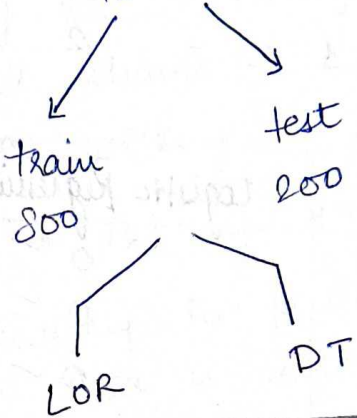
Classification Metrics

Accuracy

cgpa | iq | Placement → 1000 dataset



Actual label	Logistic Regression Prediction	Decision Tree Pred
1	1 ✓	1 ✓
0	1 ×	1 ×
0	0 ✓	0 ✓
0	0 ✓	0 ✓
1	1 ✓	1 ✓
1	1 ✓	1 ✓
0	1 ×	0 ✓
0	0 ✓	0 ✓
0	0 ✓	0 ✓
1	1 ✓	1 ✓

accuracy = no. of ✓ / Total prediction

= 8/10 = 0.8

accuracy = 80%.

accuracy = no. of ✓ / Total Predic

accuracy = 9/10

accuracy = 90%.

Accuracy of Multi-classification Problem

Iris → dataset

Setosa , Virginica , Versicolous

0 1 2

Actual label	Logistic Regression Pred	Decision Tree Pred
0	0 ✓	0 ✓
0	0 ✓	0 ✓
0	0 ✓	0 ✓
2	2 ✓	2 ✓
0	0 ✓	0 ✓
2	2 ✓	2 ✓
0	0 ✓	0 ✓
2	2 ✓	2 ✓
1	1 ✓	1 ✓
1	1 ✓	1 ✓

$$\text{Accuracy} = \frac{\text{correct prediction}}{\text{total prediction}}$$

Accuracy = 100%

How much accuracy is good?

It's depend the ~~model~~ problem you are solving and depend on data.

example:- (i) Self driving car → accuracy 99%.
but 1% chance → Crash car
so, not working.

(ii) Swiggy → Accuracy 85%.
85% accuracy to predict costumer order food. There is not harmful if 15% less accuracy.

The Problem with Accuracy

90% → 10% → Mistake → Y → N (label)
→ N → Y (label)

binary
Y / N

* Problem

We don't know which one is wrong or produce error.

like: Actual value is Yes
but predicted value is NO

or

Actual value is No
and Predicted value is Yes

} accuracy don't define which error happening
accuracy only show Number.

Confusion Matrix

Prediction

Actual \ Prediction	1	0
1	True Positive (TP)	False Negative (FN) Type II errors
0	False Positive (FP) Type I errors	True Negative (TN)

$$\text{accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

Confusion Matrix for Multi-classification Problem

0, 1, 2 → category

Predicted

Actual \ Predicted	0	1	2
0			
1			
2			

3×3

binary → 2×2

When accuracy is misleading?

Imbalance data

Yes	No
900	100

Precision

	Sent to spam	Not sent to spam
Spam	100	(FN) 170
Not Spam	30 (FP)	700

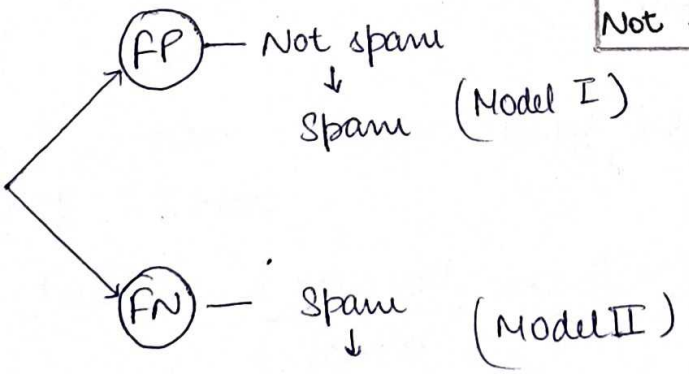
Model I (A) (80%)

$FP_A > FP_B$

$FN_A < FN_B$

Model II (B) (80%)

	Sent to spam	Not sent to spam
Spam	100	(FN) 190
Not Spam	10 (FP)	700



* Choose Model II because spam email sometimes → Not spam So, no risk to lost any important email.

Precision → What proportion of predicted Positives is truly Positive?

	Sent to Spam	Not sent to spam
Spam	True Positive	False Negative
Not Spam	False Positive	True Negative

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

$$P_A = \frac{100}{100+30} \qquad P_B = \frac{100}{100+10}$$

$$\boxed{P_A < P_B}$$

Recall :- What proportion of actual Positives is ~~not~~ correctly classified?

Recall

Predicted

	Detected cancer	Not Detected
Has cancer	1000	200 (FN)
No cancer	800 (FP)	8000

Model (A) (90%)

Type I error → Risk
↳ Precision

Type II error → Risk
↳ Recall

Predicted

	Detected cancer	Not Detected
Has Cancer	1000	500 (FN)
No Cancer	500 (FP)	8000

Model (B) (90%)

$Recall_A = \frac{1000}{1200}$

$Recall_B = \frac{1000}{1500}$

$R_A > R_B$

F1 Score

$$F1\ Score = \frac{2PR}{P+R}$$

Harmonic mean

Near to the lower term

$P = 0 \quad R = 100$

$Fscore = \frac{2 \times 0 \times 100}{100+0} = 0$

$P = 60 \quad R = 100$

$Fscore = \frac{2 \times 60 \times 100}{160}$

$= 75$

Problem

classifying Dog and Cat

Type 1 Error

Cat → Dog

Not risk

Type 2 Error

Dog → Cat

Not risk

Multi - class Precision and Recall

Positive

Yes

No

Binary

2 class

Multi

More than 2

Predicted

Actual		Dog	Cat	Rabbit	Total
	Dog	(25)	5	10	40
	Cat	0	(30)	4	34
	Rabbit	4	10	(20)	34
	Total	(29)	(45)	(34)	

$P_D = \frac{25}{29} = 0.86$, $P_C = \frac{30}{45} = 0.66$, $P_R = \frac{20}{34} = 0.58$

Macro precision

↳ $\frac{0.86 + 0.66 + 0.58}{3} = 0.70$

Weighted Precision

↳ $\frac{40}{108} \times 0.86 + \frac{34}{108} \times 0.66 + \frac{34}{108} \times 0.58$

$= 0.71$

★ Macro Precision → Use when data is almost balanced

★ Weighted Precision → Use when data is imbalanced

$\text{Recall}_D = \frac{25}{40} = 0.62$, $\text{Recall}_C = \frac{30}{34}$, $\text{Recall}_K = \frac{20}{34} = 0.58$

macro recall
Weighted Recall
} Find recall same as Macro Precision and Weighted Precision

Predicted

Actual	Dog	cat	Rabbit	Total	Recall
Dog	25	5	10	40	0.62
cat	0	30	4	34	0.88
Rabbit	4	10	20	34	0.58
Total	29	45	34		
Precision	0.86	0.66	0.58		

F_1 Score

$$F_{1D} = \frac{2 P_D R_D}{P_D + R_D} = \frac{2 \times 0.86 \times 0.62}{0.86 + 0.62}$$

$$F_{1C} = \frac{2 P_D R_D}{P_D + R_D} = \frac{2 \times 0.66 \times 0.88}{0.66 + 0.88}$$

$$F_{1R} = \frac{2 P_D R_D}{P_D + R_D} = \frac{2 \times 0.58 \times 0.58}{0.58 + 0.58}$$

- macro f_1
- Weighted f_1