
DATA SCIENCE PROCESS

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

FRAMING

- Remember the regression metrics lesson from last week, where 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**.

EVALUATING OUR MODEL

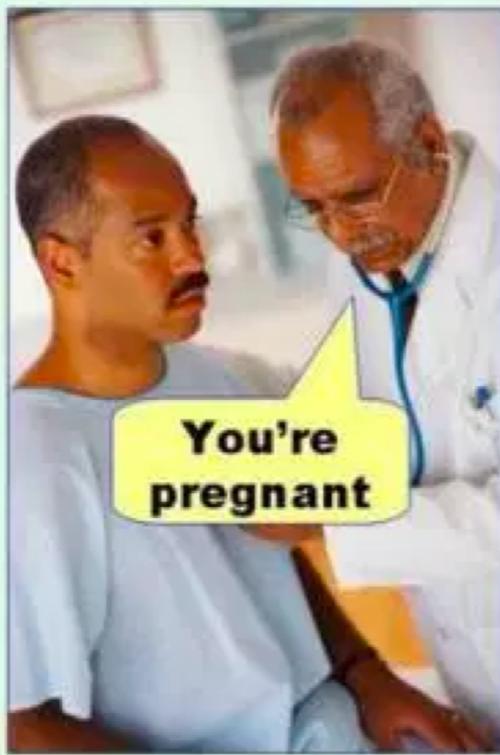
- Suppose you build a logistic regression model predicting whether or not people will vote. You make predictions for 100 people, then check to see if they actually voted.
 - There are 40 people you predicted to vote who did vote.
 - There are 20 people you predicted to vote who didn't vote.
 - There 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

Type I error
(false positive)



Type II error
(false negative)



EVALUATING OUR MODEL

- How do I keep true positives/true negatives/false positives/false negatives straight?
 - First word: Was I right?
 - Second word: What did I predict?

EVALUATING OUR MODEL

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 - First word: Was I right?
 - Second word: What did I predict?
- What is it called if I correctly predicted that someone does not vote?

EVALUATING OUR MODEL

- How do I keep true positives/true negatives/false positives/false negatives straight?
 - First word: Was I right?
 - Second word: What did I predict?
- 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		

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		
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- The axes or ordering of “Yes” vs. “No” may be rearranged!
- Be clear what “Yes” / “Positive” means.

CLASSIFICATION METRICS

- 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

$$\text{Accuracy} = \frac{\text{all correct}}{\text{all}} = \frac{TP + TN}{TP + FN + FP + TN}$$

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

	ACTUAL POSITIVE	ACTUAL NEGATIVE
PREDICTED POSITIVE	40	20
PREDICTED NEGATIVE	15	25

MISCLASSIFICATION RATE

$$\text{Misclassification Rate} = \frac{\text{all incorrect}}{\text{all}} = \frac{FN + FP}{TP + FN + FP + TN} = 1 - \text{Acc}$$

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

	ACTUAL POSITIVE	ACTUAL NEGATIVE
PREDICTED POSITIVE	40	20
PREDICTED NEGATIVE	15	25

SENSITIVITY

$$\text{Sensitivity} = \frac{\text{true positives}}{\text{all positives}} = \frac{TP}{TP + FN} = \frac{TP}{P}$$

- Interpretation: Among those who will vote, how many did I get correct?
- a.k.a. True Positive Rate, Recall

	ACTUAL POSITIVE	ACTUAL NEGATIVE
PREDICTED POSITIVE	40	20
PREDICTED NEGATIVE	15	25

SPECIFICITY

$$\text{Specificity} = \frac{\text{true negatives}}{\text{all negatives}} = \frac{TN}{TN + FP} = \frac{TN}{N}$$

- Interpretation: Among those who will not vote, how many did I get correct?
- a.k.a. True Negative Rate

	ACTUAL POSITIVE	ACTUAL NEGATIVE
PREDICTED POSITIVE	40	20
PREDICTED NEGATIVE	15	25

PRECISION

$$\text{Precision} = \frac{\text{true positives}}{\text{predicted positives}} = \frac{TP}{TP + FP}$$

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

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?