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Assignment No: 02

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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 blank 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) ∃ x∀y (child (x), witch (y) → sees (x, y))
   ¬ ∃ y (witch (y) → has (y, black cat) ∧ has (y, pointed hat))

2) ∃y (witch (y) → good (y) ∨ bad (y)).

3) Ex ((sees (x, y) → (witch (y) → good (y))) → get (x, candy)

4) Ey ((witch (y) → bad (y)) → has (y → black hat))

5) Ey (sees (x, y) → has (y, pointed hat)

B) FOL into CNF.

1) ∃ x∀y (child (x), witch (y) → sees (x, y))
→ ¬ ∃y, (witch (y) → has (y, black hat)
→ ¬ ∃y (witch (y) → has (y, pointed hat)

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

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

$\Rightarrow \sim \forall y\ [\text{seen}(x, y) \rightarrow \text{has}(y, \text{black hat})]$

c>

$\text{sees}(x, y)$ $\text{witch}(y) \vee \text{sees}(x, y)$ $\{\text{good} \vee \text{bad} / y\}$

$\sim \text{seen}[x, (\text{good}) \wedge \text{sees}(x, \text{bad})]$ $\text{has}(y, z)$ $\{y / \text{good} \vee \text{bad}\}$ $\{z / \text{black cat} \vee \text{pointed hat})\}$

$\text{seen}(x, \text{good}) \vee \text{seen}(x, \text{bad})$ $\text{has}(\text{good}, \text{pointed hats} \vee \text{get}[x, \text{candy}]$

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

$\text{gets}(x, \text{candy})$ $\text{gets}(x, \text{candy})$

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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.

→ 1) ∀ x (boy (x) or girl (x) → child (x))
2] ∀ y (child (y) → gets (y, doll) or gets (y, train) or gets (y, coal))
3] ∀ w (boy (w) → ! gets (w, doll))
4] for all z (child (z) and bad (z)) → gets (z, coal))
∀y child (y) → ! gets (y, train)
5] child (ram) → gets (ram, coal)
To prove (child (ram) → bad (ram))

CNF clauses
1] ! boy (x) or child (x)
! girl (x) or child (x)
2] ! child (y) or get (y, doll) or gets (y, train) or gets (y, ~~a~~ coal)
3] ! boy (w) or ! gets (w, doll)
4] ! child (z) or ! bad (z) or gets (z, coal)
5] ! child (ram) → gets (ram, coal)
6] bad (ram)

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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.

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Q.2] Differentiate between STRIPS and ADL.

STRIPS language	ADL
① Only allow positive literals in the States. for eg. : A valid Sentence is STRIPS is expressed as ⇒ Intelligent ∧ Beautiful.	① Can Support both positive & negative literals. for eg :- Same sentence is expressed as ⇒ stupid ∧- 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.) an mentioned 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 ∧ Beautiful.	④ We can find qualified variables in goal. for eg :- ∃x At[P1 x] ∧ At (P2, x) is the goal of having P1 & P2 in the same place in the example of blocks
⑤ Goals are conjunctions for eg :- (Intelligent ∧ Beautiful)	⑤ Goals may involve conjunctions & disjunctions for eg :- (Intelligent ∧ (Beautiful ∧ Rich))

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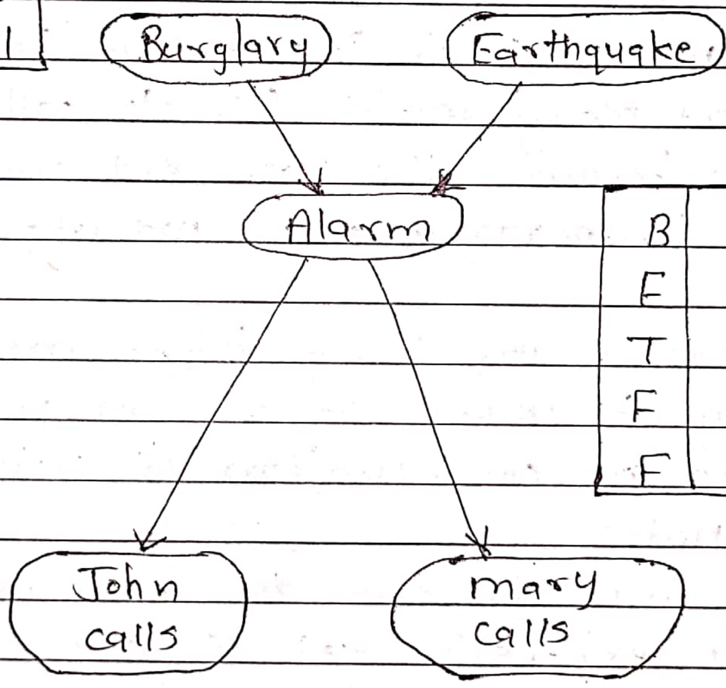
⑥ Effects are Conjunctions	⑥ Conditional effects are allowed when P:E means E is an effect only if P is satisfied
⑦ Does not support equality.	⑦ Equality Predicate (x = y) is build in.
⑧ Does not have support for types.	⑧ Support for types for eg: The variable p: person.

Q.4] You have two neighbors J & M, who have promised to call you at work when they here 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.

→

P(B)
0.001

P(E)
0.002



B	E	P(A)
F	T	0.95
T	F	0.94
F	T	0.29
F	F	0.001

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.

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- 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 a 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.

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

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

11] The value of this entry is $P(x_1, \dots, x_n) =$ $\pi i - 1, np(1, \text{parents}(xi))$, where parents $s(xi)$ denotes the specific values of the variables parents (xi)

- $P(j \wedge m \wedge a \wedge \neg b \wedge \neg e)$

$= P(j|a)\, P(m|a)\, P(a|\neg b \wedge \neg e)\, P(\neg b)\, e(\neg e)$

$= 0.09 \times 0.07 \times 0.001 \times 0.999 \times 0.998$

$= 0.000628$

12] Bayesian Network