Artificial & Computational Intelligence

AIMLCZG557

Sample Problems

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Logics

“In the marketing industry, all advertised products gain popularity. Not all profitable products have been popular, but all the popular products have been always profitable. Profitable products attract investments from corporates. “

1. Represent the knowledge base using propositional logic (without quantifiers) 1.5
2. convert KB into CNF and find any three sample complete BSAT (Binary Satisfiability) solutions to the variables using DPLL algorithm. 2
3. Using the result of part a), prove the below using equivalence laws and resolution. 3

“All the advertised products are invested by the corporates”

a, $\neg a$, T ∨ F, 8m

KB

$R_1: a \to p$

$R_2: p \to f$

$R_3: f \to i$

$R_4: \neg f \to p$

4-Var

a → adv pro

p → popular

f → profitable prod

i → investment from corporate.

$a \to b \equiv \neg a \vee b$ CNF

$(\alpha \Rightarrow \beta) \equiv (\neg\alpha \vee \beta)$ implication elimination

CNF → disjunction

Q

$a \to i$

fact

conclude

ni

Logics

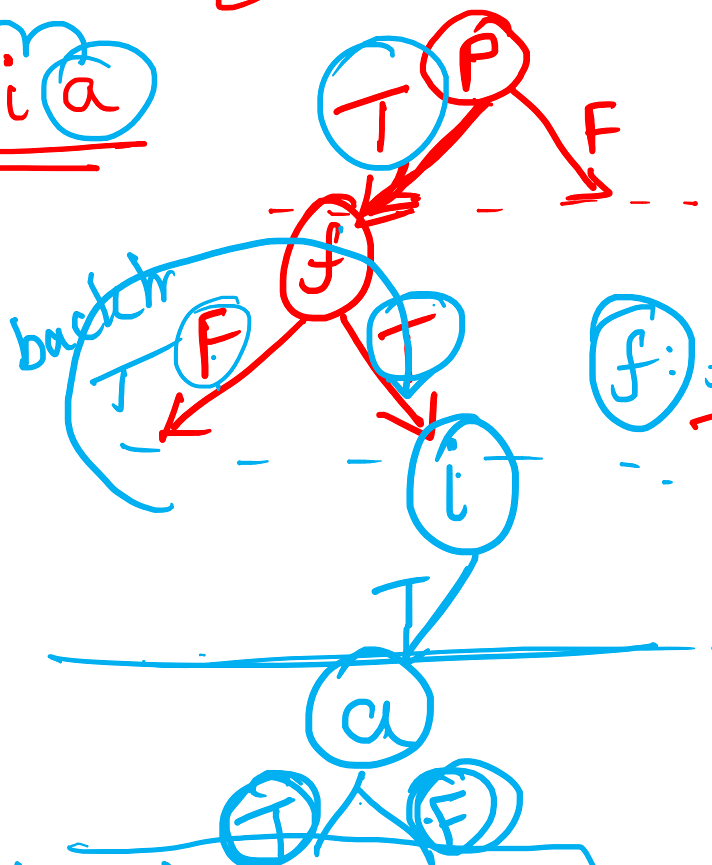
$S_1: a \to p \Rightarrow \{\neg a \vee p$

$S_2: p \to f \Rightarrow \neg p \vee f$

$S_3: f \to i \Rightarrow \neg f \vee i\}$

DPLL — DFS ~~Heuristic~~ backtracking

p f i a



f: false

True

p : T

$S_1: \neg a \vee \cancel{p} \to$ True

$S_2: \cancel{\neg p} \vee f$

$S_3: \neg f \vee i$

KB

$\neg a \vee p \to$ True

$\cancel{\neg p \vee f} \to$ False.

$\neg f \vee i$

$S_1\ \neg a \vee p \to$ True

$S_2\ \cancel{\neg p} \vee f \to$ True

$S_3\ \neg f \vee i \to$ True.

p	f	i	a	
T	T	T	T	→ sol1
T	T	T	F	→ sol2

Logics

~~KB~~

$s_1 : \neg a \vee p$

$s_2 : \neg p \vee f$

$s_3 : \neg f \vee i$

$s_4 : a$

$s_5 : \neg i$

$\cancel{\neg i}$

i

$a \rightarrow i$

S_4 $\cancel{a}$ $\cancel{\neg a} \vee p$ S_1

$\cancel{p}$ $\cancel{\neg p} \vee f$ S_2

$\cancel{f}$ $\cancel{\neg f} \vee i$ S_3

$\cancel{i}$ $\cancel{\neg i}$

$\{\} \rightarrow$ False

assumption is false

Logics

Wn

2

"A software intern is always trained in a project as a project member. Every Project member is involved in development team and support team. Every development member is involved in unit testing. Every support member is involved in user acceptance testing. A project member trained in both unit testing and acceptance testing is certified as skilled in testing."

Convert the above into predicate logic.

fn

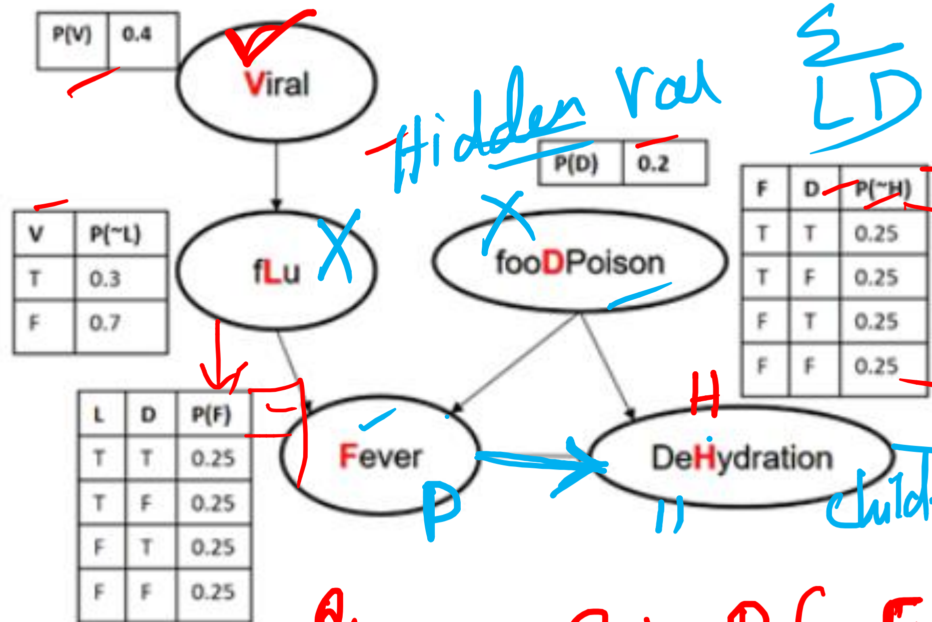
Qr

forward

Prove by backward chaining that *"Prove that all the software interns will be certified as skilled in testing."* using the results of part a. Show the steps by step inferences using neat diagram with direction.

Bayesian Network

Consider the below Bayesian Network and answer the following questions:



P(V)	0.4

V	P(~L)
T	0.3
F	0.7

P(D)	0.2

L	D	P(F)
T	T	0.25
T	F	0.25
F	T	0.25
F	F	0.25

F	D	P(~H)
T	T	0.25
T	F	0.25
F	T	0.25
F	F	0.25

P(H) = 1 − 0.25

Σ LD

P(¬F

FVHDL

FHDLV

H

Q: $P(\neg F / V H)$

1. **Exact Inference : What is the chance that a person doesn’t get fever given the evidence that his/her blood test results show viral infection and severe dehydration?**
2. **Approximate inference – Prior Sampling, Rejection sampling, likelihood weighing.**
“0.3, 0.6, 0.2, 0.1, 0.7, 0.5, 0.5, 0.25, 0.45, 0.85, 0.35, 0.9, 0.15, 0.65, 0.51, 0.2, 0.7, 0.10, 0.6, 0.8”

$P(\neg F | V H)$ 4 Sample

Bayesian Network

$P(e) + P(\sim e) = 1$

innovate achieve lead

Bayesian Network :-

$P(A|B) = \frac{P(AB)}{P(A)}$

1) $P(\sim F / VH) \rightarrow$ Exact inference

$a \quad b$

① $\Rightarrow P(\sim F | VH) + P(F | VH) = 1$

apply Bayes rule : $\left(\frac{P(\sim FVH)}{P(VH)} + \frac{P(FVH)}{P(VH)}\right) = 1$

$\frac{1}{P(VH)} = \frac{1}{P(\sim FVH) + P(FVH)} \rightarrow$ ①

c

Query : $P(\sim F | VH) \Rightarrow \frac{1}{P(VH)} P(\sim FVH)$ (Bayes rule)

from ①

↳ substitute the value.

FVH

$\Rightarrow \frac{P(\sim FVH)}{P(\sim FVH) + P(FVH)}$

$\boxed{L, D}$ are hidden variable.

Bayesian Network

$P(\neg F V H) \rightarrow \sum_{LD} P(H \neg F D L V)$

$\Rightarrow P(\neg F V H) \Rightarrow \sum_{LD} P(H \neg F D L V)$

$\boxed{H \text{ then } F}$ ✗ see diagram

apply chain rule: $\sum_{LD} P(H|\neg F D) * P(\neg F|LD) * P(L|V) * P(V) * P(D)$

$LD = T\ F$; $D\ \neg D$

L: $L\ \neg L$

4 ✓

$\sum_{L} \left\{ \begin{array}{l} P(H|\neg F D) * P(\neg F|LD) * P(L|V) * P(V) * P(D) + \\ P(H|\neg F \neg D) * P(\neg F|L \neg D) * P(L|V) * P(V) * P(\neg D) \end{array} \right.$

D, $\neg D$

$0.0315 \Rightarrow P(H|\neg F D)^{0.75} * P(\neg F|LD)^{0.75} * P(L|V)^{0.7} * P(V)^{0.4} * P(D)^{0.2} +$

$0.0135 \Rightarrow P(H|\neg F D)^{0.75} * P(\neg F|\neg L D)^{0.75} * P(\neg L|V)^{0.3} * P(V)^{0.4} * P(D)^{0.2} +$

$0.1260 \Rightarrow P(H|\neg F \neg D)^{0.75} * P(\neg F|L \neg D)^{0.75} * P(L|V)^{0.7} * P(V)^{0.4} * P(\neg D)^{0.8}$

$0.0540 \quad P(H|\neg F \neg D)^{0.75} * P(\neg F|\neg L \neg D)^{0.75} * P(\neg L|V)^{0.3} * P(V)^{0.4} * P(\neg D)^{0.8}$

0.2250

Bayesian Network

$$\frac{P(\neg F V H)}{P(\neg F V H) + P(F V H)}$$

$P(\neg F V H) \Rightarrow 0.2250$

Use same approach to find $P(FVH)$

$P(FVH) = 0.075$

Final answer $\Rightarrow$

$$P(\neg F \mid VH) = \frac{0.2250}{0.2250 + 0.075}$$

$$\Rightarrow \frac{0.2250}{0.3}$$

$$\Rightarrow 0.75$$

Bayesian Network

$P(\sim F \mid VH)$ — Q, e

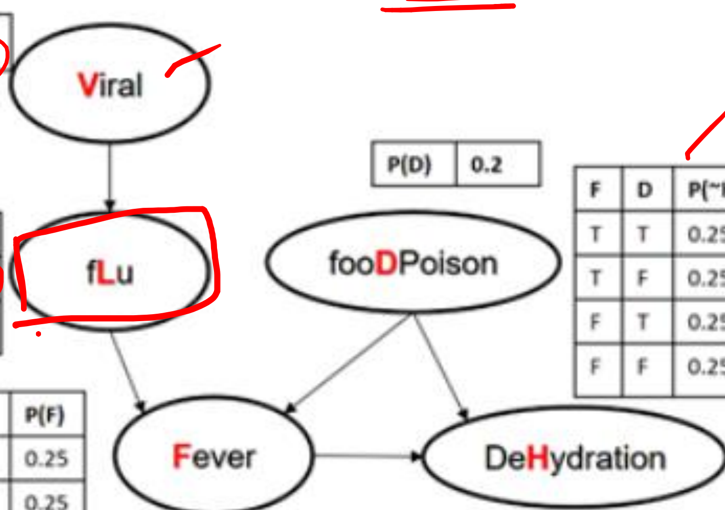
V H
T T

1. **Exact Inference :** **What is the chance that a person doesn't get fever given the evidence that his/her blood test results show viral infection and severe dehydration?**

2. **Approximate inference – Prior Sampling, Rejection sampling, likelihood weighing,**
"0.3, 0.6, 0.2, 0.1, 0.7, 0.5, 0.5, 0.25, 0.45, 0.85, 0.35, 0.9, 0.15, 0.65, 0.51, 0.2, 0.7, 0.10, 0.6, 0.8"

← Prior

n = 4



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P(D)	0.2

F	D	P(~H)
T	T	0.25
T	F	0.25
F	T	0.25
F	F	0.25

L	D	P(F)
T	T	0.25
T	F	0.25
F	T	0.25
F	F	0.25

V	L	D	F	H
T	F	-	-	T
T	-	-	-	T
T	-	-	-	T
T	-	-	-	T

0.4 × 1 ...

0.3

F

P(~L)	P(L)

0 0.3 1

Bayesian Network

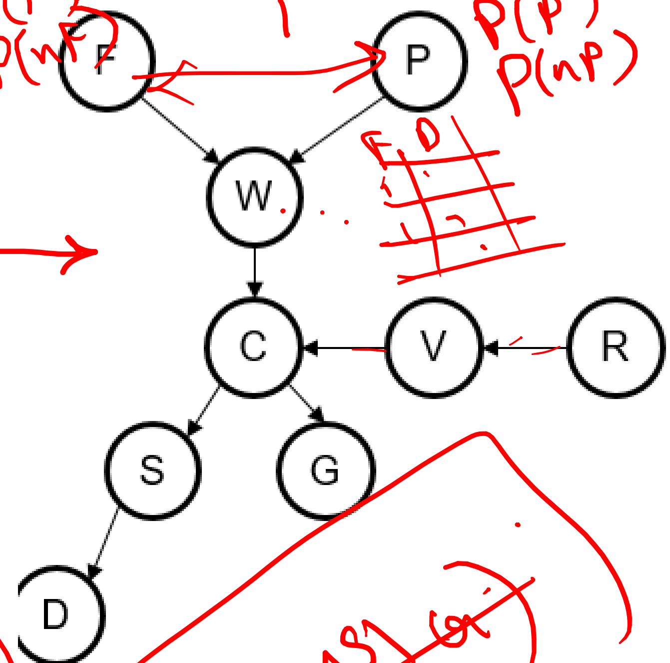
Most of the WILP students are fans (F) of cricket irrespective of their gender. With the new season of IPL (Indian Premier League) having started on the exam month almost every cricket fans spend time to watch(W) the live play. Sometimes being a parent (P) reduces the probability of watching the IPL live season. A likely consequence of watching matches is reduced concentration(C) on the following day/s. A consequence of the reduced concentration is increased stress(S) with work environment leading to reduced productivity (D) in project. Lack of concentration might also be caused by viral (V) infection, which is common in this rainy season(R). WILP students have the comprehensive exams and reduced concentration would reduce the probability of good grades (G) in the exam which reflects the performance of students in examination. Assume an AI agent is fed this information and it answers to certain queries that can be inferred. Assume all the events(conditional or unconditional) are equally likely to occur:

F

ans

P(F)
P(nF)

P(P)
P(nP)



0.5
0.5

Example Joint Prob.Distribution Query :

What is the chance that "an ardent fan of cricket who is a parent of two kids, never misses an IPL match, doesn't get stressed in work environment, is affected by viral infection and performs well in the comprehensive examination"?

P(FPWnS'VG)

D-Seperation: Performance of in the examination is independent of stress in work environment given its known that the student is affected by viral infection

G ⊥ S|V

Explain HMM & Viterbi Algorithm only for AIML

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Practice

Suppose the assumptions of markov model is applicable in the sequence prediction, to predict the browsing pattern among the customers of an e-commerce website in below example, answer the following questions.

"In an e-commerce website of a single vendor, products are segregated into three categories Groceries, Home appliances and Clothing each designed to be hosted in separate webpage. All the customers looking for home appliances searches for products and seems not to be interested to explore other product categories. It's observed that 70% of users browsing groceries buy the product and 80% of browsers under clothing category adds the product to shopping cart for later purchase. 65% of customer browsing patterns end up in Home appliances category after groceries page and under appliances page 50% of users add product to the cart. In clothing section 50% of users keep browsing for clothes and 50% navigate to the home appliances category. Only 5% of browsing pattern is expected to navigate from groceries section to the clothing page."