AI Final

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Problem 1

	Size	shape	colon	Buy
1	big	square	green	no
2	small	round	green	no
3	small	square	red	no
4	big	round	green	no
5	small	square	green	yes
6	small	round	red	no
7	big	square	green	no
8	small	square	green	yes
9	small	square	green	yes
10	small	round	red	no.

Entropy (Buy) → Yes/No.

$= -(\frac{7}{10}) \log_2 (\frac{7}{10}) - (\frac{3}{10}) \log_2 (\frac{3}{10})$

$= 0.36 + 0.52$

$= 0.88.$

IG (Size) $= 0.88 - [\frac{3}{10}(-\frac{0}{3}\log_2\frac{0}{3} - \frac{3}{3}(\cdots$ big

$[\frac{3}{10}(-\frac{0}{3}\log_2\frac{0}{3} - \frac{3}{3}\log_2\frac{3}{3})] -$

small → $[\frac{7}{10}(-\frac{4}{7}\log_2\frac{4}{7} - \frac{3}{7}\log_2\frac{3}{7})]$

$= 0.88 - 0 - 0.689$

$= 0.19.$

IG(shape) $= 0.88 - [\frac{6}{10}(-\frac{3}{6}\log_2\frac{3}{6} - \frac{3}{6}\log_2\frac{3}{6})] -$ sq.

round → $[\frac{4}{10}(-\frac{4}{4}\log_2\frac{4}{4} - \frac{0}{4}\log_2\frac{0}{4})]$

$= 0.88 - 0.6 - 0$

$= 0.28.$

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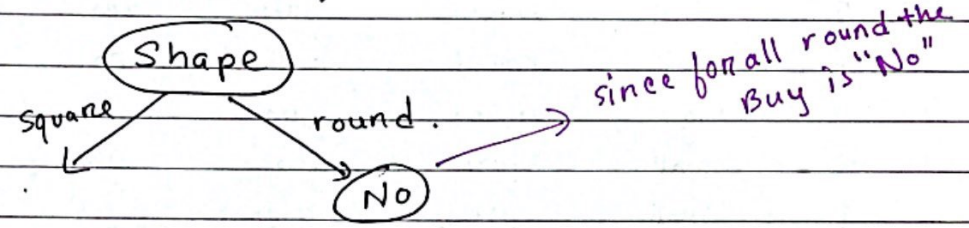
$$IG(colon) = 0.88 - \left[\frac{7}{10}\left(-\frac{4}{7}\log_2\frac{4}{7} - \frac{3}{7}\log_2\frac{3}{7}\right)\right]_{Gr.} - \left[\frac{3}{10}\left(-\frac{3}{3}\log_2\frac{3}{3} - \frac{0}{3}\log_2\frac{0}{3}\right)\right]$$

$$= 0.88 - 0.68$$

$$= 0.19.$$

$$IG(shape) > IG(colon) > IG(size.)$$



Square table

	Size	Shape	Colon	Buy.
1	big	square	green	no
2	small	square	red	no
3	small	square	green	yes
4	big	square	green	no
5	small	square	green	yes
6	small	square	green	yes

Entropy (Shape = square, Buy) → Yes/No

$$= -\frac{3}{6}\log_2\frac{3}{6} - \frac{3}{6}\log_2\frac{3}{6} = 1$$

$$IG(Size) = 1 - \left[\frac{2}{6}\left(-\frac{0}{2}\log_2\frac{0}{2} - \frac{2}{2}\log_2\frac{2}{2}\right)\right]_{big} - \left[\frac{4}{6}\left(-\frac{1}{4}\log_2\frac{1}{4} - \frac{3}{4}\log_2\frac{3}{4}\right)\right]_{small}$$

$$= 1 - 0 - 0.54 = 0.45.$$

$$IG(colon) = 1 - \left[\frac{5}{6}\left(-\frac{2}{5}\log_2\frac{2}{5} - \frac{3}{5}\log_2\frac{3}{5}\right)\right]_{green} - \left[\frac{1}{6}\left(-\frac{1}{1}\log_2\frac{1}{1} - \frac{0}{1}\log_2\frac{0}{1}\right)\right]_{red}$$

$$= 1 - 0.81 - 0 = 0.19.$$

IG(Size) > IG(color)

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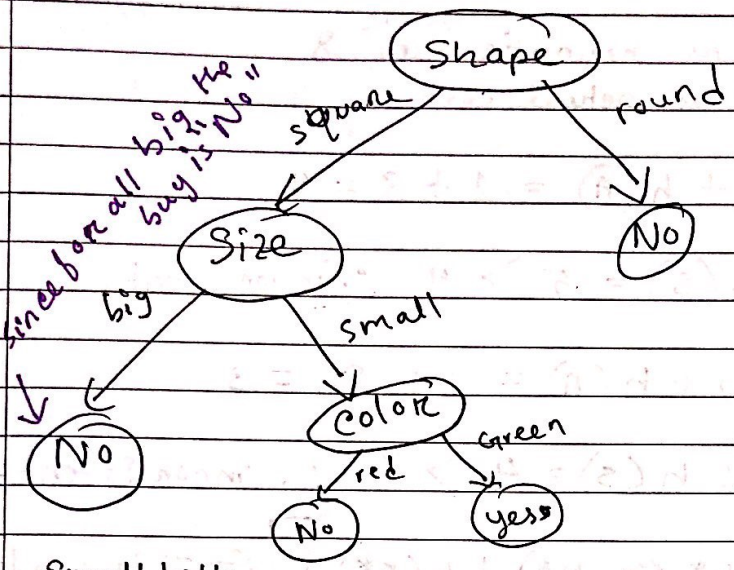

since for all big the buy is "No"

Small table

	size	Shape	colon	Buy	
1	small	square	red	no	→ for all red the buy is "No"
2	small	square	green	yess	→ for all green the Buy is "Yes"
3	small	square	green	yess	
4	small	square	green	yes	

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Problem 2 :-

a) Lets consider h as heuristic value & h* as actual cost

For S, $h^*(S, A) + h(A) = 1 + 3 = 4$

$\therefore h(S) = 5 > 4$ $\therefore$ inconsistent.

b) For S, $h^*(S, A) + h(A) = 1 + 2 = 3$

$\therefore h(S) = 4 > 3$ $\therefore$ inconsistent.

[Because $h(n) \leq h^*(n, n^*) + h(n^*)$ where, n^* is the neighbour of n.] ← This has to be true for all the nodes for the heuristic to be consistent.

c) Smallest/cheapest path cost for all nodes to Goal node :-

for, S,

$S \rightarrow A \rightarrow C \rightarrow G = 1 + 1 + 2 = 4$

for A,

$A \rightarrow C \rightarrow G = 1 + 2 = 3$

for B,

$B \rightarrow A \rightarrow C \rightarrow G = 3 + 1 + 2 = 6$

$B \rightarrow D \rightarrow C \rightarrow G = 3 + 1 + 2 = 6$

For C,

$C \rightarrow G = 2$

For D,

$D \rightarrow G = 3$

$D \rightarrow C \rightarrow G = 2 + 1 = 3$

For G,

0

Let h be heuristic cost & h* be actual cost.

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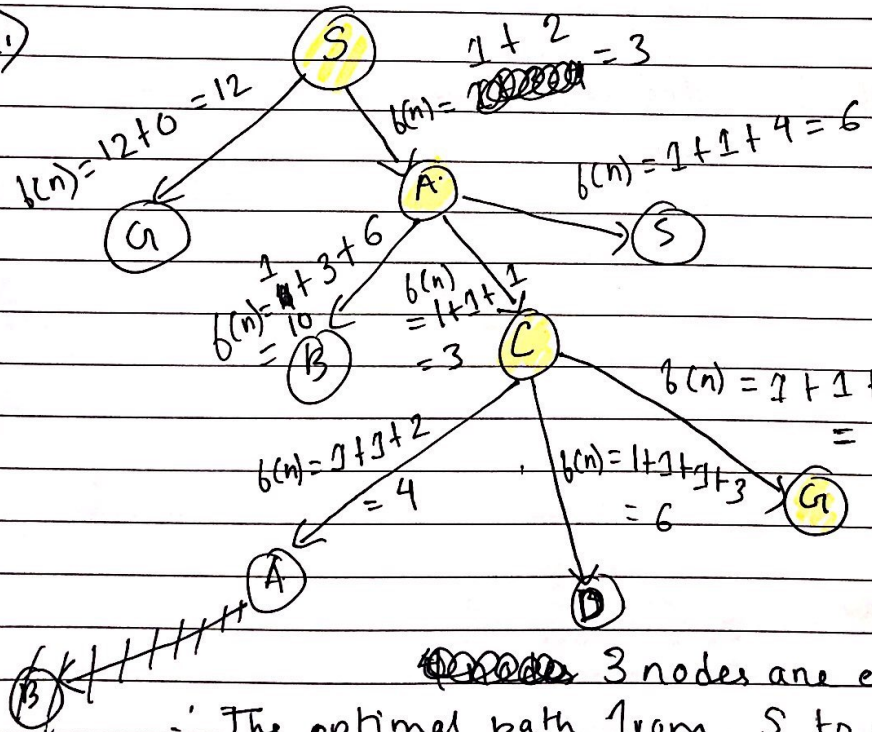
For H1,

S →	$h^*(S) = 4$	<	$h(S) = 5$	[Since heuristic cost is greater than actual cost for 'S', the heuristic H1 is not admissible]
A →	$h^*(A) = 3$	=	$h(A) = 3$	
B →	$h^*(B) = 6$	=	$h(B) = 6$	
C →	$h^*(C) = 2$	=	$h(C) = 2$	
D →	$h^*(D) = 3$	=	$h(D) = 3$	
G →	$h^*(G) = 0$	=	$h(G) = 0$	

For H_2,

S →	$h^*(S) = 4$	=	$h(S) = 4$	[since for all nodes m heuristic cost is either less than or equals to the actual cost, the heuristic H2 is admissible]
A →	$h^*(A) = 3$	>	$h(A) = 2$	
B →	$h^*(B) = 6$	=	$h(B) = 6$	
C →	$h^*(C) = 2$	>	$h(C) = 1$	
D →	$h^*(D) = 3$	=	$h(D) = 3$	
G →	$h^*(G) = 0$	=	$h(G) = 0$	

d)



3 nodes are expanded.

∴ The optimal path from S to G is :-

S → A → C → G with a cost of 4.

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Problem 3

Let spam be represented by S
& not " " " " ¬S
& Spam detection true be T
" " not true be ¬T

Given,

$P(S) = 0.4$.

$P(\neg S) = 1 - 0.4 = 0.6$.

$P(\neg T | S) = 0.095$

$P(T | \neg S) = 0.05$

We need to find out :-

$(\neg S | T)$ ← Given test shows true but actually a non-spam

↓

?

Comparing :-

$$P(\neg S | T) \rightleftharpoons P(S | T)$$

$$\Rightarrow \frac{P(T | \neg S) P(\neg S)}{P(T)} \rightleftharpoons \frac{P(\neg T | S) P(S)}{P(T)}$$

Since $P(T)$ is common in both, we can ignore that.

$$\Rightarrow 0.05 \times 0.6 \rightleftharpoons 0.95 \times 0.4$$

$$= 0.03 \quad < \quad = 0.38$$

↑ not spam given detected true

↑ spam given detected true

$$\therefore P(\neg S | T) = \frac{0.03}{0.03 + 0.38} = 0.073$$

∴ Probability of having a non-spam email while the designed software has detected a spam is 0.073

Problem 4 :-

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We need to find :- (LE, ST, Temp.) (I)

$P(\text{Weather} = \text{sunny} \mid \text{not cultivated} \wedge \text{Medium} \wedge \text{silt} \wedge 19^\circ)$ >>

$P(\text{weather} = \text{rainy} \mid \text{not cultivated} \wedge \text{medium} \wedge \text{silt} \wedge 19^\circ)$ (II)

Leaning phase tables:

Land Elevation	Given Sunny	Given Rainy
High	3/8	1/4
Medium	3/8	1/4
Low	2/8	2/4

Soil Type	Given Sunny	Given Rainy
Sandy	2/8	2/4
Clay	4/8	1/4
Silt	2/8	1/4

Temp	Given Sunny	Given Rainy
low	3/8	1/4
medium	3/8	1/4
high.	2/8	2/4

Crop Cultivation	Given Sunny	Given Rainy
Yes	4/8	2/4
No	4/8	2/4

$P(\text{Weather} = \text{Sunny}) = 8/12$ $P(\text{weather} = \text{Rainy}) = 4/12$

(I) $= P(\text{not cultivated} \mid \text{sunny})\, P(\text{Medium}^{LE} \mid \text{sunny})\, P(\text{silt} \mid \text{sunny})\, P(19 \mid \text{sunny})\, P(w = \text{Sunny})$

$= 4/8 \times 3/8 \times 2/8 \times 3/8 \times 8/12 = 0.0117$

(II) $P(\text{not cultivated} \mid \text{rainy})\, P(\text{Medium}^{LE} \mid \text{rainy})\, P(\text{silt} \mid \text{rainy})\, P(19 \mid \text{rainy})\, P(w = \text{rainy})$

$= 2/4 \times 1/4 \times 1/4 \times 1/4 \times 4/12 = 2.6 \times 10^{-3}$

$= 0.0026$

(sunny) $0.0117 > 2.6 \times 10^{-3}$ (rainy)

∴ If crops are not being cultivated, Land elavation is Medium, soil type is silt, temp is 19° the more probabal weather condition is sunny.