Quiz 1 (a)

First Layer:

+ 1 2 5 6 7
- 3 4 8

$\boxed{\text{season}}$

summer — winter

+ 1 6 7   + 2 5
-     - 3 4 8

$$Gain(season) = 1 - \left[\frac{3}{8}(I,0) + \frac{5}{8} I\left(\frac{2}{5}, \frac{3}{5}\right)\right]$$

$$= 1 - \left[\frac{3}{8}(0) + \frac{5}{8}\left(-\frac{2}{5}\log_2 \frac{2}{5} - \frac{3}{5}\log_2 \frac{3}{5}\right)\right]$$

$$= 1 - \left[\frac{5}{8}(0.528772 + 0.442182)\right]$$

$$= 1 - 0.60684625$$

$$= 0.39315375$$

+ 1 2 5 6 7
- 3 4 8

$\boxed{\text{country}}$

italy — austria — spain

+ 1 2   + 5   + 6 7
-     - 3 4   - 8

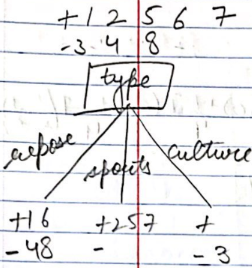
$$Gain(country) = 1 - \left[\frac{2}{8} I(1,0) + \frac{3}{8} I\left(\frac{1}{3}, \frac{2}{3}\right) + \frac{3}{8} I\left(\frac{2}{3}, \frac{1}{3}\right)\right]$$

$$= 1 - \left[\frac{1}{4}(0) + \frac{3}{8}\left(-\frac{1}{3}\log_2 \frac{1}{3} - \frac{2}{3}\log_2 \frac{2}{3}\right) + \frac{3}{8}\left[-\frac{2}{3}\log_2 \frac{2}{3} - \frac{1}{3}\log_2 \frac{1}{3}\right]\right]$$

$$= 1 - \left[\frac{3}{8}(0.528321 + 0.389975) + \frac{3}{8}(0.389975 + 0.52832)\right]$$

$$= 1 - 6.88722$$

$$= 0.311278$$



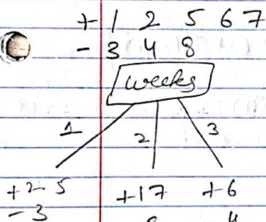
$$Gain(type) = 1 - \left[\frac{4}{8} I\left(\frac{2}{4},\frac{2}{4}\right) + \frac{3}{8} I(1,0) + \frac{1}{8} I(0,1)\right]$$

$$= 1 - \left[\frac{1}{2}\left(-\frac{2}{4}\log\frac{2}{4} - \frac{2}{4}\log\frac{2}{4}\right) + 0 + 0\right]$$

$$= 1 - 0.5[0.5 + 0.5]$$

$$= 1 - 0.5$$

$$= 0.5$$



$$Gain(Weeks) = 1 - \left[\frac{3}{8} I\left(\frac{2}{3},\frac{1}{3}\right) + \frac{3}{8} I\left(\frac{2}{3},\frac{1}{3}\right) + \frac{2}{8} I\left(\frac{1}{2},\frac{1}{2}\right)\right]$$

$$= 1 - \left[\frac{3}{8}(0.389975 + 0.528321) \times 2 + \frac{2}{8} \times 1\right]$$

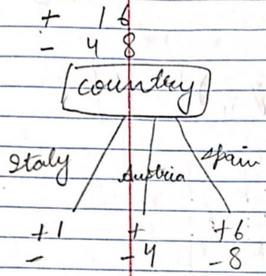
$$= 1 - 0.938722$$

$$= 0.061278$$

Since Gain(Weeks) < Gain(country) < Gain(season) < Gain(type),

1st layer of decision tree will be Type.

Second Layer :- (After type)

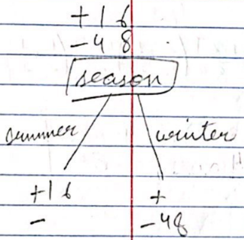


$$gain(country) = 1 - \left[\frac{1}{4} I(1,0) + \frac{1}{4} I(0,1) + \frac{2}{4} I\left(\frac{1}{2}, \frac{1}{2}\right)\right]$$

$$= 1 - \left[0 + 0 + \frac{1}{2} \times 1\right]$$

$$= 1 - 0.5$$

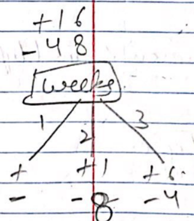
$$= 0.5$$



$$gain(season) = 1 - [I(1,0) + I(0,1)]$$

$$= 1 - (0 + 0)$$

$$= \underline{1}$$



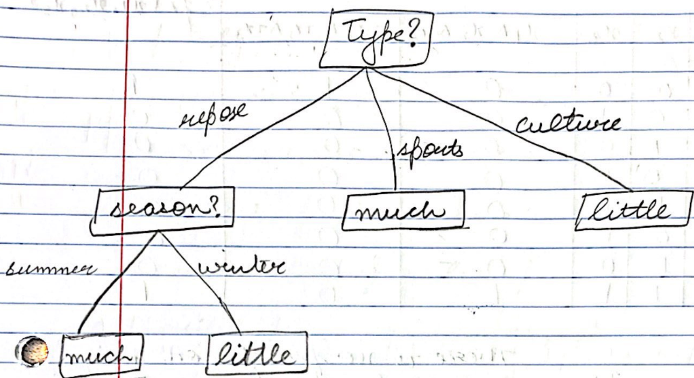
$$gain(weeks) = 1 - \left[0 + \frac{2}{4} I\left(\frac{1}{2}, \frac{1}{2}\right) + \frac{2}{4} I\left(\frac{1}{2}, \frac{1}{2}\right)\right]$$

$$= 1 - \left[\frac{1}{2} + \frac{1}{2}\right]$$

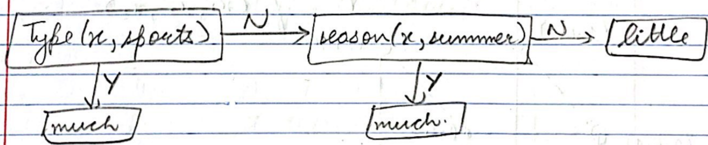
$$= 0$$

gain(weeks) < gain(country) < gain(season).

Decision Tree :-

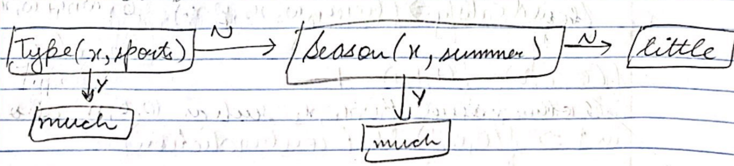


(b) (i)



The above Tests contains only one literal.

(ii) The decision list has more than one test as only one test is not possible, thus it has at least two tests.



Scanned with CamScanner

Ques 2 (a)

example	I_D	I_C	I_S	$I_\#$	I_M	I_h	I_m	I_e	T
1	0	0	1	2	1	1	0	0	1
2	0	1	0	3	0	0	0	1	0
3	0	1	0	1	0	0	1	0	0
4	1	0	0	2	1	0	0	1	1
5	1	0	0	1	0	1	0	0	1
6	0	0	1	3	1	0	0	1	1
7	0	1	0	1	0	1	0	0	1
8	0	0	1	2	0	0	0	1	0

Local encoding → actors, marketing, reception

distributed encoding → genre, cost.

Scanned with CamScanner

$$a_i = step_0\left(\sum_{j=0}^{n} w_{ji} \times a_j\right)$$

$\alpha = 2$

$E = T - O$

$$w_j = w_j + \alpha \times I_j \times Error$$

(b)

	example	O	E	W_b	W_c	W_S	$W_\#$	W_M	W_h	W_m	W_e
initial				+1	+1	+1	+1	+1	+1	+1	+1
	1	1	0								
	2	1	-1		-1		-5				-1
	3	0	0								
epoch1	4	0	1	+3			-1	+3			+1
	5	1	0								
	6	1	0								
	7	0	1		+1		+1		+3		
	8	1	-1			-1	-3				-1
	1	0	1			+1	+1	+5	+5		
	2	1	-1		-1		-5				-3
	3	0	0								
epoch2	4	0	1	+5			-1	+7			-1
	5	1	0								
	6	1	0								
	7	1	0								
	8	0	0								
	1	1	0								
	2	0	0								
	3	0	0								
epoch3	4	1	0								
	5	1	0								
	6	1	0								
	7	1	0								
	8	0	0								

Ques 3

(a) $f_1(x_1, x_2, x_3) = (x_1 \equiv (x_2 \wedge x_3))$

TRUTH TABLE

x_1	x_2	x_3	$x_2 \wedge x_3$	$x_1 \equiv (x_2 \wedge x_3)$
0	0	0	0	1
0	0	1	0	1
0	1	0	0	1
1	0	0	0	0
1	1	0	0	0
1	0	1	0	0
0	1	1	1	0
1	1	1	1	1

$step_t(x) = 0 \quad , \quad x < t$

$step_t(x) = 1 \quad , \quad x \geq t$

$x_1 \equiv (x_2 \wedge x_3) \Rightarrow x_1 \Leftrightarrow (x_2 \wedge x_3)$

$f_1(x_1, x_2, x_3) = (x_1 \equiv (x_2 \wedge x_3))$

$= (x_1 \wedge x_2 \wedge x_3) \vee (\sim x_1 \wedge \sim(x_2 \wedge x_3))$

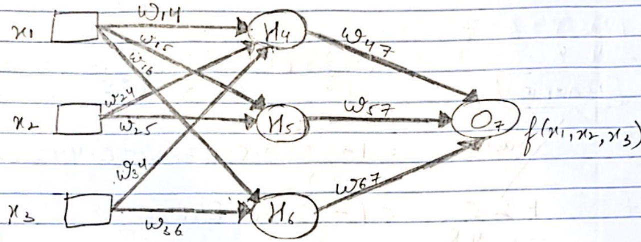
$= (x_1 \wedge x_2 \wedge x_3) \vee (\sim x_1 \wedge (\sim x_2 \vee \sim x_3)$

$= (x_1 \wedge x_2 \wedge x_3) \vee (\sim x_1 \wedge \sim x_2) \vee (\sim x_1 \wedge \sim x_3)$

Hidden layer consists of three neurons.

neural network:

Input → x_1, x_2, x_3
Hidden layer → H_1, H_2, H_3
Output layer → O_7



activation function: $f(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$

For O_7

$w_{47} = w_{57} = w_{67} = 1$
threshold for $O_7 = 0.5$
[As it is disjunction (OR) of outputs from hidden neurons]

For H_4:

$w_{14} = w_{24} = w_{34} = 1$
threshold of $H_4 = 2.5$
[As it is conjunction (AND) of all x_1, x_2 and x_3]

for H_5

$w_{15} = w_{25} = -1$
threshold of $H_5 = 0$
[It is $\sim(x_1 \vee x_2)$ which is true only when both are 0]

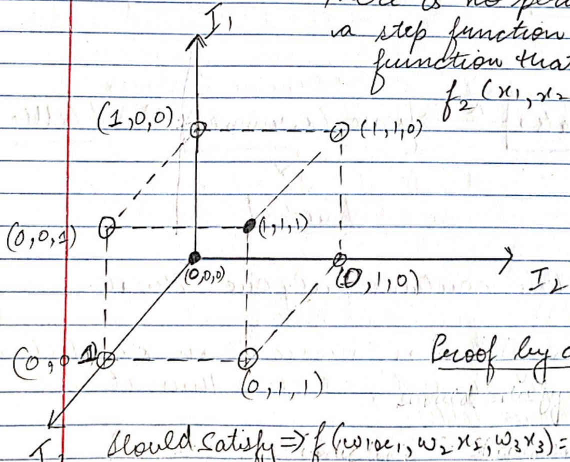
for H_6

$w_{16} = w_{36} = -1$
threshold of $H_6 = 0$.
[It is $\sim(x_1 \vee x_3)$ which is true only when both are 0]

Ques 3 (b) $f_2(x_1, x_2, x_3) = (x_1 \wedge x_2 \wedge x_3) \vee (\neg x_1, \neg x_2, \neg x_3)$

x_1	x_2	x_3	$x_1 \wedge x_2 \wedge x_3$	$\neg x_1 \wedge \neg x_2 \wedge \neg x_3$	$f_2(x_1, x_2, x_3)$
0	0	0	0	1	1
0	0	1	0	0	0
0	1	0	0	0	0
1	0	0	0	0	0
0	1	1	0	0	0
1	0	1	0	0	0
1	1	0	0	0	0
1	1	1	1	0	1

There is no perceptron using a step function as activation function that can represent $f_2(x_1, x_2, x_3)$.



Proof by contradiction:-

Should satisfy $\Rightarrow f(w_1x_1, w_2x_2, w_3x_3) = \begin{cases} 0, & w_1x_1 + w_2x_2 + w_3x_3 < t \\ 1, & \text{else} \end{cases}$

$f(0,0,0) = f(1,1,1) = 1$

all other values of x_1, x_2, x_3 such as $(0,0,1)$ also results in 1 $\Rightarrow f(0,0,1) = 1$ (contradiction)

The function $f_2(x_1, x_2, x_3)$ results in 1 only when $(x_1=0, x_2=0, x_3=0)$ or $(x_1=1, x_2=1, x_3=1)$. When these two points that is $(1,1,1)$ and $(0,0,0)$ are plotted on a 3-D figure, then these two points can not be separated from all other possible value of (x_1, x_2, x_3) by a plane. There is no plane that has $(0,0,0)$ and $(1,1,1)$ on one side and other points are on other side as they are not linearly separable, hence it is not represented as step function as activation function.