

Assignment No. 2

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Sub: IS lab.

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Q.7 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) $\exists x \forall y (\text{child}(x), \text{witch}(y) \rightarrow \text{sees}(x, y))$
 $\neg \exists y (\text{witch}(y) \rightarrow \text{has}(y, \text{black cat}) \wedge \text{has}(y, \text{pointed hat}))$
- 2) $\exists y (\text{witch}(y) \rightarrow \text{good}(y) \vee \text{bad}(y))$
- 3) $\exists x ((\text{sees}(x, y) \rightarrow (\text{witch}(y) \rightarrow \text{good}(y))) \rightarrow \text{get}(x, \text{candy}))$
- 4) $\forall y ((\text{witch}(y) \rightarrow \text{bad}(y)) \rightarrow \text{has}(y, \text{black hat}))$
- 5) $\forall y (\text{sees}(x, y) \rightarrow \text{has}(y, \text{pointed hat}))$

B) FOL into CNF

- 1) $\exists x \forall y (\text{child}(x), \text{witch}(y) \rightarrow \text{sees}(x, y))$
 $\rightarrow \neg \exists y (\text{witch}(y) \rightarrow \text{has}(y, \text{black hat}))$
 $\rightarrow \neg \exists y (\text{witch}(y) \rightarrow \text{has}(y, \text{pointed hat}))$
- 2) $\forall y (\text{witch}(y) \rightarrow \text{good}(y))$
 $\wedge y (\text{witch}(y) \rightarrow \text{bad}(y))$
- 3) $\exists x [(\text{sees}(x, y) \rightarrow (\text{witch}(y) \rightarrow \text{good}(y))) \rightarrow \text{get}(x, \text{candy})]$
 $\rightarrow \exists x [(\text{sees}(x, y) \rightarrow (\text{good}(y) \rightarrow \text{get}(x, \text{candy}))]$

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

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

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

e)

Sees (x, y)

|

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

{ good \vee bad / y }

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

|

has (y, z)

{ y / good \vee bad }

{ z / black cat \vee

pointed hat }

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

|

has (good, pointed
hats) \vee get (x, candy)

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

|

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

gets (x, candy)

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 a 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) $\forall x (\text{boy}(x) \text{ or } \text{girl}(x) \rightarrow \text{child}(x))$
 - 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 $(\text{child ram}) \rightarrow \text{bad}(\text{ram})$

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) $\neg \text{boy}(w) \text{ or } \neg \text{gets}(w, \text{doll})$.
- 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,goal)

5) bad(cram)

7) !child(from) or gets(from,coal).

Substituting z by ram.

8) (a) !boy(x) or child(x)
boy(cram)

9) child(ram) (substituting x by ram)

7) !child(cram) or gets(cram,coal).

8) child(cram)

9) gets(ram,coal)

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

7) child(ram)

10) gets(ram,doll) or gets(ram,train) or gets
(cram,coal).

(substituting y by ram)

9) gets(ram,coal).

11) get(cram,doll) or gets(cram,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(cram,train)

12) !gets(ram,doll)

13) gets(ram,coal)

6) <a> get(cram,goal)

13) gets(ram,coal)

Hence, bad(cram) is proved!

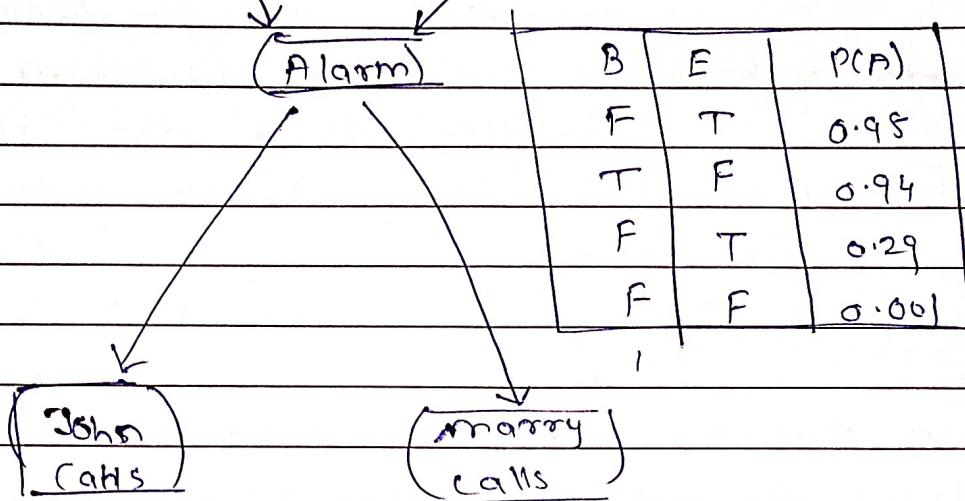
Q.2) Different between STRIPS and ADL

STRIPS language	ADL
i) only allow positive literals in the states - for eg. A valid sentence is STRIPS is expressed as → Intelligent ∧ Beautiful.	can support both positive & negative literals. for eg: Some sentences is expressed as → stupid ∧ -ugly
a) STRIPS stands for standard Research Institute Problem Solver.	stands for Action Description language.
b) makes use of closed world assumption (i.e.) unmentioned literals are false.	makes use of open world Assumption (i.e.) unmentioned literals are unknown.
c) we only can find ground literals in goals. for eg. Intelligent ∧ Beautiful.	we can find qualified variables in goal for eg: $\exists x At(p_1, x)$ $\wedge At(p_2, x)$ is the goal of having p_1 & p_2 in the same place in the examples of blocks.

5) Goals are conjunctions for eg. (Intelligent \wedge Beautiful)	Goals may increase involve conjunctions & disjunctions for eg :- (Intelligent \wedge (Beautiful \wedge Rich))
6) Effects are conjunctions.	Conditional effects are allowed when p : E mean E is an effect only p is satisfied.
7) Does not support equality	Equality predicate ($x = y$) is build in.
8) Does not have support for types	Support for types for eg : The variable p : person.

Q. 4)

	$P(CB)$		$P(CE)$
\rightarrow	0.001	(Burglary)	0.002



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 and earthquake affect the probability of the alarms going off.
 - whether John and marry call depends only on alarm.
 - They do not perceive any burglaries directly they do not notice minor earthquake and they do not contact before calling.

- 2) Mary listening to loud music & John confusing phone ringing to sound of alarm can be read from network only implicitly as uncertainty associated to calling at work.
- 3) The probability actually summarizes 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.
 - 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 Col/0 gives probability for values of random variables depending on combination of values for the parent nodes.
 - 5) Each row must 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.

- a) Every entry in full joint probability distribution can be calculated from information in Bayesian network.
- b) 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 $p(x_1, \dots, x_n)$
- i) 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 variables parents (x_i)
- $p(j \mid m \wedge n \wedge b \wedge r \wedge e)$
 - $= p(j|m) p(m|n) p(a|b \wedge r) p(r|b) p(e|r)$
 - $= 0.09 \times 0.07 \times 0.001 \times 0.999 \times 0.998$
 - $= 0.000628$
- c) Bayesian Networks.

