Twitter Sentiment Analysis for Bungie and Destiny 2

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SpringBoard Data Science Bootcamp

Overview

- What's Bungie / Destiny 2?
- Getting Data From Twitter
- Exploratory Data Analysis
- Machine Learning Analysis
- Conclusions

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What’s Bungie / Destiny 2?

- Bungie
  - Game Company
  - They’re in Bellevue
- Destiny 2
  - Hit game by Bungie
  - Magic space ninjas with guns

Social Media Presence

- Official Twitter Accounts
  - @Bungie
  - @DestinyTheGame
- Lots of tweets
  - Announcements
  - Etc
- Use Twitter data
  - What do players think of recent updates to Destiny 2?
  - What do people think of Bungie?

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Data Acquisition

- Twitter Standard Search API
  - Get tweets from the last 7 – 10 days
  - Not exhaustive ($$$)
  - Search terms
- Search for 4 types of tweets
  - Tweets about Destiny 2 (21.4k)
  - Tweets about Bungie (24.7k)
  - @DestinyTheGame's tweets (46)
  - @Bungie's tweets (107)

Data Cleaning

- Missing / misaligned data
- Reduced columns
  - 320 to 50
- Kept the data as 4 DataFrames
  - Concatenate them when appropriate
- Datetime columns

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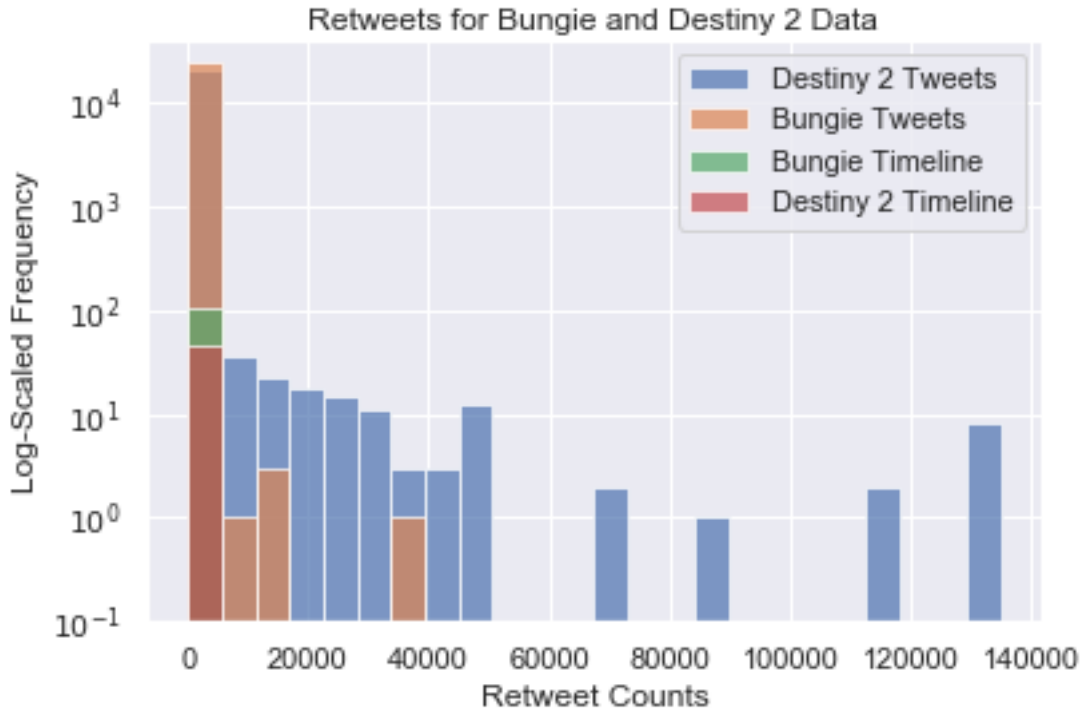
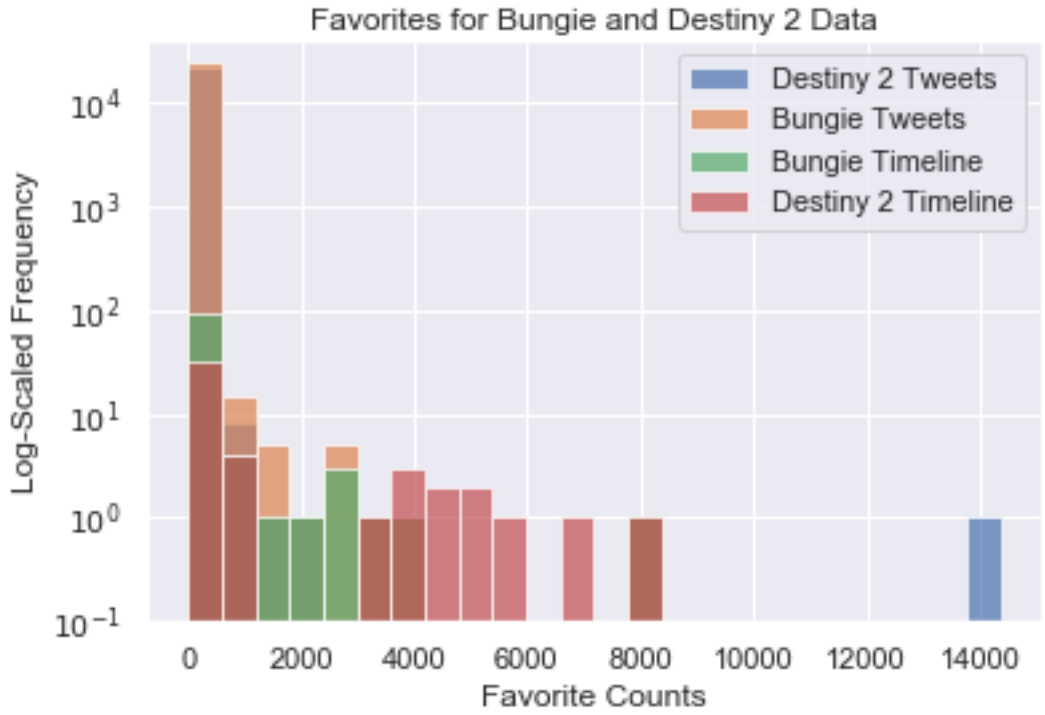
How Do I Measure Engagement?

- Retweets
  - Official accounts don’t get many compared to other accounts



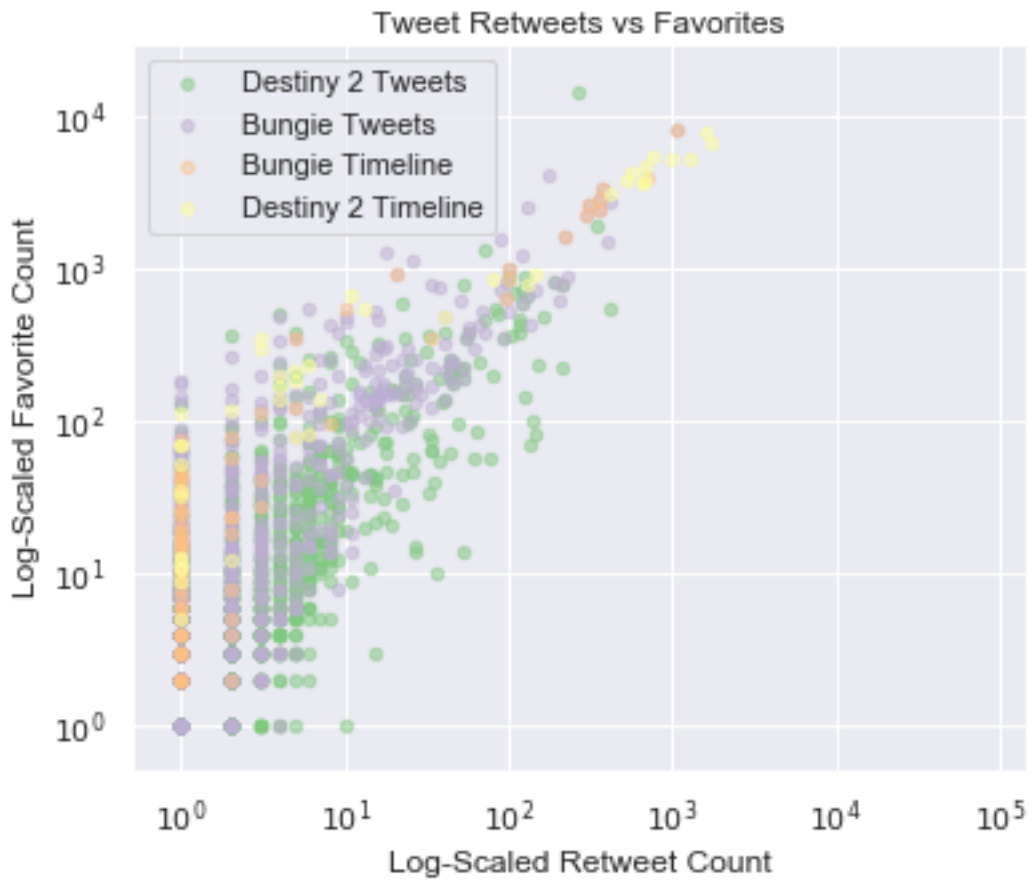
How Do I Measure Engagement?

- Retweets
  - Official accounts don’t get many compared to other accounts
- Favorites
  - Official accounts do get at least as many as other accounts



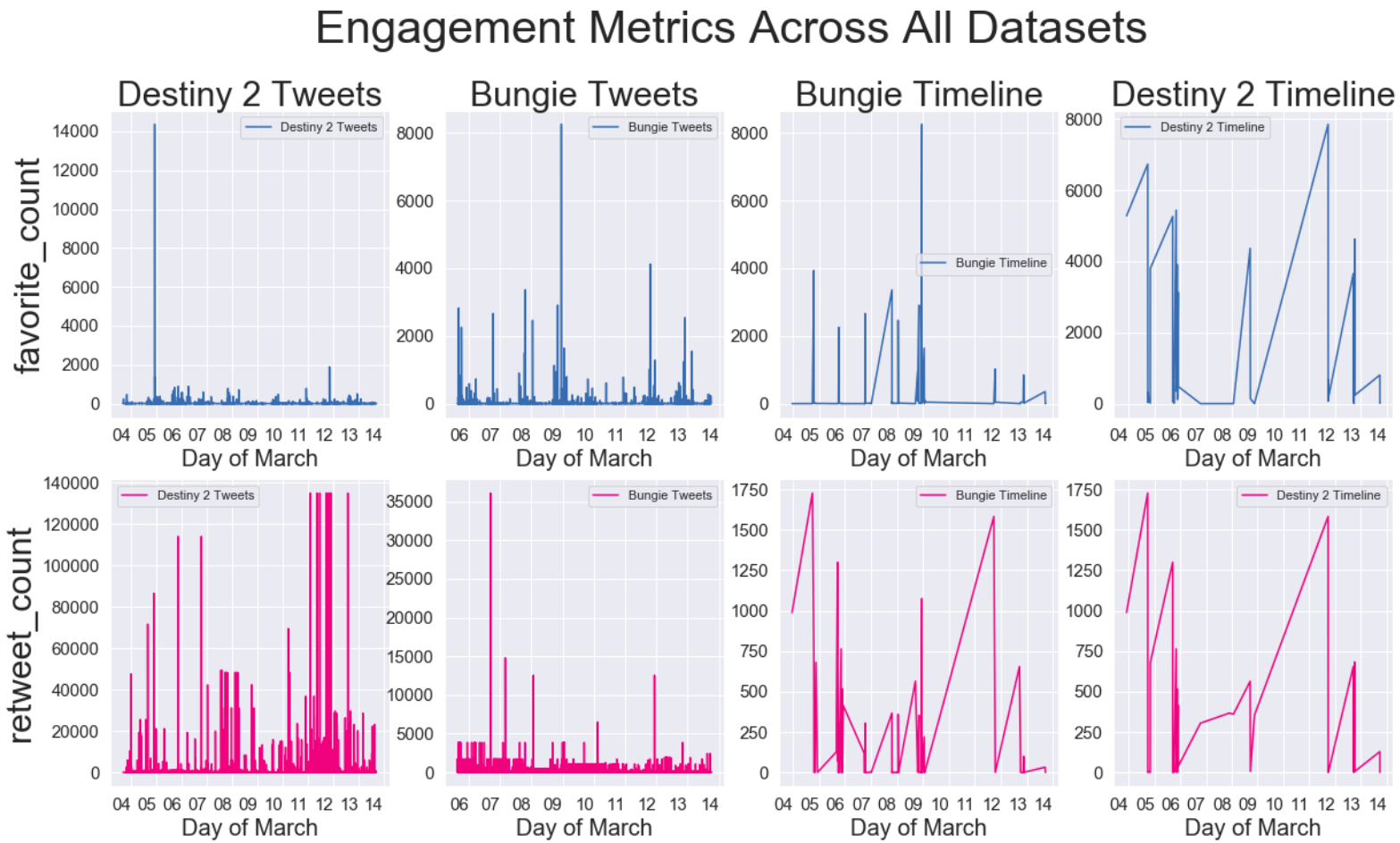
Do Favorites and Retweets Correlate?

- Only if you log scale them both
  - Darn outliers
- Generally more favorites than retweets!
  - The outliers ruin the visuals



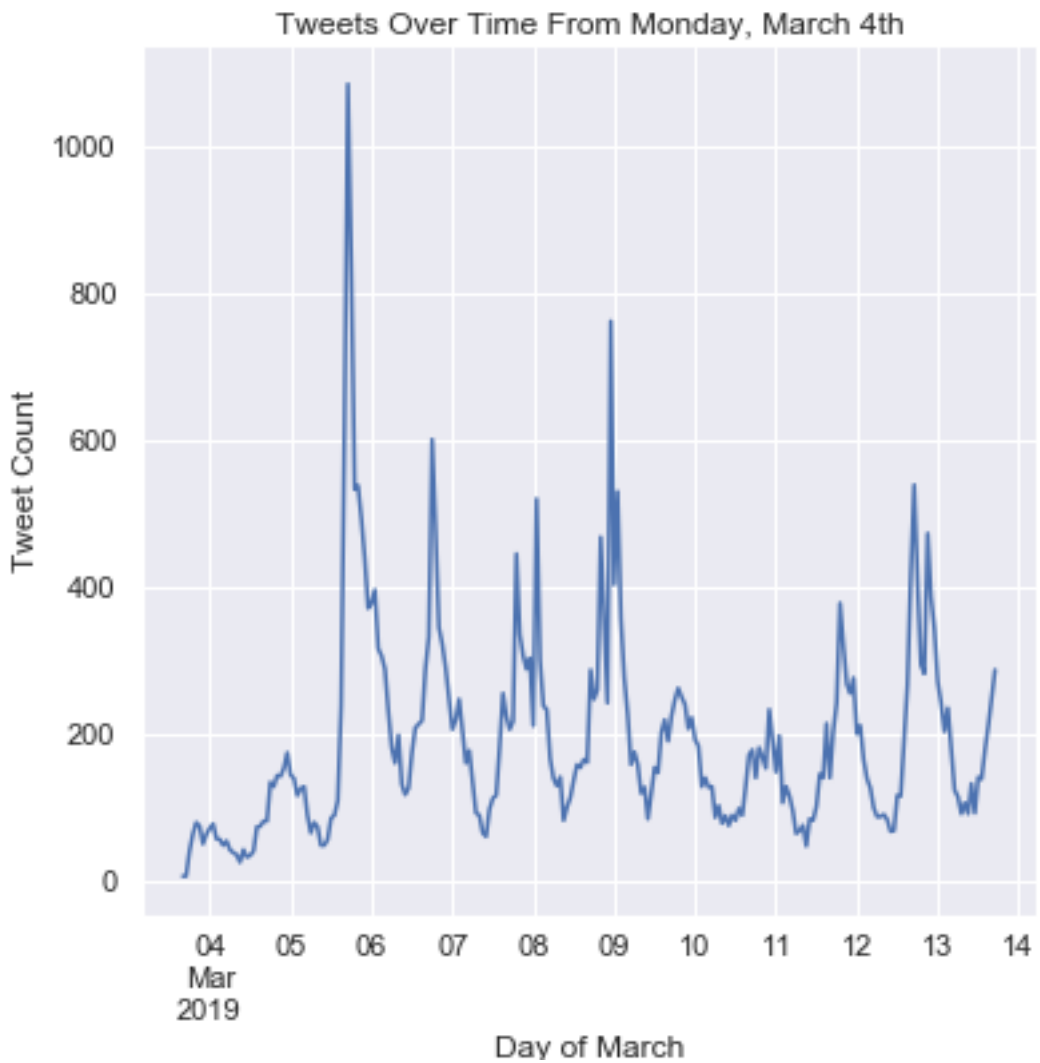
Time Correlations?

- Only on the official accounts



Speaking of Time…

- When are these tweets posted?
  - March 3rd – 13th
- Note:
  - The Destiny 2 tweets start on the 3rd
  - Bungie tweets start on the 5th
- Tweets posted in the evening, mostly on weekdays



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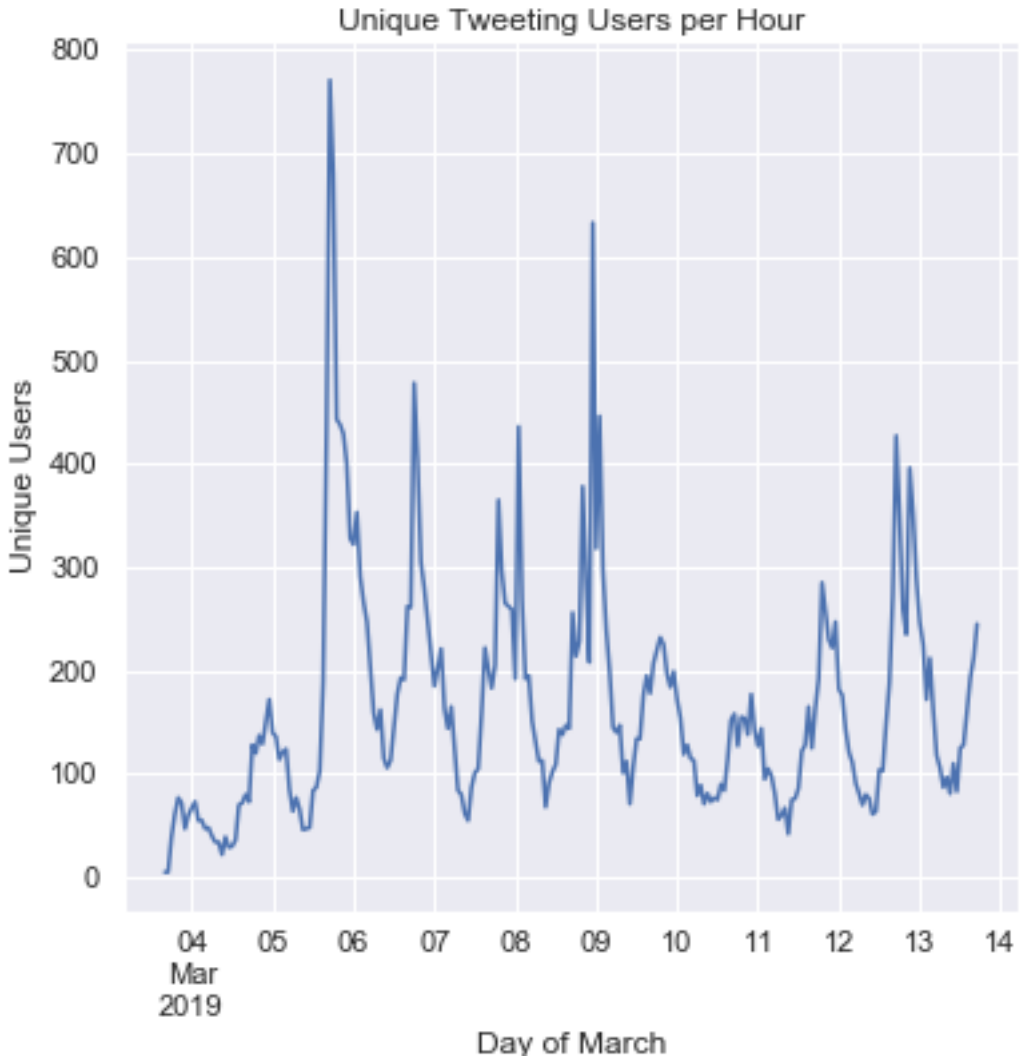
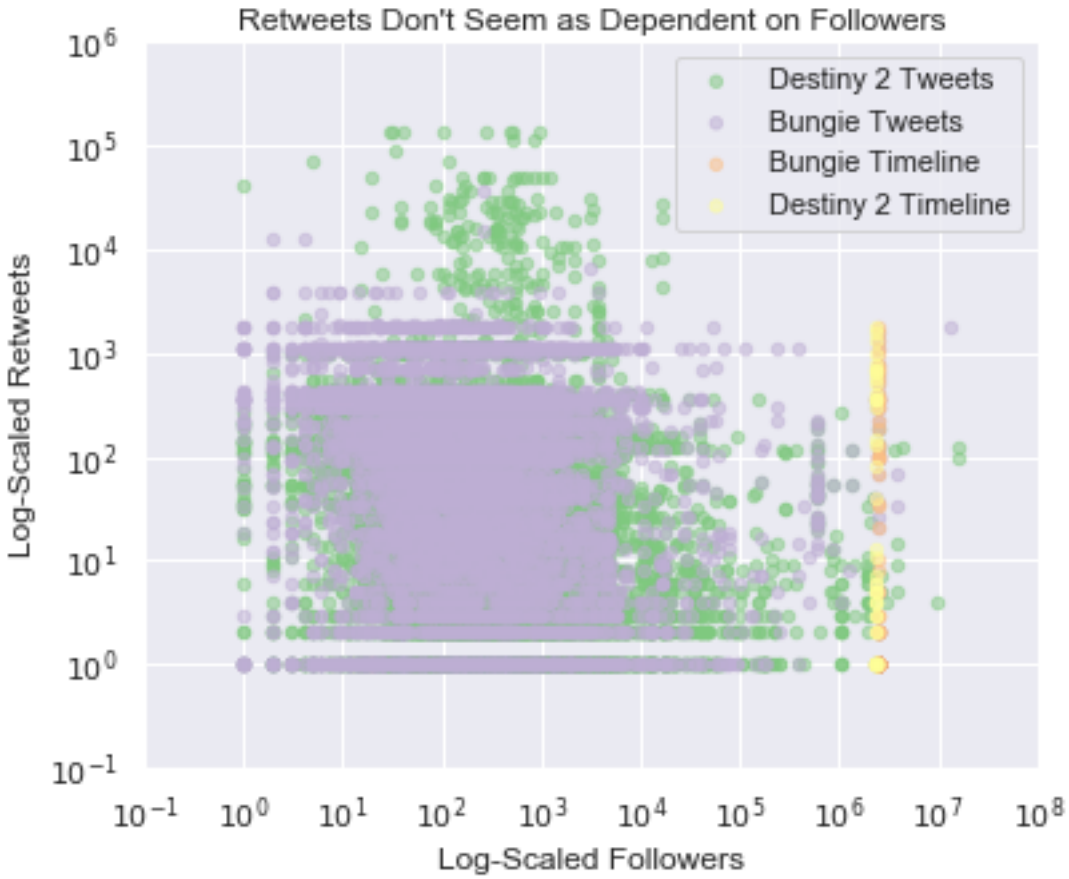
- Tweets posted in the evening, mostly on weekdays
- Unique users mirrors the same trend



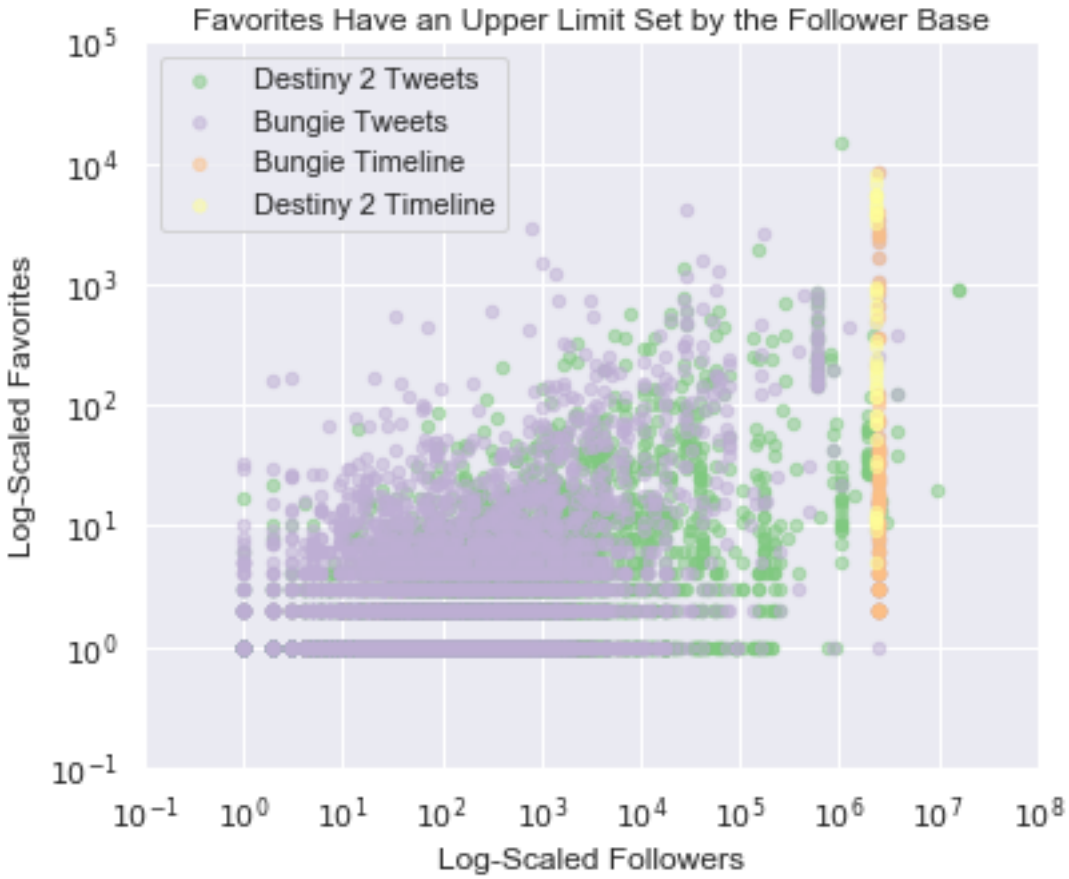
What Drives Engagement?

- First Guess: Followers
- More people will see your tweets, and then interact with it?
  - Apparently not for retweets



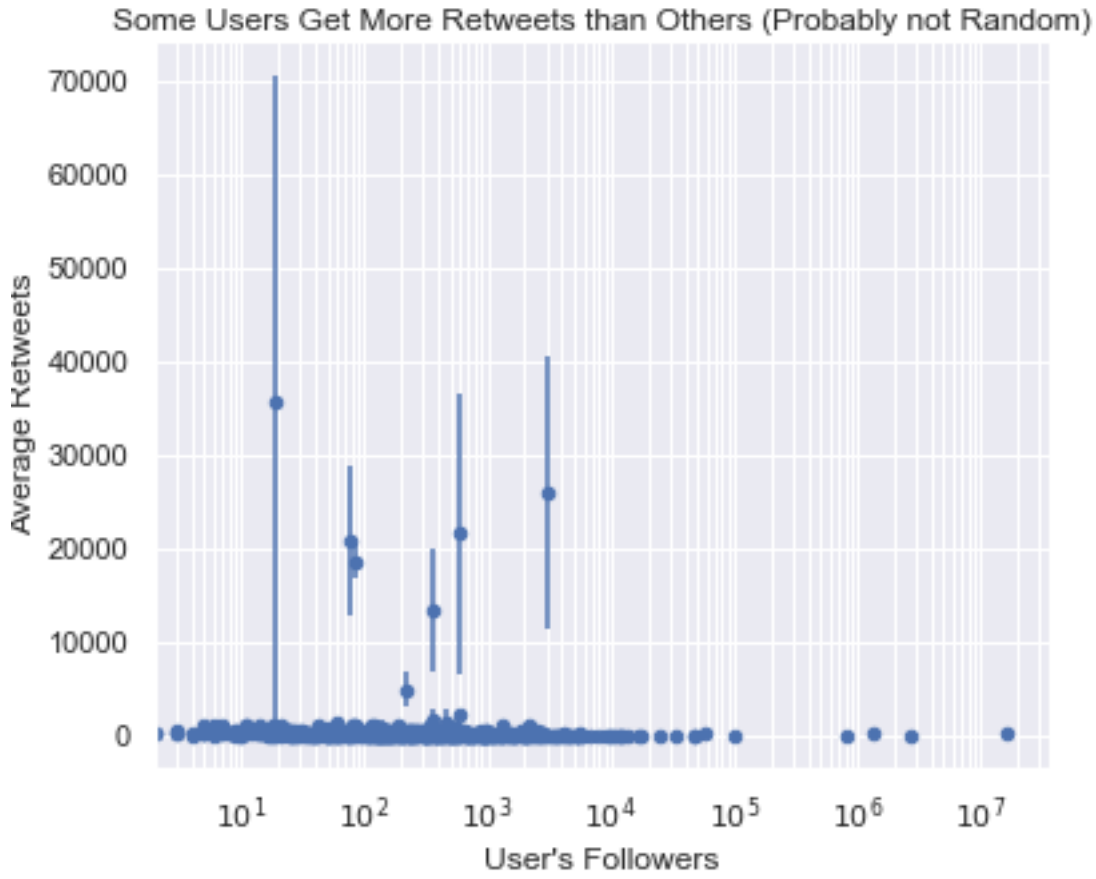
What Drives Engagement?

- First Guess: Followers
- More people will see your tweets, and then interact with it?
  - Apparently not for retweets
  - Maybe for favorites
- These are single tweets
  - Aggregate over each user and check again



Engagement per User

- See if this gets us better results
- Can do a z-test
  - Average retweets
  - Compare to the baseline of 0
- Error bars are the 95% confidence interval for average retweets
  - Some users definitely get more retweets



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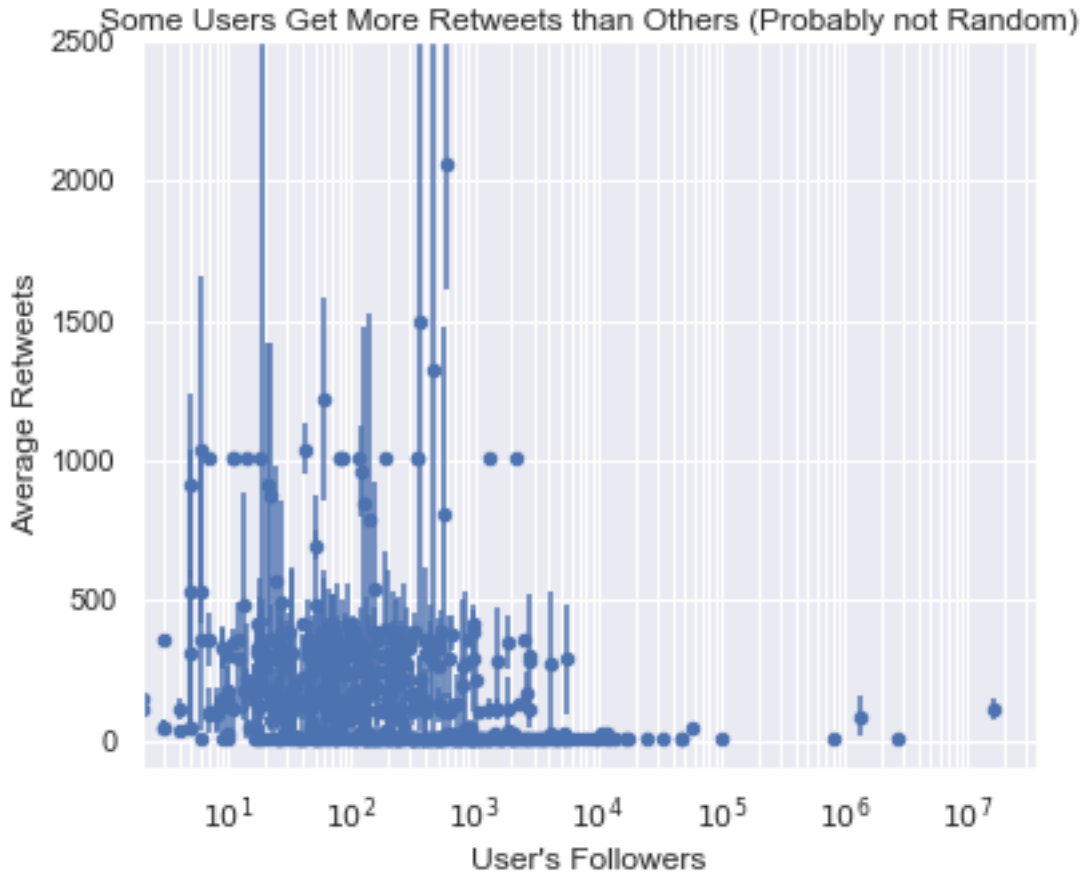
  - Zooming in, more evidence



What Drives Engagement?

- Timing?
- Can check time of day
- Time since @Bungie or @DestinyTheGame tweeted?

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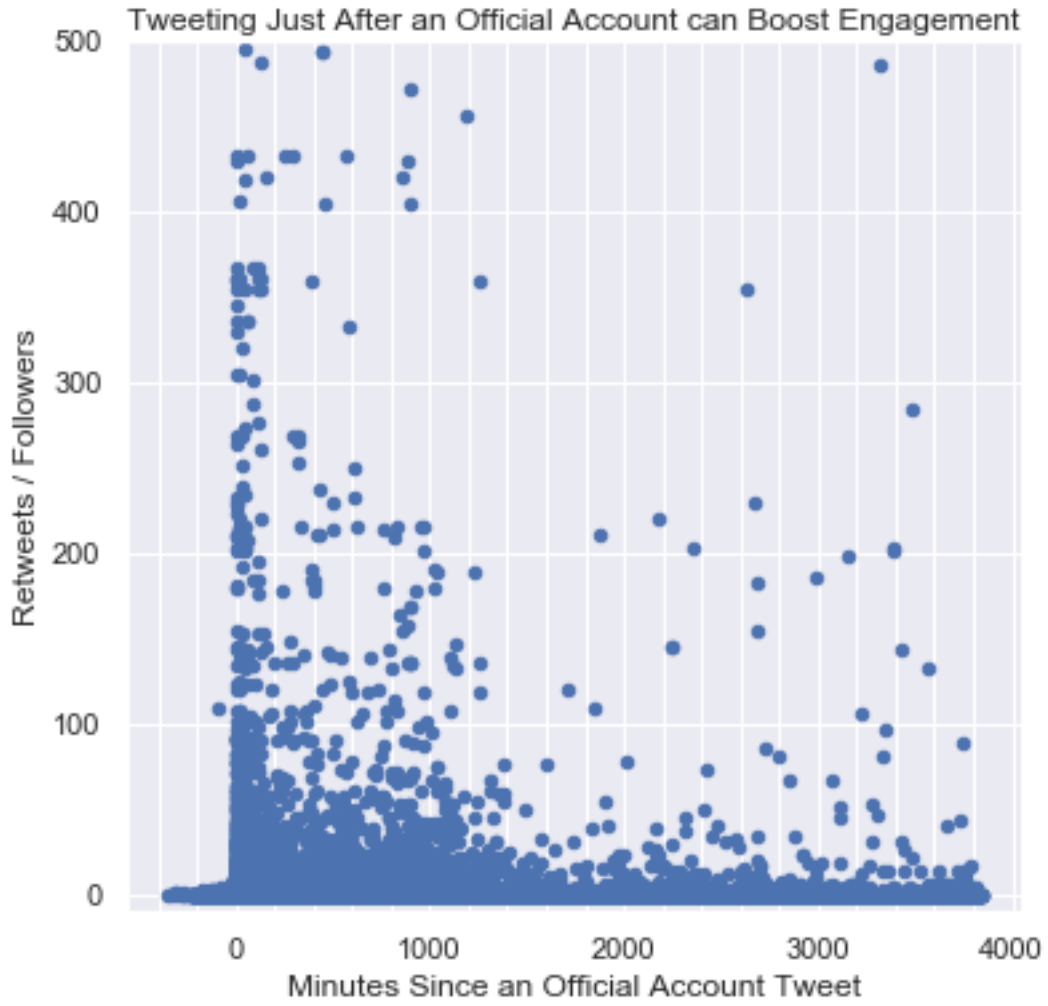
  - Negative correlation
  - Official tweets can boost your signal



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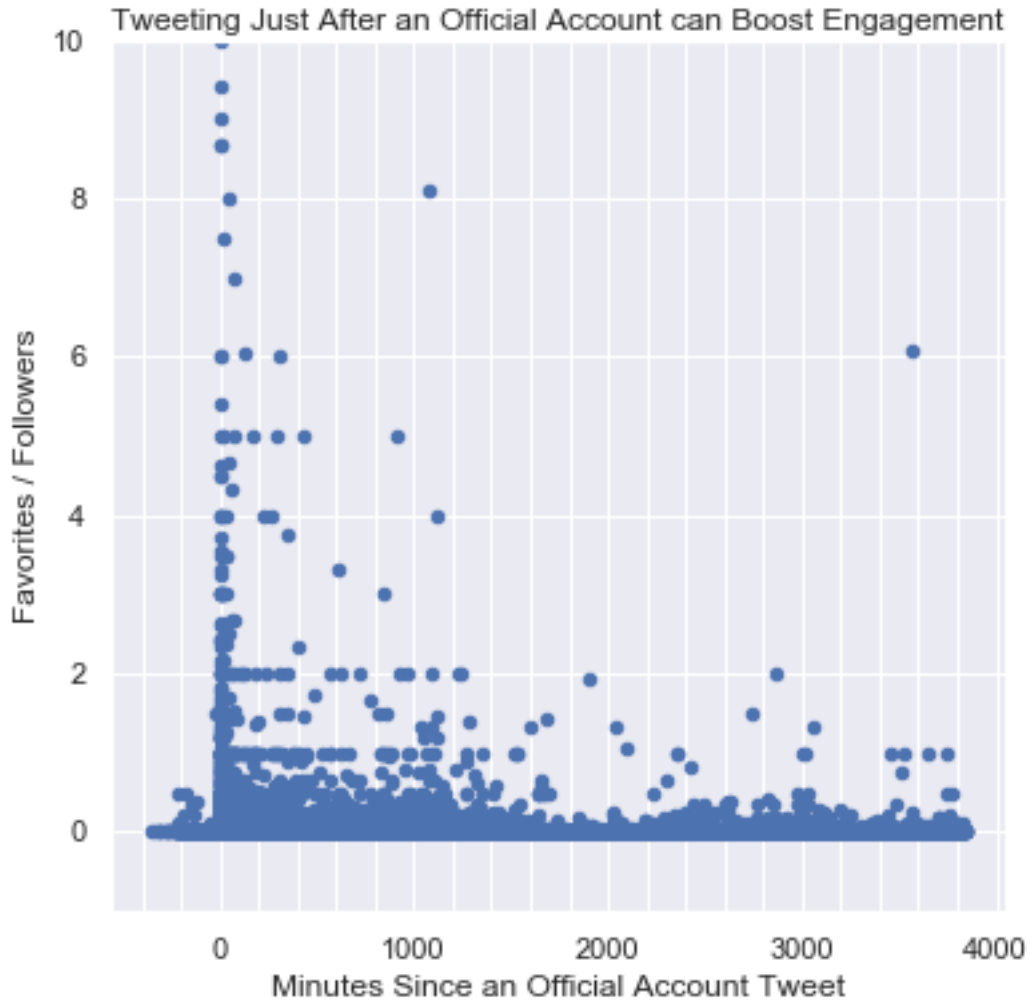

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NLP

- Don’t want to label ~48k tweets with sentiments
- Package to do that for me?
  - Feature Engineering rather than Machine Learning
- VADER
  - In NLTK

Valence Aware Dictionary and sEntiment Reasoner

- https://github.com/cjhutto/vaderSentiment

```
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
nltk.download('vader_lexicon')
```

- Specializes in social media text
- Can interpret special text cases
  - Emojis
  - ALL CAPS
  - Excessive punctuation

VADER Scores

- Vader will score Strings
- Multivariate
  - Positive: Proportion of words in the text that are positive
  - Negative: Proportion of words in the text that are negative
  - Neutral: Proportion of words in the text that are neutral
- Univariate
  - Compound: Score between -1 and 1

VADER Score Examples

- Neg: 0.815 “@Bungie Cancer”
- Comp: -0.8552 “@Bungie It’s worst in Gambit Prime killed 3 envoys with hammerhead and we killed the prime evil only 2% increase are we serious \U0001f633”
- Pos: 0.879 “@DestinyTheGame @Bungie Yes yes yes yes YES!”
- Comp: 0.9836 “AAAAAAHHHH I forgot how fun Destiny 2 is. Gambit Prime is intense but super fun. :) :) :) :0 :)”
- Neu: 1.0 “RT @DestinyTheGame: Season of the Drifter is underway and the latest Bungie ViDoc outlines what to expect all season long. \U0001f4a0”

Feature Engineering and Processing

- All 4 VADER scores
- Options for the time since the last official account tweet
  - Linear: $-t$
  - Inverse: $1/t$
  - Exponential Decay: $e\uparrow -t$
- Scale the Data
  - 0 – 1
- Train test split
  - Test size is 30%

ML Model 1

- Predict number of retweets
  - Best metric for Twitter engagement
- Linear Regression
  - Vary the time column
  - Vary the scaling
  - Remove negative time values
- Performed terribly
  - All the R-squared values were very low (> 0.0007)

ML Model 1

- Exact retweet numbers
  - Lots of randomness
- Would need a hugely complex model to get a good accuracy
- Tried a random forest regressor
  - Also did not perform well
- What now?

ML Model 2

- Retweets are important
- Predict a range
- Class 0: 0 – 99 retweets
- Class 1: 100 – 9999 retweets
- Class 2: 10000+ retweets
- Classification problem
  - K Nearest Neighbors
  - Random Forests

ML Model 2

- K Nearest Neighbors Classifier
- Test Score: 0.901
- After hyperparameter tuning: 0.915
- Confusion matrix:

Predictions	Class 0	Class 1	Class 2
Actual Class 0	11020	340	3
Actual Class 1	800	1546	1
Actual Class 2	25	0	9

ML Model 2.1

- Class imbalance -> Upsample!
- About 5 times more Class 0 data than Class 1
- About 332 times more Class 0 data than Class 2
- Retry K Nearest Neighbors: 0.921
- Hyperparameter tuning: 0.951

Predictions	Class 0	Class 1	Class 2
Actual Class 0	9714	1596	52
Actual Class 1	52	11681	3
Actual Class 2	0	0	11355

ML Model 2.1

- Model works great!
- Might be biased with repeated data for “nearest neighbors”
- Interpret the model…
  - I can’t
  - K Nearest Neighbors is a black box
- Try Random Forests

ML Model 3

- Normal data sampling: 0.920
- Hyperparameter tuning: 0.924
- Confusion matrix has the same trends as K Nearest Neighbors

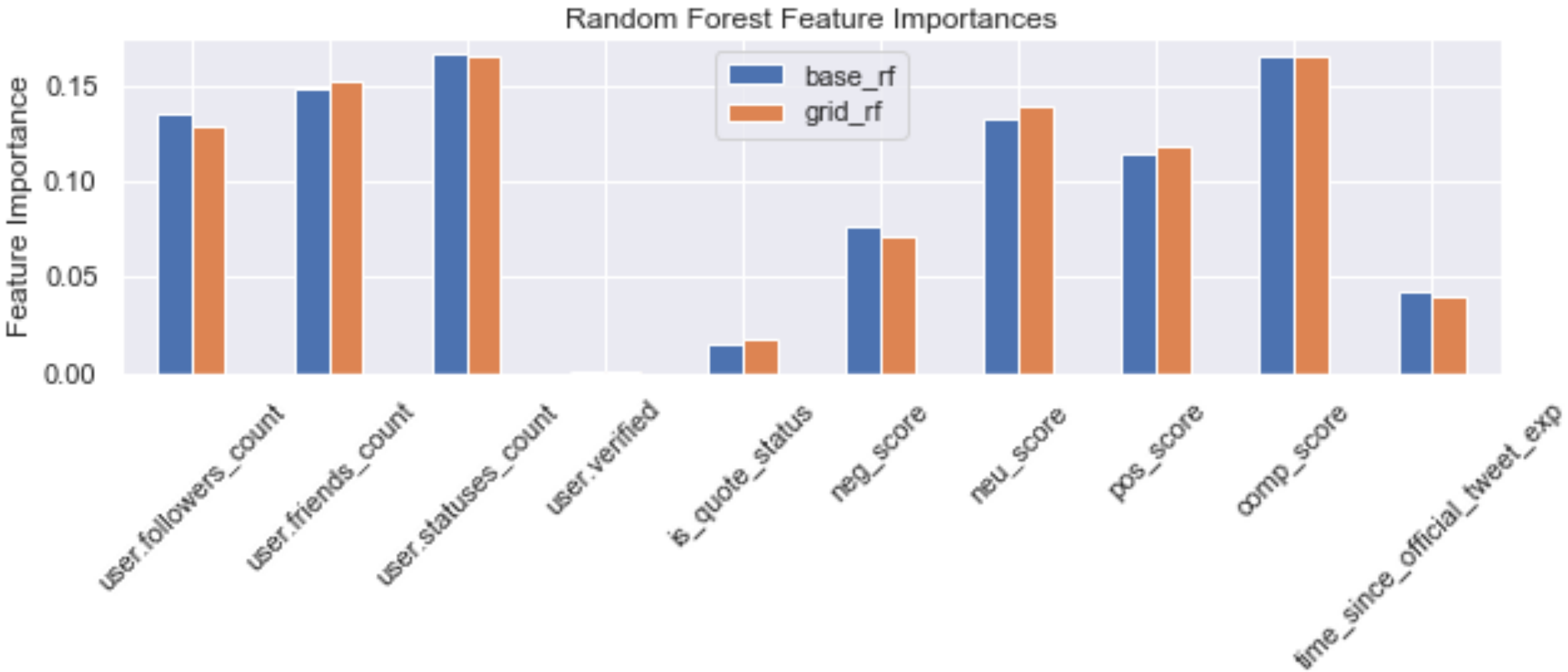
Predictions	Class 0	Class 1	Class 2
Actual Class 0	11206	157	0
Actual Class 1	860	1487	0
Actual Class 2	31	0	3

ML Model 3.1

- Upsampled data: 0.973
- Hyperparameter tuning: 0.975
- Again, same trends as K Nearest Neighbors with upsampled data
- Only this time, I can extract feature importances

Predictions	Class 0	Class 1	Class 2
Actual Class 0	10583	771	8
Actual Class 1	84	11647	5
Actual Class 2	0	0	11355

Random Forest Feature Importances

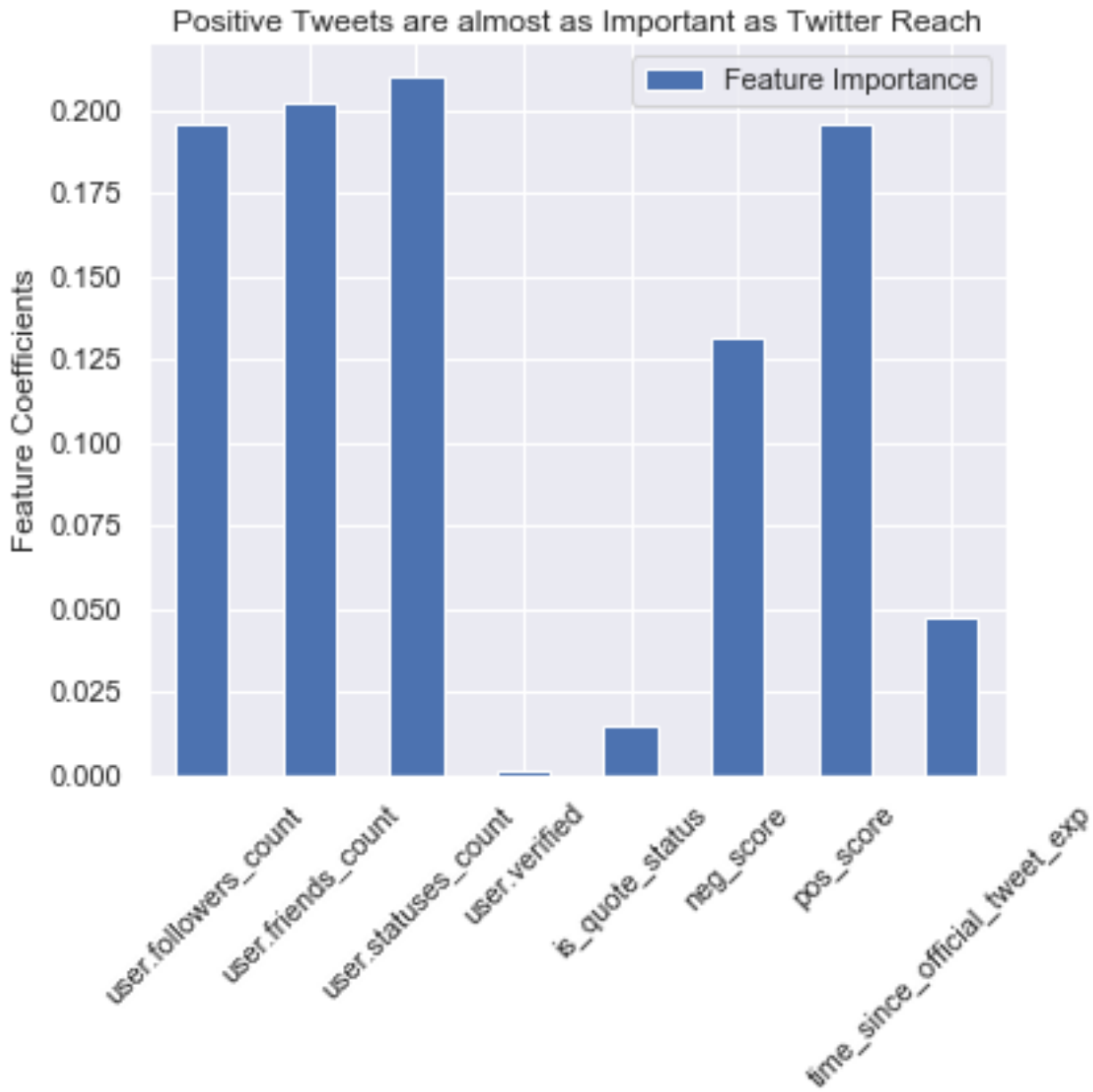


ML Model 3.1 Correlation Problems

- VADER Scores
  - Higher positive correlates with higher compound
  - Higher negative correlates with lower compound
  - Higher neutral correlates with compound closer to 0
- I want to know if positive or negative tweets get more engagement
  - Keep positive and negative scores
  - See which is more important

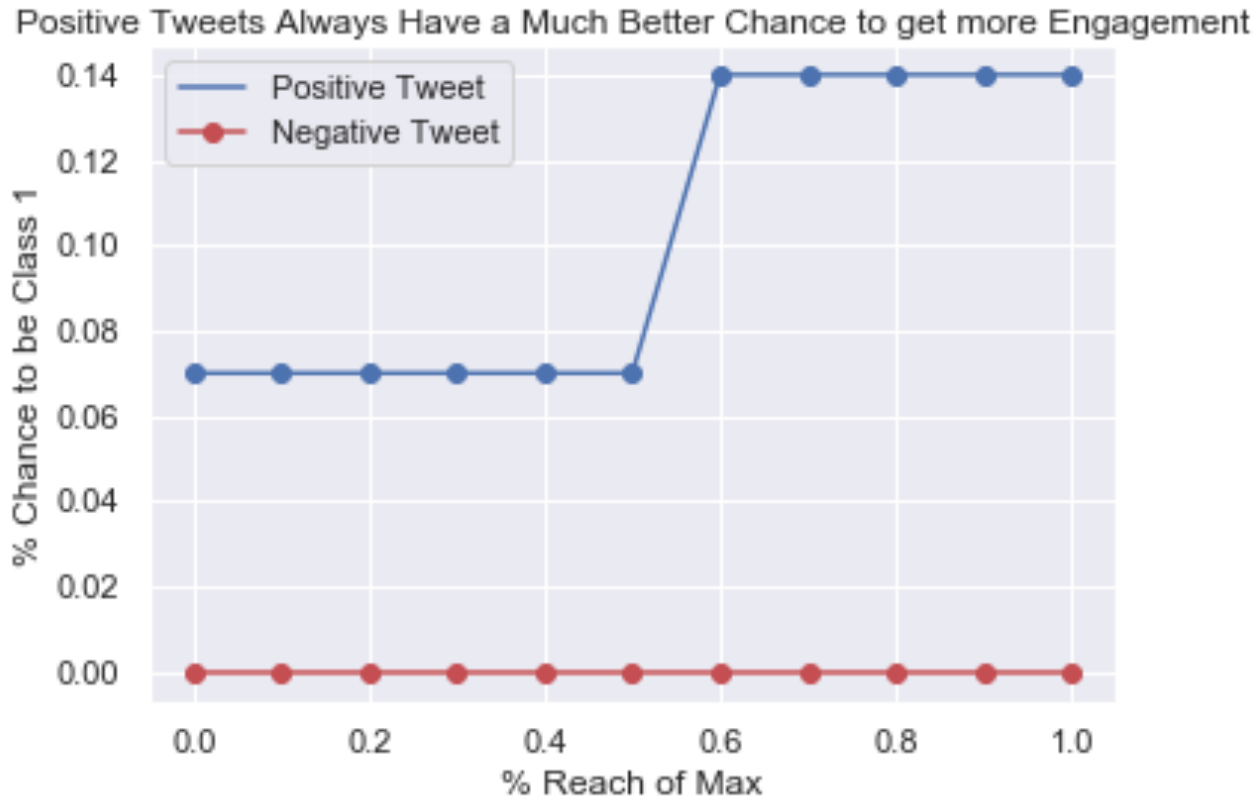
ML Model 3.2

- Drop neutral and compound scores
- Use features that hyperparameter tuning found for v3.1
- Test Score: 0.971
  - Very similar
- Careful, feature importance is not necessarily positive



Positive vs Negative: Which Gets More Retweets?

- Predict class probabilities on simulated data
- One has positive sentiment, one has negative
  - Everything else controlled



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Conclusions

- Wanted to draw conclusions from social media data
- Found that:
  - People are more active on Twitter in the evening
  - People can tweet right after Bungie or Destiny to get a small engagement boost
  - ML models can predict if tweets will fall into a certain range
    - Can repurpose this to help Bungie craft tweets that should get more engagement
  - People like positive tweets about Bungie and Destiny 2 way more than negative ones!

Future Work

- Collect cleaner data
- More exhaustive exploratory analysis
- Use sentiment scores better
- Log-scale retweets and retry linear regression
- More categories for the ML models
- Run a ML model on only official account tweets