INFO 1998: Introduction to Machine Learning

Mid Semester Feedback Form!

CDS Education

We explore, learn, and educate big minds.

Lecture 6: Intro to Classifiers

INFO 1998: Introduction to Machine Learning

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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?”
- “What major is a student in based on their classes?”
- “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

Lazy vs. Eager Learning Algorithms: The Difference

Property	Lazy Learning	Eager Learning
Training Speed	Fast, stores the data while training	Slow, Tries to learn from data while training
Prediction Speed	Too Slow tries to apply functions and learnings in the prediction stage	Faster, predicts very fast as there are pre-defined functions
Learning Scope	Medium, it can learn from data while training	Medium, it can learn from data while testing
Pre Calculated Algorithm	Absent, calculations are done while the testing phase	At present, here calculations are already done in the training phase
Example	KNN	Linear Regression

K-Nearest Neighbors Classifier

What is the KNN Classifier?

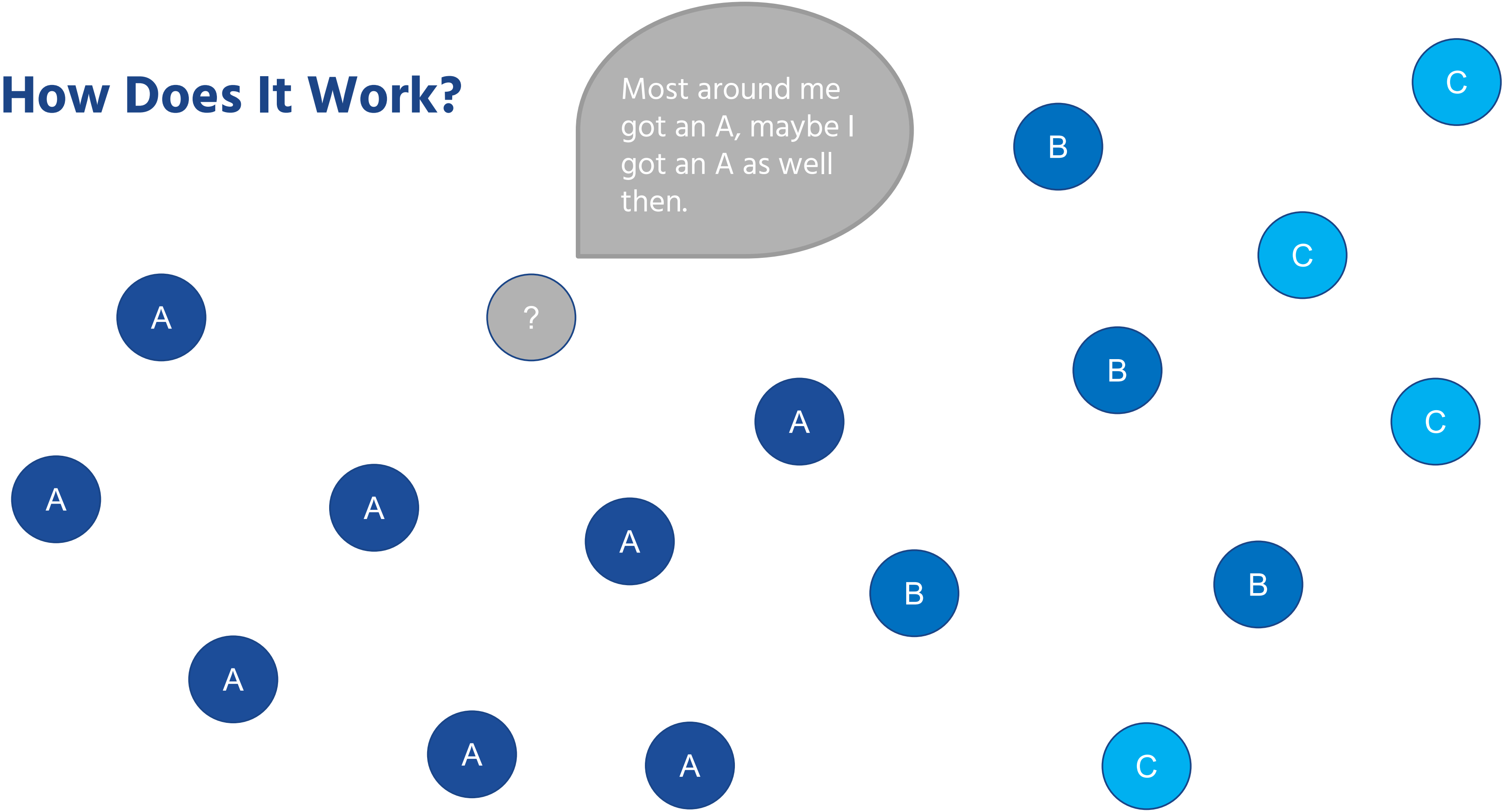
- Lazy learner classifier
- Easy to interpret
- Fast to calculate
- Good for coarse analysis

How Does It Work?

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

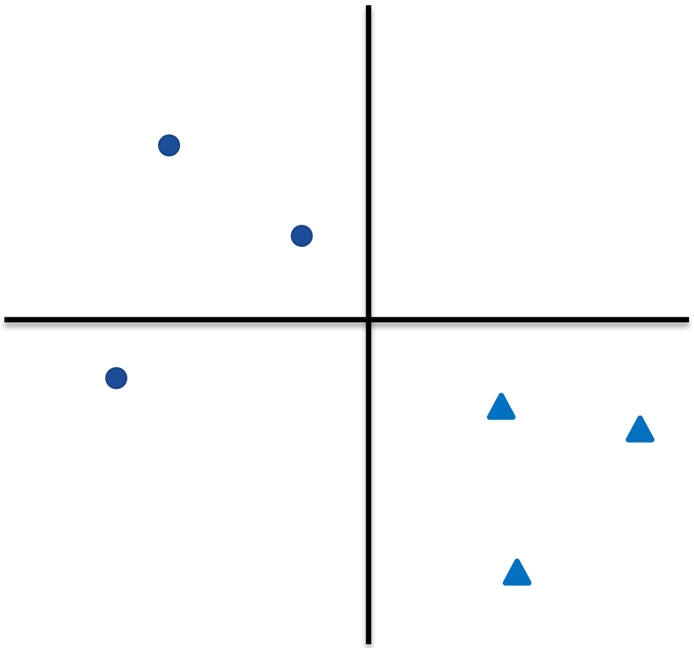
- A simple assumption: the values **nearest** to a data point are **similar** to it
- k is a **hyperparameter** of the KNN model (a parameter that affects the learning process)!

How Does It Work?



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

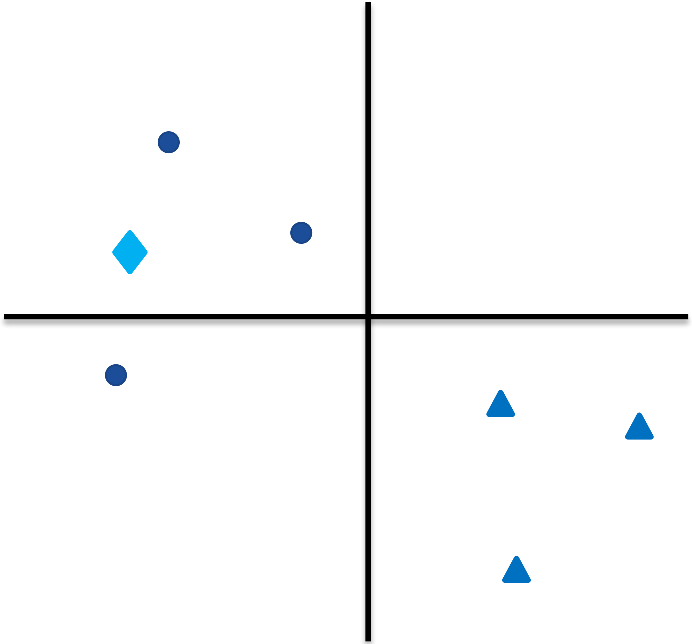
Define a *k* value (in this case k = 3)



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

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

Pick a point to predict (blue diamond)

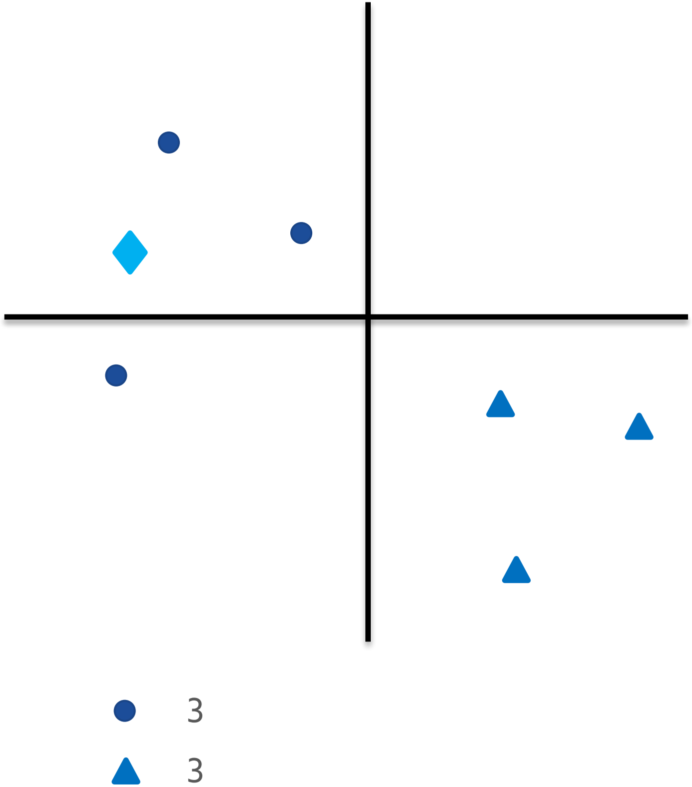


How Does It Work? (Step-By-Step Example)

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

Pick a point to predict (blue diamond)

Count the number of closest points



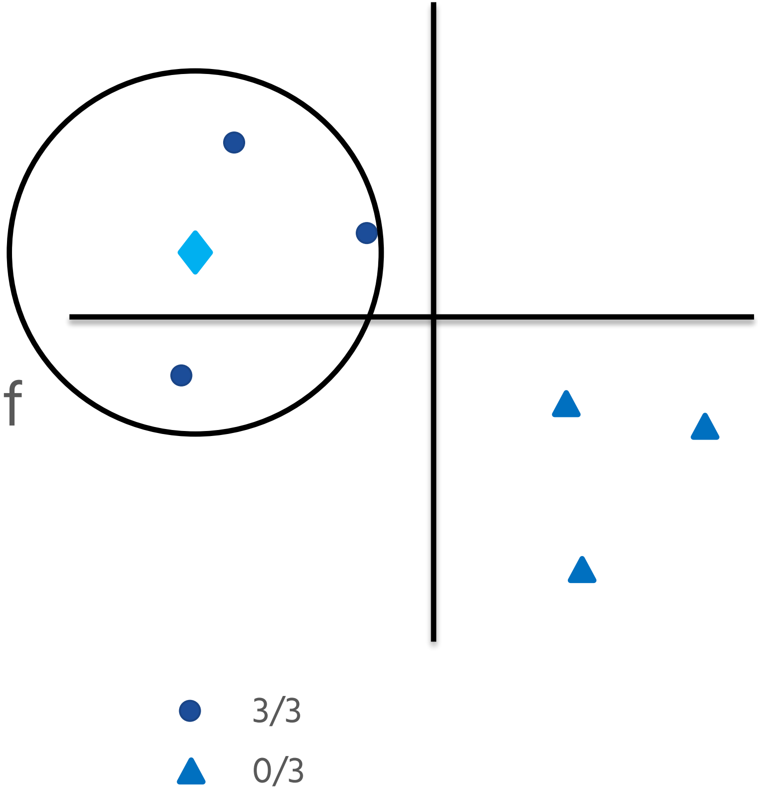
How Does It Work? (Step-By-Step Example)

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)

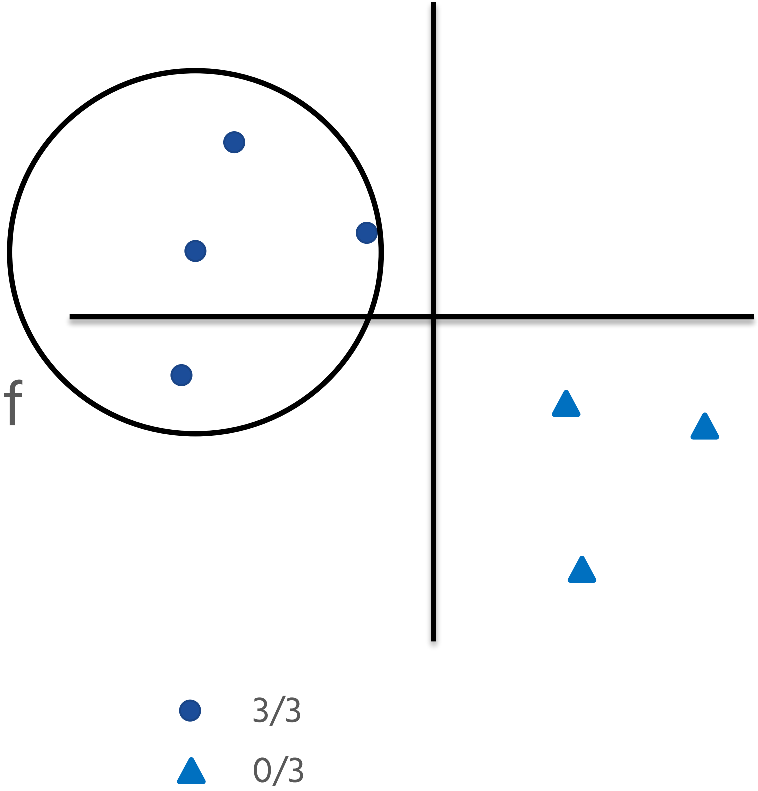
Define a *k* value (in this case k = 3)

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

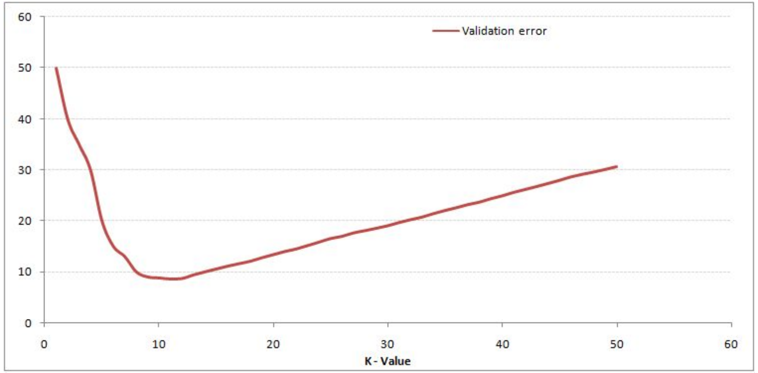
Fit/Overfitting

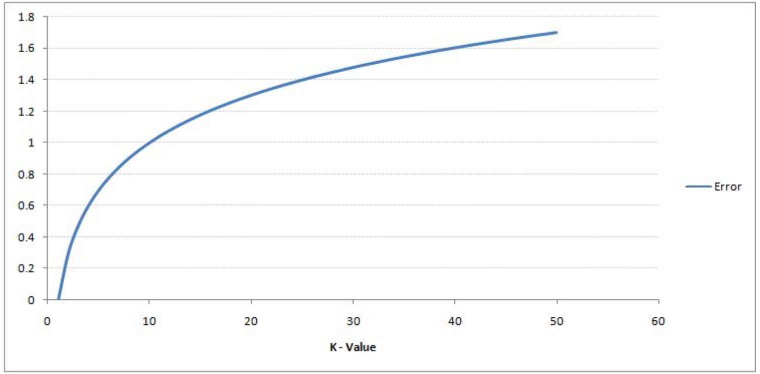
Overfitting

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

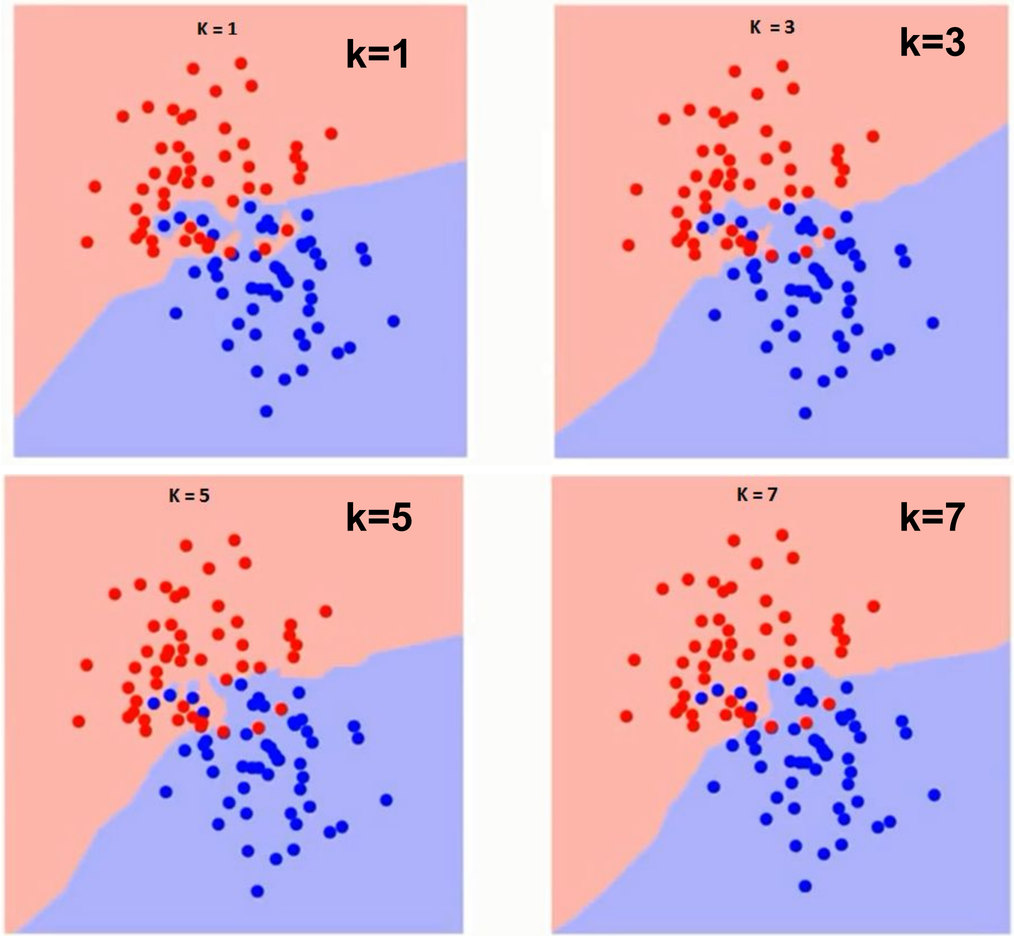




Relationship Between k and Fit

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 (or the label that is most common/likely)



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: Initial diagnosis of fatal disease

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

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

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

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

Question

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

A. DNA tests for a death penalty case
B. Deciding which iPhone to buy
C. Airport security

Overall Accuracy

Proportion of correct predictions

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

Accuracy =
(True Positive + True Negative) / Total

Overall Error Rate

Proportion of incorrect predictions

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

Error =
(False Positive + False Negative) / Total

Precision

Proportion of correct positive predictions among all positive predictions

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

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

Coming Up

- **Assignment 5:** Due **tonight** at 11:59pm!
- **Assignment 6**: Due next Wednesday, March 27th
- **Mid-Semester Check-In:** Details on ED Discussion! Due **this Friday**.
- **Feedback Survey:** Please fill it out!
- **Next Lecture**: Applications of Supervised Learning pt. 1

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