BIG DATA:
SUPERVISED LEARNING LAB
APPLICATION: SPAM FILTERING

Vibhav Gogate
The University of Texas at Dallas
SPAM FILTERING

- Given: A set of emails
- To do: Classify each email as either “spam” or “ham.”
STEPS IN SUPERVISED LEARNING: REVISITED

1. Determine the representation for “x,f(x)” and determine what “x” to use
   - Feature Engineering

2. Gather a training set (not all data is kosher)
   - Data Cleaning

3. Select a suitable evaluation method

4. Find a suitable learning algorithm among a plethora of available choices
SPAM Filtering: What features to use?

- First swipe at the problem
  - Features $X$ are word sequence in the email.
    - $X_i$ for $i^{th}$ word in the email
  - Each Email has at least 1000 words, $X=\{X_1,\ldots,X_{1000}\}$
    - $X_i$ represents $i^{th}$ word in the email, i.e., the domain of $X_i$ is entire vocabulary, e.g., Webster’s Dictionary (+ some more), 10,000 words, etc.
  - Size of the space: $10,000^{1000} = 10^{4000}$
  - Atoms in Universe: $10^{80}$
    - We may have a problem...
SPAM FILTERING: WHAT FEATURES TO USE?

- **Bag of Words Model**
  - Position of the word in the email does not matter
  - Ignore the order of words
  - Sounds really silly, but often works very well!

- **For each word in the Dictionary**
  - Count how many times the word appears in the email

- **Each Email = A vector/array of pairs of the form (w,#) where “w” is the word and “#” is the number of times “w” appears in the email**
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EVALUATION

- Given a set of emails which are already classified as Spam/ham
- Try different algorithms
  - Perform 10-fold Cross-Validation
  - Choose one or a collection based on their accuracy and F1 score
- Use WEKA
  - A tool for machine learning
- Key Step: Transform your data into ARFF format
WEKA’S ARFF FORMAT

% ARFF file for weather data with some numeric features
% @relation weather

@attribute outlook {sunny, overcast, rainy}
@attribute temperature numeric
@attribute humidity numeric
@attribute windy {true, false}
@attribute play? {yes, no}

@data
sunny, 85, 85, false, no
sunny, 80, 90, true, no
overcast, 83, 86, false, yes
...
USING WEKA

- Usage:
  - `java -Xmx1000M -jar ~/weka/weka.jar`
- Load data from directory “data”
- Run Different Classifiers
  - Best F1-score?
  - Classifier with the best F1-score?
  - Options used for Classifier with the best F1-score?