CSE 422
Artificial Intelligence
Online Proctored ~~Ex~~ Final Exam
Fall - 2023

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Section : 11

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Answer to the question no 1

(a)

The new heuristic $h_2(n)$ which would be dominant to given heuristic is as follows

States,	$h_2(n)$
A	13
B	10
C	12
D	6
E	11
F	8
G	0
H	7
I	2

$\therefore$ Now if we check, $h_2(A) \leq h(B') + G(A-B)$

$\Rightarrow 13 \leq 10 + 4$

$\Rightarrow 13 \leq 14$ True

$h_2(A) \leq h(C) + G(A-C)$

$\Rightarrow 13 \leq 12 + 1$

$\Rightarrow 13 \leq 13.$

$h_2(B)$

$\Rightarrow 10 \leq 6+4$

$\Rightarrow 10 \leq 10$ True.

$h_2(F)$, θ_2

$\hookrightarrow 8 \leq 4+7$ True.

$h_2(H)$;

$\hookrightarrow 7 \leq$

$h_2(C)$

$\hookrightarrow 12 \leq 11+2$

$\Rightarrow 12 \leq 13$ True.

$h_2(C)$

$\hookrightarrow 12 \leq 0+15$.

$\Rightarrow 12 \leq 15$ True.

$h_2(D)$,

$\hookrightarrow 6 \leq 11+1$

$\Rightarrow 6 \leq 12$ ✓

$h_2(D)$,

$\hookrightarrow 6 \leq \cancel{7+4} \; 7+4$.

$\Rightarrow 6 \leq 11$ ✓

Similarly, $h_2(E)$,

$\hookrightarrow 11 \leq 7+7$

$\Rightarrow 11 \leq 14$ ✓ True.

$h_2(E)$,

$\hookrightarrow 11 \leq 4+8$ ✓

So, we can see that for all node, our updated $h_2(n)$ dominance over the given heuristic.

CamScanner

(b)

$\boxed{A^{12}}$

A^{12} $\boxed{B^{13} \quad C^{10}}$

C^{10} $\boxed{B^{13} \quad E^{10} \quad G^{16}}$

E^{10} $\boxed{B^{13} \quad G^{16} \quad F^{14} \quad H^{12}}$

H^{12} $\boxed{B^{13} \quad G^{16} \quad F^{14} \quad I^{12}}$

I^{12} $\boxed{B^{13} \quad \cancel{G^{16}} \quad F^{14} \quad G^{13}}$

G^{13} $\boxed{B^{13} \quad F^{14}}$

So, we have reached our goal node, G with the optimal path being,

$A \rightarrow C \rightarrow E \rightarrow H \rightarrow I \rightarrow G$; Path cost : 13.

and it is the most optimal path. And the two non optimal path and their cost are,

$A \rightarrow C \rightarrow G$; Path cost = 16

$A \to B \to D \to H \to I \to G$ Path cost = 15,

$\therefore$ Our A* search gives us optimal path.

(c)

$h(F) \leq h(H) + G(F-H)$

$\Rightarrow 7 \leq 2 + 4$

$\Rightarrow 7 \leq 6$.

$\therefore$ For $h_1(n)$ heuristic of F is not consistent.

Answer to the question no 2

(a)

Given that,

an event x has n possible out come, where

$n = 8$.

Then, the maximum value of entropy of X, $H(X)$ would

be, 8.

As, there are 8 possible outcomes so maximum

heuristic would be 8.

(P.T.O)

(b)

IG (Prior Exp):

$$E\ (\text{Decision}) = -P(\text{yes})\log_2 P(\text{yes}) - P(\text{no})\log_2 P(\text{no})$$

$$= -\left(\frac{6}{10} * \log_2 \frac{6}{10}\right) - \left(\frac{4}{10} * \log_2 \frac{4}{10}\right)$$

$$= 0.9709$$

$$E\ (\text{yes}) = \left(-\frac{4}{6}\log_2 \frac{4}{6}\right) - \left(-\frac{2}{6}\log_2 \frac{2}{6}\right)$$

$$= 0.9182$$

$$E\ (\text{No}) = \left(-\frac{2}{4}\log_2 \frac{2}{4}\right) - \left(-\frac{2}{4}\log_2 \frac{2}{4}\right)$$

$$= 1$$

$$\therefore IG\ (\text{Prior Exp}) = E\ (\text{decision}) - P(\text{yes}) * E\ (\text{yes}) - P(\text{no}) * E\ (\text{no})$$

$$= 0.9709 - \left(\left(\frac{6}{10}\right) * 0.9182\right) - \left(\frac{4}{10} * 1\right)$$

$$= 0.01998$$

IG (Course ~~time~~ Name):

$$E\ (\text{Decision}) = 0.9709.$$

$$\therefore E\ (\text{Mathematics}) = -\left(\frac{1}{3}\log_2 \frac{1}{3}\right) - \left(\frac{2}{3}\log_2 \frac{2}{3}\right)$$

$$= 0.9182.$$

$\therefore$ E (Programming) $= -\left(\frac{2}{4}\log_2 \frac{2}{4}\right) - \left(\frac{2}{4}\log_2 \frac{2}{4}\right)$

$= 1$

$\therefore$ E (Machine learning) $= -\left(\frac{3}{3}\log_2 \frac{3}{3}\right) - \left(\frac{0}{3}\log_2 \frac{0}{3}\right)$

$= 0$

$\therefore$ IG (Course Name) = E (decision) − P (Programming) E (Programming)

− P (ML) · E (ML) − P (Math) E (Math)

$= 0.9709 - \left(\frac{4}{10} * 1\right) - \left(\frac{3}{10} * 0\right) - \left(\frac{3}{10} * 0.9182\right)$

$= 0.29544.$

IG (Course time):

E (decision) = 0.9709.

E (Day) $= -\left(\frac{4}{4}\log_2 \frac{4}{4}\right) - \left(\frac{0}{4}\log_2 \left(\frac{0}{4}\right)\right)$

$= 0.$

E (Night) $= -\left(\frac{2}{6}\log_2 \frac{2}{6}\right) - \left(\frac{4}{6}\log_2 \frac{4}{6}\right)$

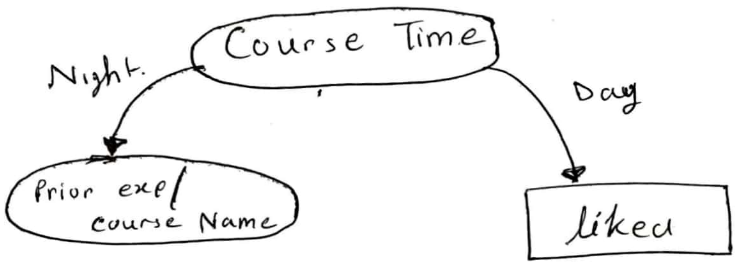
$= 0.9182$

$\therefore$ IG (Course time) $= 0.9709 - \left(\frac{4}{10} * 0\right) - \left(\frac{6}{10} * 0.9182\right)$

$= 0.41998$

As IG (Course time) > IG (Course Name) > IG (Prior exp.)

So, Course time would be our root node and we can see, whenever we get day in course time our ~~likelihood~~ is liked is always yes. So, for Course time = yes it would be a leaf node.



(P.T.O)

(c)

IG (Course Time | Mathematics) :

$E \text{ (decision)} = -\left(\frac{1}{3} \log_2 \frac{1}{3}\right) - \left(\frac{2}{3} \log_2 \frac{2}{3}\right)$

$= 0.9182$

$\therefore E(\text{Day}) = -\left(\frac{1}{1} \log_2 \frac{1}{1}\right) - \left(\frac{0}{1} \log_2 \frac{0}{1}\right)$

$= 0$

$\therefore E \text{ (Night)} = -\left(\frac{0}{2} \log_2 \frac{0}{2}\right) - \left(\frac{2}{2} \log_2 \frac{2}{2}\right)$

$= 0$

$\therefore$ IG (Course time) given that the student take math is

$= 0.9182 - \left(\frac{1}{3} * 0\right) - \left(\frac{2}{3} * 0\right)$

$= 0.9182.$

Answer to the question no 3'

(a)

Given that,

$P(A|V) = 0.95$; $\therefore P(\sim A|V) = 0.05$

$P(A|\sim V) = 0.10$; $\therefore P(\sim A|\sim V) = 0.90$

$P(B|V) = 0.90$; $\therefore P(\sim B|V) = 0.10$

$P(B|\sim V) = 0.05$; $P(\sim B|\sim V) = 0.95$

$\therefore P(V) = 0.01$ $\therefore P(\sim V) = 0.99$

$P(V|A) = ?$

$P(V|B) = ?$

Now, by applying Bayes Theorem, we can write,

$$\therefore P(V|A) = \frac{P(A|V) * P(V)}{P(A)}$$

$$= \frac{P(A|V) * P(V)}{P(A|V) * P(V) + P(A|\sim V) * P(\sim V)}$$

$$= \frac{0.95 * 0.01}{(0.95 * 0.01) + (0.10 * 0.99)}$$

$$= 0.08756$$

$$\therefore P(V|B) = \frac{P(B|V) * P(V)}{P(B)}$$

$$= \frac{P(B|V) * P(V)}{P(B|V) * P(V) + P(B|\sim V) * P(\sim V)}$$

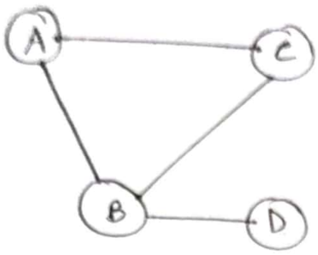
$$= \frac{0.90 * 0.01}{(0.90 * 0.01) + (0.05 * 0.99)}$$

$$= 0.153846$$

As, $P(V|B) > P(V|A)$ therefore, the test B returning positive is more indicative of someone really carrying the virus.

Ans to ques no 4

(i)



(ii)

The given constrain are:

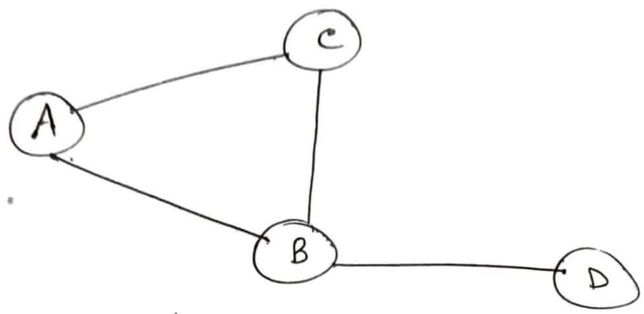
$A \neq B$, $A \neq C$; $B \neq C/2$, $B \neq 1$ D cannot be a multiple of 2.

So, here is only one unary constraint which is $\{B \neq 1.\}$

And thae rest are binary constraint. ~~and those~~ as they depend on two variables. and those constraints are,

$\{ A \neq B;$,
$A \neq C;$,
$B \neq C/_2;$,
D can't be a multiple of 2 }

(iii)



1st choice | 2nd choice

	A	B	C	D
picking A. and assigning 1	1	~~2~~, 3, 4, 5	~~2~~, 3, 4, 5	1, 2, 3, 4, 5
picking B and assigning 2	1	3	2, 4, 5	1, 2, 4, 5
picking D and assigning 5	1	3	2, 4, ~~5~~.	5
Pickinge C and assigning 2	1	3	2	5