

Assignment No: 02

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Name: Pratik S. Utakar.

Roll No: 73

class: BE/IT

Sem: 7

Sub: ISLAB

DOP	Doc	Marks	Sign.

Q.1] Solve the following with forward chaining or backward chaining or resolution (any one) use predicate logic as language of knowledge representation clearly specify the facts & inference rule used.

Q.1] Example 1:

- 1] Every child sees some witch. No witch has both a black cat & a pointed hat.
- 2] Every witch is good or bad.
- 3] Every child who sees any good witch gets candy.
- 4] Every witch that is bad has a black cat.
- 5] Every witch that is seen by any child has a pointed hat.
- 6] Prove: Every child gets candy.

→ A) facts into fol.

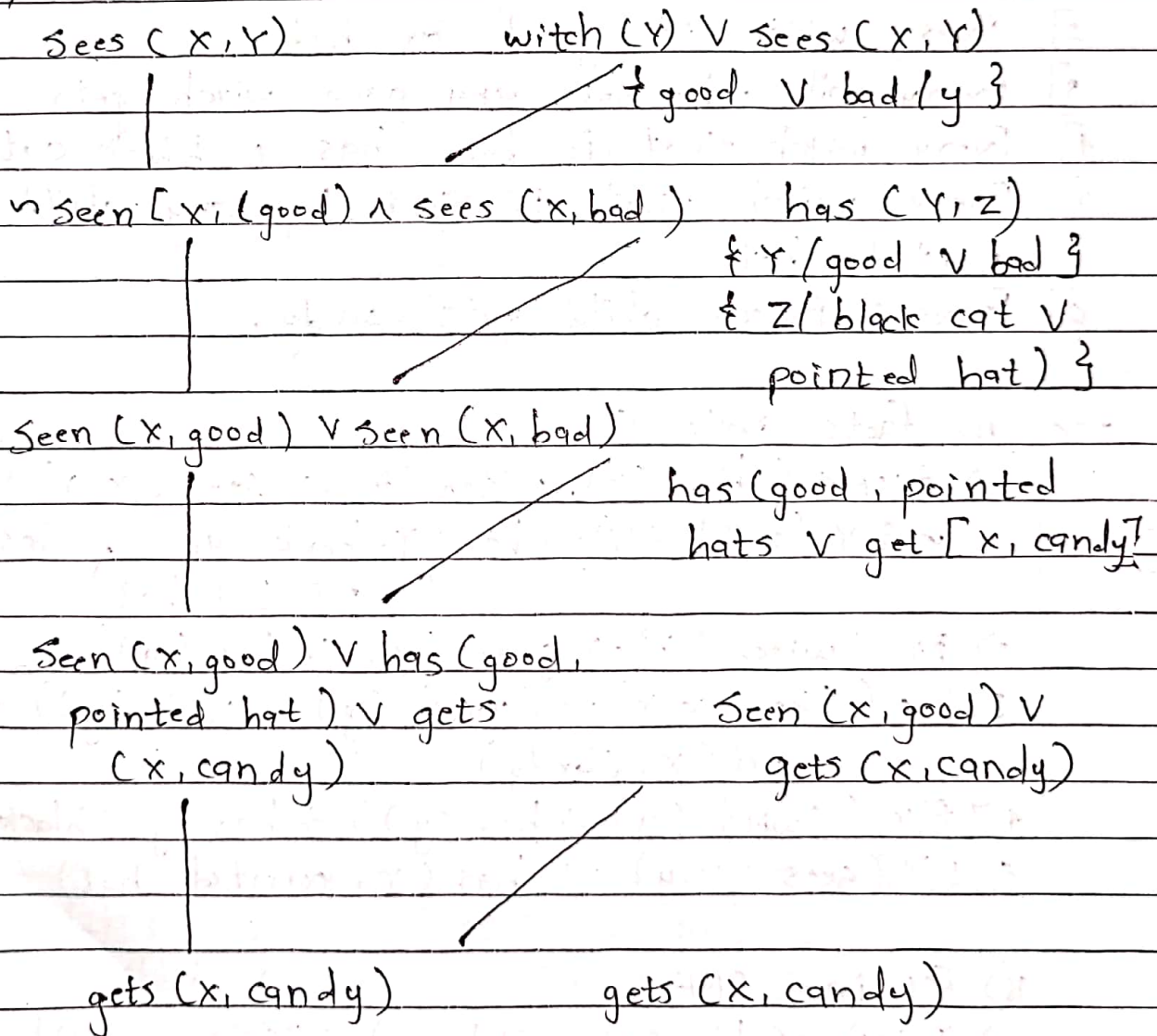
- 1) $\exists x \exists y (child(x), witch(y) \rightarrow sees(x, y))$
 $\wedge \exists y (witch(y) \rightarrow has(y, black\ cat) \wedge has(y, pointed\ hat))$
- 2) $\exists y (witch(y) \rightarrow good(y) \vee bad(y))$
- 3) $\forall x (sees(x, y) \rightarrow (witch(y) \rightarrow good(y)) \rightarrow get(x, candy))$
- 4) $\forall y ((witch(y) \rightarrow bad(y)) \rightarrow has(y, black\ hat))$
- 5) $\forall y (sees(x, y) \rightarrow has(y, pointed\ hat))$

B) FOL into CNF.

- 1) $\exists x \exists y (child(x), witch(y) \rightarrow sees(x, y))$
 $\rightarrow \wedge \exists y, (witch(y) \rightarrow has(y, black\ hat))$
 $\rightarrow \wedge \exists y (witch(y) \rightarrow has(y, pointed\ hat))$

- 2) $\forall y (\text{witch}(y) \rightarrow \text{good}(y))$
 $\forall y (\text{witch}(y) \rightarrow \text{bad}(y))$
 3) $\exists x [(\text{sees}(x, y) \rightarrow \text{witch}(y) \rightarrow \text{good}(y)) \rightarrow \text{gets}(x, \text{candy})]$
 $\Rightarrow \exists x [\text{sees}(x, \text{good}(y)) \rightarrow \text{gets}(x, \text{candy})]$
 4) $\exists x [\text{bad}(y) \rightarrow \text{has}(y, \text{black hats})]$
 5) $\exists x [\text{seen}(x, y) \rightarrow \text{has}(y, \text{pointed hat})]$
 $\Rightarrow \neg \forall y [\text{seen}(x, y) \rightarrow \text{has}(y, \text{black hat})]$

c)



2] Example 2:

- 1] Every boy or girl is a child
- 2] Every child gets a doll or a train or a lump of coal.
- 3] No boy gets any doll.
- 4] Every child who is bad gets any lump of coal.
- 5] No child gets a train
- 6] Ram gets lump of coal
- 7] Prove: Ram is bad.

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- 1] $\forall x (\text{boy}(x) \text{ or } \text{girl}(x) \rightarrow \text{child}(x))$
 - 2] $\forall y (\text{child}(y) \rightarrow \text{gets}(y, \text{doll}) \text{ or } \text{gets}(y, \text{train}) \text{ or } \text{gets}(y, \text{coal}))$
 - 3] $\forall w (\text{boy}(w) \rightarrow \neg \text{gets}(w, \text{doll}))$
 - 4] for all $z (\text{child}(z) \text{ and } \text{bad}(z)) \rightarrow \text{gets}(z, \text{coal})$
 $\forall y \text{ child}(y) \rightarrow \neg \text{gets}(y, \text{train})$
 - 5] $\text{child}(\text{ram}) \rightarrow \text{gets}(\text{ram}, \text{coal})$
- To prove $(\text{child}(\text{ram}) \rightarrow \text{bad}(\text{ram}))$

CNF clauses

- 1] $\neg \text{boy}(x) \text{ or } \text{child}(x)$
 $\neg \text{girl}(x) \text{ or } \text{child}(x)$
- 2] $\neg \text{child}(y) \text{ or } \text{get}(y, \text{doll}) \text{ or } \text{gets}(y, \text{train}) \text{ or } \text{gets}(y, \text{coal})$
- 3] $\neg \text{boy}(w) \text{ or } \neg \text{gets}(w, \text{doll})$
- 4] $\neg \text{child}(z) \text{ or } \neg \text{bad}(z) \text{ or } \text{gets}(z, \text{coal})$
- 5] $\neg \text{child}(\text{ram}) \rightarrow \text{gets}(\text{ram}, \text{coal})$
- 6] $\text{bad}(\text{ram})$

Resolution

4] ! child (z) or ! bad (z) or get (z, coal)

6] bad (ram)

7] ! child (ram) or gets (ram, coal)

Substituting z by ram

1] (a) ! boy (x) or child (x)

boy (ram)

8] child ram / substituting x by ram

7] ! child (ram) or gets (ram, coal)

8] child (ram)

9] gets (ram, coal)

2] ! child (y) (or gets (y, doll) or gets (y, train) or gets (y, coal)

8] child (ram)

10] gets (ram, doll) or gets (ram, train) or gets (ram, coal)

(Substituting y by ram)

9] gets (ram, coal)

10] gets (ram, doll) or gets (ram, train) or gets (ram, coal)

11] gets (ram, doll) or gets (ram, coal)

3] ! boy (w) or ! gets (w, doll)

5] boy (ram)

12] ! get (ram, doll) (substituting w by ram)

11] gets (ram, doll) or gets (ram, train)

12] ! gets (ram, doll)

13] gets (ram, coal)

6] <a> get (ram, coal)

13] gets (ram, coal)

Hence, bad (ram) is proved.

Q.2]

Differentiate between STRIPS and ADL.

STRIPS language	ADL
① Only allow positive literals in the States. for eg. : A valid sentence in STRIPS is expressed as \Rightarrow Intelligent \wedge Beautiful.	① Can Support both positive & negative literals. for eg :- Same sentence is expressed as \Rightarrow Stupid \wedge - ugly.
② STRIPS stands for Standard Research Institute problem Solver.	② Stands for Action Description Language.
③ Makes use of closed world assumption (i.e.) unmentioned literals are false.	③ Makes use of open world Assumption (i.e.) unmentioned literals are unknown.
④ We only can find ground literals in goals. for eg :- Intelligent \wedge Beautiful.	④ We can find qualified variables in goal. for eg :- $\exists x \text{ At}[P_1, x] \wedge \text{At}(P_2, x)$ is the goal of having P_1 & P_2 in the same place in the example of blocks
⑤ Goals are conjunctions for eg :- (Intelligent \wedge Beautiful)	⑤ Goals may involve conjunctions & disjunctions for eg :- (Intelligent \wedge (Beautiful \wedge Rich))

⑥ Effects are Conjunctions

⑥ Conditional effects are allowed when $P:E$ means E is an effect only if P is satisfied.

⑦ Does not support equality.

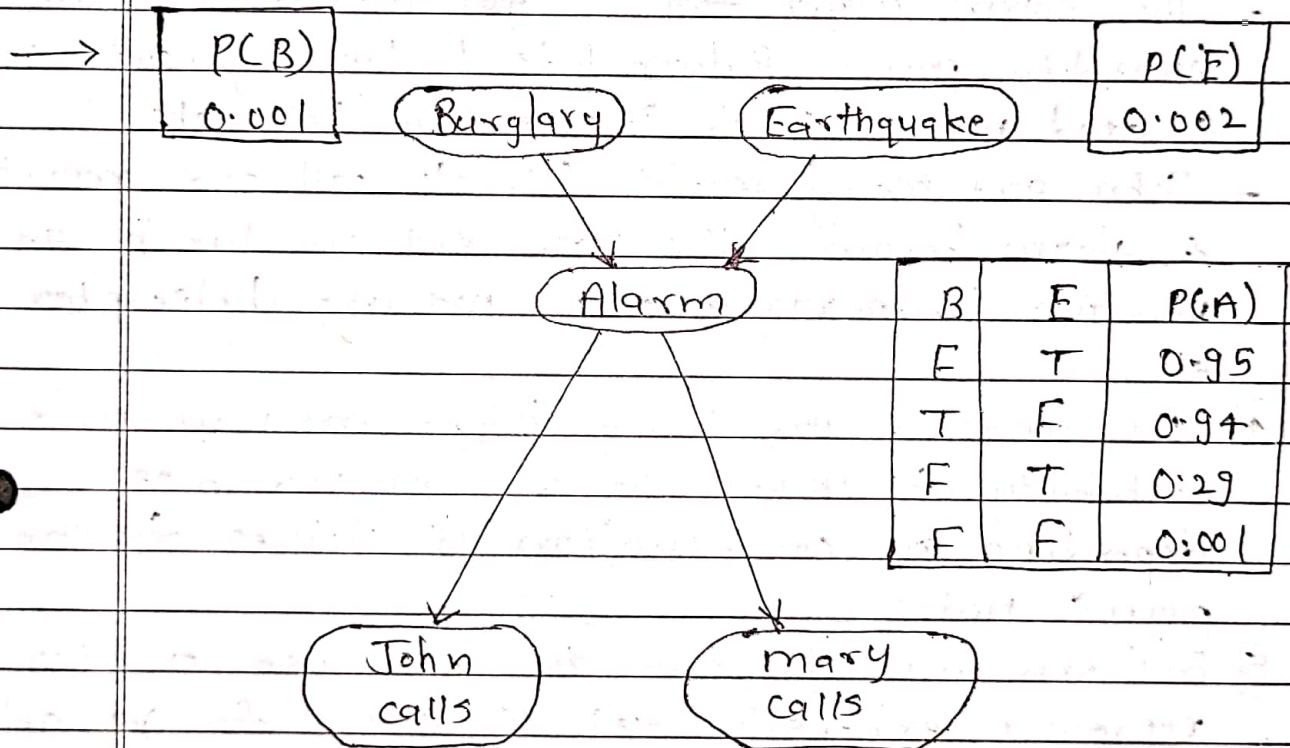
⑦ Equality predicate $(x=y)$ is built in.

⑧ Does not have support for types.

⑧ Support for types for eg: The variable P : person.

Q.4]

You have two neighbors J & M, who have promised to call you at work when they hear the alarm. J always calls when he hears the alarm, but sometimes confused telephone ringing with alarms & calls then too. M likes loud music & sometimes misses the alarm together. Given the evidence of who has or has not called we would like to estimate the probability of burglary. Draw a Bayesian network for this domain with suitable probability table.



A	$P(T)$
T	0.09
F	0.05

A	$P(M)$
T	0.70
F	0.01

- ① The topology of the network indicates that
- Burglary & earthquake affect the probability of the alarms going off.

- Whether John and Mary call depends only on alarm.
- They do not perceive any burglaries directly they do not notice minor earthquakes and they do not confer before calling.
- 2] Mary listening to loud music & John confusing phone ringing to sound of alarm can be read from network only implicitly as uncertainly associated to calling at work.
- 3] The probability actually summarize potentially infinite set of circumstances.
 - The alarm might fail to go off due to, high humidity, power failure, dead battery, cut wires, a dead mouse stuck inside the bell, etc.
 - John and Mary might fail to call and report & alarm because they are out to lunch, on vacation, temporarily deaf, passing helicopter, etc.
- 4] The condition probability tables in n/w gives probability for values of random variables depending on combination of values for the parent nodes.
- 5] Each row must be sum to 1, because entries represent exhaustive set of cases for variable
- 6] All variables are Boolean
- 7] In general, a table for a Boolean variable with k parents contains 2^k independently specific probabilities.
- 8] A variable with no parents has only one row, representing prior probabilities of each possible value of the variable.

9] Every entry in full joint probability distribution can be calculated from information in Bayesian network.

10] A generic entry in joint distribution is probability of a conjunction of particular assignments to each variable $P(X_1 = x_1 \wedge \dots \wedge X_n = x_n)$ abbreviated as $P(X_1, \dots, X_n)$

11] The value of this entry is $P(X_1, \dots, X_n) = \prod_{i=1}^n p(i, \text{parents}(X_i))$, where $\text{parents}(X_i)$ denotes the specific values of the variables $\text{parents}(X_i)$

$$\begin{aligned} &= P(j|a) P(m|a) P(a|mbne) P(mb) P(ne) \\ &= 0.09 \times 0.07 \times 0.001 \times 0.999 \times 0.998 \\ &= 0.000628 \end{aligned}$$

12] Bayesian Network

