

Evaluation of Multi-class Classification

- Bi-Classification $\rightarrow 2 \times 2$
- Multi-Class (3) $\rightarrow 3 \times 3$
- Multi-Class (n) $\rightarrow n \times n$

Y_{Act}	Y_{Pr}
A	A
B	C
C	B
A	A
B	C
C	A
A	B
C	C

Prediction		
A	B	C
Actual	A	T_P_A
	B	E_{AB}
	C	E_{AC}

2	81	9
10	6	20
30	40	7

$$\xrightarrow{\text{Ans}} \frac{TP}{n}$$

→ ① & ② \rightarrow Positive Class \rightarrow Precision & Recall.

→ A, B, C \rightarrow P_{ActA} , P_{ActB} , P_{ActC} , R_{ActA} , R_{ActB} , R_{ActC} ,
 $F-1-A$, $F-1-B$, $F-1-C$

→ FN \rightarrow Total No of FN for a Class is the Sum of Values in that row, excluding the TP

FP \rightarrow Total No of FP for a Class is the Sum of Value in that Column, excluding the TP.

TN \rightarrow Total no of TN for a Class will be Sum of all Col & row excluding the TP.

Prediction		
A	B	C
Actual	A	T_P_A
	B	E_{AB}
	C	E_{AC}

$$\text{Accuracy} = \frac{T_P_A + T_P_B + T_P_C}{n}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

$$P_A = \frac{T_P_A}{(T_P_A + E_{BA} + E_{CA})}$$

$$P_B = \frac{T_P_B}{(T_P_B + E_{AB} + E_{CB})}$$

$$\text{Recall} = \frac{TP}{n}$$

$$\frac{21}{28} = 75\%$$

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

$$R_A = \frac{TP_A}{TP_A + F_{AB} + F_{AC}}$$

$$R_B =$$

$$R_C =$$

<u>Recall</u>	Praeud	$F_1 =$
R_A	P_A	F_A
R_B	P_B	F_B
R_C	P_C	F_C

$$P_B = \frac{TP_B}{(TP_B + F_{AB} + F_{CB})}$$

$$P_C = \frac{TP_C}{(TP_C + F_{AC} + F_{BC})}$$

$$\frac{2PR}{P+R}$$

$$\underline{F-1-Score} = 2$$

$$F_A = \frac{2P_A R_A}{(P_A + R_A)}$$

$$F_B = \frac{2P_B R_B}{(P_B + R_B)}$$

$$F_C = \frac{2P_C R_C}{(P_C + R_C)}$$

Recall = Sensitivity

$$\rightarrow \text{Specificity} = \left(\frac{TN}{TN + FP} \right)$$

	A	B	C
A	25	5	2
B	3	32	4
C	1	0	15

$$A = \frac{25 + 32 + 15}{25 + 32 + 15 + 3 + 1 + 0 + 5 + 2 + 4} = A = 82\%$$

$$P_A = \frac{25}{25 + 4} = \frac{25}{29} = 86\%$$

$$R_A = \frac{25}{25 + 7} = 78\%$$

$$\checkmark \underbrace{P_A \ P_B \ P_C}_{100 \rightarrow A \ B \ C \ 20}$$

$$\underbrace{R_A \ R_B \ R_C}_{\text{A}}$$

(i) A

Support \rightarrow Refers to the no. of actual occurrence of the class in the dataset.

$$\begin{array}{l} \Delta \\ \square \\ \Delta \\ \square \\ \Delta \\ \square \\ \end{array} \begin{array}{l} A=2 \\ B=1 \\ C=1 \end{array}$$

Macro $\frac{1}{n}$ Mean of scores of all classes

$$\text{Macro Praeud} = \frac{P_A + P_B + P_C}{3}$$

$$\text{Macro Recall} = \frac{R_A + R_B + R_C}{3}$$

$$\text{Macro } \frac{F_A + F_B + F_C}{3}$$

- Arithmetic Mean (Unweighted mean)

\rightarrow This method treats all class equally.

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Weighted Average: Is calculated by taking the mean of all Class Score while Considering each Class's Support.

→ "Weight" essentially refers to the proportion of each class' support relative to sum of all Support.

	<u>Premises</u>	<u>Support</u>	<u>Support proportion</u>
A	0.67	3	$3/10 = 0.3$
B	0.40	1	$1/10 = 0.1$
C	0.67	6	$6/10 = 0.6$
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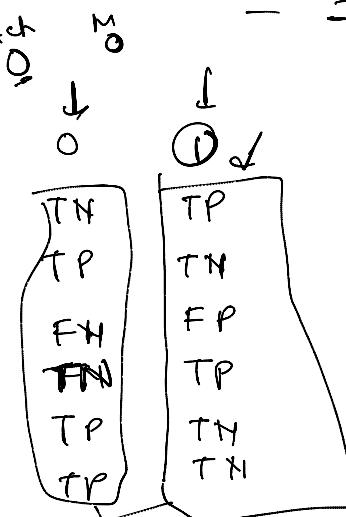
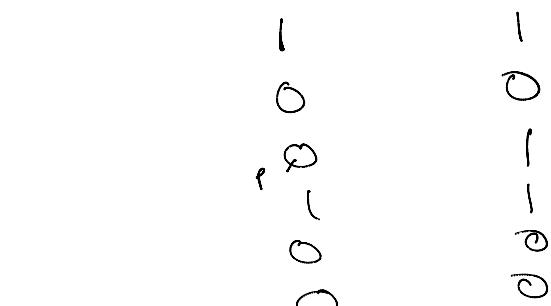
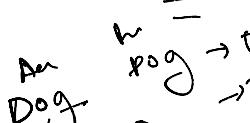
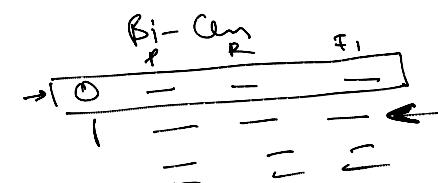
Weighted Avg Pm.

$$= (0.67 \times 0.3) + (0.40 \times 0.1) + (0.4 \times 0.7)$$

$$f\omega_b = 0.64$$

Macro: When we are working with an imbalance dataset where all classes are equally important.

Weighted Avg: When we are working with an imbalanced dataset where we want to assign greater contribution to classes.



$$P_{\perp} = \frac{TP}{TP + FP} = \frac{2}{2+1} = \frac{2}{3}$$

$$f_0 = \frac{TP}{TP + FN} = \frac{3}{3+0} = 1$$

