Classification Metrics I

Author: Maheshkumar Paik

Data Science Process

1. Define the problem
2. Gather data
3. Explore data
4. Model with data
5. Evaluate model
6. Deploy the model
7. Model Governance

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Framing

Remember the regression metrics
we explored different methods for evaluating the performance of
regression models.

We'll do the same thing today, but for **classification models.**

- In regression, we quantify the performance of our model by **comparing predicted** and **observed values** in some capacity.
- We'll do the same thing in classification… but predicted and observed are categories, so it's slightly different.

We're going to focus on **binary classification problems.**

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Evaluating Our Model

Suppose you build a logistic regression model predicting whether or not people will vote. You make predictions for 100 people, then check to see if they actually voted.

- There are 40 people you predicted to vote who did vote.
- There are 20 people you predicted to vote who didn’t vote.
- There are 15 people you predicted to stay home who did vote.
- There are 25 people you predicted to stay home who didn’t vote.

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Evaluating Our Model

Suppose you build a logistic regression model predicting whether or not people will vote. You make predictions for 100 people, then check to see if they actually voted.

- There are 40 people you predicted to vote who did vote.
  - These are called **true positives**.
- There are 20 people you predicted to vote who didn't vote.
  - These are called **false positives**.
- There are 15 people you predicted to stay home who did vote.
  - These are called **false negatives**.
- There are 25 people you predicted to stay home who didn't vote.
  - These are called **true negatives**.

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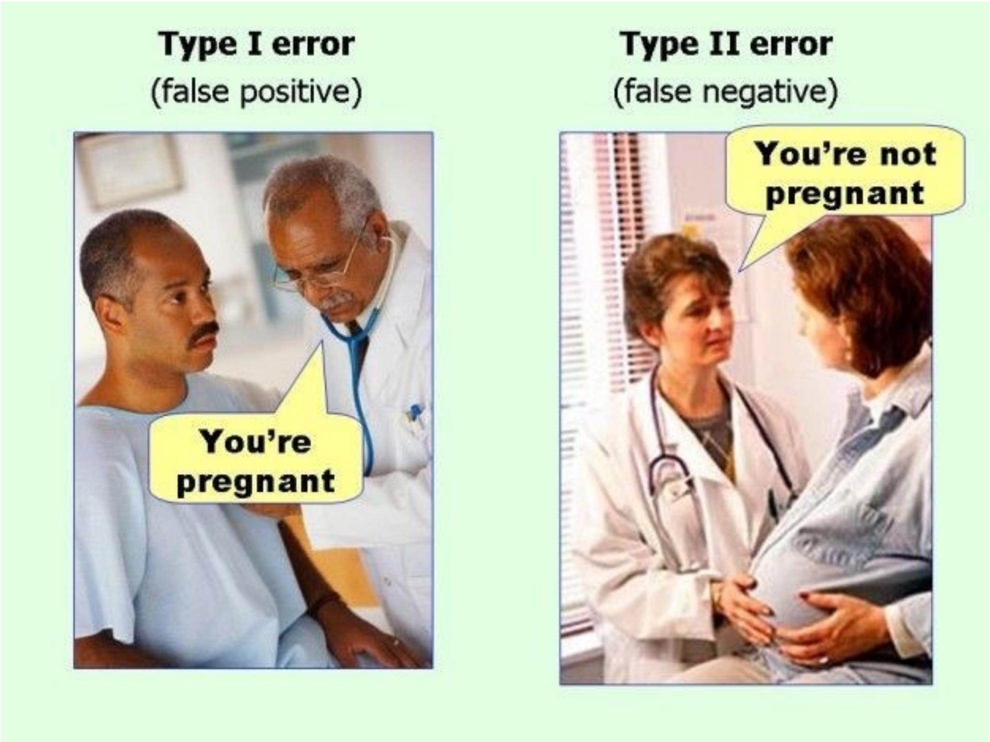
Evaluating Our Model



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Evaluating Our Model

How do I keep true positives/true negatives/false positives/false negatives straight?

- First word (true/false): Was I right?
- Second word (positive/negative): What did I predict?

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Evaluating Our Model

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What is it called if I correctly predicted that someone does not vote?

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Confusion Matrix

It’s helpful for us to list out the number of each category in a 2x2 grid called a **confusion matrix.**

	Actual Positive	Actual Negative
Predicted Positive		
Predicted Negative		

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Confusion Matrix

It's helpful for us to list out the number of each category in a 2x2 grid called a **confusion matrix.**

	Actual Positive	Actual Negative
Predicted Positive		
Predicted Negative		

The axes or ordering of "Yes" vs. "No" may be rearranged!

Be clear what "Yes" / "Positive" means.

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Confusion Matrix

A confusion matrix is a convenient way for us to visualize how our model performs.

However, there are metrics that can help us to summarize performance with one number.

- Accuracy
- Misclassification Rate
- Sensitivity
- Specificity
- Precision

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Accuracy

Interpretation: What percentage of observations did I **correctly** predict?

$$\text{Accuracy} = \frac{\textit{All Correct}}{\textit{All Predictions}} = \frac{TP + TN}{TP + FP + TN + FN}$$

	Actual Positive	Actual Negative
Predicted Positive	40	20
Predicted Negative	15	25

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Misclassification Rate

Interpretation: What percentage of observations did I **incorrectly** predict?

$$\text{Misclassification Rate} = \frac{\textit{All Incorrect}}{\textit{All Predictions}} = \frac{FP + FN}{TP + FP + TN + FN} = 1 - \text{Acc}$$

	Actual Positive	**Actual Negative**
Predicted Positive	40	20
Predicted Negative	15	25

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Sensitivity

Interpretation: Among those who will vote, how many did I get correct?

$$\text{Sensitivity} = \frac{\textit{True Positives}}{\textit{All Positives}} = \frac{TP}{TP + FN} = \frac{TP}{P}$$

a.k.a. True Positive Rate, Recall

	Actual Positive	Actual Negative
Predicted Positive	40	20
Predicted Negative	15	25

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Specificity

Interpretation: Among those who will not vote, how many did I get correct?

$$\text{Specificity} = \frac{\textit{True Negatives}}{\textit{All Negatives}} = \frac{TN}{TN + FP} = \frac{TN}{N}$$

a.k.a. True Negative Rate

	Actual Positive	Actual Negative
Predicted Positive	40	20
Predicted Negative	15	25

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Precision

Interpretation: Among those I predicted to vote, how many did I get correct?

$$\text{Precision} = \frac{\textit{True Positives}}{\textit{Predicted Positives}} = \frac{TP}{TP + FP}$$

a.k.a. Positive Predictive Value

	Actual Positive	Actual Negative
Predicted Positive	40	20
Predicted Negative	15	25

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Example

Suppose I'm working on a fraud analytics team and our goal is to detect fraudulent credit card transactions. I take a random sample of 500 transactions. Of these transactions, 50 are fraudulent. I predict 100 total fraudulent transaction, 45 of which are correct.

1. Identify the TP, TN, FP, FN and construct a confusion matrix.
2. Calculate the accuracy, misclassification rate, positive predictive value, recall, and true negative rate.

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Example

Suppose I’m working on a fraud analytics team and our goal is to detect fraudulent credit card transactions. I take a random sample of 500 transactions. Of these transactions, 50 are fraudulent. I predict 100 total fraudulent transaction, 45 of which are correct.

When building my classification model, I want to optimize one of the above metrics. Given the use-case of identifying fraudulent transactions, which metric should I optimize as I build my model?

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Final Notes

We explored binary classification problems today.

We can construct confusion matrices for 3+ categories and calculate a lot of these metrics (accuracy, misclassification error, etc.), but they get a lot more complicated.

These get *especially* complicated when working with **ordinal data**.

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