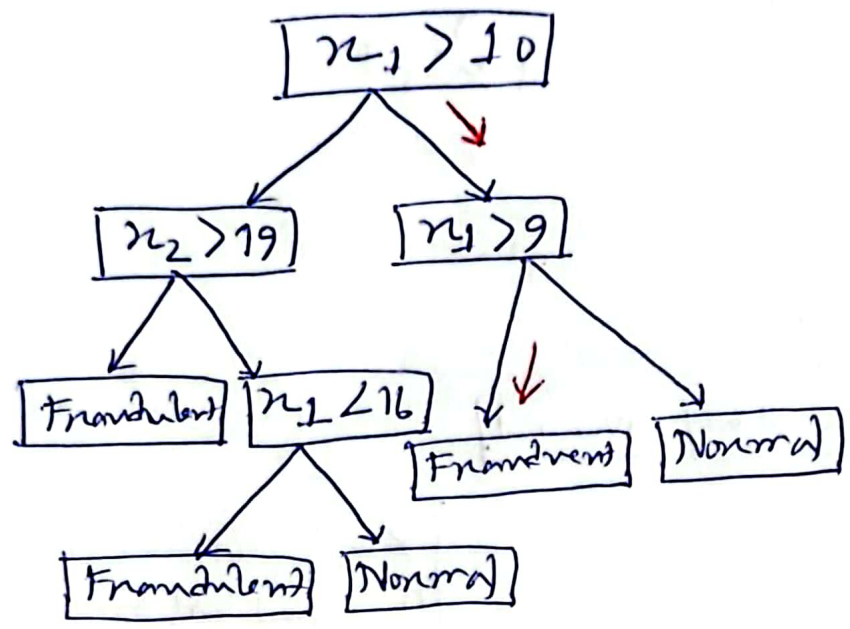


①

Question 1

For the first instance,

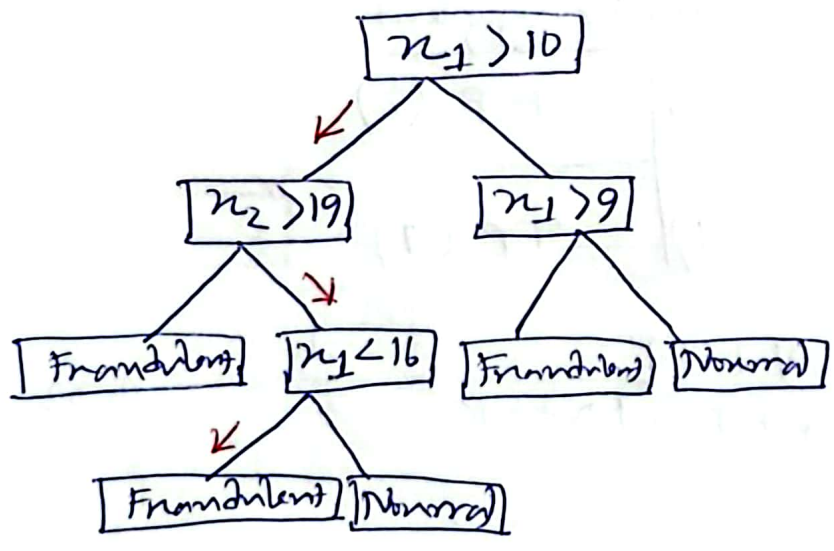
$$x_1 = 10, x_2 = -2, y = \text{Fraudulent}$$



$\hat{y} = \text{Fraudulent}$
 $y = \text{Fraudulent}$

For the second instance

$$x_1 = 20, x_2 = 12, y = \text{Normal}$$

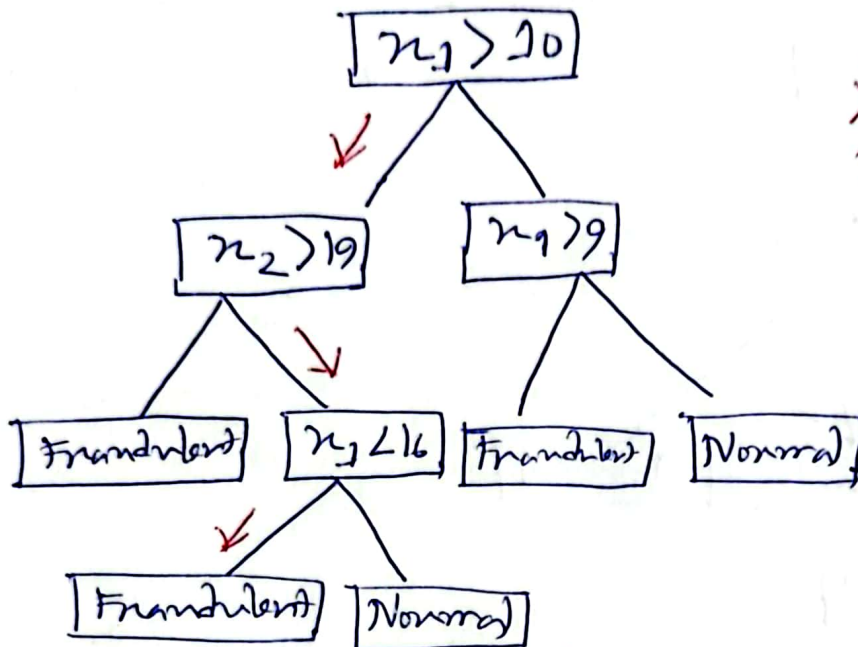


$\hat{y} = \text{Fraudulent}$
 $y = \text{Normal}$

(2)

For the third instance,

$$x_1 = 15, x_2 = -2, y = \text{Normal}$$



$\hat{y} = \text{Fraudulent}$
 $y = \text{Normal}$

$y = \text{Fraudulent, Normal, Normal}$
 $\hat{y} = \text{Fraudulent, Fraudulent, Fraudulent}$

40

True Negative

Confusion Matrix

	Normal (0)	Fraudulent (1)	
Normal (0)	TN (0)	FP (2)	False Positive
Fraudulent (1)	FN (0)	TP (1)	True Positive
	False Negative		

$$\text{Accuracy} = \frac{TN + TP}{TN + TP + FN + FP} = \frac{1}{3} = 0.33$$

$$\text{Recall} = \frac{TP}{FN + TP} = \frac{1}{0 + 1} = 1$$

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{1}{3} = 0.33$$

$$F1 = \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} = \frac{0.33 \times 1}{0.33 + 1} = 0.25$$

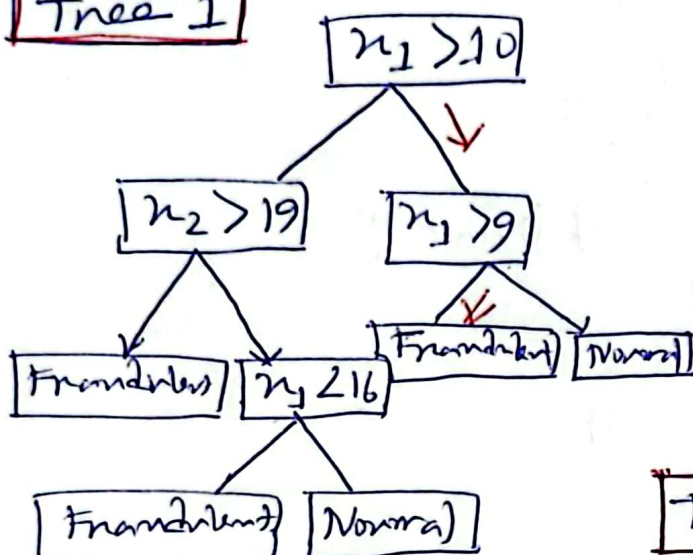
3

Question No. 2 :-

Q) For the first instance :-

$x_1 = 10, x_2 = -2, y = \text{Fraudulent}$

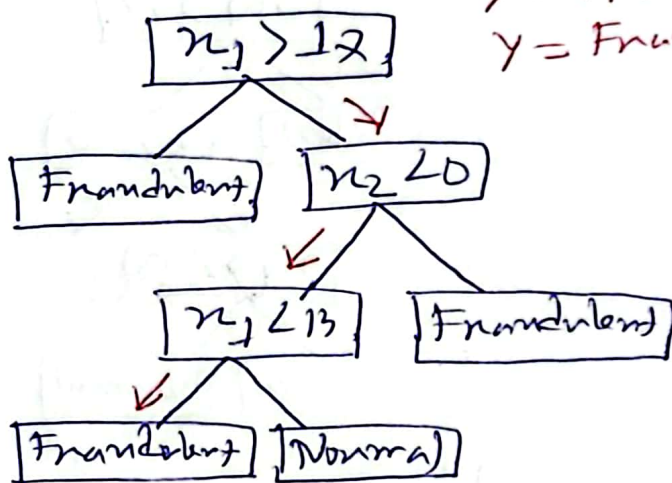
Tree 1



$\hat{y} = \text{Fraudulent}$

$y = \text{Fraudulent}$

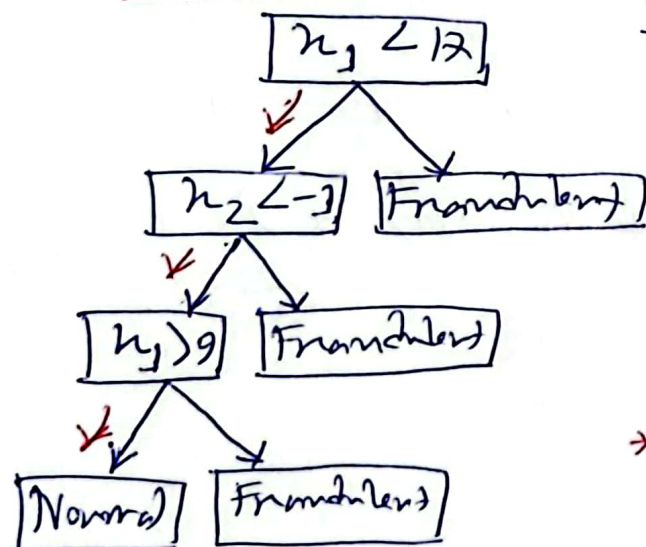
Tree 2



$\hat{y} = \text{Fraudulent}$

$y = \text{Fraudulent}$

Tree 3



$\hat{y} = \text{Normal}$

$y = \text{Fraudulent}$

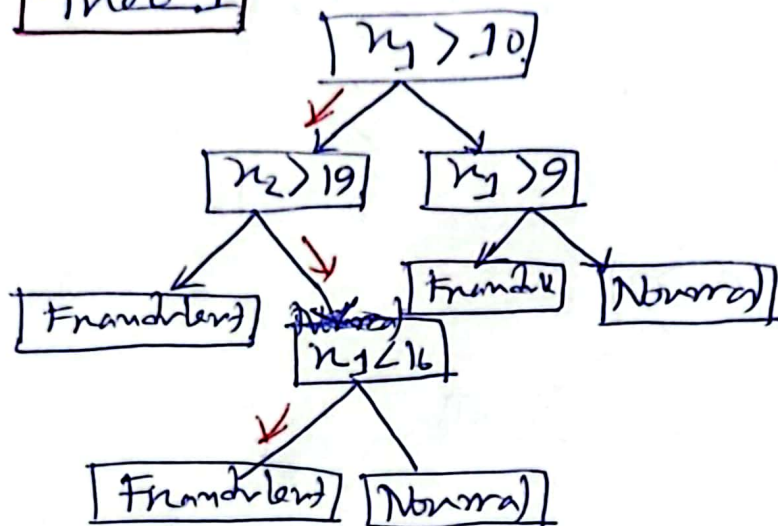
* Majority of $\hat{y} = \text{Fraudulent}$ for the first instance.

④

14) For the second instance

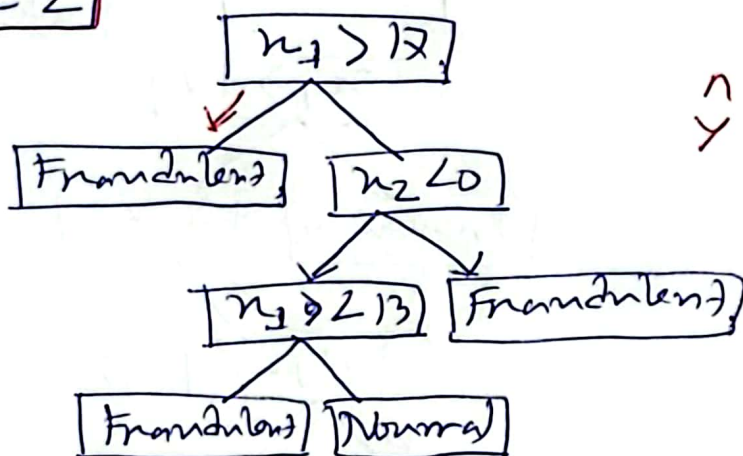
$$x_1 = 20, x_2 = 12, y = \text{Normal}$$

Tree 1



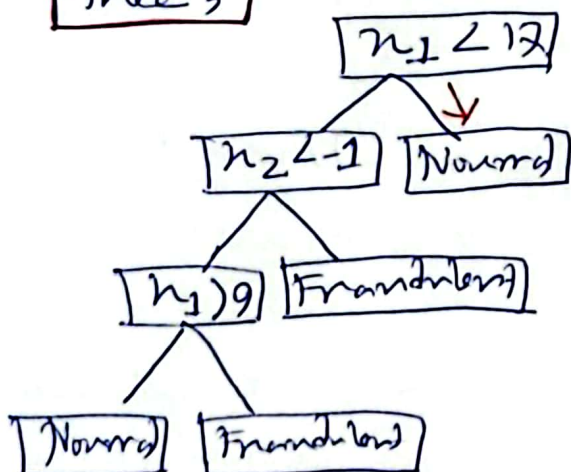
$\hat{y} = \text{Fraudulent}$

Tree 2



$\hat{y} = \text{Fraudulent}$

Tree 3



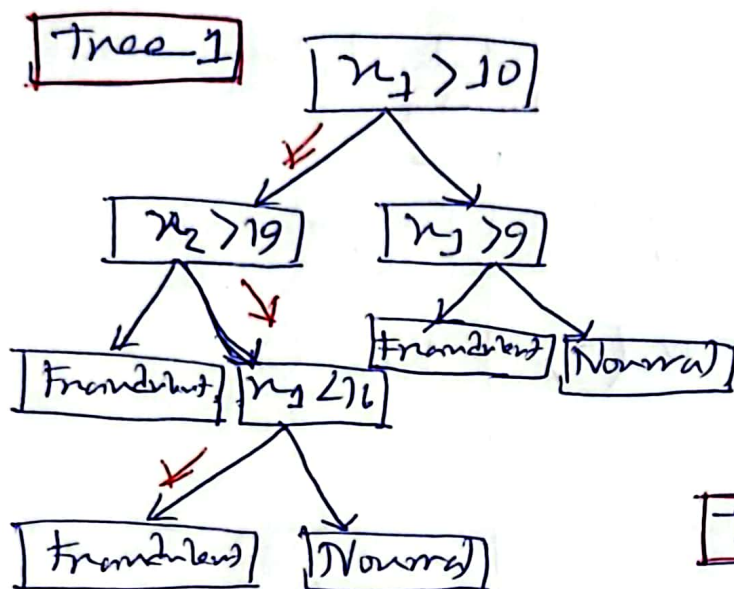
$\hat{y} = \text{Normal}$

* Majority of $\hat{y} = \text{Fraudulent}$
for the second instance

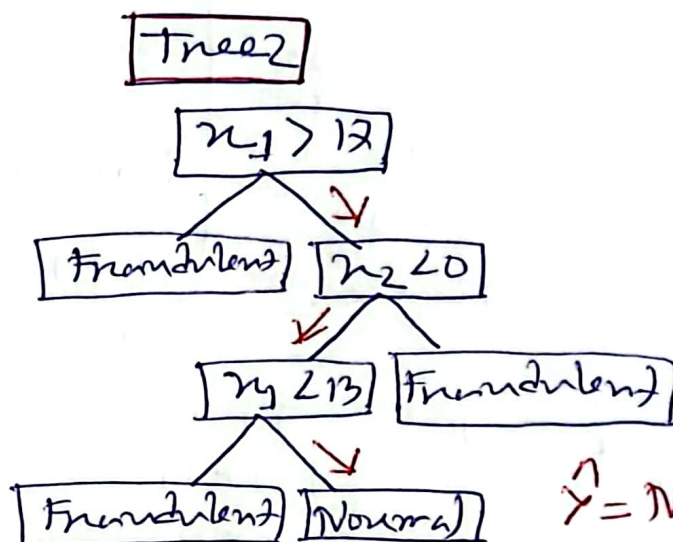
(5)

For the third instance

$$x_1 = 15, x_2 = -2, y = \text{Normal}$$



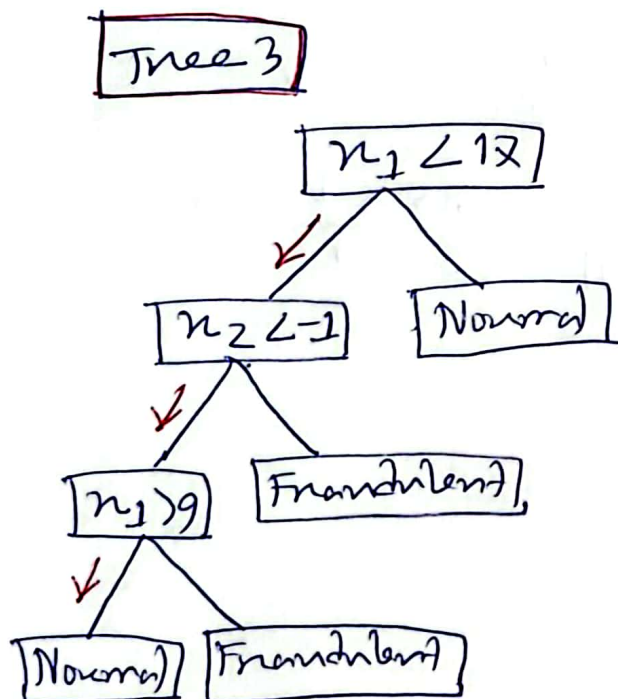
$$\hat{y} = \text{Fraudulent}$$



$$\hat{y} = \text{Normal}$$

$$\hat{y} = \text{Normal}$$

* The majority of $\hat{y} = \text{Normal}$ for the third instance.



$$\therefore \hat{y} = \text{Fraudulent}, \text{Fraudulent}, \text{Normal}$$

$$y = \text{Fraudulent}, \text{Normal}, \text{Normal}$$

(6)

Confusion Matrix for question 2

$Y = \text{Fraudulent}^{(1)}, \text{Normal}^{(0)}, \text{Normal}^{(0)}$

$\hat{Y} = \text{Fraudulent}^{(1)}, \text{Fraudulent}^{(1)}, \text{Normal}^{(0)}$

	Normal (0)	Fraudulent (1)
Normal (0)	TN (1)	FP (1)
Fraudulent (1)	FN (0)	TP (1)

True Negative (diagonal from top-left to bottom-right)

False Positive (arrow from FP cell to text)

True Positive (arrow from TP cell to text)

False Negative (arrow from FN cell to text)

$$\text{Accuracy} = \frac{TN + TP}{TN + TP + FN + FP} = \frac{2}{3} = 0.66$$

$$\text{Recall} = \frac{TP}{FN + TP} = \frac{1}{1} = 1$$

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{1}{2} = 0.5$$

$$F1 = \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} = \frac{0.5 \times 1}{0.5 + 1} = \frac{0.5}{1.5} = 0.33$$

(2)

Question No. 3

X	Y
15	0
20	0
11	1
17	1

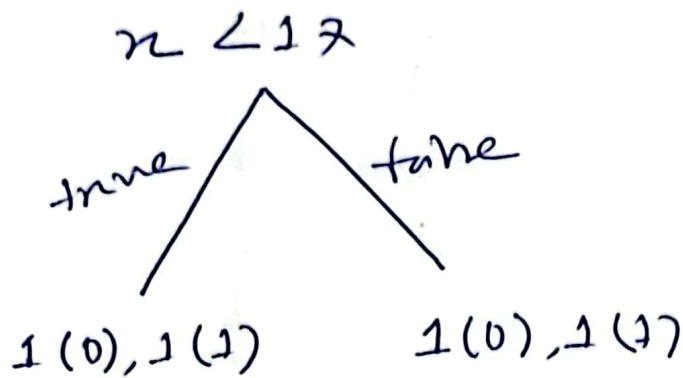
$x < 11$
 true false
 $0(0), 0(1)$ $2(0), 2(1)$
 $1 - \left(\left(\frac{0}{2} \right)^2 + \left(\frac{0}{2} \right)^2 \right)$ $= 1 - \left(\left(\frac{2}{4} \right)^2 + \left(\frac{2}{4} \right)^2 \right)$
 $= 1 - 0$ [undefined but considered as 0] $= 1 - \left(\frac{4}{16} + \frac{4}{16} \right)$
 $= 1$ $= 1 - \frac{8}{16} = 0.5$

$\therefore \text{Score for } x < 11 = \left(\frac{0}{4} \times 1 + \frac{4}{4} \times 0.5 \right)$
 $= \boxed{0.5}$

$x < 15$
 true false
 $0(0), 1(1)$ $0(0), 1(0), 2(1)$
 $= 1 - \left(\left(\frac{0}{2} \right)^2 + \left(\frac{1}{2} \right)^2 \right)$ $= 1 - \left(\left(\frac{1}{3} \right)^2 + \left(\frac{2}{3} \right)^2 \right)$
 $= 1 - (0 + 1)$ $= 1 - \left(\frac{1}{9} + \frac{4}{9} \right)$
 $= 0$ $= 1 - \frac{5}{9}$
 $= \frac{4}{9}$

$\therefore \text{Score for } x < 15 = \left(\frac{1}{4} \times 0 + \frac{3}{4} \times \frac{4}{9} \right)$
 $= \frac{1}{3} = \boxed{0.33}$

(8)



x	y
15	0
20	0
11	1
12	1

$$\begin{aligned}
 & 1 - \left(\left(\frac{1}{2} \right)^2 + \left(\frac{1}{2} \right)^2 \right) \\
 &= 1 - \left(\left(\frac{1}{2} \right)^2 + \left(\frac{1}{2} \right)^2 \right) \\
 &= 1 - \left(\frac{1}{4} + \frac{1}{4} \right) \\
 &= 1 - \frac{2}{4} \\
 &= 0.5
 \end{aligned}$$

$$\begin{aligned}
 &= 1 - \left(\left(\frac{1}{2} \right)^2 + \left(\frac{1}{2} \right)^2 \right) \\
 &= 1 - \left(\frac{1}{4} + \frac{1}{4} \right) \\
 &= 1 - \left(\frac{2}{4} \right) \\
 &= 0.5
 \end{aligned}$$

$$\begin{aligned}
 \text{score for } x < 12 &= \frac{2}{4} \times 0.5 + \frac{2}{4} \times 0.5 \\
 &= 0.25 + 0.25 \\
 &= \boxed{0.5}
 \end{aligned}$$

$x < 20$

```

      / \
  true /   \ false
     /       \
  1(0), 2(1)  1(0), 0(1)
  
```

$$\begin{aligned}
 &= 1 - \left(\left(\frac{1}{3} \right)^2 + \left(\frac{2}{3} \right)^2 \right) \\
 &= 1 - \left(\frac{1}{9} + \frac{4}{9} \right) \\
 &= 1 - \frac{5}{9} \\
 &= \frac{4}{9}
 \end{aligned}$$

$$\begin{aligned}
 &= 1 - \left(\left(\frac{1}{3} \right)^2 + \left(\frac{0}{3} \right)^2 \right) \\
 &= 1 - (1 + 0) \\
 &= 0
 \end{aligned}$$

$$\begin{aligned}
 \text{score for } x < 20 &= \frac{3}{4} \times \frac{4}{9} + \frac{1}{4} \times 0 \\
 &= \frac{1}{3}
 \end{aligned}$$

∴ The lowest score is $(x < 11, x < 20) = \boxed{0.33}$ $(x < 11, x < 20)$