



Classifying Musical Valence using Song Lyrics and Spotify Audio Features

by Kidd Jason Evangelista and Juan Miguel Bawagan III

Introduction

- Machine learning is one of the many fields in Computer Science that is rapidly growing and is still being developed.
- Sentiment analysis, one of machine learning's applications, is applied to a range of text-based models such as tweets, reviews, etc., to classify the ideas of a certain population, to detect and extract subjective information, and to analyze trends.
- An interesting source of emotion-based text are present in musical lyrics. Several studies have applied Sentiment Analysis in identifying and classifying emotions from lyrics.

The Problem

- Studies conducted have the similar struggle of accurately identifying lyrical emotion without considering its musical elements such as pitch, tempo, energy, and danceability, among many others.
- Music is subjective. It may be the case that while lyrical text examined conveys positivity, its musical element may lean towards negativity. This contrasting effect may have an impact in predicting the song's emotions accurately.
- Lyrical text takes advantage of the use of figurative language such as metaphor, irony, and sarcasm. This makes it harder to decrypt what writers mean by their lyrics.
- Researchers occasionally use a library to determine which words are positive or negative. The classification of words in the library is subjective due because it is handpicked by researchers. The subjectivity may result to inaccuracy.

Proposed Solution: Musical Valence

- Valence is the intrinsic attractiveness or aversiveness of an event, object, or situation.
- Valence is also used to classify emotions into two groups, those who possess positive valence and those who possess negative valence. For example, emotions such as fear and anger have negative valence, while joy and hope have positive valence.
- Musical valence, on the other hand, is the positivity and the negativity of a song based on its musical features. Spotify has quantified musical valence for each track in its database and we can use this as an alternative label for training data.
- By using musical valence, we reduce the subjectivity in music emotion classification and we consider the musical elements in a song.

Sample Valence Values From Spotify API

Note: A valence score of 0.500 and above denotes that the track possess positive valence, otherwise a score below 0.500 denotes that the track possess negative valence.



The Cranberries – Zombie
Valence: 0.313



Pharrell Williams – Happy
Valence: 0.962



Aerosmith – I Don't Want to
Miss a Thing
Valence: 0.138

Objectives of the Study

- To predict if a song has positive or negative valence given its lyrics
- To determine if valence is a suitable classification label and feature for song sentiment analysis by comparing to the accuracy of results obtained from previous works using the Multinomial Naïve Bayes Classifiers and Support Vector Machines
- To criticize valence's performance and discuss possible future works
- To accurately capture current trends in songwriting (e.g. most used words by positive or negative valence) by using the most popular songs for the past decade as data

Methodology

Gathering the Data

- The dataset used were songs retrieved from The Billboard Hot 100 from the year 2006-2016 for a total of 1100 songs.
- Of the 1100 songs, 10 were unavailable through Spotify. Hence the data was reduced to 1090 songs.
- The songs' lyrics were searched using the Genius API, an interface for the retrieval of user-annotated lyrics, and were stored in the database along with their Spotify audio features.

Classifying the Data

- Each song's audio features were extracted using the Spotify API. A property of the *Audio Feature* object is *valence* which we will use to classify the songs for positivity or negativity.
- A score equal or greater than 0.5 were labeled as positive and a score less than 0.5 were labeled negative.

Feature Selection

- After classification, the lyrics were collected and were transformed into a vector. The model used for transformation was the Term Frequency – Inverse Document Frequency (TF-IDF) model.
- TF-IDF model is used to highlight word importance.
- The data's respective audio features were also used as features. The features used were *danceability*, *energy*, *loudness*, *acousticness*, *instrumentalness*, and *tempo*.

Audio Feature	Description
acousticness	A confidence measure from 0.0 to 1.0 of whether the track is acoustic. 1.0 represents high confidence the track is acoustic.
danceability	Danceability describes how suitable a track is for dancing based on a combination of musical elements including tempo, rhythm stability, beat strength, and overall regularity. A value of 0.0 is least danceable and 1.0 is most danceable.
energy	Energy is a measure from 0.0 to 1.0 and represents a perceptual measure of intensity and activity.
Instrumentalness	The closer the instrumentalness value is to 1.0, the greater likelihood the track contains no vocal content.
loudness	The overall loudness of a track in decibels (dB). Values typical range between -60 and 0 db.
tempo	The overall estimated tempo of a track in beats per minute (BPM).

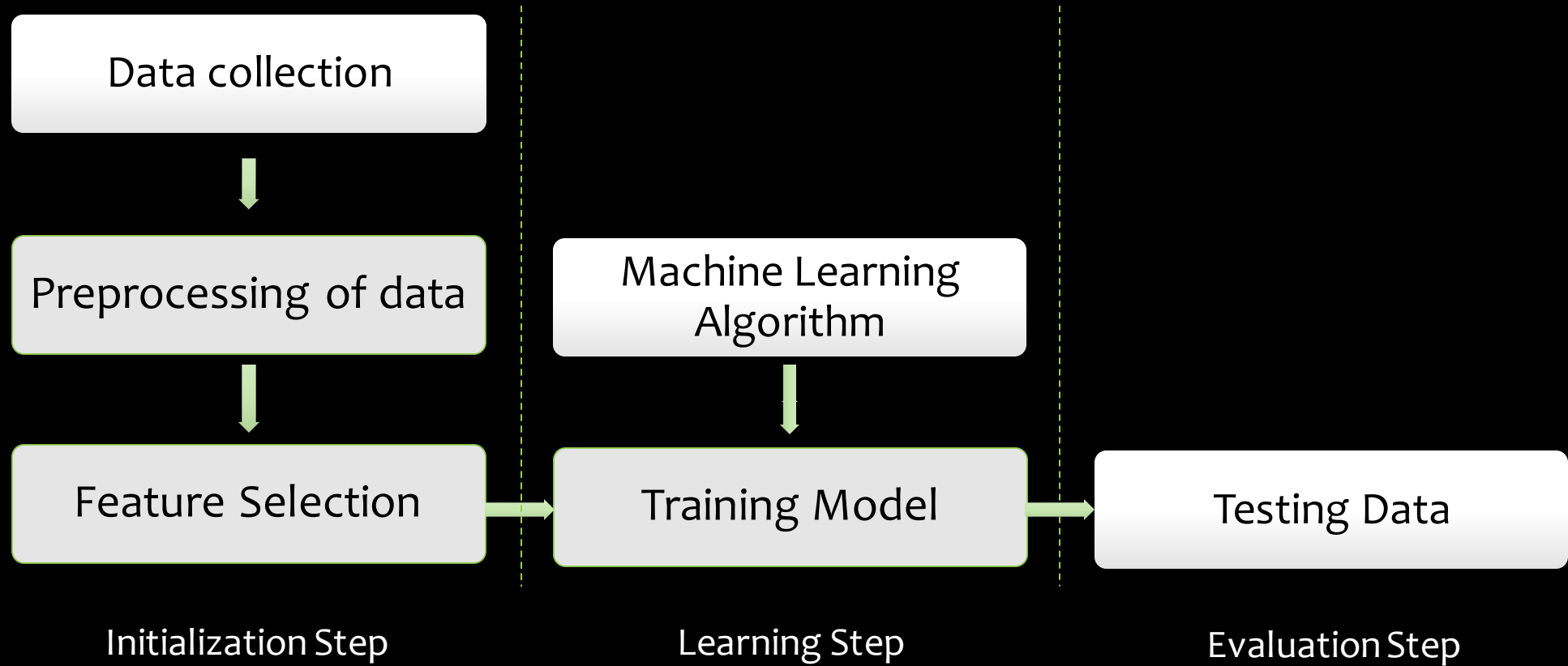
Training the Model

- In training, we used two classification models: the Multinomial Naïve Bayes and the Support Vector Machine (SVM).
- We chose these two models because they are simple and efficient methods in text classification.
- For comparison, two SVM models were trained. One without audio features and one with audio features.

Data Splitting and Testing

- The initial dataset retrieved was split into two, one for training and one for testing.
- The training and testing of data were cross validated using the K-fold Cross Validation, where $K=10$.
- For testing, four performance measures were recorded: *accuracy*, *precision*, *recall*, and *f1 score* (also called *f-score*).

General Workflow



Technologies Used

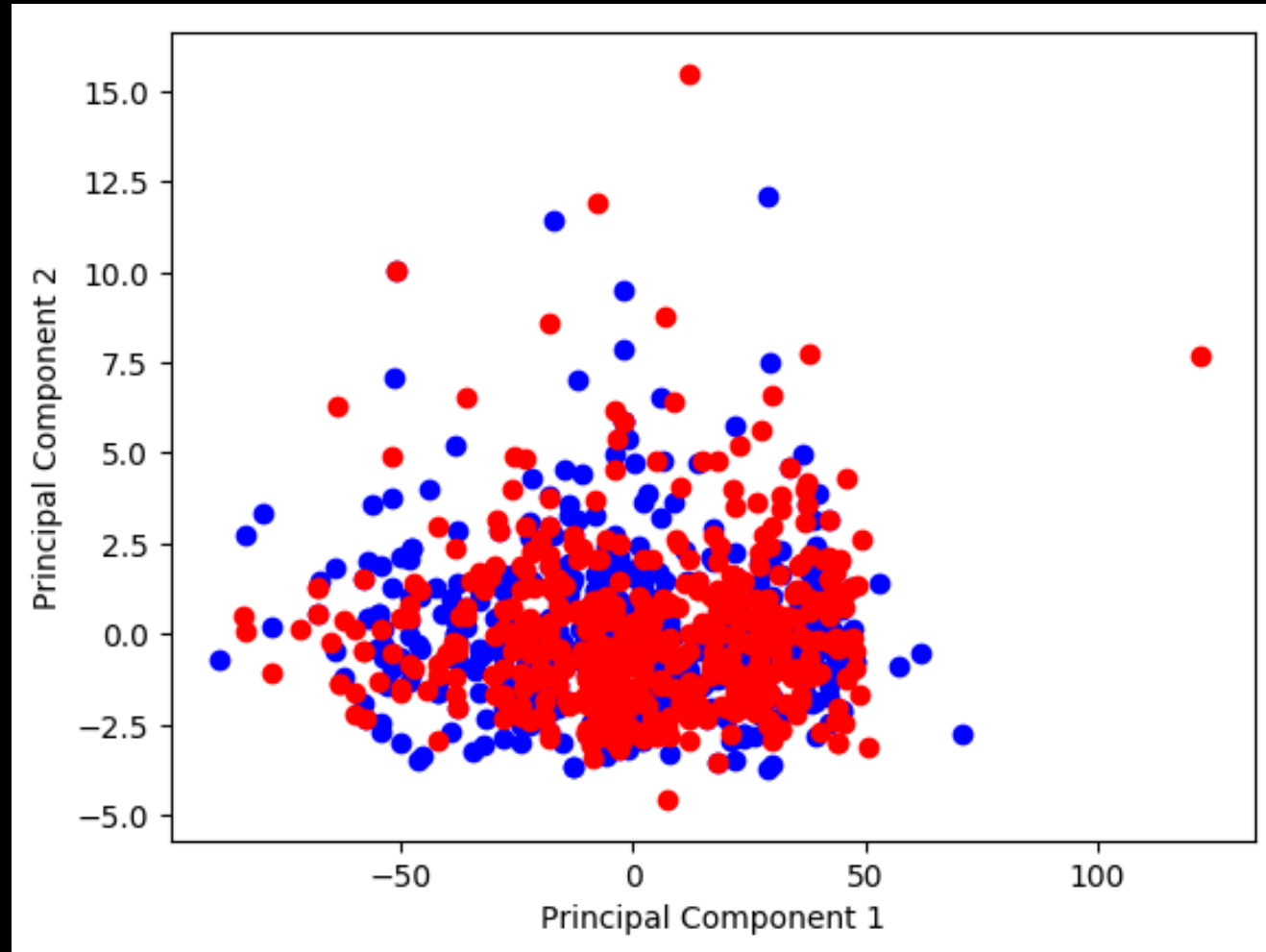
- To help us in our study, we created a web application that classifies song valence.
- Django, a high-level Python Web framework, will be used in this study alongside PostgreSQL as the DBMS. Python is chosen as the base programming language for this study for its rich machine learning libraries.
- Scikit-learn library is used for its various classification, regression, and clustering algorithms.

Results and Discussion

Classifier Performance Evaluation

Classifier	Testing Accuracy	Precision	Recall	F1 Score
Multinomial Naïve Bayes	0.6248	0.6755	0.6255	0.6495
SVM w/o AF	0.6615	0.6621	0.6610	0.6615
SVM w/ AF	0.7220	0.7245	0.7182	0.7213

- Initially, SVM w/ AF did not perform well, with accuracy ranging from 60-63%.
- Principal Component Analysis was used to apply dimensionality reduction.

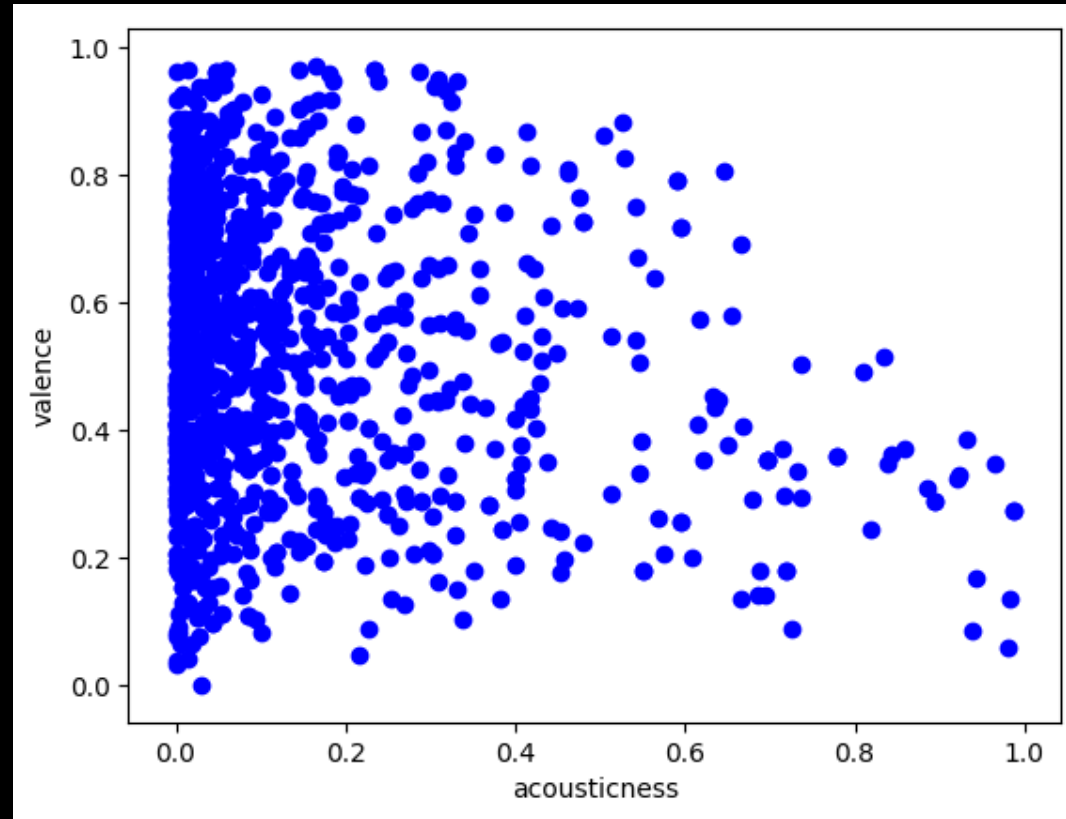


PCA applied in the initial dataset

Spotify Audio Feature Importance

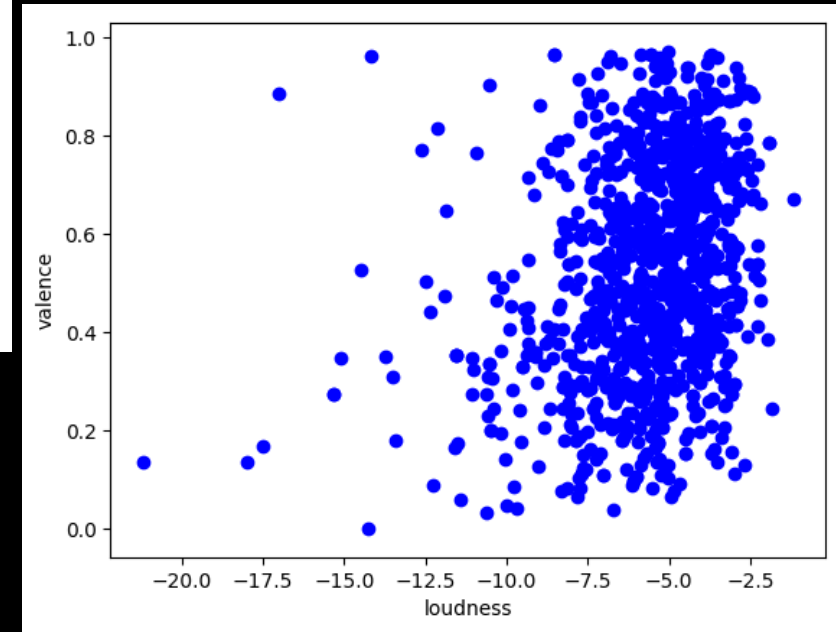
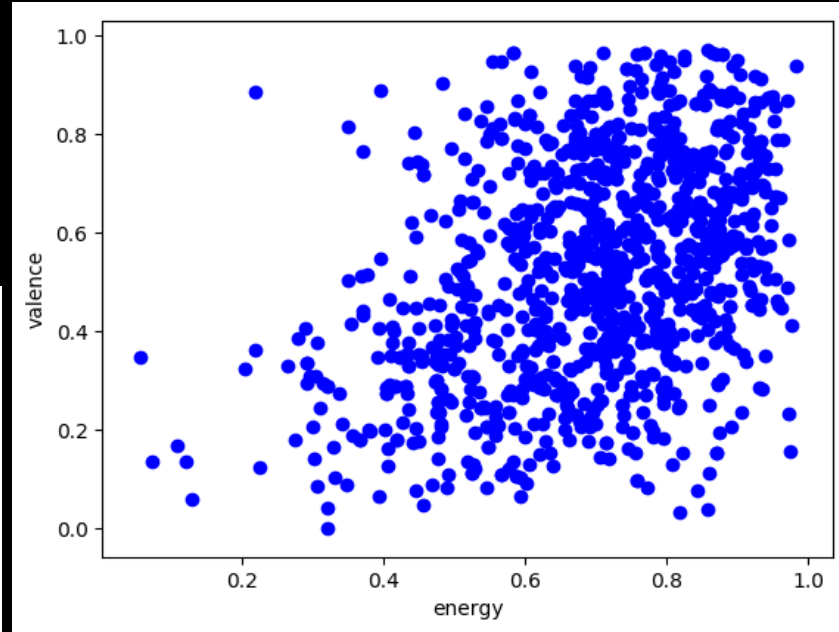
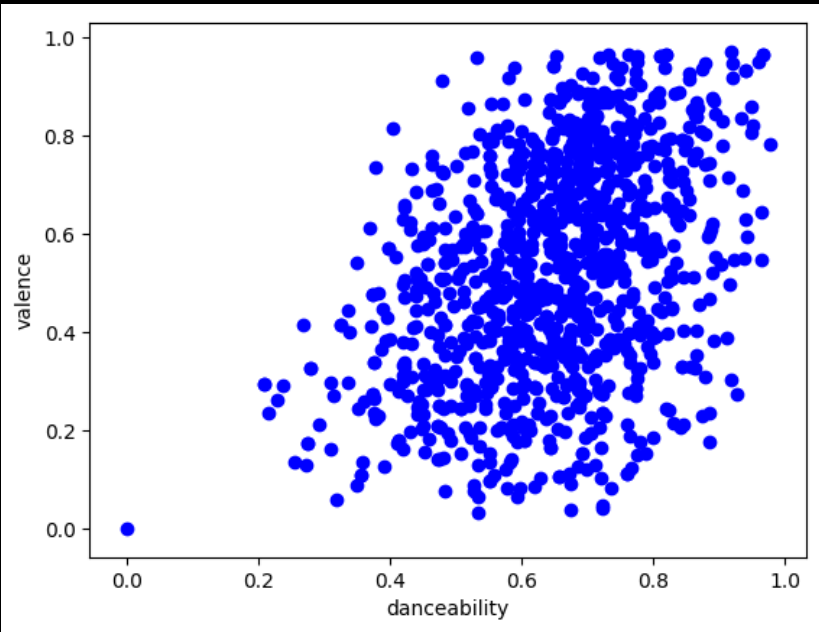
- Out of the 6 Spotify Audio Features used in the study, 4 of them have a seemingly important correlation to musical valence.
- These features are acousticness, danceability, energy, and loudness.

Acousticness



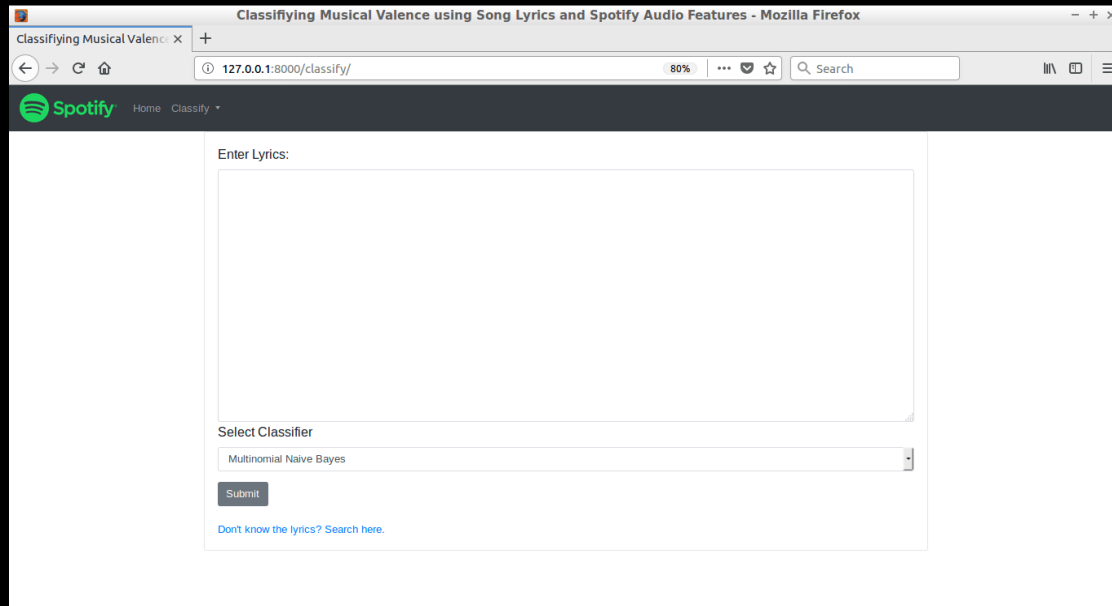
We can observe that as acousticness increases, the values for valence become smaller.

Danceability, Energy, and Loudness



We can observe that as their values decrease, the values for valence also decrease and are limited in such a way that they only include values that will classify them as negative.

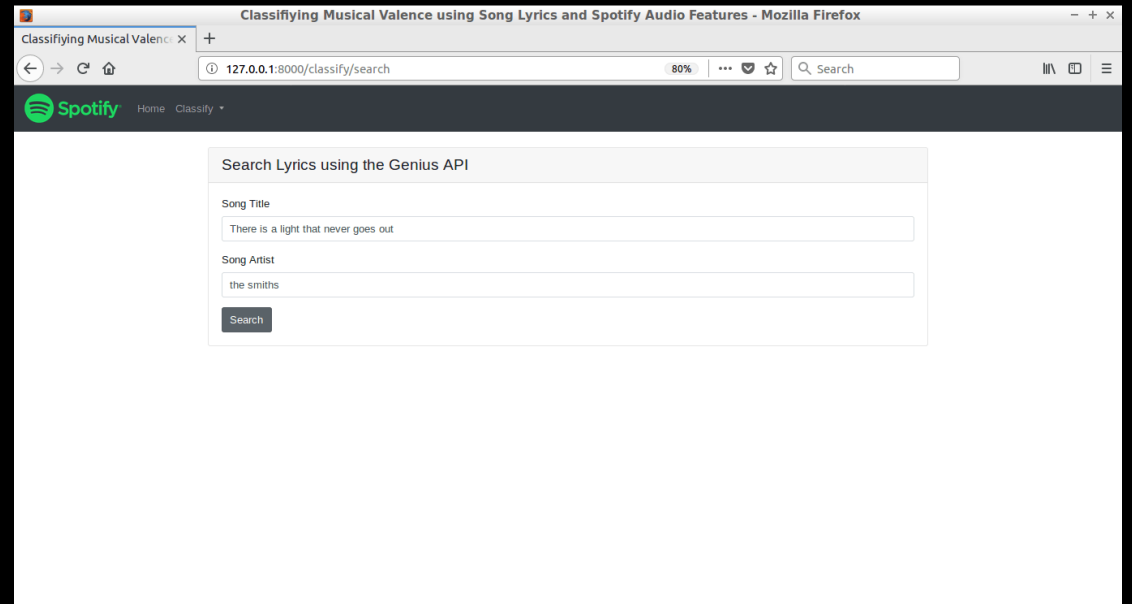
Web Application for Classifying Musical Valence



The screenshot shows a web browser window titled "Classifying Musical Valence using Song Lyrics and Spotify Audio Features - Mozilla Firefox". The address bar shows the URL "127.0.0.1:8000/classify/". The page features a Spotify logo and navigation links for "Home" and "Classify". The main content area is titled "Enter Lyrics:" and contains a large text input field. Below the input field is a "Select Classifier" dropdown menu with "Multinomial Naive Bayes" selected. A "Submit" button is located below the dropdown. At the bottom of the form, there is a link that says "Don't know the lyrics? Search here."

Lyrics Mode

Search Mode



The screenshot shows a web browser window titled "Classifying Musical Valence using Song Lyrics and Spotify Audio Features - Mozilla Firefox". The address bar shows the URL "127.0.0.1:8000/classify/search". The page features a Spotify logo and navigation links for "Home" and "Classify". The main content area is titled "Search Lyrics using the Genius API". It contains two input fields: "Song Title" with the text "There is a light that never goes out" and "Song Artist" with the text "the smiths". A "Search" button is located below the input fields.

Web Application for Classifying Musical Valence

Search Lyrics using the Genius API

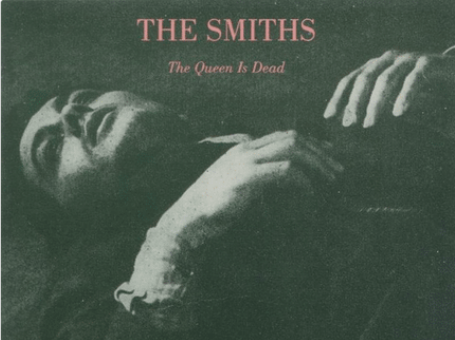
Song Title

There is a light that never goes out

Song Artist

the smiths

Search



There Is A Light That Never Goes Out - 2011 Remastered Version - The Smiths


Take me out tonight
Where there's music and there's people
And they're young and alive
Driving in your car
I never, never want to go home
Because I haven't got one anymore

Take me out tonight
Because I want to see people
And I want to see life
Driving in your car
Oh, please don't drop me home
Because it's not my home, it's their home and I'm welcome no more

And if a double-decker bus crashes into us
To die by your side is such a heavenly way to die
And if a ten-tonne truck kills the both of us
To die by your side, well, the pleasure, the privilege is mine

Take me out tonight
Take me anywhere, I don't care
I don't care, I don't care
And in the darkened underpass
I thought oh God, my chance has come at last
But then a strange fear gripped me and I just couldn't ask

Search Result



Track Details:

Spotify ID: 0WQIDwKJclirSYG9v5tayI
Artist: The Smiths
Album: The Queen Is Dead
Date Released: 1986

Take me out tonight
I don't care, I don't care
And in the darkened underpass
I thought oh God, my chance has come at last
But then a strange fear gripped me and I just couldn't ask

Take me out tonight
Oh take me anywhere, I don't care
I don't care, I don't care
Driving in your car
I never never want to go home
Because I haven't got one, oh, I haven't got one

And if a double-decker bus crashes into us
To die by your side is such a heavenly way to die
And if a ten-tonne truck kills the both of us
To die by your side, well, the pleasure, the privilege is mine

There is a light and it never goes out
There is a light and it never goes out
There is a light and it never goes out
There is a light and it never goes out
There is a light and it never goes out
There is a light and it never goes out
There is a light and it never goes out
There is a light and it never goes out

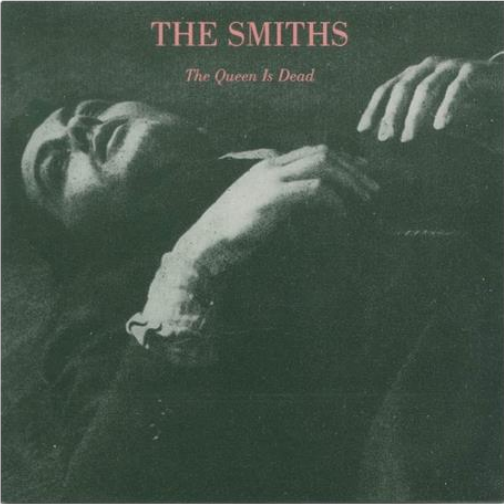
Get Audio Features and Classify with SVM

Classify using SVM without Audio Features

Classify using Multinomial Naive Bayes

Lyrics + Track Details

Web Application for Classifying Musical Valence



There Is A Light That Never Goes Out - 2011 Remastered Version - The Smiths

Negative

Using SVM with Audio Features

[Search again](#)

Track Details:

Acousticness: 0.04

Danceability: 0.523

Energy: 0.769

Instrumentalness: 0

Loudness: -5.855

Tempo: 136.162

Valence: 0.876

Classification Results
when using SVM w/ AF

Lyrics	Predicted Musical Valence
Take me out tonight Where there's music and there's people And they're young and alive Driving in your car I never, never want to go home Because I haven't got one anymore	Negative Using Support Vector Classifier without Audio Features Try again
Take me out tonight Because I want to see people And I want to see life Driving in your car Oh, please don't drop me home Because it's not my home, it's their home and I'm welcome no more	
And if a double-decker bus crashes into us To die by your side is such a heavenly way to die And if a ten-tonne truck kills the both of us To die by your side, well, the pleasure, the privilege is mine	
Take me out tonight Take me anywhere, I don't care I don't care, I don't care And in the darkened underpass I thought oh God, my chance has come at last But then a strange fear gripped me and I just couldn't ask	

Classification Results
when using SVM w/o AF

Conclusion

- It is safe to assume that Spotify's valence is a suitable label for classification because it summarizes a song's positivity or negativity based on musicality.
- Valence also correlates well with other features Spotify has provided.
- The problem arises if there is a need for specific emotion classification because valence is weak in detecting specific emotions in a song.
- SVM utilizes the audio features very well in junction with lyrics as its feature space.
- Valence is overgeneralized, but perhaps it could be used as a feature for training *specific* emotion classification models in the future.

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