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CMRIT — CMR INSTITUTE OF TECHNOLOGY, BENGALURU. ACCREDITED WITH A+ GRADE BY NAAC

Internal Assessment Test 4 – Feb 2022

Sub:	Introduction to Artificial Intelligence				Sub Code:	18CS753	Branch:	ECE/EEE/ME/CIV
Date:	05/02/2022	Duration:	90 mins	Max Marks: 50	Sem/Sec:	VII		OBE

<u>Answer any FIVE FULL Questions</u>

		MARKS	CO	RBT
1.	What is Artificial Intelligence Technique? Explain Tic-Tac-Toe Game with any two different solutions.	[10]	CO1	L1
2.	You are given two jugs, a 4-gallon one and a 3-gallon one. Neither has any measuring markers on it. There is a pump that can be used to fill the jugs with water. How can you exactly 2 gallons of water into 4-gallon jug. Consider the above case and write the production rules and one solution of the water jug problem.	[10]	CO1	L3
3	Explain different approaches to knowledge representation.	[10]	CO2	L2
4	Explain Resolution algorithm for predicate logic with example.	[10]	CO2	L2
5	Explain Dempster- Shafer Theory in detail	[10]	CO3	L2
6	Explain Bayes' theorem and Bayesian Networks	[10]	CO3	L2

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Answer any FIVE FULL Questions — MARKS | CO | RBT

1. What is Artificial Intelligence Technique? Explain Tic-Tac-Toe Game with any two different solutions. [10] CO1 L1

- Artificial intelligence is **the simulation of human intelligence processes by machines**, especially computer systems.
- Its the **theory and development of computer systems** able to perform tasks normally requiring human intelligence.

TIC TAC TOE- Techniques

Board: A **9-element vector** representing the board, where the elements of the vector correspond to the board positions as follows:

1 2 3
4 5 6
7 8 9

An **element** contains the following **value**: 0→ blank square
1→ X
2→ O

Movable Table:
A large vector of **19,683 elements** each element of which is a 9-element vector.
The contents of this vector are chosen specifically .

The Algorithm: To make a move , do the following :

1. View the vector Board as a **ternary number** (1020 base 3). Convert it to a **decimal number** (33 base 10).
2. Use the number computed in step 1 as an **index** into Movetable & access the vector stored there.
3. The vector selected in step 2 represents the way the board will look after the move that should be made. So **set board equal to that vector**.

Comments:

- This program is very **efficient** in terms of **time**. And in theory it could play an optimal game of tic tac toe.

Disadvantages:

- It **takes a lot of space** to store the table that specifies the correct move, from each board position.
- Someone will have to do a lot of work specifying **all the entries in movetable**.
- It is very unlikely that all the required movetable entries **can be determined** and entered without any errors.
- **Extending** the game to 3-Dimension (3^{27}) is difficult & overwhelms computer memories

2. You are given two jugs, a 4-gallon one and a 3-gallon one. Neither has any measuring markers on it. There is a pump that can be used to fill the jugs with water. How can you exactly 2 gallons of water into 4-gallon jug. Consider the above case and write the production rules and one solution of the water jug problem. [10] CO1 L3

To show generality of state space representation consider the following problem
A Water Jug Problem:
You are given 2 Jugs, a 4-gallon one & a 3-gallon one. Neither has any measuring markers on it. There is a pump that can be used to fill the jugs with water. *How can you get exactly 2 gallons of water into the 4-gallon jug?*
State Space: set of ordered pairs of integers(x,y), x= 0,1,2,3,4 & y= 0,1,2,3.
x→ water in 4-gallon jug
y→ water in 3-gallon jug

Start State: (0,0)
Goal state: (2,n), n→ any value

Production Rules for Water Jug Problem

1	(x,y) is X<4 →(4,Y)	Fill the 4-gallon jug
2	(x,y) if Y<3→(x,3)	Fill the 3-gallon jug
3	(x,y) if x>0→(x-d,Y)	Pour some water out of the 4-gallon jug.
4	(x,y) if Y>0 →(x,Y-d)	Pour some water out of 3-gallon jug.
5	(x,y) if x>0 → (0,y)	Empty the 4-gallon jug on the ground
6	(x,y) if y>0 →(x,0)	Empty the 3-gallon jug on the ground
7	(x,y) if X+Y >= 4 and y>0 →(4,y-(4-x))	Pour water from the 3-gallon jug into the 4-gallon jug until the 4-gallon jug is full
8	(x,y) if X+Y>=3 and x>0→(x-(3-y),3))	Pour water from the 4-gallon jug into the 3-gallon jug until the 3-gallon jug is full.
9	(x,y) if X+Y <=4 and y>0 → (x+y,0)	Pour all the water from the 3-gallon jug into the 4-gallon jug.
10	(x,y) if X+Y<=3 and x>0 →(0,x+y)	Pour all the water from the 4-gallon jug into the 3-gallon jug.
11	(0,2) →(2,0)	Pour the 2-gallon water from 3-gallon jug into the 4-gallon jug.
12	(2,Y)→(0,y)	Empty the 2-gallon in the 4-gallon jug on the ground.

One Solution to the Water Jug Problem

Gallons in the 4-gallon jug	Gallons in the 3-gallon	Rule Applied
0	0	
0	3	2
3	0	9
3	3	2
4	2	7
0	2	5 or 12
2	0	9 or 11

3	Explain different approaches to knowledge representation.	[10]	CO2	L2

- ✓ There are variety of ways of representing knowledge (facts) used in AI programs.
- ✓ **Knowledge representation** *deals* with two different kinds of **entities**.

1. ***Facts:*** truths in some relevant world.
 These are things we want to represent.
2. ***Representations of facts*** in some chosen form.
 These are things that can be manipulated.

- ✓ A good system for the representation of knowledge should have four properties:

1. **Representational Adequacy:** ability to represent all kinds of knowledge needed in that domain.
2. **Inferential Adequacy:** ability to manipulate the representational structure to drive new structures.
3. **Inferential Efficiency:** ability to incorporate additional information into knowledge structure.
4. **Acquisitional Efficiency:** ability to acquire new information easily.

- Unfortunately no single system that optimizes all these capabilities is yet found.

1. Simple Relational Knowledge
2. Inheritable Knowledge
3. Inferential Knowledge
4. Procedural Knowledge

4 Explain Resolution algorithm for predicate logic with example. [10] CO2 L2

Algorithm: Resolution

1. Convert all statements of F (set of axioms) to clause form.
2. Negate P (proposition) and convert the result to clause form. Add it to set of clauses obtained in step 1.
3. Repeat until either a contradiction is found or no progress can be made:

a. Select 2 clauses . Call these as parent clauses.

b. Compare them. Resulting Resolvent, will be disjunction of all of the literals of both parent clauses. (if T1 and ¬T2 present in one of the parents, then eliminate them) T1 and T2 are Complementary Literals

c. If resolvent is empty clause, then contradiction is found, else add it to set of clauses.

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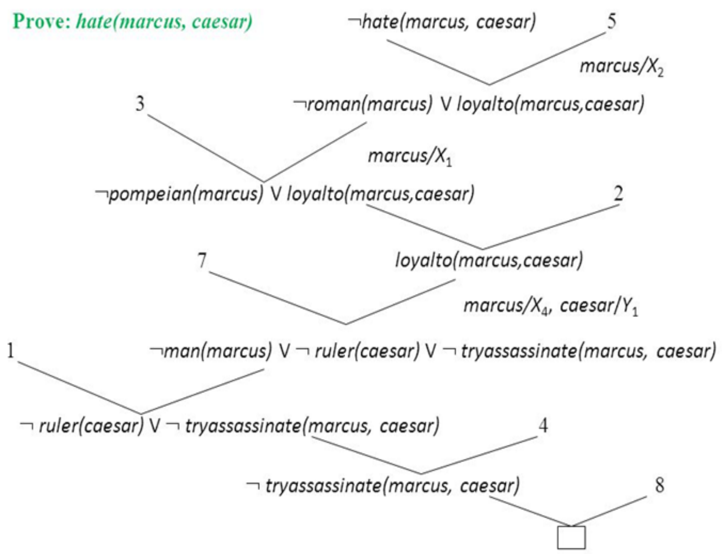


5 Explain Dempster- Shafer Theory in detail [10] CO2 L2

- This Approach considers sets of propositions and assigns to each of them an interval

[Belief, Plausibility]

- Suppose we have 2 belief functions m1 & m2.
- Let X be the set of subsets of Θ to which m1 assigns a nonzero value and Y be corresponding set for m2.
- We define combination m3 of m1 and m2 to be

$$m_3(Z) = \frac{\sum_{X \cap Y = Z} m_1(X) \cdot m_2(Y)}{1 - \sum_{X \cap Y = \phi} m_1(X) \cdot m_2(Y)}$$

- This gives us new belief function that we can apply to any subset Z of Θ.
- Suppose m1, corresponds to our belief after observing fever:

{ Flu, Cold, Pneu} (0.6)
{**Θ**} (0.4)

- Suppose m2, corresponds to our belief after observing running nose:

{ All, Flu, Cold} (0.8)
{**Θ**} (0.2)

- Then we can compute their combination m3 using the following table, which we can derive using numerator of combination rule:

	{A, F, C}	(0.8)	Θ	(0.2)
{F, C, P} (0.6)	{F, C}	(0.48)	{F, C, P}	(0.12)
Θ (0.4)	{A, F, C}	(0.32)	Θ	(0.08)

- The 4 sets that are generated by taking all ways of intersecting an element of X & an element Y are shown in body of the table.

- It is possible for the same set to be derived in more than one way during intersection process.
- Complex situation arises when some of the subsets created by intersection operation are empty.
- If no nonempty subsets are created, the scaling factor is 1.
- To know how it works, add a new piece of evidence to the example. As a result of applying m1 and m2, produce my.

{ Flu, Cold} (0.48)
{All, Flu, Cold} (0.32)
{ Flu, Cold, Pneu} (0.12)
{**Θ**} (0.08)

- Let m4 correspond to our belief given just the evidence that the problem goes away when the patient goes on a trip:

{All} (0.9)
{**Θ**} (0.1)

- Applying numerator of combination rule to produce to following

		{A}	(0.9)	Θ	(0.1)
{F, C}	(0.48)	ϕ	(0.432)	{F, C}	(0.048)
{A, F, C}	(0.32)	{A,F,C}	(0.288)	{A, F, C}	(0.032)
{F, C, P}	(0.12)	ϕ	(0.108)	{F, C, P}	(0.012)
Θ	(0.08)	{A}	(0.072)	Θ	(0.008)

- But there is now a total belief of 0.54 associated with Φ .
- Only 0.45 is associated with outcomes that are in fact possible
- So we need to scale remaining values by the factor 1-0.54= 0.46
- Combining alternative ways of generating the set {All, Flu, Cold} , then we get the final combined belief function , m5.

{ Flu, Cold} (0.104)
{All, Flu, Cold} (0.696)
{ Flu, Cold, Pneu} (0.026)
{All} (0.157)
{**Θ**} (0.017)

- Percentage of m5 initially assigned to empty set was large, this happened due to conflicting evidence between m1 and m4.

6 Explain Bayes' theorem and Bayesian Networks [10] CO2 L2

- The fundamental notion of Bayesian statistics is that of conditional probability:

P(H\E)

- The probability of hypothesis H given that we have observed evidence E.
- To compute this, we should know
  - ➢ The prior probability of H and
  - ➢ The extent to which E provides evidence of H.

- To do this, we need to define a Universe that contains set of Hi's. Then , let
  P(Hi\E) = probability that hypothesis Hi is true given evidence E.
  P(E\Hi) = probability that we observe evidence E given hypothesis ***i*** is true.
  P(Hi) =a priori probability that hypothesis ***i*** is true in absence of specific evidence.
  k= number of possible hypotheses.

- Bayes' theorem then states that

$$P(H_i \backslash E) = \frac{P(E \mid H_i) \cdot P(H_i)}{\sum_{n=1}^{k} P(E \mid H_n) \cdot P(H_n)}$$

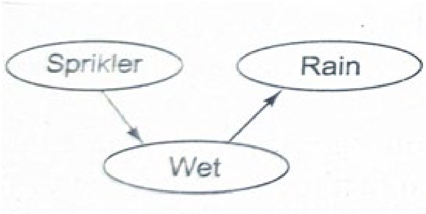
- Bayesian network preserves the formalism and rely on modularity of the world we are trying to model.
- Figure shows flow of constraints in MYCIN- style rules.

1. Constraints flowed incorrectly here. &
2. Distinction couldn't be made.

- 2 different ways propositions can influence likelihood of their symptoms.

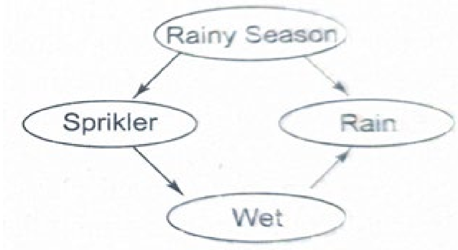
1. First is that, causes influence the likelihood of their symptoms
2. Second is that, observing a symptom affects the likelihood of all of its possible causes.

- Bayesian network structure makes clear distinction between these 2 kind of influence.



(a)

- Construct Directed Acyclic Graph(DAG) that represents causality relationships among variables.
- The variables in such graph may be propositional or they may be variables that take on values of some other type.
- DAG illustrates causality relationships that occur among the nodes it contains.
- In order to use it as a basis for probabilistic reasoning we need to know for each value of parent node what evidence is provided about the values that the child node can take on.



(b)

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