# HUDK 4050:CORE METHODS IN EDM

11/27/18 2:11 PM

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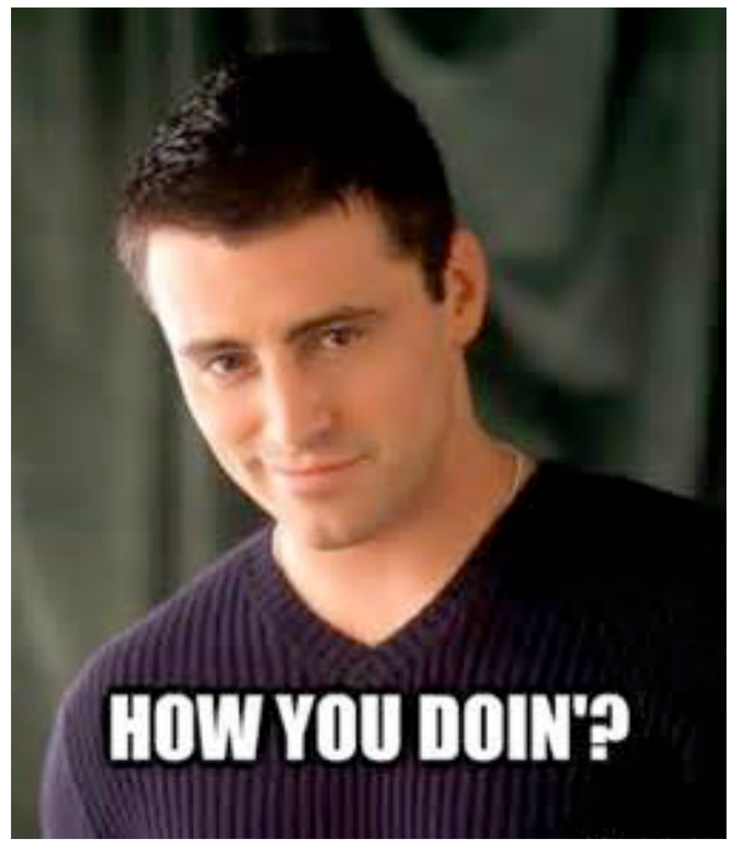
|---|---|
| Today | Diagnostics, Vectr Activity, Assignment 7, Catch up on Assignments 2-6 |
| 11/29 | Visit from Vectr App team, Quantified Student |
| 12/4 | Quantified Student, Assignment 8 Group Work |
| 12/6 | Assignment 8 Group Work |
| 12/11 | Assignment 8 Groupwork (A7 Due)<br>Last in person class |
| 12/13 | Assignment 8 Due - start watching and rating |
| 12/18 | Assignment 8 - finish watching and rating |
| 12/20 | EVERYTHING DUE - LAST CHANCE |


assignment2
assignment3
assignment4
assignment5
assignment6
assignment7
assignment8

# Diagnostic Metrics




How to determine how well your model is doing

# Diagnostic Metrics

Classification

- Accuracy
- Cohen's Kappa
- ROC/AUC/A'
- Correlation
- RMSE

Regression

- MAE/RMSE
- Pearson's Correlation/$R^2$
- AIC/BIC

# Terms

- **Ground truth**: data that is available, relevant, and most trustworthy to train your model

- **Baseline**: initial measurement

- **Gold standard**: (expensive) comparative measurement

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- **Inference**: data that is inferred from logic + data

# Diagnostics for Classifiers

# Accuracy

- $\dfrac{\text{correct predictions}}{\text{total predictions}}$
- Gotcha: unequal categories
- EG - Predicting fraudulent credit card transactions
- False positives/negatives (over/under predict)

# Precision & Recall

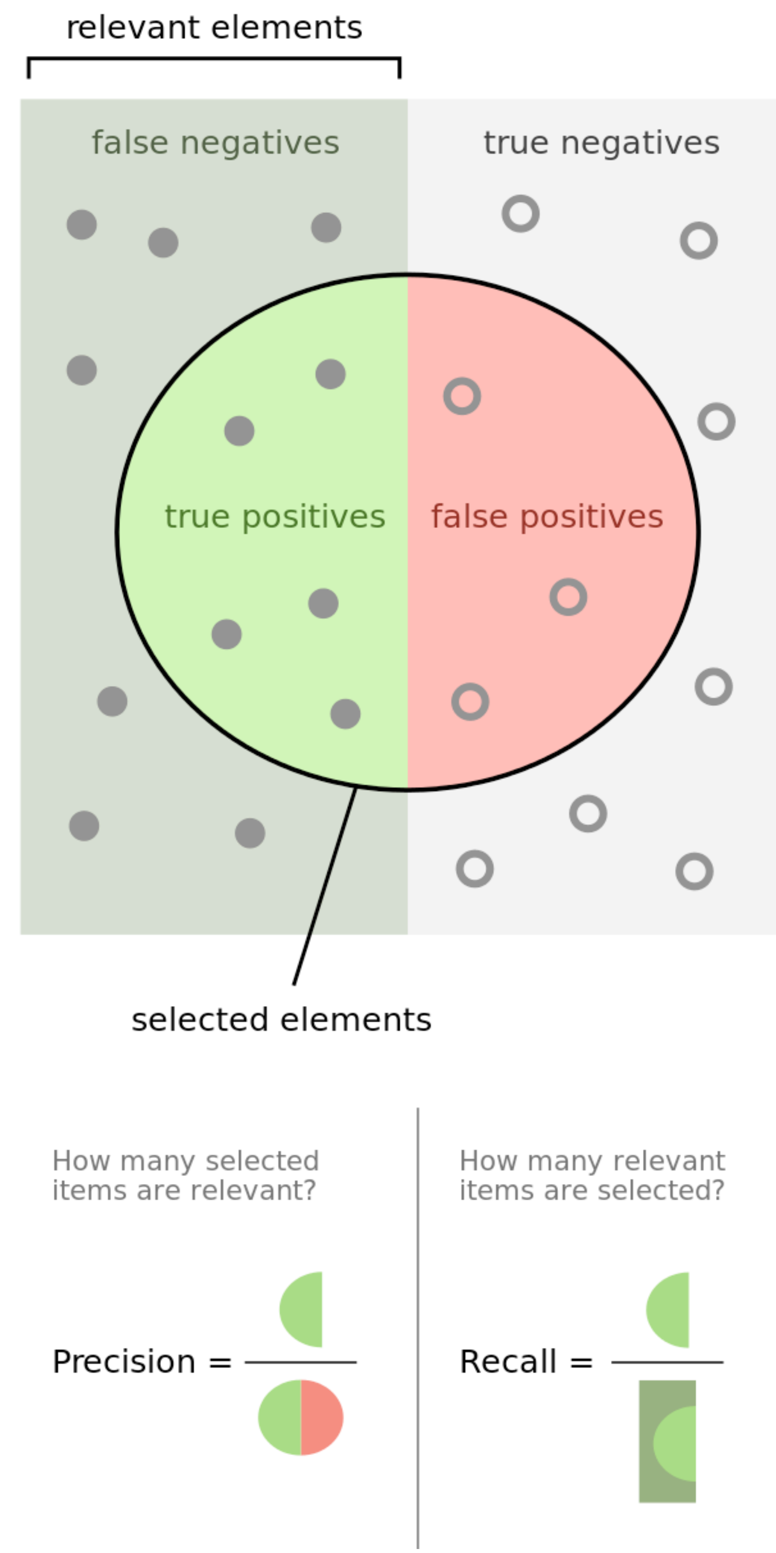
$$\textbf{Precision} = \frac{\text{True Positive}}{\text{True Positive + False Positive}}$$

$$\textbf{Recall} = \frac{\text{True Positive}}{\text{True Positive + False Negative}}$$

# Precision & Recall

**Precision**
The fraction (probability) of predictions that are ***relevant***

**Recall**
The fraction (probability) of relevant instances that are ***predicted***




Walber, 2014

# Cohen's Kappa ($\kappa$)

- Traditionally used for inter-rater reliability
- We will use it to look at the reliability between the data and our model

$$\kappa = \frac{p_o - p_e}{1 - p_e}$$

Observed Agreement

Expected Agreement (hypothetical probability of chance agreement)

| | | Model | | |
|---|---|---|---|---|
| | | Yes | No | |
| Data | Yes | 4 | 2 | 6 |
| | No | 3 | 3 | 6 |
| | | 7 | 5 | 12 |

$p_o = (4 + 3)/12 = 0.58$

$p_e = (7/12) \times (6/12) + (5/12) \times (6/12) = 0.5$

$\kappa = (0.58 - 0.5)/(1 - 0.5) = 0.16$

Is this good? Depends on the context

# Gotchas with Kappa

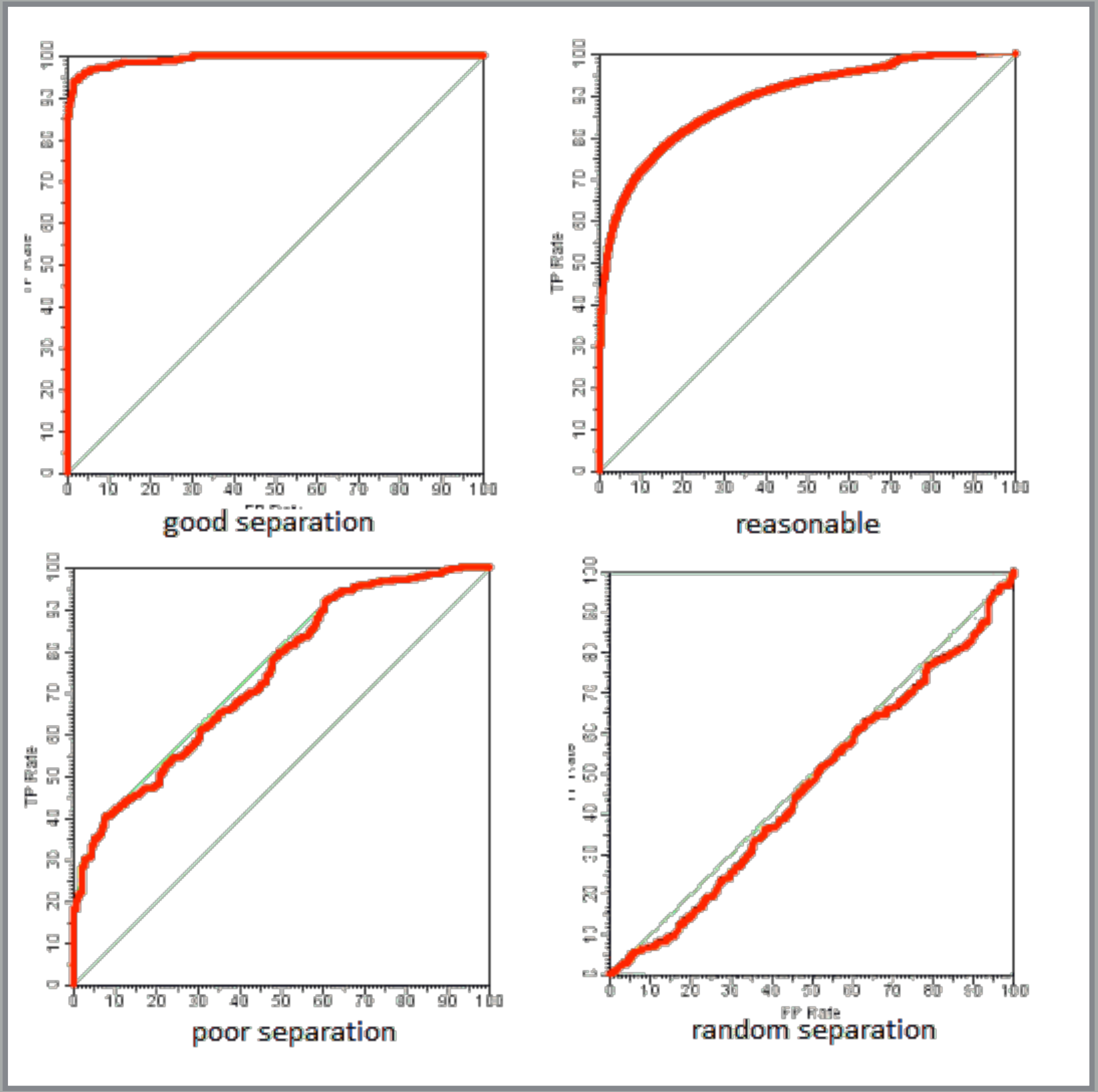
- Again, rare categories pose a problem and will incur a higher penalty than common categories
- Does the marginal probability represent “chance”?

# Probabilities

- Model assigns a probability of belonging to a class, rather than a class directly
- Then choose a probability threshold to assign to a class
- Allows us to choose a preference based on the consequences of false positives/negatives
- http://www.navan.name/roc/

# Receiver Operating Characteristic (ROC)

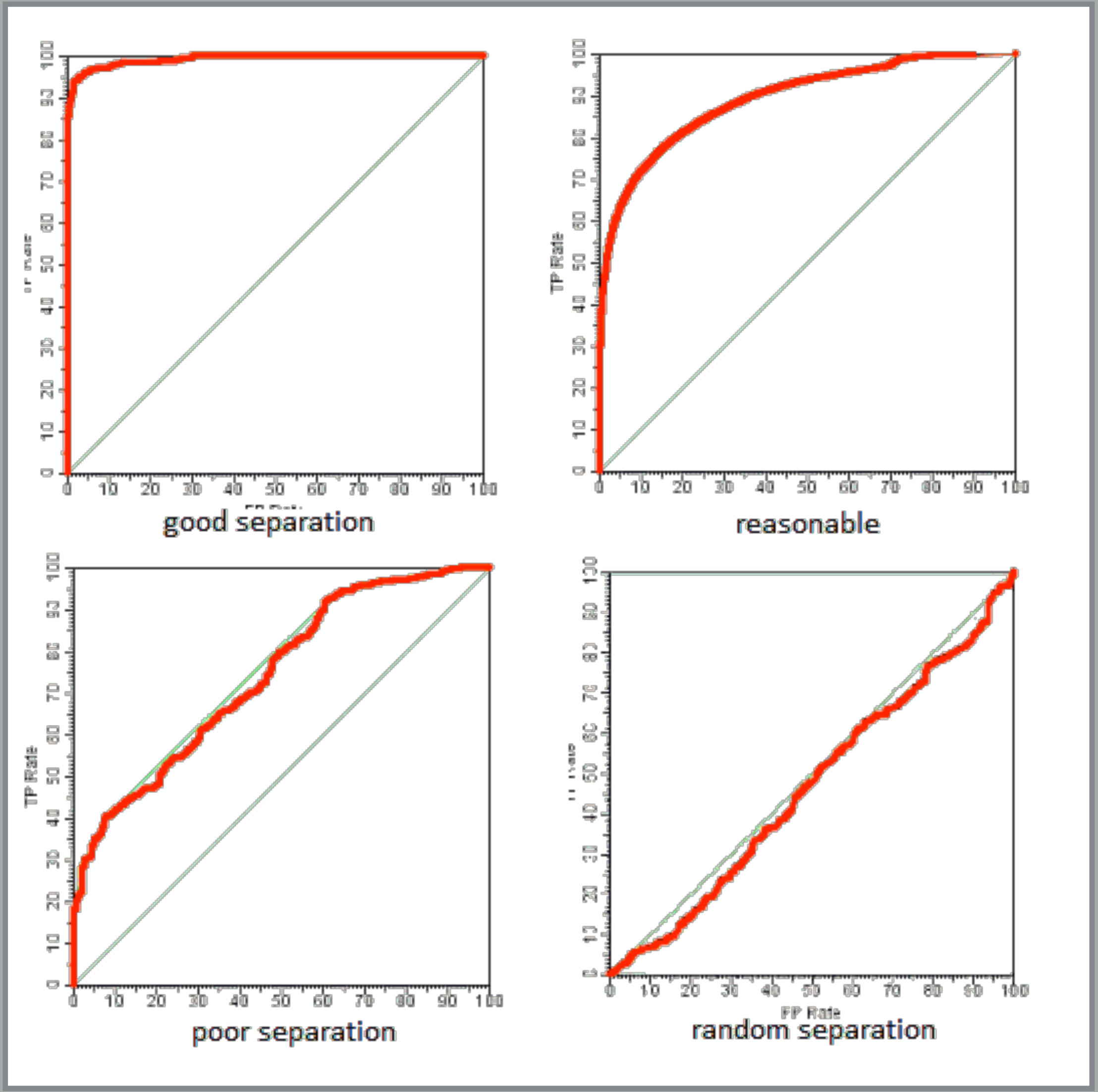
- Relationship between the false positive and the true positive rates
- World War II for detecting enemy objects on radar in response to Pearl Harbor
- Demonstrates the sensitivity vs specificity tradeoff



# Receiver Operating Characteristic (ROC)

<u>Area Under the ROC Curve:</u>

- AUC is the collapsed metric to compare models
- AUC is the probability that a classifier will rank a randomly chosen positive instance higher than a randomly chosen negative one
- It is equivalent to the Wilcoxon Sum-Rank Test and can therefore generate a probability test
- Is sometimes called A' (A Prime) depending on how it is calculated



# Diagnostics for Regressors

# Mean Absolute Error

- Mean of observed values minus predicted values

$$\text{MAE} = \frac{\sum |x - \bar{x}|}{n}$$

# Root Mean Squared Error

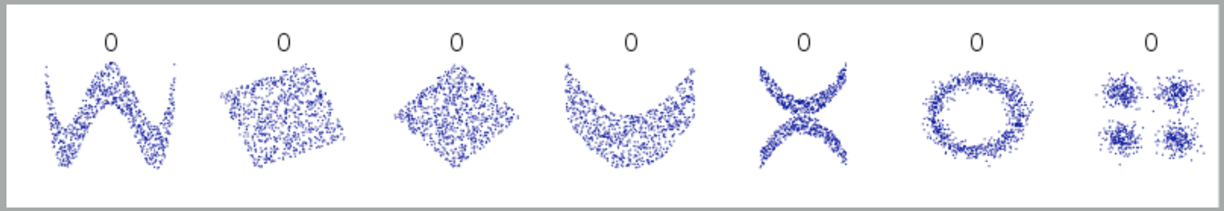
- Square root of the observed values minus predicted values squared

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}(p_i - a_i)^2}{n}}$$

# Pearson's Correlation

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

- Measure of the <u>linear</u> dependence between two variables
- Covariance between two variables divided by the product of the standard deviation of those variables
- Development began ~ 1880s by Galton and then Pearson
- <u>Gotcha</u>: must be a linear relationship




Denis Boigelot, 2011

# $r^2$

- The proportion of the variance in the dependent variable that is predicted from the independent variable
- There are several ways to calculate $R^2$
- If it involves two variables it is the square of the correlation (OLS classes will go more in depth)

# Akaike Information Criterion (AIC)

AIC = number of parameters - goodness of fit

- Developed by Akaike in 1971 based on thermodynamics
- Relative estimate of the information lost when a given model is used to represent the process that generates the data
- Model with lowest AIC “wins”
- Represents the trade off between goodness-of-fit with model complexity
- It compares models, cannot give an estimate of model fit in an absolute sense
- Gatcha: Software implementation was not always reliable

# Bayesian Information Criterion (BIC)

BIC = number of parameters x sample size - goodness of fit

- Developed by Schwarz in 1978
- Uses Bayes Theorem to penalize the addition of parameters
- Penalty for adding parameters is great than in AIC
- Represents the trade off between goodness-of-fit with model complexity
- Lowest BIC “wins”
- Gotcha: Does poorly when dealing with many parameters

## Coursera Co-Founder Andrew Ng Wants to Bring 'AI to Everyone' in Latest Course

EdSurge

## Smarter AI—machine learning without negative data

November 26, 2018, RIKEN

PHYS.ORG

## Amazon opens its internal machine learning courses to all for free

TC

## The Future Of Learning? Well, It's Personal

npr one