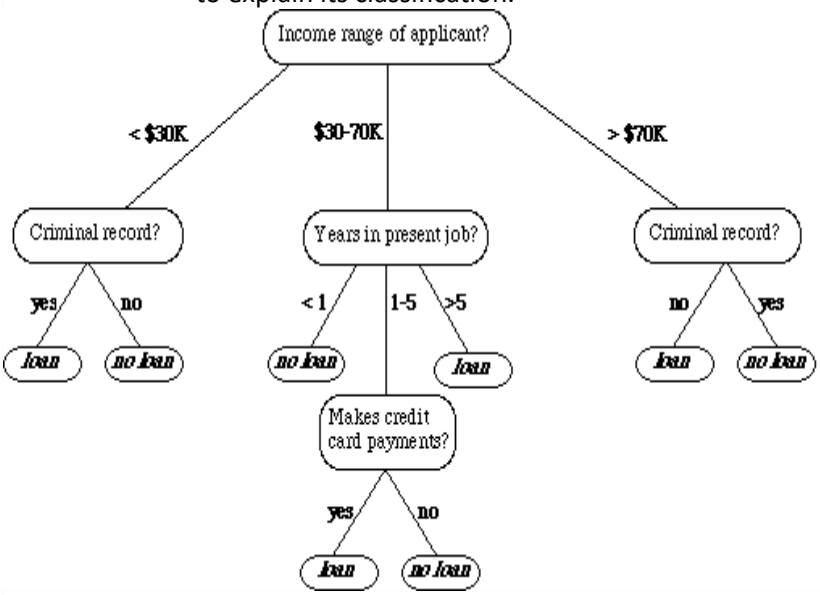
1. Consistency
2. Well foundedness



3 (a) What are decision trees? Explain with a suitable example. [10] CO4 L2

Ans Basically each leaf of a *decision tree* asserts a positive(yes) or negative(no) concept. To classify a particular input we start at the top and follow assertions down until we reach an answer.

- Quinlan in his ID3 system (1986) introduced the idea of decision trees.
- Decision tree advantages:
  - Quicker than version spaces when concept space is large.
  - Disjunction easier.
- Disadvantages:
  - Representation not natural to humans -- a decision tree may find it hard to explain its classification.



4 (a) What are the key issues in non-monotonic reasoning system? Explain the two approaches used for logic representation for non-monotonic reasoning. [10] CO3 L2

Ans **Non-monotonic reasoning:** Axioms or rules of inference are extended to make it possible to reason with incomplete information. At any given moment a statement is either true, false or not believed to be either.

Key issues in Non-monotonic reasoning:

1. How can knowledge base be extended to allow inferences to be made on the basis of lack of knowledge as well as on the presence of it?
   - Ex: if you have no reason to suspect that a particular person committed a crime , then assume he didn't. (nonmonotonic inference)
   - Defeasible : new fact added may defeat the nonmonotonic inference made earlier.

2. How can the knowledge base be updated properly when a new fact is added to the system?
    - Keep track of justifications(proofs) that depended on the absence of facts.
    - Once new facts are found such justifications can be marked as invalid.
3. How can knowledge be used to help resolve conflicts when there are several inconsistent non-monotonic inferences that could be drawn?
    - Inferences based on lack of knowledge and as well as its presence and hence conflicts are commonplace.
    - Needs additional methods to solve conflicts.

Approaches for non-monotonic logic representation:

1. Nonmonotonic Logic(NML): Language of first-order logic is augmented with a modal operator M.
   M can be read as "is consistent"
   Ex: $\forall$x, y:Related(x,y) $\wedge$ M GetAlong(x,y)$\rightarrow$WillDefend(x,y)
   Interpretation: " For all x and y, if x and y are related and if the fact that x gets along with y is consistent with everything else that is believed , then conclude that x will defend y"
   Need to define consistency on some heuristic basis.

2. Default Logic (DL): Inference rules are of the form:
   $\frac{A:B}{C}$
   " If A is provable and it is consistent to assume B, then conclude C"

5 (a) What are partitioned semantic nets? Express the following quantified expressions using semantic nets: [10] CO2 L3
i. Every dog has bitten a mail carrier. ii. Every town dog has bitten every mail carrier.

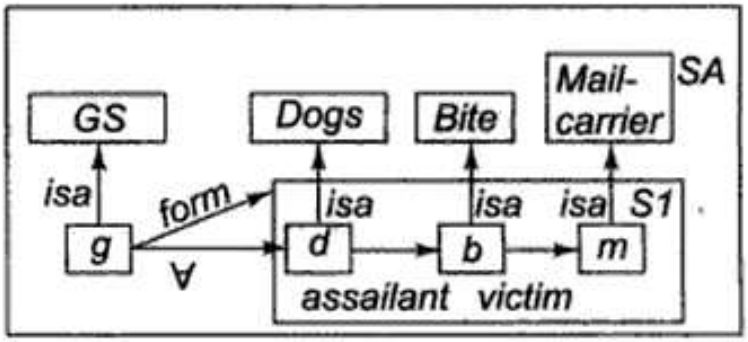
Ans

- Partitioned semantic nets are used for expressing quantified expression. By partitioning the semantic net into a hierarchical set of spaces, each of which corresponds to the scope of one or more variables. Necessary to encode the scope of the universal quantifier x, which is done using the node g , which is an instance of a special class called GS (general statements).Every element in GS has two attributes:
    - A form, which states the relation being asserted.
    - One or more $\forall$ connections for each universal variable.

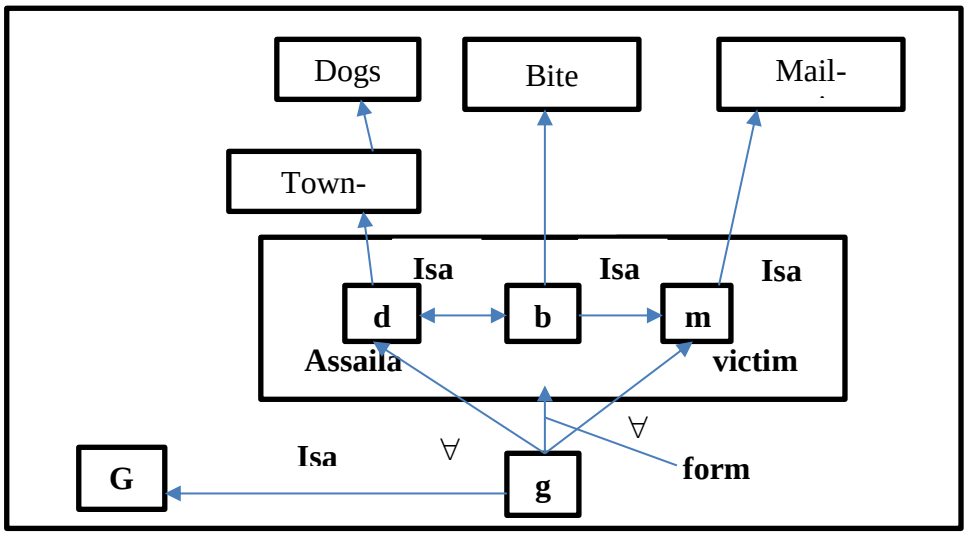
Problems:

i) Every dog has bitten a mail carrier.

$\forall x: Dog(x) \rightarrow \exists y: mailcarrier(y) \wedge Bite(x, y)$



ii) Every town dog has bitten every mail carrier.



6 (a) Describe the frame slot-and-filler structure? Illustrate the usage of frames with a simplified frame system [10] CO2 L2

Ans A frame is a collection of attributes (slots) and associated values that describe some entity in the world. Uses set theory as its basis. A frame system is collection of frames that are connected to each other by virtue of the fact that value of attribute of one frame may be another frame. Each frame represents either a class or an instance.

- isa relation corresponds to subset relation.
  - Ex: adult-male is a subset of people
- instance corresponds to element-of set relation.
  - Ex: Pee Wee Reese is an element of the set of players.

A simplified Frame System

Person
isa : *Mammal*
cardinality : 6,000,000,000
* *handed* : *Right*
Adult-Male
isa : *Person*
cardinality : 2,000,000,000
* *height* : 5-10
ML-Baseball-Player
isa : *Adult-Male*
cardinality : 624
**height* : 6-1
* *bats* : equal to handed
* *batting-average* : .252
* *team* :
* *uniform-color* :
Fielder
isa : *ML-Baseball-Player*
cardinality : 376
**batting-average* : .262
Pee-Wee-Reese
instance : *Fielder*
height : 5-10
bats : *Right*
batting-average : .309
team : *Brooklyn-Dodgers*
uniform-color : *Blue*
ML-Baseball-Team
isa: *Team*
cardinality : 26
* *team-size* : 24
* *manager* :
Brooklyn-Dodgers
instance : *ML-Baseball-Team*
team-size : 24
manager : *Leo-Durocher*
players : {*Pee-Wee-Reese*,...}

7 (a) Define Bayes' theorem. What are its limitations? How certainty factor is used to overcome its limitation? [10] CO3 L2

Ans To compute conditional probability, we need to take into account the prior probability of H(the probability that we would assign to H if we had no evidence) & the extent to which E provides evidence of H.

To do this we need to define a universe that contains an exhaustive, mutually exclusive set of Hi's , among which we are trying to discriminate.

P(Hi \E) – The probability that hypothesis Hi is true given evidence E

P(E\ Hi) – The probability that we will observe evidence E given that hypothesis i is true.

P(Hi) – The a priori probability that hypothesis I is true in the absence of any specific evidence. These probabilities are called prior probabilities or priors.

K = The number of possible hypothesis.

$$P(H_i|E) = \frac{P(E|H_i)P(H_i)}{\sum_{k=1}^{n} P(E|H_k)P(H_k)}$$

Limitations:

The Bayes' theorem is intractable for several reasons :

The knowledge acquisition problem is insurmountable; too many probabilities have to be provided. And there are substantial evidence that people are very bad probability estimators.

The space that would be required to store all the probabilities is too large.

The time required to compute the probabilities is too large.

Even if we have the above mentioned problems the theorem is still very useful for the uncertain system. Various mechanisms to use it have been developed. Some of them are

a. Attaching certainty factors to rules
b. Bayesian Networks
c. Dempster-Shafer Theory

Certainity Factor :

A certainty factor(CF[h,e])is defined in terms of two components :

MB[h,e] - a measure (between 0 and 1) of belief in hypothesis "h" given the evidence "e". MB measures the extend to which the evidence supports the hypothesis. It is zero if the evidence fails to support the hypothesis.

MD[h,e] - a measure (between 0 and 1) of disbelief in hypothesis "h" given the evidence "e". MD measures the extend to which the evidence supports the negation of the hypothesis. It is zero if the evidence support the hypothesis.

$$CF[h,e] = MB[h,e] - MD[h,e]$$

8 (a) What is discovery? Explain the different types automated discovery system [10] CO3 L2

Ans

- Discovery is a restricted form of learning in which one entity acquires knowledge without the help of a teacher.
- Three types of automated discovery system:
  - Theory-Driven Discovery ex: AM program
  - Data-Driven Discovery: ex:BACON program
  - Clustering ex: AUTOCLASS

Theory Driven Discovery: AM PROGRAM

- AM is a program that was programmed to discover concepts in elementary mathematics and set theory. AM has 2 inputs:
  - A description of some concepts of set theory (in LISP form). *E.g.* set union, intersection, the empty set.
  - Information on how to perform mathematical operations. *E.g.* functions.
- Given the above information AM discovered:
  - Integers-- it is possible to count the elements of this set and this is an image of this counting function -- the integers -- interesting set in its own right.
  - Addition-- The union of two disjoint sets and their counting function.
  - Multiplication-- Having discovered addition and multiplication as laborious set-theoretic operations more effective descriptions were supplied by hand.
  - Prime Numbers-- factorisation of numbers and numbers with only one factor were discovered.

Data-Driven Discovery: BACON Program

- Many discoveries are made from observing data obtained from the world and making sense of it , ie create hypothesis and design and execute experiment to prove the hypothesis.-- *E.g.* Astrophysics - discovery of planets, Quantum mechanics - discovery of sub-atomic particles.
- BACON is an attempt at provided such an AI system.
- BACON system outline:
  - Starts with a set of variables for a problem.

        - *E.g.* BACON was able able to derive the *ideal gas law*. It started with four variables *p* - gas pressure, *V* -- gas volume, *n* -- molar mass of gas, *T* -- gas temperature. Recall $pV/nT = k$ where *k* is a constant.
    - Values from experimental data from the problem are inputted.
    - BACON holds some constant and attempts to notice trends in the data.
    - Inferences made.
- BACON has also been applied to Kepler's 3rd law, Ohm's law, conservation of momentum and Joule's law.

Clustering

- Similar to induction, a program learns to classify objects. Induction is provided with a teacher who provides the labeling where as in clustering no labelings are provided.
- AUTOCLASS: Programs accepts number of training cases and hypothesizes a set of classes. For any given case , the program provides a set of probabilities that predict into which class the case is likely to fall.
- Ex: AUTOCLASS: Found meaningful new classes of stars from their infrared spectral data.