F1 Score

- If you don't know which error is more dangerous Ex. Type I Error - model predicted cat for dog
  Type II error → model predicted dog for cat

- So you don't know which to focus at. You have to focus on both. because there is a tradeoff

- If precision ↑, recall ↓ & vice versa

- Hence introduction of F1 score which is the avg of recall & precision

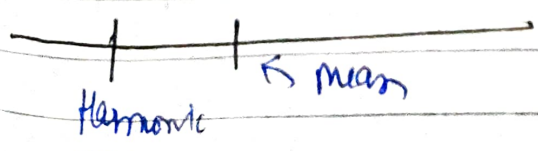
- This mean is Harmonic mean

$$F1\ score = \frac{2 \times Precision \times Recall}{Precision + Recall}$$

- Generally mean is biased towards higher value
  Ex → Precision = 80, Recall 30
  avg = $\frac{80+30}{2} = 55$

- But Harmonic penalizes the smaller value
  Ex $\frac{2 \times 80 \times 30}{80+30} = \frac{4800}{110} = 40.$

Mean vs Harmonic mean



Multi class Precision & Recall

- In Binary class all focus is on value of 1.
  Ex: email: spam → 1 ; Heart Disease → 1
  Yes or → 1

- And if you see formula for precision & recall in binary it focuses on True (1) values. And calculates for 1.

- $P \Rightarrow \frac{TP}{TP+FP}$; $R = \frac{TP}{TP+FN}$

- But what if tell you it calculate precision & Recall value for both binary classes i.e 0 and 1.

- Similarly, it will calculate Precision & Recall for all classes in Multi class problem

Ex

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

- model predicted total →

Actual total

Multi class Precision

- Calculate precision — $\frac{\text{no of actual class pts}}{\text{No of predicted total pts of that class}}$

$P_{dog} = \frac{\text{Actual dog}}{\text{Model Predicted}} = \frac{25}{29} = 0.86$

$P_{cat} = \frac{30}{45} = 0.66$

$P_{Rabbi} = \frac{20}{34} = 0.58$

- Calculate combined precision
- 2 ways → ① Macro = avg

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

Macro = 0.70

→ ② Weighted precision =
- Precision multiplied by class weight.
- ~~Actual total dog / Total Actual total × P_{dog}~~ +

Weighted precision

$= \frac{\text{Actual total of dog}}{\text{Actual total}} \times P_{dog} + \frac{\text{Actual total cat}}{\text{Actual total}} \times P_{cat} + \frac{\text{Actual total R.}}{\text{Actual total}} \times P_{Rab}$

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

Weighted = 0.71

① When to calculate Macro and Weighted

Ans • Use macro for balanced
• Use Weighted " " Imbalanced

• Multiclass Recall

→ Separate Recall

• Recall → Right classified from ~~model~~ total

- $R_D = \frac{\text{Actual Dog}}{\text{No of Dogs predicted by model}} = \frac{25}{}$

- $R_D = \frac{\text{Correctly classified dogs}}{\text{Actual dogs in data}} = \frac{25}{40}$

- $R_C = \frac{\text{Correctly ~~cat~~ classified cats}}{\text{Actual cats in data}} = \frac{30}{34}$

- $R_{Rabbit} = \frac{\text{Correctly classified Rabbit}}{\text{Actual Rabbits}} = \frac{20}{34}$

Combined Recall

macro (Avg) | Weighted recall

→ Weighted recall same as Weighted Precision

Now we have

	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		

Multiclass F1 score

- calculate separate F1 score

(Dog) $F1_D = \frac{2 \times P_D \times R_D}{P_D + R_D} = \frac{2 \times 0.86 \times 0.62}{0.86 + 0.62}$

(Rabbit) $F1_R = \frac{2 \times P_R \times R_R}{P_R + R_R} = \frac{2 \times 0.58 \times 0.58}{0.58 + 0.58}$

(Cat) $F1_C = \frac{2 \times 0.66 \times 0.88}{0.66 + 0.88}$

- calculate combine F1 score
  - Avg
  - Macro.