Suicide Detection

Natural Language Processing for Suicide Detection

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Capstone 3 - Springboard

Background: Most people who die by suicide talk about it first. Many of these people can be helped.

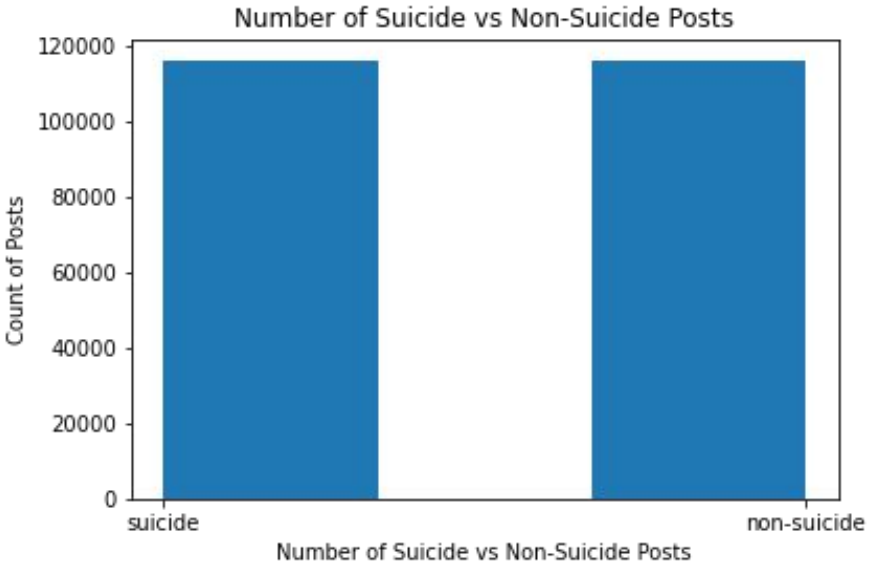
Objective: Develop a model to interpret written text and flag when someone's risk of suicide is high.

Stakeholders: Social media companies (schools, parents), online therapy providers such as Betterhelp, 7 cups, Talkspace

Dataset

- Dataset consisted of 232,074 social media posts from Reddit
  - Exactly half were from ‘Suicide Watch’ Subreddit
  - The other half were from ‘Teenager’ Forum

- Downloaded the dataset from kaggle.com



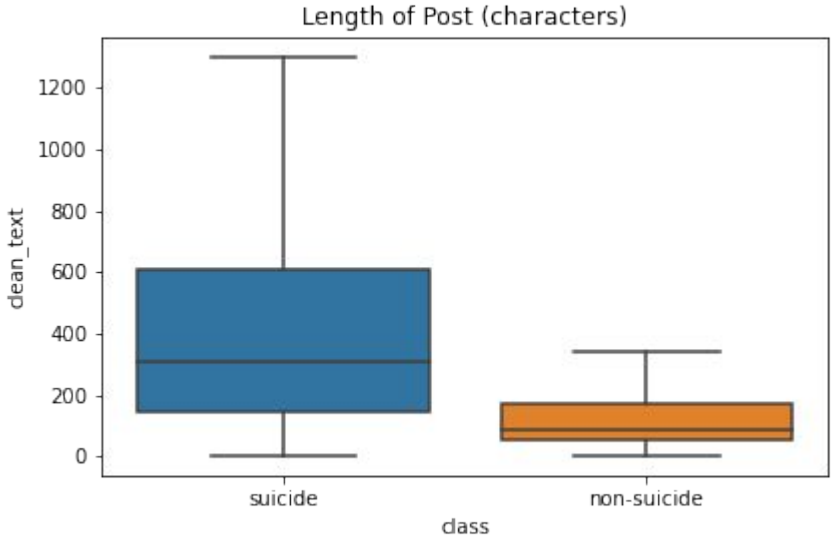
Data Wrangling and Data Cleaning

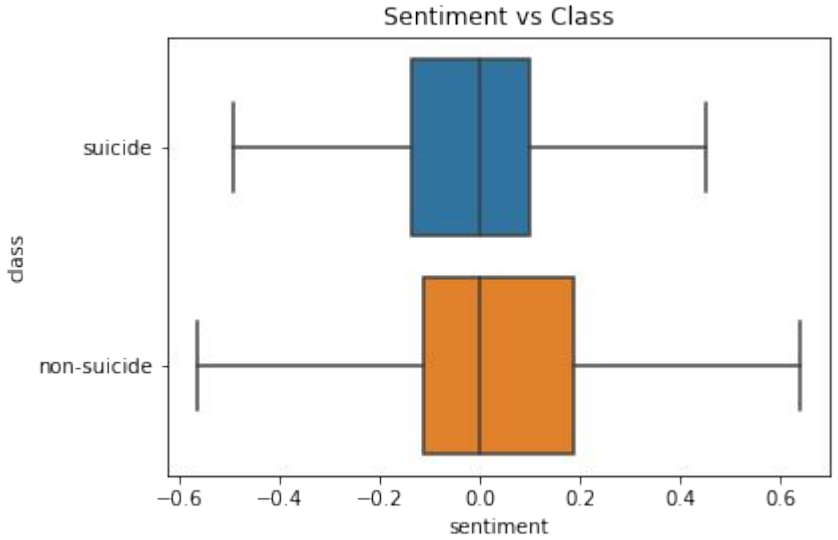
Confirmed there were no duplicate posts and no blank posts (no text)

Normalize Text:

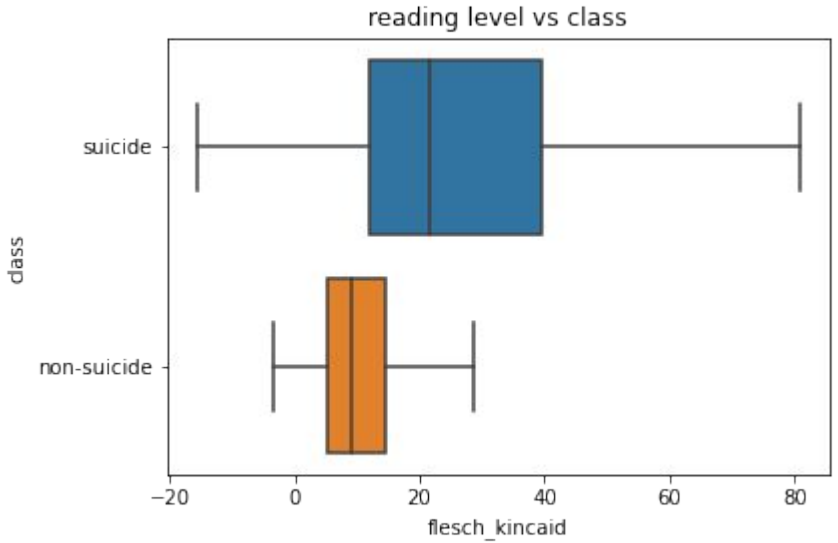
- Converting all text to lowercase
- Converting all hyperlinks and urls to standard text
- Converting all emojis and emoticons to text
- Removing punctuation and numerals
- Removing white spaces
- Ensuring all posts are written in the English language
- Expanding contractions
- Removing stopwords utilizing the spacy dictionary
- Lemmatizing verbs to convert them to their lemma or stem

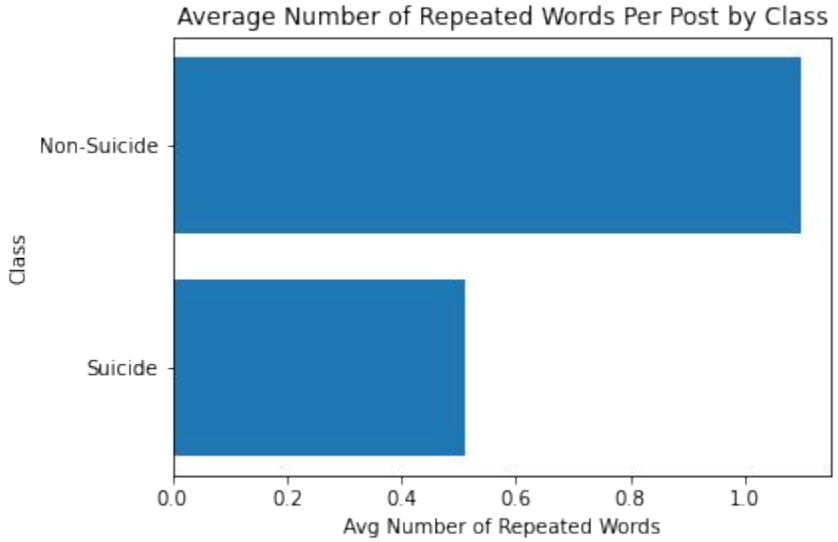
Exploratory Data Analysis



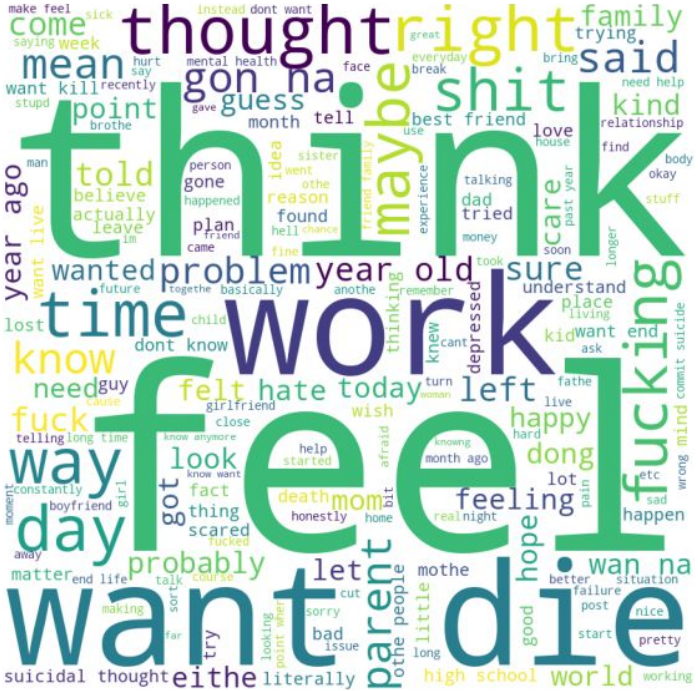


Exploratory Data Analysis - Continued

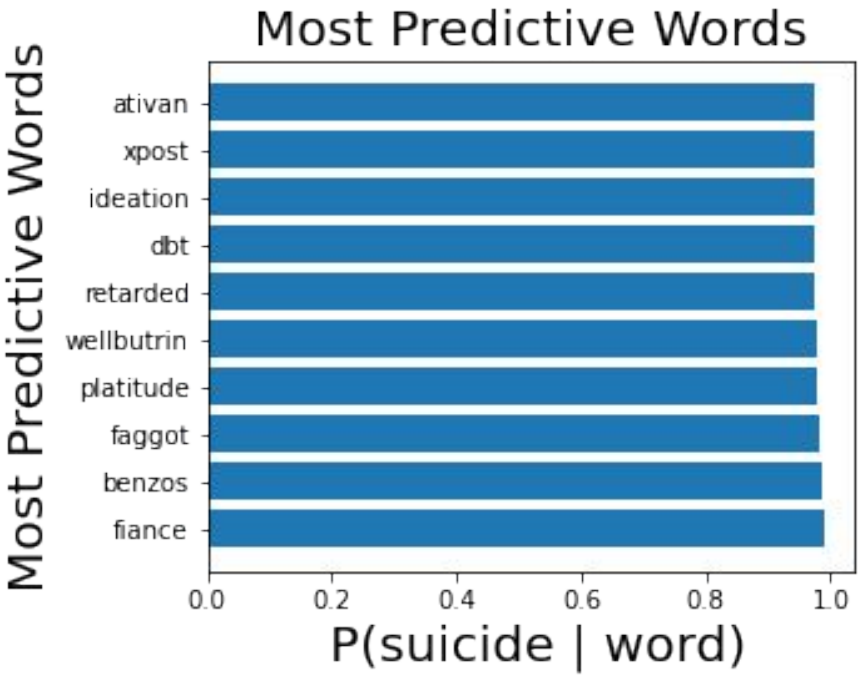




Vocabulary - Frequency



Vocabulary - Predictive



Overall the most predictive words seem to be used to talk about one or more of the following:

- Relationships gone bad (fiance)
- Talking about suicide (xpost, platitudes)
- Treatment for depression (dbt, benzos, ativan, wellbutrin)
- Self loathing (f*ggot, ret*rded)
- Suicide attempts (benzos, ativan, wellbutrin, ideation, fiance)

Modeling

Three different machine learning models:

1) Multinomial Naive Bayes
2) Random Forest
3) Logistic Regression

Count Vectorizer and TF-IDF Vectorizer

Text only and with All Features (text PLUS length, reading level, sentiment, repetition)

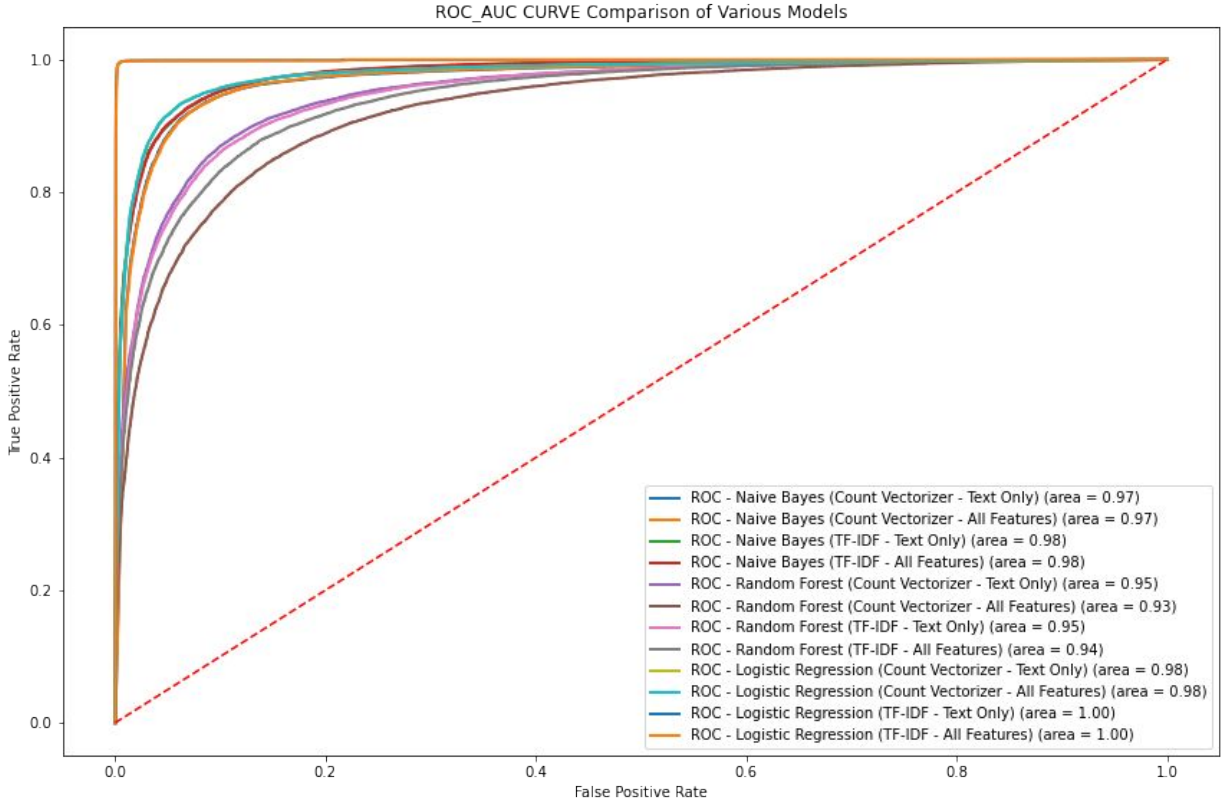
Total of 12 models analyzed

Modeling

For all models:

- 75 / 25 Train Test Split
- Set min_df = 3
- Set n_grams = (1,2) - analyzed unigrams and bigrams
- Used Grid Search to Optimize Hyperparameters
  - For Multimomial Naive Bayes - ‘Alpha’
  - For Random Forest - ‘Max Depth’ and ‘N-Estimators’ (optimized on a subset)
  - For Logistic Regression - ‘C’

Model Metrics



Model Metrics

Model	Accuracy	Precision	Recall	F1	ROC_AUC
Naive Bayes (Count Vectorizer - Text Only)	0.92	0.893	0.953	0.922	0.971
Naive Bayes (Count Vectorizer - All Features)	0.923	0.904	0.946	0.924	0.971
Naive Bayes (TF-IDF - Text Only)	0.922	0.89	0.962	0.924	0.98
Naive Bayes (TF-IDF - All Features)	0.925	0.9	0.956	0.927	0.98
Random Forest (Count Vectorizer - Text Only)	0.881	0.909	0.847	0.877	0.952
Random Forest (Count Vectorizer - All Features)	0.841	0.888	0.779	0.83	0.926
Random Forest (TF-IDF - Text Only)	0.878	0.905	0.842	0.872	0.949
Random Forest (TF-IDF - All Features)	0.865	0.895	0.824	0.858	0.942
Logistic Regression (Count Vectorizer - Text Only)	0.931	0.955	0.903	0.928	0.978
Logistic Regression (Count Vectorizer - All Features)	0.931	0.955	0.903	0.929	0.978
Logistic Regression (TF-IDF - Text Only)	0.996	0.995	0.996	0.996	0.999
Logistic Regression (TF-IDF - All Features)	0.996	0.995	0.996	0.996	0.999

Model Metrics

Model	True Positive	False Positive	True Negative	False Negative
Naive Bayes (Count Vectorizer - Text Only)	27518	3295	25856	1343
Naive Bayes (Count Vectorizer - All Features)	27290	2902	26249	1571
Naive Bayes (TF-IDF - Text Only)	27751	3433	25718	1110
Naive Bayes (TF-IDF - All Features)	27593	3076	26075	1268
Random Forest (Count Vectorizer - Text Only)	24434	2449	26702	4427
Random Forest (Count Vectorizer - All Features)	22470	2821	26330	6391
Random Forest (TF-IDF - Text Only)	24301	2544	26607	4560
Random Forest (TF-IDF - All Features)	23790	2779	26372	5071
Logistic Regression (Count Vectorizer - Text Only)	26057	1220	27931	2804
Logistic Regression (Count Vectorizer - All Features)	26069	1215	27936	2792
Logistic Regression (TF-IDF - Text Only)	28753	143	29008	108
Logistic Regression (TF-IDF - All Features)	28750	148	29003	111

Selected Model - Logistic Regression (TF-IDF: Text Only)

Selected Model	Logistic Regression: TF-IDF Text Only
Accuracy	0.996
Precision	0.995
Recall	0.996
ROC-AUC Score	0.999
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True Suicide	28753
False Suicide	143
True Non-Suicide	29008
False Non-Suicide	108
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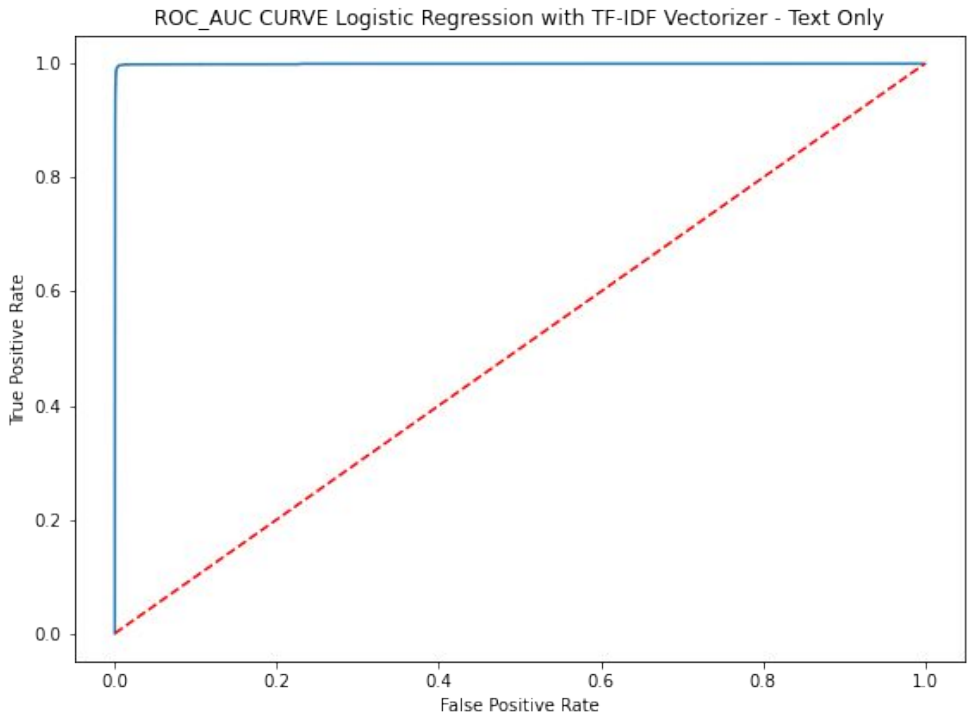
Optimal: C	10



Mis-Identified Posts

FALSE POSITIVE

- Primarily posts dealing with suicide that were posted in the teenager forum

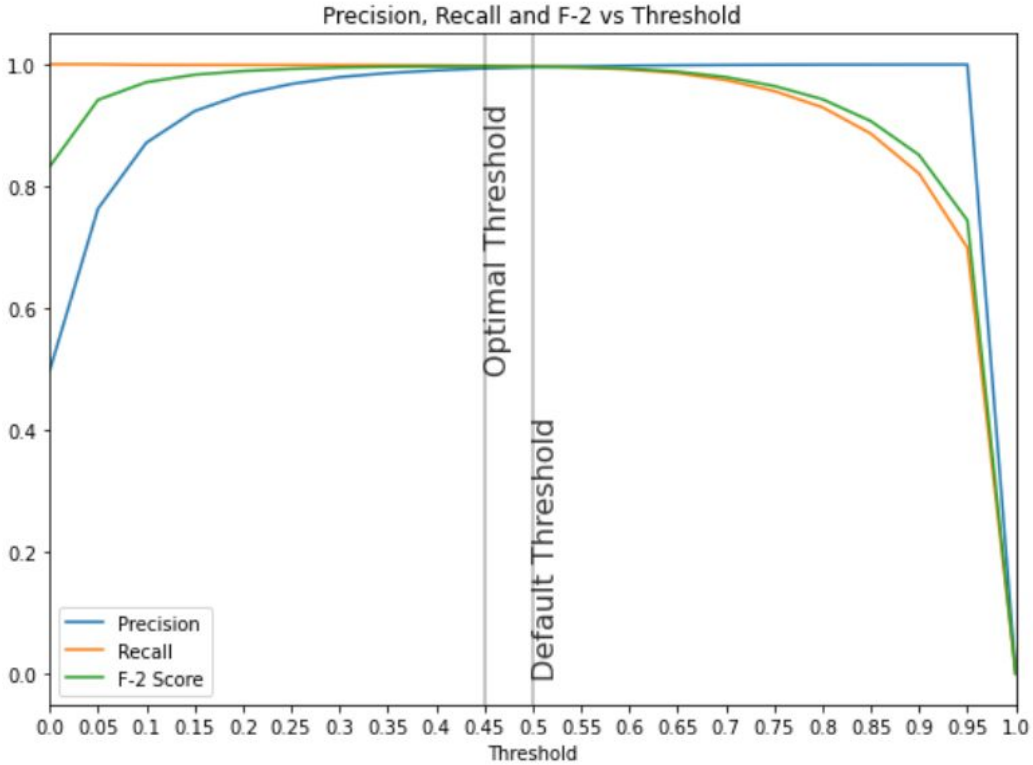
FALSE NEGATIVE

- Mostly very short texts
- Not explicit about suicide / intention
- Included misspelled words / lack of spacing between words

Mis-Identified Posts - False Negative

```
iteration   19   i can not do this any morebye

iteration   20   i quitm done

iteration   21   heymessage me to call me

iteration   22   helloanyone out the

iteration   23   nowgoodbye

iteration   24   hydrocodonehow much is too much

iteration   25   tonightقبل أن أموت
خنزير الرب القضيب أسود

iteration   26   i am really sadanyone out the

iteration   27   why do anythingwhy  why do anything
```

Thresholding



- Identify Threshold so that F-2 score is maximized
- Recall increases
- Precision decreases
- False Negatives decrease

Thresholding

```
df_threshold[df_threshold['Threshold'].isin([0.45, 0.5])]
```

	Threshold	Precision	Recall	F-2 Score	True Positive	False Positive	True_Negative	False Negative
9	0.45	0.993032	0.997436	0.996552	28787	202	28949	74
10	0.50	0.995051	0.996258	0.996016	28753	143	29008	108

Evaluate Text From a Different Source

	title	song	length	class	repetition	sentiment	flesch_kincaid
0	Smells Like Teen Spirit	load up on guns bring your friends it is fun t...	1280	0	24	-0.19892	102.7
1	Walking on Sunshine	oh ohhhh yeeeh i used to think maybe you loved...	1679	0	3	0.48771	141.7
2	Everybody Hurts	when your day is long and the night the night ...	886	1	2	0.1125	67.6
3	Happy and You Know It	if you are happy and you know it clap your han...	165	0	0	0.725	11.8
4	Wonderful World	i see trees of green red roses too i see them ...	598	0	0	0.373333	47.3
5	Never Gonna Give You Up	we are no strangers to love you know the rules...	1741	0	0	-0.158796	139.4
6	Save Myself	i gave all my oxygen to people that could brea...	1632	1	0	0.010606	135.5
7	Adams Song	i never thought i would die alone i laughed th...	1364	1	3	0.076	110.5
8	Cemetary Drive	this night walk the dead in a solitary style a...	911	1	0	-0.114418	73.8
9	Haunted	louder louder the voices in my head whispers t...	1181	1	3	-0.02381	100.7

	Predicted Non-Suicide	Predicted Suicide
Actual Non-Suicide	5	0
Actual Suicide	0	5

Summary

- Evaluated 12 Models
- Best model was Logistic Regression (TF-IDF Vectorizer - Text Only)
- Model seems to perform well enough to be useful.
- Additional input on performance from potential stakeholders.
- These include Social media companies (schools, parents), online therapy providers such as Betterhelp, 7 cups, Talkspace.

Next Steps

- Extremely High ROC-AUC Score. Consider analysis between more similar groups .
- Enhance the engineered features.
- False negatives: Look into ways to correct text prior to prediction.
- More robust hyperparameter optimization.