

DATA 301: Precision/Recall, F1 Score, Confusion Matrix

Topics

Classification metrics

Accuracy, and why it's often not useful

Precision/Recall

F1 Score

Confusion Matrix

Classification

These metrics apply to classification not regression problems.

Classification: predict a class

Regression: Predict a number

Accuracy, and why it's not as useful

It's a fine measure if you have a balanced dataset. Or roughly the same number of every class in the dataset.

Accuracy fails if you have an unbalanced dataset, for instance

- Cancer diagnosis dataset

- Or credit card fraud dataset

There are likely to be very few positive cancer diagnosis, or frauds in the above datasets.

For each of these datasets your model can always predict the majority class and score high accuracy. (The more unbalanced, the better the accuracy)

A better way- Precision/Recall/F1

Precision: Out of all found how accurate were predictions?

$$P = \frac{T_p}{T_p + F_p}$$

Tp true positives
Fp false positives
Tn true negatives
Fn false negatives

Recall: How accurate if you consider all?

$$R = \frac{T_p}{T_p + F_n}$$

F1 score: The harmonic mean of precision and recall

$$F1 = 2 \frac{P \times R}{P + R}$$

Precision/Recall/F1

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Example: A database has 100 items, 60 are Positive, 40 are Negative

Database

60 P

40 N

Precision/Recall/F1

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Example: A database has 100 items, 60 are Positive, 40 are Negative
Model predicts 50 positives, 40 are correct

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Database	60 P	40 N
Model	40 P	10 P

Precision/Recall/F1

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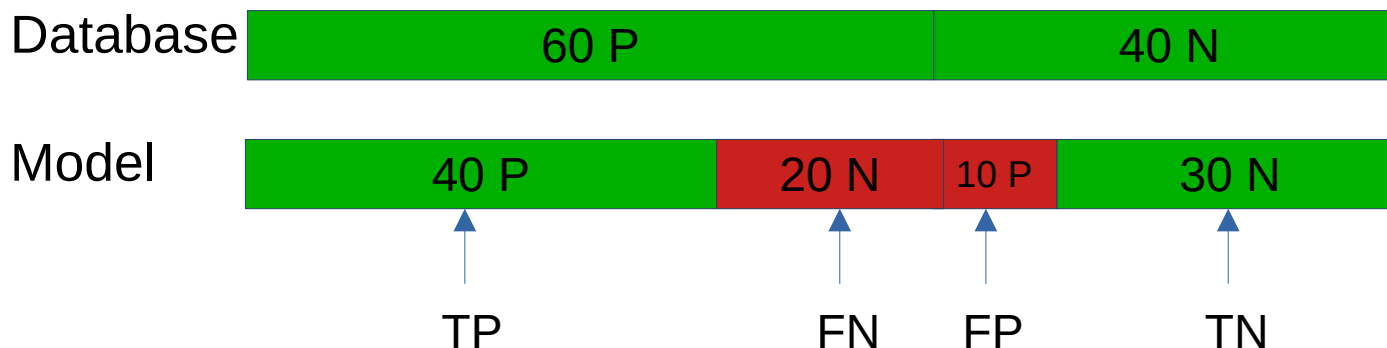
Example: A database has 100 items, 60 are Positive, 40 are Negative
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Database	60 P		40 N	
Model	40 P	20 N	10 P	30 N

Precision/Recall/F1

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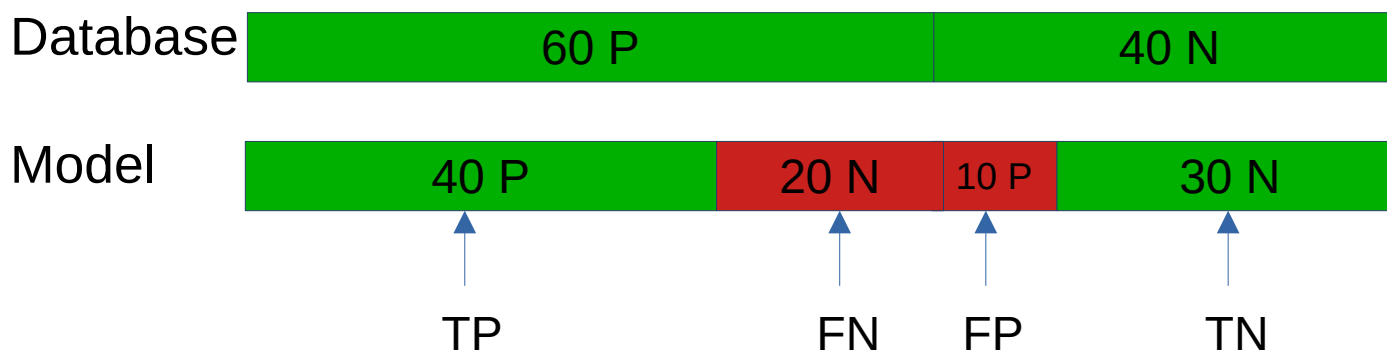
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Accuracy = $70/100 = .7$

$P = 40/(40+10) = .8$ (how accurate finding Positives?)

$R = 40/(40+20) = .66$ (how accurate overall?)

$F1 = 2 * (.8 * .66) / (.8 + .66) = .723$

Strive for high precision and recall

Precision/Recall/F1 for Multiple classes

When you have more than 2 classes?

Precision:

Just calculate TP and FP for each class and sum;

$$\sum \text{of TP} / (\sum \text{of TP} + \sum \text{of FP})$$

Precision/Recall/F1 for Multiple classes

Example

A multiclass classification problem with 3 classes.

A,B,C

With a 1:1:100 class ratio (100 times as many C's as A's)

If a dataset has 10,000 C's it will have 100 A's and B's

Precision/Recall/F1 for Multiple classes

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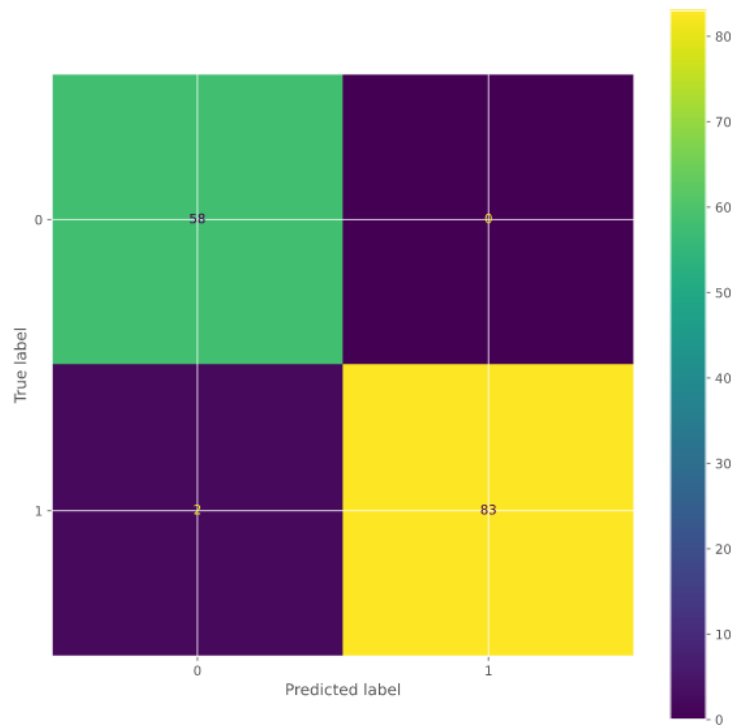
A model predicts 70 A's, 50 are correct and 20 wrong

Predicts 150 B's, 99 are correct and 51 wrong

$$\begin{aligned}\text{Precision} &= (50 + 99) / ((50 + 99) + (20 + 51)) \\ &= .677\end{aligned}$$

Confusion Matrix

Very simple display:
shows the number right and wrong for every class



Summary

Accuracy is misleading, especially if your dataset is imbalanced

Precision/Recall

F1 Score

Confusion Matrix- just a visual way to check your models predictions against correct values for all classes