A binary classifier gave the following results:

50 samples were actually positive, and it predicted 45 as positive, 5 as negative.

Out of 50 actually negative samples, it predicted 10 as positive, 40 as negative.

* Confusion Matrix :

True positive : - 45

True Negative : - 40

False Positive : -10

False Negative : - 5

* Accuracy :

Accuracy = TP+TN/(FP+FN+TP+TN​)

Accuracy = 45 + 40 / (10 + 5 + 40 + 45) = 85 / 100 = 0.85

* Precision :

Precision = TP / (TP + FP)

Precision = 45 / (45 + 10) = 0.8182

* Recall

Recall = TP / (TP + FN)

Recall = 45 / (45 + 5) = 0.9

* F1 Score

F1 = 2 \* (Precision \* Recall) / (Precision + Recall)

F1 = 2 \* (0.8182 \* 0.9) / (0.8182 + 0.9) = 0.8572

Q2. Fill in the Blanks

A model produced the following confusion matrix:

|  |  |  |
| --- | --- | --- |
|  | Predicted Positive | Predicted Negative |
| Actual Positive | 70 | 30 |
| Actual Negative | 10 | \_\_\_ |

Find the missing number. Then, calculate:

Accuracy

Precision

Recall

F1 Score

---

**Find TN:**  
Total Actual Negative = TN + FP = ? + 10

TP = 70, FN = 30, FP = 10

Total = 70 + 30 + 10 = 110

TN = 200 - 110 = 90

* Confusion Matrix :

True positive : - 70

True Negative : - 90

False Positive : -10

False Negative : - 30

* Accuracy :

Accuracy = TP+TN/(FP+FN+TP+TN​)

Accuracy = (70 + 90) / 200 = 0.80

* Precision :

Precision = TP / (TP + FP)

Precision = 70 / (70 + 10) = 0.875

* Recall

Recall = TP / (TP + FN)

Recall = 70 / (70 + 30) = 0.70

* F1 Score

F1 = 2 \* (Precision \* Recall) / (Precision + Recall)

F1 = 2 \* (0.875 \* 0.7) / (0.875 + 0.7) = 0.778\

Q3. Model Comparison

Two models A and B gave the following metrics:

Metric Model A Model B

TP 80 60

FP 20 10

FN 40 20

TN 60 90

👉 For model 1, calculate:

Accuracy = TP + TN / TP + TN + FP + FN = 0.7 %

Precision = TP / TP + FP = 0.8 %

Recall = TP / TP + FN = 0.6666%

F1 Score = 2 \* (Precision \* Recall) / (Precision + Recall) = 0.7272%

👉 For model 2, calculate:

Accuracy = TP + TN / TP + TN + FP + FN = 0.8333 %

Precision = TP / TP + FP = 0.8571%

Recall = TP / TP + FN = 0.75%

F1 Score = 2 \* (Precision \* Recall) / (Precision + Recall) = 0.7999 %

👉 Which model performs better in terms of F1 score?

Model B performs better in terms of F1 score.

Q4. Precision vs Recall Tradeoff

A medical test detects a disease. Out of 1000 people:

100 have the disease (actual positive)

Model detects 95 positives, out of which only 60 are correct

👉 Calculate:

TP = 60, FP = 35 , FN = 40, TN = 865

Accuracy = TP + TN / TP + TN + FP + FN = 0.925 %

Precision = TP / TP + FP = 0.632 %

Recall = TP / TP + FN = 0.60 %

F1 Score = 2 \* (Precision \* Recall) / (Precision + Recall) = 0.616 %

Q5. Imbalanced Dataset Challenge

A dataset contains 950 negatives and 50 positives.

A model predicts all as negative.

👉 Create the confusion matrix

|  |  |  |
| --- | --- | --- |
|  | Predicted Positive | Predicted Negative |
| Actual Positive | TP = 0 | FN = 50 |
| Actual Negative | FP = 0 | PN = 950 |

👉 Calculate all five metrics

TP = 0, FP = 0, FN = 50, TN = 950

Accuracy = TP + TN / TP + TN + FP + FN = 0.95 %

Precision = TP / TP + FP = 0 %

Recall = TP / TP + FN = 0 %

F1 Score = 2 \* (Precision \* Recall) / (Precision + Recall) = 0 %

👉 Interpret whether this is a good model or not. Why?

This is not a good model. Because it is biased toward the majority class (negatives), and it fails completely at detecting the minority class (positives).

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Q6. Improving Precision

A spam filter model flags 100 emails as spam.

Out of them, 80 are really spam.

The model misses 20 spam emails.

👉 Calculate:

TP = 80, FP = 20, FN = 20

Precision = 0.80

Recall = 0.80

F1 Score = 0.80

Now, recommend one method to improve precision.

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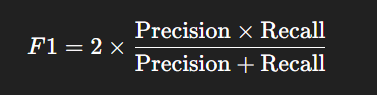
Q7. F1 Score Focus

A binary classification model has:

Precision = 0.75

Recall = 0.60

👉 Calculate the F1 Score using the formula:

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F1 Score = 0.667

Q8. Real-Life Example

A facial recognition system unlocks a phone only for the actual user. Out of 100 attempts:

30 were from the real user, and 25 were accepted.

70 were from others, and 10 were wrongly accepted.

👉 Find:

Confusion matrix (TP, FP, FN, TN)

Predicted Positive Predicted Negative

Actual Positive TP = 25 FN = 5

Actual Negative FP = 10 TN = 60

Precision = 0.714, Recall = 0.833, Accuracy = 0.85, F1 Score = 0.77

---

Q9. Calculate from Percentages

Given the following:

Precision = 85%, Recall = 68%

👉 Compute the F1 Score

F1 Score = 0.755

👉 What does this score say about the balance of the model?

The F1 Score balances precision and recall, making it especially useful when both false positives and false negative matter.

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Q10. Multi-Step: Find the Missing

A model gives:

Precision = 0.80

TP = 64

FP = 16

FN = 36

👉 Calculate:

Recall = 0.64

F1 Score = 0.711

TN (assume total = 200 samples) = 84