

## Assignment no :- 2

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Dop	Doc	manage	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.

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

B] EOL into CNF

1)  $\exists x \forall y$  (child (x), witch (y)  $\rightarrow$  sees (x, y))  
 $\rightarrow \neg \exists y, (\text{witch (y)} \rightarrow \text{has (y, black hat)})$   
 $\rightarrow \neg \exists y (\text{witch (y)} \rightarrow \text{has (y, pointed hat)})$

2)  $\forall y$  (witch (y)  $\rightarrow$  good (y))

$\forall y$  (witch (y)  $\rightarrow$  bad (y))

3)  $\exists x [(\text{sees (x, y)} \rightarrow \text{witch (y)} \rightarrow \text{good (y)})$   
 $\rightarrow \text{gets (x, candy)}$

$\rightarrow$

4)  $\exists y [\text{bad (y)} \rightarrow \text{has (y, black hats)}]$

5)  $\exists y [\text{seen (x, y)} \rightarrow \text{has (y, pointed hat)}]$   
 $\rightarrow \neg \forall y [\text{seen (x, y)} \rightarrow \text{has (y, black hat)}]$

C]

sees (x, y)

witch (y)  $\vee$  sees (x, y)

$\{ \text{good } \vee \text{ bad (y)} \}$

$\neg \text{seen (x, (good)} \wedge \text{sees (x, bad)}$

has (y, z)

$\{ y/\text{good } \vee \text{ bad}$   
 $\{ z/\text{black cat}$   
 $\vee \text{ pointed hat} \}$

seen (x, good)  $\vee$  seen (x, bad)

has (good, pointed  
 hats  $\vee$  gets (x, candy)

seen (x, good)  $\vee$  has (good,  
 pointed hat)  $\vee$  gets (x, candy)

seen (x, good)  
 gets (x, candy)

## 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)  $\forall w (\text{boy}(w) \rightarrow \neg \text{gets}(w, \text{train}))$
  - 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)  $\neg \text{child}(y) \text{ or } \text{gets}(y, \text{doll}) \text{ or } \text{gets}(y, \text{train}) \text{ or } \text{gets}(y, \text{coal})$
- 3)  $\neg \text{boy}(w) \text{ or } \neg \text{gets}(w, \text{train})$
- 4)  $\neg \text{child}(z) \text{ or } \neg \text{bad}(z) \text{ or } \text{gets}(z, \text{coal})$
- 5)  $\text{bad}(\text{ram})$ .

- 4) ! child (z) or ! bad (z) or get (z, coal)
- 5) 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, brain) or gets (y, coal)
- 8) child (ram)
- 10) get (ram, doll) or gets (ram, brain) or gets (ram, coal)
- 9) gets (ram, coal)
- 10) gets (ram, doll) or gets (ram, brain) or gets (ram, coal)
- 3) ! boy (w) or ! gets (w, doll)
- 5) boy (ram)
- 11) gets (ram, doll) or get (ram, brain)
- 12) ! gets (ram, doll)
- 13) gets (ram, coal)
- 6) (a) get (ram, coal)

13) gets (ram, coal)

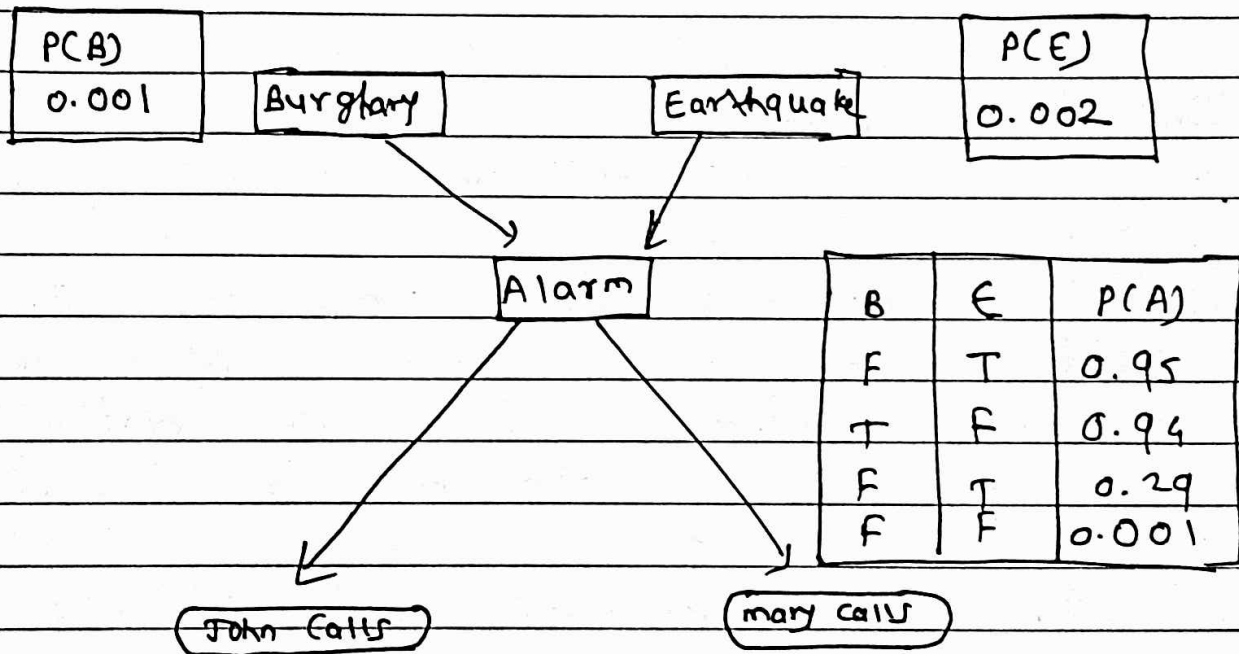
Hence, bad (ram) is proved.



## Q.2 Differentiate bet<sup>n</sup> STRIPS & ADL.

STRIPS language	ADL
<p>① Only allow positive literals in the states for eg: A valid sentence is STRIPS is expressed as <math>\rightarrow</math> Intelligent <math>\wedge</math> Beautiful.</p> <p>② STRIPS stand for standard Research Institute Problem solver</p> <p>③ makes use of closed world assumption (i.e.) an mentioned literals are false.</p> <p>④ we only can't find ground literals in goals.</p> <p>⑤ Goals are conjunctions, for eg:- (Intelligent <math>\wedge</math> Beautiful)</p>	<p>① Can support both positive &amp; negative literals. for eg:- same sentence is expressed as <math>\rightarrow</math> stupid <math>\wedge</math> - ugly.</p> <p>② stands for Action Description Language</p> <p>③ makes use of open world Assumption (i.e.) unmentioned literals are unknown</p> <p>④ we can find qualified variables in goals.</p> <p>⑤ Goals may involve conjunctions &amp; disjunctions for eg:- Intelligent <math>\wedge</math> Beautiful</p>

Q.4. You have two neighbors J and 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 like loud music & sometimes misses the alarm together.



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.

- They do not perceive any burglaries directly. ~~to~~ they do not notice minor earth quakes and they do not confer before calling.

2) Many 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 sets 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.

4) The condition probability tables in n/w give probability for values of random variables depending on combination of value for the parent nodes.

5) Each row must be sum to 1. because entries represents exhaustive set of cases for variables.

6) All variables are ~~to~~ Boolean.



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  $p(x_1 = x_1, \dots, x_n = x_n)$

11) The value of this entry is  $P(x_1, \dots, x_n) = \prod_{i=1}^n p(x_i | \text{parents}(x_i))$ , where  $\text{parents}(x_i)$  denotes the specific values of the variable  $\text{parent}(x_i)$

$$\begin{aligned}
 &= P(j \wedge m \wedge a \wedge b \wedge e) \\
 &= P(j|a) P(m|a) P(a|b \wedge e) P(b|e) P(e) \\
 &= 0.09 \times 0.07 \times 0.001 \times 0.999 \times 0.998 \\
 &= 0.000628
 \end{aligned}$$

12) Bayesian Network.

