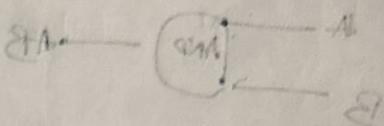


stop left ①



C S C E - 5380

Data Mining

Top	0	1
0	0	0
0	1	0
0	0	1
1	1	1

$$HW - 4 \quad 2.0 = SW \quad S \cdot 1 = IW^T \\ 2.0 = RP$$

Sai Mahesh Mudavat

F = topmost, O = 0, A = 1

$$11527206 + S \cdot 1 \cdot O = SW \\ 0 = 10000000 - 11527206 \text{ (steering)} \leftarrow$$

A = topmost, I = 0, O = 1

$$2.0 = 2.0 \cdot 1 + S \cdot 1 \cdot O = SW$$

O = 0 (most) \leftarrow

O = topmost, O = 0, I = 1 \leftarrow

$$S \cdot 1 = 2.0 \cdot 0 + S \cdot 1 \cdot 1 = IW$$

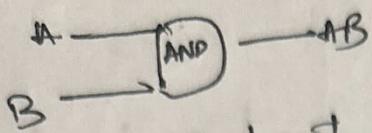
Work out steering \leftarrow
the response is based with the res value with

$$(1.0 - f) \cdot n + IW = ?W \quad \underline{\underline{f}}$$

$$F \cdot O = (1 - O) \cdot 2.0 + S \cdot 1 = IW$$

f = 0.5
n = 10

① And gate



A	B	out
0	0	0
0	1	0
1	0	0
1	1	1

Let $w_1 = 1.2$ $w_2 = 0.6$, Threshold = 1

$$L \cdot R = 0.5$$

4) $A=0, B=0, \text{target} = 0$

$$\sum w_i x_i = 0 * 1.2 + 0 * 0.6 = 0$$

→ not greater than threshold 1 - so $O/p \approx 0$

$A=0, B=1, \text{target} = 0$

$$\sum w_i x_i = 0 * 1.2 + 1 * 0.6 = 0.6$$

→ Again $O/p \approx 0$

$A=1, B=0, \text{target} = 0$

$$w_i x_i = 1 * 1.2 * 0 * 0.6 = 1.2$$

$$O/p = 1 \rightarrow \text{greater than threshold}$$

Now weights are modified based on perceptron rule

$$w_i = w_i + n(t - o/p)x_i$$

$$w_1 = 1.2 + 0.5(0 - 1) = 0.7$$

$$w_2 = 0.6 + 0.5(0 - 1) = 0.1$$

$$t = \text{target}$$

$$o = O/p$$

0.7 0.6 - are modified wts

Restart the process from start

$$\rightarrow W_1 = 0.7 \quad W_2 = 0.6 \quad \text{Thr} = 1 \quad LR_{(n)} = 0.5$$

$$W_i x_i = 0 * 0.7 + 1 * 0.6 = 0$$

not greater than Threshold '1', $O/p = 0$

$$A = 0, B = 1 \quad T = 0$$

$$W_i x_i = 1 * 0 + 0.7 * 1 = 0.7 = 0.6$$

→ not greater than Threshold '1', $O/p = 0$

$$A = 0, B = 1 \quad \text{target} = 0$$

$$W_i x_i = 0 * 0.7 + 1 * 0.6 = 0.6 = 0.5$$

not greater than Threshold '1', $O/p = 0$

$$A = 1, B = 0 \quad \Rightarrow \text{Target} = 0$$

$$1 * 0.7 + 0 * 0.6 = 0.7$$

not greater than threshold of '1', $O/p = 0$

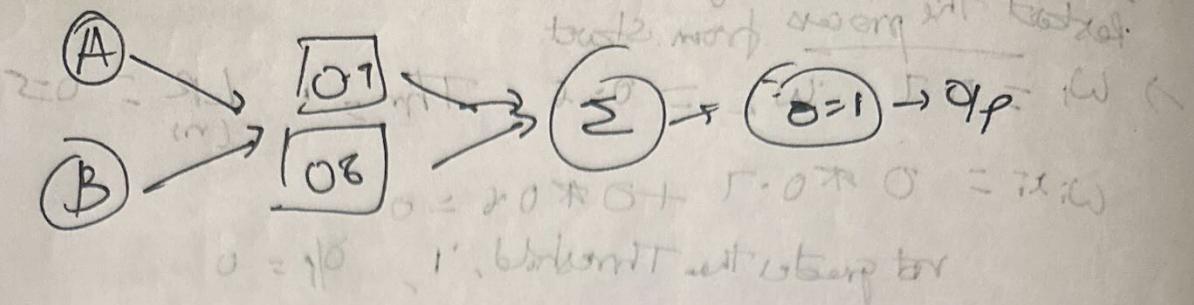
$$A = 1, B = 1 \quad \text{target} = 1$$

$$1 * 0.7 + 1 * 0.6 = 1.3$$

greater than '1', $O/p = 1$

Step 11A -

$$W_1 = 0.7, W_2 = 0.6 \rightarrow \text{weights}$$



Approach 2

If we set bias value of -1.5

$\Sigma = w_1 x_1 + w_2 x_2 + b$

$$\Sigma = x_1 + x_2 - 1.5$$

$0 = 10, i.e., backward with step function$

$$1 + 1 - 1.5 = 0.5$$

Step (0.5) = 1

If $\Sigma = 2.0 * 0 + 0 * 1$
 $\Sigma = 0 + 0 = 0$

$0 = 10, i.e., backward with step function$

$$-1 + 0 - 1.5 = -2$$

$$= -0.5$$

$$y = \text{Step}(-0.5) = 0$$

$\Sigma(x_1 + x_2 - 1.5) + 2.0 * 1$ proves true
 for this condition

- AND gate

$Zwischenkomm = 2.0 = 10, P.0 = 0$

Approach 3

$$w_1 = 0.5 \quad w_2 = 0.5 \quad b = -0.7$$

$$0 \leq \mu x_1 + \mu x_2 - 0.7 \leq 1$$

using AND function

$$z = w_1 \otimes x_1 + w_2 \otimes x_2 + b$$

$$= 0.5 \otimes 1 + 0.5 \otimes 1 - 0.7 = 0.3$$

$$y = \text{Step}(z) = 1$$

$$\begin{cases} \text{Step}(x) = 0 & \text{if } x < 0 \\ = 1 & \text{if } x \geq 0 \end{cases}$$

$$\text{Step}(0.3) = 1$$

$$T(x_1 + x_2 - 0.7) \rightarrow \text{proves true for And function}$$

$$1 = \text{Step}(0.3) = 1$$

$\mu x_1 \otimes x_2 = (x_1 \otimes x_2)$, P meeting notes

minimum to maximum

$$\mu x_1 \otimes x_2 = (x_1 \otimes x_2)$$

$$\textcircled{3} \quad \textcircled{a} \quad x_1 \cdot x_2 \geq x_3 \cdot x_4$$

$$\rightarrow x_1 \cdot x_2 - x_3 \cdot x_4 \geq 0$$

can't be true for some points

$$F(x) = \sum_{i=1}^x w_i \phi_i(x) \geq 0 =$$

$$\boxed{\text{out of } \phi_i(x) \text{ for } i=1, 2, 3, 4}$$

$$x_1 \cdot x_2 = (x_3)^{x_4} = V$$

$$\cancel{x_1} \cdot x_1 + x_1 \cdot \cancel{x_2 + x_3 \cdot x_4} = 1 \cdot ((x_1 \cdot x_2) + (x_3 \cdot x_4) \cdot x_1)$$

$$\text{but } \cancel{x_1} \cdot x_1 + x_1 \cdot \cancel{x_2 + x_3 \cdot x_4} = \begin{pmatrix} x_1 x_2 \\ x_3 x_4 \end{pmatrix}_{(x+1, x)}$$

$$w_1 = 1 \quad w_2 = -1$$

Feature functions $\Phi_1(x) = x_1 \cdot x_2 \quad \Phi_2(x) = x_3 \cdot x_4$

Mathematical Expression

$$\boxed{F(x) = x_1 \cdot x_2 - x_3 \cdot x_4}$$

(b) Mathematical Expression for Linear classifier of form

$$F(x) = w \cdot \phi(x)$$

w = weight $\phi(x)$ = Feature function

$$F(x) = -1 + (x_1, x_2))$$

$$w = -1 \quad \phi(x) = x_1, x_2$$

$$\rightarrow \text{Hence we get } F(x) = -x_1, x_2$$

But this case is not valid when $w = 1$

as we get $\phi(x) = x_1, x_2 \quad | F(x) = 0 \cdot x_1, x_2$
which can't classify.

$$S.O = \text{balanced}$$

$$+++\dots + -$$

$$++ - + - + -$$

$$1 = NT \quad 2 = 9T \quad 0 = MT \quad 2 = 9T$$

$$FPR = 1 = \frac{2}{9T} = \frac{4T}{NT+CT} = 9T$$

(5)

Classifier G_1 :

Threshold = 0.15

$x \cdot \phi \cdot w = x \geq 0$

Pred: + + + + + + + + +

Actual: - - + - + + + + +

$x \cdot \phi \geq 0$

TP = 5 FN = 0 FP = 5 TN = 5

$x \cdot \phi = 0$ top row white

$$\text{TPR} = \frac{\text{TP}}{\text{TP} + \text{FN}} = \frac{5}{5+0} = 1$$

TPR = True Positive Rate

$$\text{PPR} = \frac{\text{FP}}{\text{FP} + \text{TN}} = \frac{5}{5+0} = 1$$

PPR = Precision

Threshold = 0.2

Pred: - + + + + + + +

Actual: - - + - + - + +

TP = 5 FN = 0 FP = 4 TN = 1

$$\text{TPR} = \frac{\text{TP}}{\text{TP} + \text{FN}} = \frac{5}{5+0} = 1$$

$$\text{PPR} = \frac{\text{FP}}{\text{FP} + \text{TN}} = \frac{4}{5} = 0.8$$

iii) Threshold = 0.25

$$TN = 66 \text{ Normal} \quad \textcircled{V}$$

Pred	Act	TP	FP	TN	FN
- + + + + + + + + + + + + + +	- + + - + - + - + - + - + -	5	3	66	0

$$TP = 5 \quad TN = 66 \quad FP = 3 \quad FN = 0 \quad \text{HT} = 97$$

$$TPR = \frac{TP}{TP+FN} = \frac{5}{5+0} = \frac{5}{5} = 1.0 = 100\%$$

$$FPR = \frac{FP}{FP+TN} = \frac{3}{5+66} = \frac{3}{69} = 0.0435 = 4.35\%$$

iv) Threshold = 0.37

$$TN = 97 \quad \textcircled{W}$$

Pred	Act	TP	FP	TN	FN
- - + + + + + + + + + + + +	- + + + + + - + - + - + - + -	4	3	97	2

$$TP = 4 \quad FP = 3 \quad TN = 97 \quad FN = 2 \quad \text{HT} = 97$$

$$TPR = \frac{TP}{TP+FN} = \frac{4}{4+2} = \frac{4}{6} = 0.67 = 67\%$$

$$FPR = \frac{FP}{FP+TN} = \frac{3}{3+97} = \frac{3}{100} = 0.03 = 3\%$$

$$25.0^\circ = \text{blank} + \Delta T$$

$$\textcircled{V} \quad \text{Threshold} = 0.41$$

	Threshold	-	+	+	+	+	+	+	+	+	+	+	+
Pred	-	-	+	+	-	-	+	+	-	-	+	+	-
Act	-	-	+	-	-	+	-	-	+	-	+	-	-

$$TP = 4 \quad FP = 2 \quad FN = 1 + TN = 3$$

$$TPR = \frac{TP}{TP+FN} = \frac{4}{5} = 0.8 = \frac{8T}{8T+9F} = 89\%$$

$$FPR = \frac{FP}{FP + TN} = \frac{2}{5} = 0.4 = \frac{97}{97+97} = 99\%$$

18.0 = Weight

$$V_1 = 0.55$$

	++	+	+	+	+	-	-
Pred	-	-	-	-	+	+++	+
Act	-	-	+	-	+	-	+++

$$TP = 3 \quad FP = 2 \quad FN = 2, \quad TN = 3 \quad = 9T$$

$$TPR = \frac{TP}{TP + FN} = \frac{3}{3+2} = 0.6$$

$$FPR = \frac{FP}{FP + TN} = \frac{2}{5} = \frac{0.4}{0.6} = 66.67\%$$

$$\text{VII) } Th = 0.85$$

	Pred	Act
	- - - - + + + +	- - + - + - + + +

$$TP = 3 \quad FP = 1 \quad FN = 2 \\ TN = 4$$

$$TPR = \frac{TP}{TP+FN} = \frac{3}{5} = 0.6$$

$$FPR = \frac{FP}{FP+TN} = \frac{1}{5} = 0.2$$

$$\text{X) } Th = 0.99$$

	Pred	Act
	- - - - + + + +	- - + - + - + + +

$$TP = 1 \quad FP = 0$$

$$FN = 4 \quad TN = 5 = 9T$$

$$TPR = \frac{TP}{TP+FN} = \frac{1}{5} = 0.2$$

$$FPR = \frac{FP}{FP+TN} = \frac{0}{5} = 0$$

$$FP = 0 = \overline{FP}$$

$$\text{VIII) } Th = 0.8$$

	Pred	Act
	- - - - + + + +	- - + - + - + + +

$$TP = 3 \quad FP = 0, \quad FN = 2, \quad TN = 5$$

$$8.0 = \overline{FP}$$

$$1.0 = \overline{FP}$$

$$TPR = \frac{TP}{TP+FN} = \frac{3}{3+2} = 0.6$$

$$1.0 = \overline{FP}$$

$$FPR = \frac{FP}{FP+TN} = \frac{0}{0+5} = 0 \quad O = HT \quad Z = HT \quad Z = 9T \quad Z = 9T$$

$$1.0 = \overline{FP}$$

$$\text{IX) } Th = 0.92$$

	Pred	Act
	- - - - + + + +	- - + - + - + + +

$$TP = 2 \quad FP = 0$$

$$1 = \overline{FP}$$

$$FN = 3, \quad TN = 5 \quad S = HT \quad Z = 9T \quad N = 9T$$

$$1.0 = \overline{FP}$$

$$TPR = \frac{TP}{TP+FN} = \frac{2}{2+3} = 0.4$$

$$5.0 = \overline{FP}$$

$$0.0 = \overline{FP}$$

$$FPR = \frac{FP}{FP+TN} = \frac{0}{0+5} = 0$$

Classifier 2

$$Th = 0.33$$

$$TP = 4 \quad FP = 4 \quad TN = 1 \quad FN = 1$$

$$TPR = 0.8$$

$$FPR = 0.8$$

$$Th = 0.22$$

$$TP = 4 \quad FP = 5 \quad TN = 0 \quad FN = 1$$

$$TPR = 0.8$$

$$FPR = 0.1$$

$$Th = 0.1$$

$$\overline{TP} = 5 \quad FP = 5 \quad TN = 0 \quad FN = 0$$

$$T.O = \frac{\epsilon}{\epsilon + \epsilon} = \frac{97}{97+97}$$

$$TPR = 0.1$$

$$FPR = 1$$

$$Th = 0.41$$

$$TP = 4 \quad FP = 3 \quad TN = 2 \quad FN = 1$$

$$TPR = 0.8$$

$$FPR = 0.8$$

$$T.O = \frac{\epsilon}{\epsilon + \epsilon} = \frac{97}{97+97}$$

$$O = \frac{\epsilon}{250} = \frac{97}{97+250}$$

$$Th = 0.68$$

$$TP = 3 \quad FP = 1 \quad TN = 2 \quad FN = 1$$

$$TPR = 0.5$$

$$FPR = 0.2$$

$$Th = 0.59$$

$$TP = 3 \quad FP = 2 \quad TN = 3 \quad FN = 2$$

$$TPR = 0.8 \quad FPR = 0.4$$

$$Th = 0.72$$

$$TP = 3 \quad FP = 1 \quad TN = 4 \quad FN = 3$$

$$TPR = 0.4 \quad FPR = 0.2$$

$$Th = 0.75$$

$$TP = 2 \quad FP = 0 \quad TN = 5 \quad FN = 3$$

$$TPR = 0.4 \quad FPR = 0$$

$$Th = 0.64$$

$$TP = 4 \quad FP = 1 \quad TN = 4 \quad FN = 1$$

$$TPR = 0.8 \quad FPR = 0.2$$

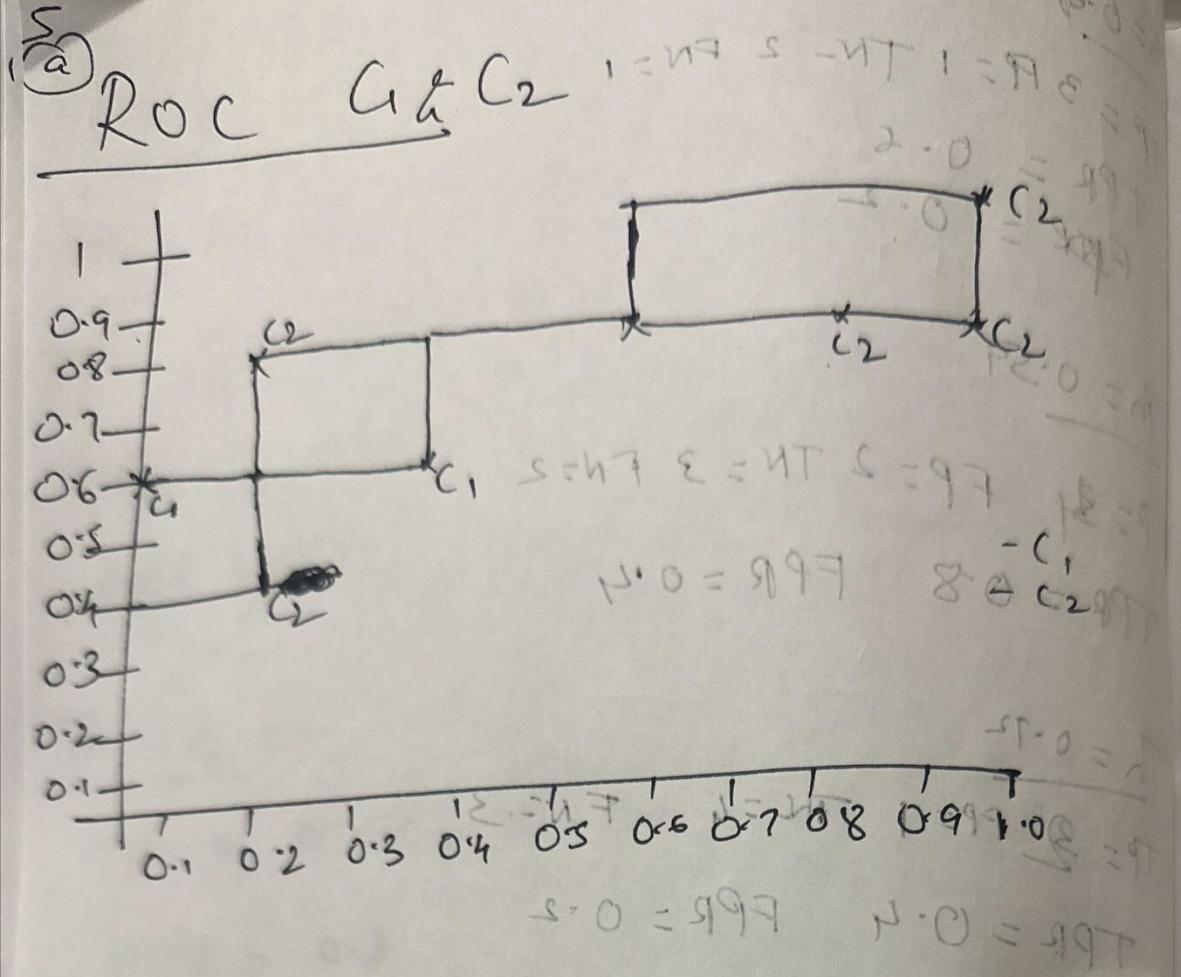
$$Th = 0.85$$

↓ below work

$$TP = 1 \quad FP = 0 \quad TN = 5 \quad FN = 4$$

$$TPR = 0.2$$

$$FPR = 0 \quad \text{FNR} = 0.8$$



(b) Area under Curve G_1 :

$$\frac{1}{2} * \sum_{i=1}^{n-1} [(T_{PPi} + T_{FPi}) * (TPR_i + FPR_i)]$$

$$\Rightarrow 0.6 \times 0.4 + 0.8 \times 0.2 + 1 \times 0.4$$

$$0.24 + 0.16 + 0.40 = 0.80$$

$$\boxed{G_1 \rightarrow 0.80}$$

Area under G_2 :

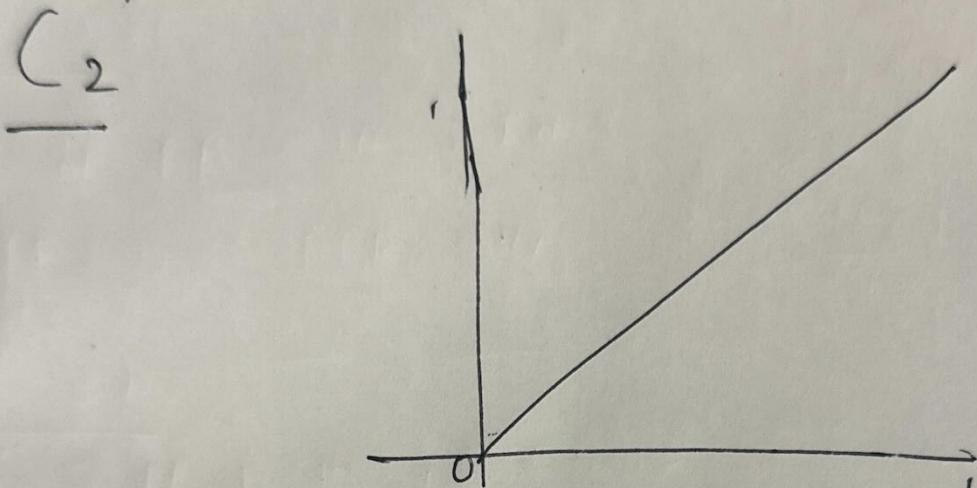
$$0.4(0.2) + 0.8(0.8) = 0.32 + 0.64$$

$$\boxed{T_{G_2} \rightarrow 0.72}$$

$$\boxed{T_{G_2} \rightarrow 0.72}$$

(c) $C_1 = 0.8$ $C_2 = 0.72$

Classifier 1 has more Area under Curve
 C_1 provides more accurate results than C_2



It also falls ~~less~~ above lower half of plot
~~from point~~ from point $(0,0)$ to $(1,1)$

In few cases C_2 can also be considered as
ROC curves that C_2 has higher TPR than C_1 for most
~~of FPR values~~

Overall C_1 (or) C_2 either of them can be
considered