INFO 1998: Introduction to Machine Learning

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Lecture 6: Intro to Classifiers

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Agenda

1. What is a Classifier?
2. K-Nearest Neighbors Classifier
3. Fit/Overfitting
4. Confusion Matrices

What are Classifiers?

What are Classifiers?

Classifiers are able to help answer questions like…

- "What species is this?"
- "How would consumers rate this restaurant?"
- "Which Hogwarts House do I belong to?"
- "Am I going to pass this class?"

What are Classifiers?

- Classifiers predict the class/category of a set of data points
- This class/category is based off of the target variable we are looking at
- Difference between linear regression and classifiers
  - Linear regression is used to predict the value of a **continuous variable**
  - Classifiers are used to predict **categorical or binary variables**

What are Classifiers?

Two categories of classifiers: lazy learners and eager learners

- **Lazy Learners**
  - Store the training data and wait until a testing data appear
  - Classification is conducted based on the most related data in the stored training data
  - Less training time, more time in predicting
- **Eager Learners**
  - Construct a classification model based on the given training data before receiving data for classification
  - More training time, less time in predicting

K-Nearest Neighbors Classifier

What is the KNN Classifier?

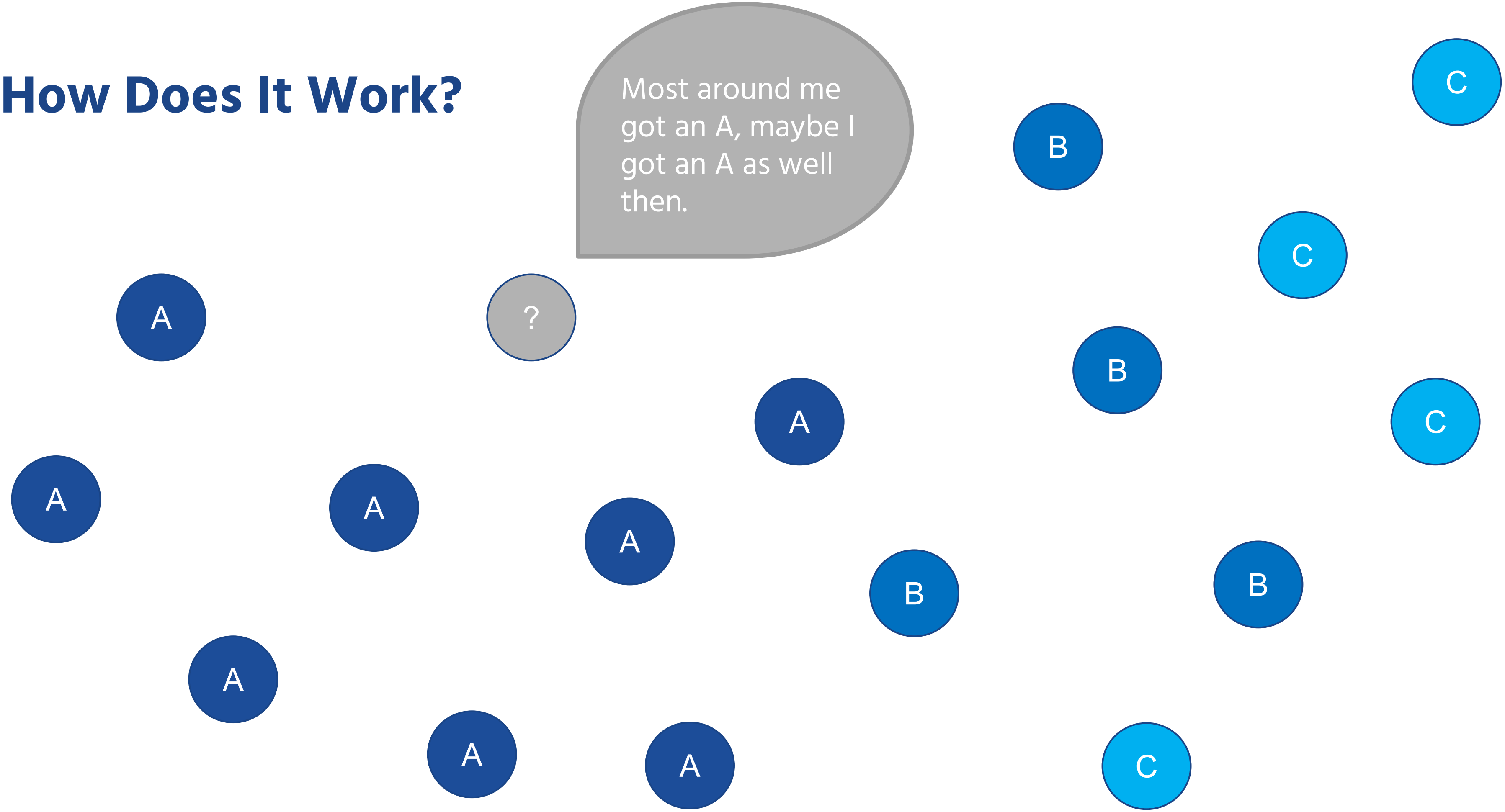
- Lazy learner classifier
- Easy to interpret
- Fast to calculate
- Good for coarse analysis

How Does It Work?

KNN is based off of a simple assumption that the values **nearest** to a data point are **similar** to it

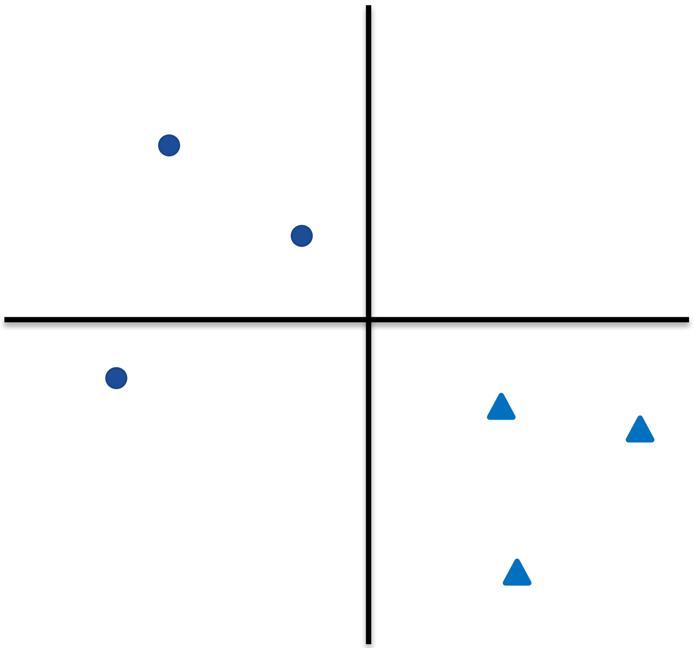
Uses the k (a user specified value) nearest data points to predict the unknown one

How Does It Work?



How Does It Work? (Step-By-Step Example)

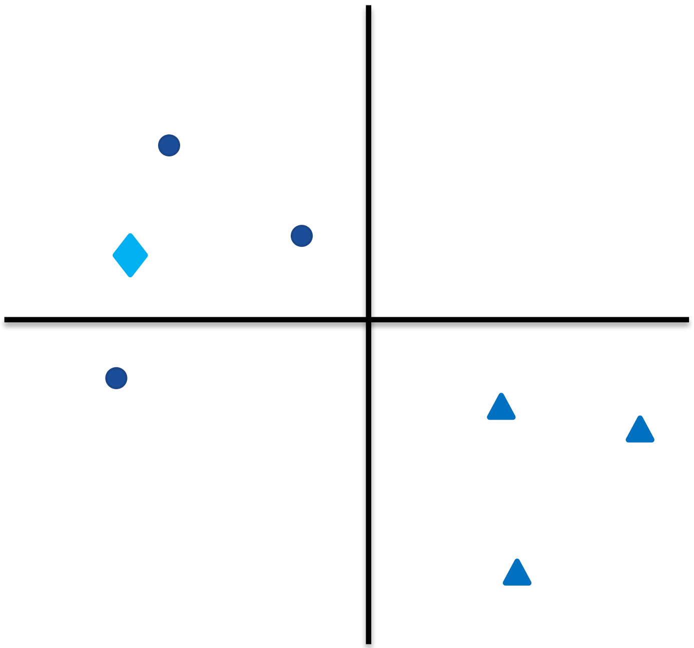
Define a *k* value (in this case k = 3)



How Does It Work? (Step-By-Step Example)

Define a *k* value (in this case k = 3)

Pick a point to predict (blue diamond)

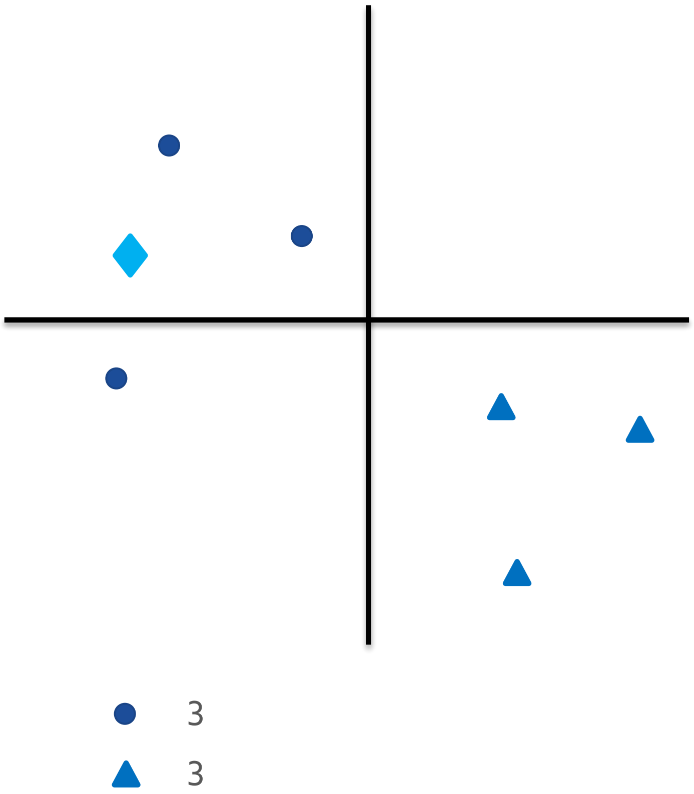


How Does It Work? (Step-By-Step Example)

Define a *k* value (in this case k = 3)

Pick a point to predict (blue diamond)

Count the number of closest points



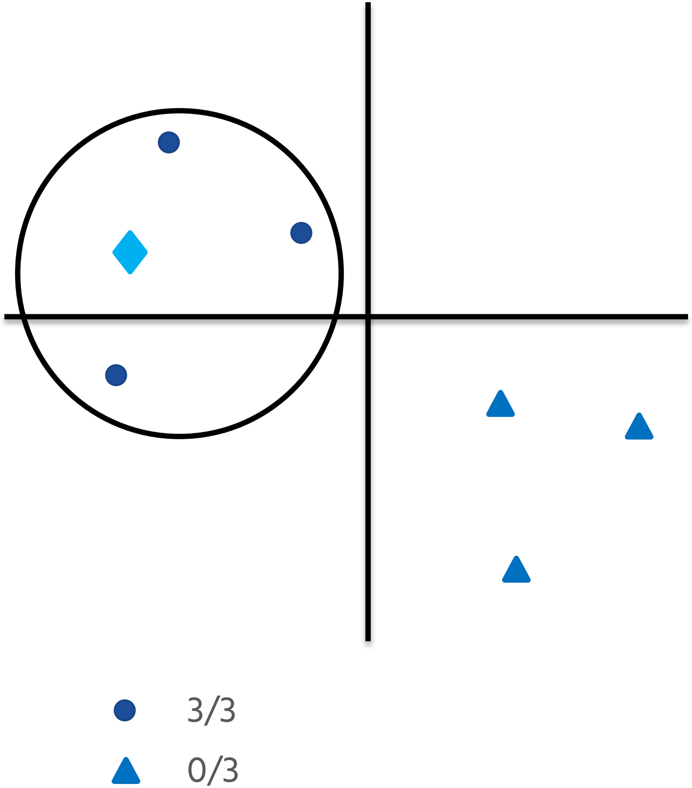
How Does It Work? (Step-By-Step Example)

Define a *k* value (in this case k = 3)

Pick a point to predict (blue diamond)

Count the number of closest points

Increase the radius until the number of points within the radius adds up to 3



How Does It Work? (Step-By-Step Example)

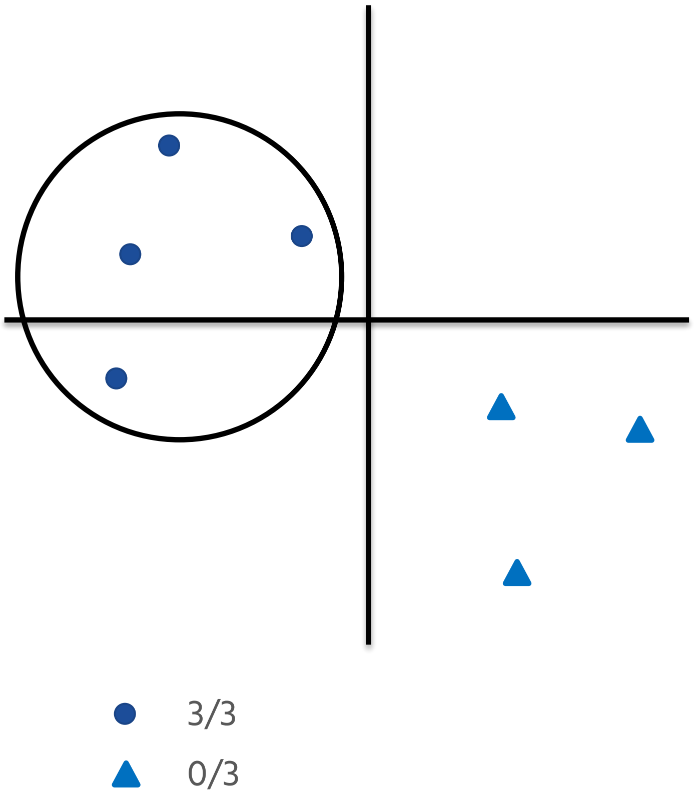
Define a *k* value (in this case k = 3)

Pick a point to predict (blue diamond)

Count the number of closest points

Increase the radius until the number of points within the radius adds up to 3

Predict the blue diamond to be a blue circle!

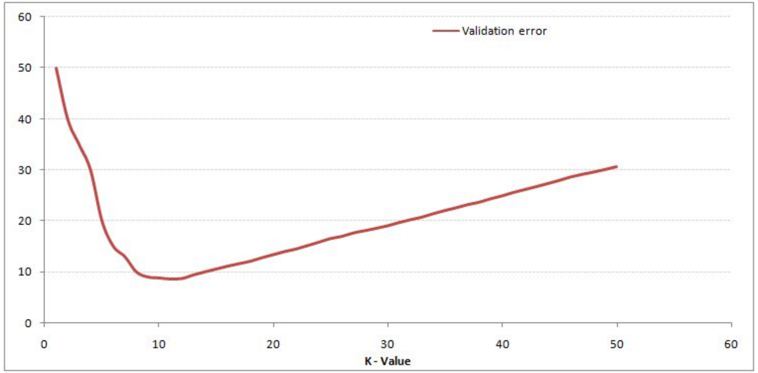


Demo

Fit/Overfitting

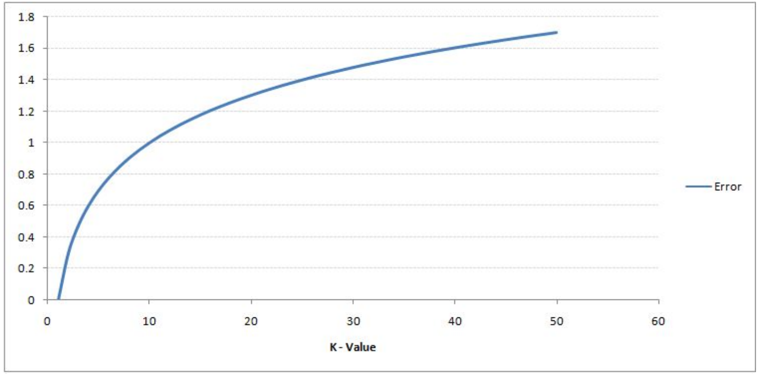
Overfitting

When the model corresponds too closely to training data and then isn't transferable to other data.



Can fix by:

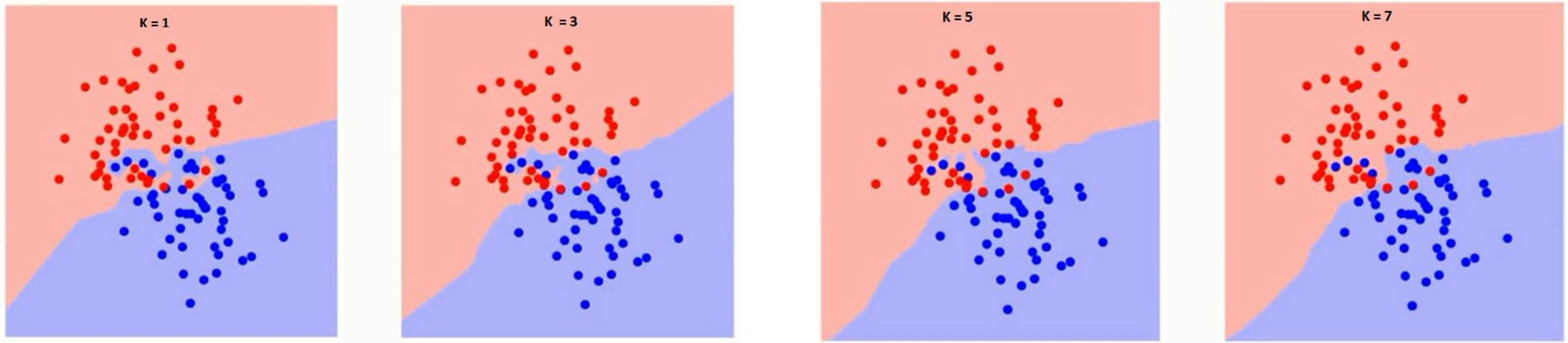
- Splitting data into training and validation sets
- Increasing k



Relationship Between k and Fit

The **k** value you use has a relationship to the fit of the model

A higher k gives a smoother line, but too large of a k and it is the average of all the data



Demo

Confusion Matrix

What is a Confusion Matrix?

Table used to describe the performance of a classifier on a set of binary test data for which the true values are known

	p' (Predicted)	n' (Predicted)
p (Actual)	True Positive	False Negative
n (Actual)	False Positive	True Negative

Sensitivity

Called the **true positive rate**

Tells us how many positives are correctly identified as positives

Optimize for: airport security & initial diagnosis of fatal disease

Sensitivity = True Positive/
(True Positive + False Negative)

Specificity

Called the **true negative rate**

Tells us how many negatives are correctly identified as negatives

Optimize for: testing for a disease with a risky treatment

Specificity = True Negative/
(True Negative + False Positive)

Question

Which is an example of when you would want **higher specificity**?

- DNA tests for a death penalty case
- Deciding which iPhone to buy
- Airport security

Overall Accuracy

Proportion of correct predictions

Accuracy =

(True Positive + True Negative) / Total

Overall Error Rate

Proportion of incorrect predictions

Error =

(False Positive + False Negative) / Total

Precision

Proportion of correct positive predictions among all positive predictions

Precision = True Positive / (True Positive + False Positive)

Demo

Coming Up

- **Assignment 6**: Due at 4:30pm on April 14th, 2021
- **Mid-Semester Check-In:** Don’t forget!! Complete before next lecture
- **Next Lecture**: Applications of Supervised Learning

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