Classification Metrics

GENERAL ASSEMBLY

Data Science Process

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

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.

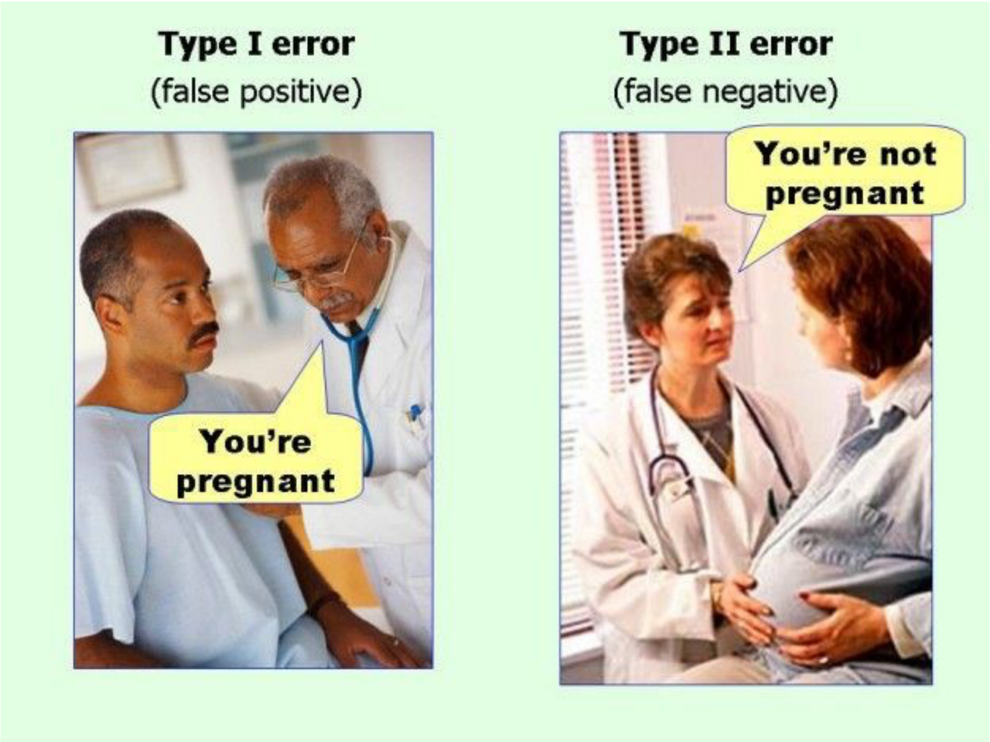
- There are 40 people you predicted to vote who did vote.
- There are 20 people you predicted to vote who didn’t vote.
- There are 15 people you predicted to stay home who did vote.
- There are 25 people you predicted to stay home who didn’t vote.

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**.

Evaluating Our Model



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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What is it called if I incorrectly predicted that someone does vote?

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

Be clear what “Yes” / “Positive” means.

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

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

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

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

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

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.

	Actual +	Actual -
Predicted +	45	55
Predicted -	5	395

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?

FP ↓ FN ↓ optimize

→ sensitivity

Final Notes

We’ve explored binary classification these past two weeks.

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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