

# Predicting YouTube Comedy Slam Winners

STAT 222 Class 2013

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# YouTube Comedy Slam Data

- from UCI ML Repository; donated by Google employee
- a trial is an ordered pair of video IDs ( $v_i, v_j$ )
- data: ( $v_i, v_j$ ) + “left” or “right” found funnier by viewer
- order of the pair in each trial was random
- repository has training data and test data
- YouTube has metadata about videos
- no data about viewers

## Goal

Predict which video in a pair will be funnier, from metadata

(Not OK to use video IDs as features.)

# Tools

- Github
- IPython notebook
- numpy, scipy, matplotlib, nltk, scikit-learn

# Descriptive statistics of training data

- 912,969 records
- 18,474 distinct video IDs
- 267,211 distinct video ID pairs
- 359,874 distinct ordered pairs of video IDs
- right video won 51.8% of the time.  $P$ -value: nil
- judgments often discordant: '-iuk0PbfaHY wDx28Y2RcCI'  
left and right each “funnier” 119 times
- accuracy of ideal (Bayes) classifier for training data: 73.4%  
#correct/#cases (includes videos with no comments)
- if order is ignored, accuracy of ideal classifier drops to 65%

# PageRank

- for individual videos, directed graph of “funnier than”
- can summarize that graph by PageRank
- PageRank algorithm:

Assign each video ID (graph node) a value between 0 to 1, known as its *PageRank*.

At $t = 0$ , $PR(p_i; 0) = \frac{1}{N}$ , $N$ is the total number of nodes.
$PR(p_i; t + 1) = \frac{1-d}{N} + d \sum_{p_j \in M(p_i)} \frac{PR(p_j; t)}{L(p_j)}$
Stop when $ PR(t + 1) - PR(t)  \leq \epsilon$
$d$ is a damping factor, default 0.85 in scikit-learn.

- Amounts to using the power method to estimate the principal eigenvector of incidence matrix of the directed graph

# Prediction using metadata: Feature selection

- Acquired metadata: queried YouTube with video IDs using Google APIs in Python  
nontrivial: required throttling the requests
- Mutual information:

Variable	Mutual Info (bits)
average rating	0.00227
number of views	0.00431
number of votes	0.00468
views per day	0.00382

- Logistic regression using  $\log(\text{average rating})$ , # views, # votes had negligible “lift”
- Comments more promising

# Comments: complications and cleaning

- Data Encoding: re-encoded comments in ASCII; omit garbled words
- Inconsistent Spellings
  - Spelling: tried Norvig's spelling corrector, ported to AWS.  
(e.g.: "spelng" → "spelling")  
Not accurate on this corpus  
(e.g.: "youtube" → "couture", "lol" → "ll", "haha" → "hata")
  - Text-speak: used RegExp to standardize words

Pattern	standard
lol, lolll, llol, lollloll	lol
ha, hahahh,ahaha, jhajha	ha

- Emoticons: used RegExps to replace happy faces (e.g., ":-]") with "happyface" before stripping other punctuation
- Stemmed with nltk PorterStemmer; removed "stopwords"
- Most frequent words: like, love, lol, funni, video

# Bags of Bags of Words

- ordered pair of videos reduced to two “bags of bags of words”  
each comment is a bag, each video has a bag of bags
- features derived from bags of bags:
  - presence of a word in any comment for video ID
  - (relative) frequency of comments that contain a given word
  - logOdds of frequencies and relative frequencies
- derived feature: PageRank predicted by linear regression  
using (among other things)  $\arctan(\text{difference in LOL counts})/(\pi/2)$



# Logistic Regression: log Bayes factor as feature

- 1 determine whether video  $v_i$  won more than it lost, or vice versa.  
if  $v_i$  won more than lost, it's a "winner"  
if  $v_i$  lost more than won, it's a "loser"

- 2 for each word  $w$  in comment of "significant" winner/loser, find:  
 $\mathbb{P}_1(w)$  = percentage of winner comments that contain  $w$   
 $\mathbb{P}_0(w)$  = percentage of loser comments that contain  $w$   
(pad to avoid zeros)

- 3 derive new feature:

$$\logOdds(v) = \sum_w m_w \log\left(\frac{\mathbb{P}_1(w)}{\mathbb{P}_0(w)}\right) + (n - m_w) \log\left(\frac{1 - \mathbb{P}_1(w)}{1 - \mathbb{P}_0(w)}\right)$$

$n$ : #comments on video  $v$

$m_w$ : #comments on video  $v$  containing  $w$ .

# Logistic Regression with Log Bayes Factors

$$\text{logit}(\mathbb{P}) = X\beta$$

- $\mathbb{P}$  = Probability that the right video is funnier



$$X = \begin{pmatrix} 1 & B(v_{11}) & B(v_{12}) \\ \vdots & \ddots & \vdots \\ 1 & B(v_{n1}) & B(v_{n1}) \end{pmatrix}$$

- Newton-raphson to find MLE for  $\beta$

# Linear regression

- Model: high frequency words (in  $\geq 1500$  comments) as features

$$\text{Logit } Y = \beta_0 + \beta_1 x_1 + \dots + \beta_m x_m = \beta^T X$$

- *Logit*  $Y$ : log odds for ID pair,  $\log(\frac{\# \text{ left funnier}}{\# \text{ right funnier}})$
- $x_i$ : difference in  $\#$ comments containing  $w_i$  for  $v_{\text{left}}$  and  $v_{\text{right}}$
- Dimension of  $X$ :  $359,874 \times 3,392$
- Build  $X$  in  $B$  blocks of 20,000 rows; save all the blocks to disk.

$$X^T X = \sum_{b=1}^B X_b^T X_b$$

$$X^T Y = \sum_{b=1}^B X_b^T Y_b$$

# PageRank Linear regression classifier

- Predict continuous PageRank of video IDs from word frequencies by linear regression
- Classify pair as “right” if predicted PageRank of right video is higher than left
- Classify pair as “left” if predicted PageRank of left video is higher than right

# CART

- Features: high frequency words
- Model

$$f(x) = \sum_{k=1}^K c_k I_{x \in R_k}$$

- $\{R_k\}_{k=1}^K$ : partition of feature space.
- $c_k \in \{0, 1\}$ .
- How to find region  $R_k$ ?

# CART

- Greedy algorithm to find partitions

$$R_1(j, s) = \{X | x_j \leq s\} \text{ and } R_2(j, s) = \{X | x_j > s\}$$

Seek the splitting variable  $j$  and split point  $s$  by solving

$$\min_{j,s} [\min_{c_1} \sum_{x_i \in R_1(j,s)} (y_i - c_1)^2 + \min_{c_2} \sum_{x_i \in R_2(j,s)} (y_i - c_2)^2]$$

Inner minimization is solved by 0 or 1, which minimize inner part.  
Scan through all of the inputs to determinate the best pair  $(j, s)$ .  
Repeat the splitting process on each of the two regions.

- Python package: *mipy*.

# Test data

- 225,593 records
- 75,447 distinct ordered pairs of videos
- right video won 51.6% of the time
- Accuracy of ideal classifier: 69.5%
- Accuracy of ideal classifier w/o order info: 65%

# Performance on test data: only count pairs with comments

$$\text{score} = \frac{\text{Number of Correct Prediction}}{\text{Number of Predictable Pairs}}$$

- logistic regression: 52.3%
- linear regression: 52.2%
- PageRank linear regression classifier: 51.3%
- CART: 52.4%



# Conclusions

- Quantitative metadata: not informative
  - Comments:
    - heavy cleanup—must look at data by hand to understand problems
    - many comments irrelevant
    - many foreign-language comments
    - text-speak and emoticons matter
    - treat comments as bags of bags of words
    - derive features from the bags
    - logistic regression
    - linear regression
    - PageRank linear regression classifier
    - CART
  - Results not encouraging: problem is HARD
  - Humor very personal: lots of disagreement among voters
  - Even the order of presentation matters
  - Grouping/modeling individual voters might help, a la Netflix.
- No rater information available in this dataset.

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