Lyrical Sentimental Analysis

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Abstract*— In today's digital age, sentiment analysis has become crucial for businesses to understand and respond to customer feedback effectively. This process involves analyzing textual data, to determine the underlying sentimental tone—whether positive, negative, or neutral. In this proposal, we advocate for the analysis of song lyrics using sentiment analysis techniques to categorize songs based on their sentimental content. By collecting and preprocessing data from various sources, including popular music platforms and online databases, we aim to identify trends across different musical genres, artists, and time periods. Ultimately, this analysis could aid in curating playlists tailored to specific sentimental contexts or occasions, offering insights for both music enthusiasts and businesses seeking to enhance customer experience through music.

Keywords*— Selenium, Tokenization, Exploratory Data Analysis(EDA), Hugging Face (Transformer), Root Mean Square Error, Natural Language Processing(NLP), TensorFlow.

I. Introduction

Sentiment analysis is the process of examining digital text to identify if the message's sentimental tone is positive, negative, or neutral. Businesses now handle massive amounts of text data, including emails, chat transcripts from customer service, comments and reviews on social media. Sentiment analysis technologies are able to automatically identify the author's attitude toward a certain issue by scanning this material. Businesses utilize sentiment analysis data to boost brand reputation and enhance customer service.

In addition to being a powerful way of expressing our emotions, music is frequently utilized as a form of therapy to help us cope with difficult times or as a means of commemorating happy occasions. A component of music that occasionally escapes our notice when we listen to it is the lyrics of the songs. The many sounds, rhythms, and effects employed in music have the power to temporarily alter our feelings. The song's lyrics are eloquent writings that express the author's thoughts at the time it was written.

Therefore, we are proposing an idea of analyzing the lyrics of the top songs and performing sentiment analysis on said lyrics to identify positive, negative and neutral songs. We clean and preprocess the data that we scrape from the internet. We can find common terms and analyze and contrast them amongst songs that have positive and negative sentiments through the use of data visualization tools like word clouds. After that, we can do analysis by focusing on certain musicians, years when particular songs are popular, and various musical genres. By doing this, we can establish groups in which we can suggest different songs depending on the occasion.

II. Data sets

In the current, data-driven world, the availability of enormous datasets makes it possible to conduct degrees of study and analysis in a broad variety of subjects that were previously impossible.

By including a carefully selected compilation of the top 100 songs from the famous Billboard Hot 100 list over the period of 11 years from 2013 to 2023, this dataset is able to depict the music industry in all of its complexities. Through each entry's fundamental properties, such as the song's title, the artist or group that produced it, whether or not the lyrics are accessible, the year of release, and the genre, the dataset demonstrates the rich and diverse musical tapestry that existed throughout that time period. In order to uncover the hidden themes, attitudes, and

linguistic patterns that are included inside the songs, researchers and analysts may investigate them. Considering that all of the lyrics are available to the general public, the dataset makes it simple to investigate and evaluate lyrical content.

The meticulous categorization of each item according to its genre also makes the collection a one-of-a-kind chance for professional analysis and interpretation. By learning about the musical styles represented in the top 100 songs, users can delve deeper into their own tastes, current trends, and the influence of these events on the music industry. The wealth of genre data at our disposal allows us to delve further into new genres, monitor the ebb and flow of existing genres, and hypothesize on the impact of genre dynamics on chart positions over time. Using this massive database which consists of over 11000 columns of data that has genre information, we can look into the social and cultural factors that influence people's genre preferences, find new relationships between different types of music, and maybe even predict how people's tastes in music will change over time. The data is therefore useful for researching musical trends and the intricate relationship between different musical styles and cultural factors.

III. Literature Review

Sentiment analysis in music lyrics explores various methods such as natural language processing (NLP) and machine learning algorithms according to Li et al. [1]. They are able to show the importance of these methods in capturing the sentimental expressions within the music's lyrics. A sentiment vector space model (s-VSM) that has been tailored for song lyrics is proposed by Xia et al. [3]. This addressed challenges like the sparsity of sentiment bearing words in lyrics and the presence of ambiguous nouns and verbs by including negation handling and sentiment intensity. Their work contributes to the refinement of sentiment analysis techniques, making them more suitable for the unique characteristics of song lyrics.

Chen et al. [2] investigated the classification of song sentiment by using lyrics as evidence where they employed a hierarchical framework and leveraged song lyrics to identify stress levels in the second step. Numerous scholarly works have emerged to tackle sentiment analysis challenges within the field of natural language processing research. The approach is particularly notable for its application in discerning stress levels, showcasing the adaptability of sentiment analysis methodologies to address specific aspects of sentimental content in song lyrics.

Identifying the sentimental polarity of a song based solely on song lyrics is challenging, which Oudenne et al. [4] tackles by using natural language processing to classify a song as either positive or negative. According to them, algorithms that consider the prevalence of terms seem to do better than presence-based algorithms.

IV. State of The Art Methods And Algorithms

For this project, we will be utilizing a classical machine learning approach alongside a more modern deep learning model. Listed below are some of the prominent Python packages and frameworks commonly used in both classical machine learning and deep learning for sentiment analysis tasks.

A. Classical Machine Learning Approaches

Scikit-learn

- Scikit-learn is a versatile machine learning library that is a staple for classical machine learning. It has many functionalities such as data preprocessing, model training, and evaluation.
- It provides implementation algorithms such as Support Vector Machines (SVM), Random Forests, and Naive Bayes, all of which can be applied to sentiment analysis.

NLTK (Natural Language Toolkit)

- NLTK is a powerful library for natural language processing. It has features which include tokenization, stemming, and part-of-speech tagging.
- NLTK also has a package called VADER (Valence Aware Dictionary and Sentiment Reasoner) imported as nltk.sentiment.vader. It's a pre-built sentiment analysis tool specifically designed to analyze text for sentiment polarity [8].

TextBlob

- TextBlob is built on top of NLTK and provides a simplified API for common NLP tasks.
- TextBlob has a pre-trained sentiment analysis model that assigns polarity to text, indicating whether the sentiment is positive, negative, or neutral.

B. Deep Learning Approaches

TensorFlow with Keras

- TensorFlow is an open source machine learning framework largely recognized for its flexibility and comprehensive set of tools for building and deploying deep learning models.
- Keras is the high-level API of Tensorflow, providing an interface for machine learning problems, with a focus on modern deep learning [9].
- With Keras, we will be able to easily define model architectures, compile models with optimizers and loss functions, and integrate various layers for sentiment analysis.

Transformers (Hugging Face)

- The transformers library from Hugging Face includes pre-trained models such as BERT and GPT that can handle sentiment analysis.
- Transformers excel in capturing contextual information and intricate relationships within text. This makes them highly effective for sentiment analysis on complex datasets like song lyrics.

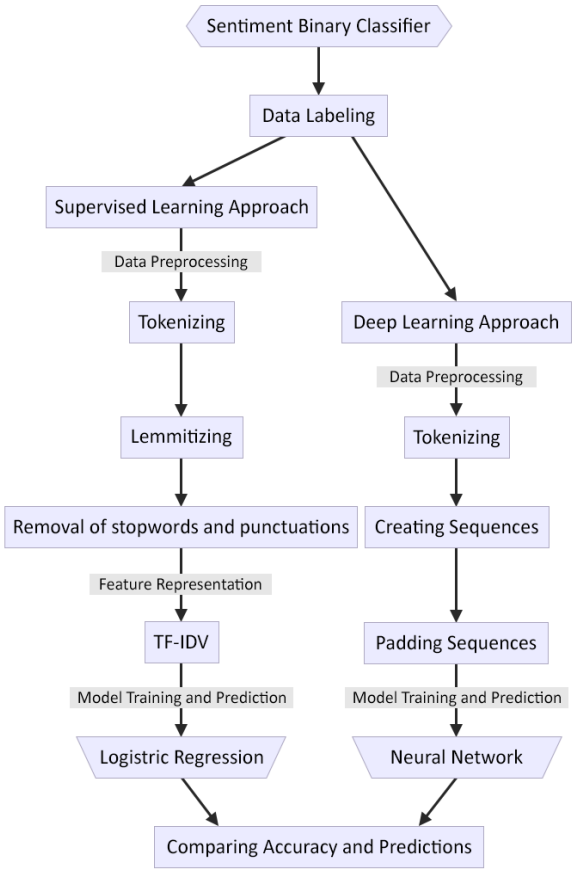

Fig. 1. Classical ML vs Deep Learning Approaches [10].

V. Research Plan

This project will include the following four stages:

Stage 1: Scrape the top 100 song dataset from the website.

Stage 2: Create and incorporate two unique classifiers into the model, with each displaying varying degrees of complexity throughout training.

Stage 3: Understanding and modifying the outcomes to improve both performance and overall effectiveness.

Stage 4: Graphical representation of the neural network and analysis of the findings.

A- Data Collection & Pre-processing: We plan to scrape lyrics from online song databases using tools such as Selenium. This dataset will include top 100 songs across various genres and time periods, focusing on metadata such as song title, artist, lyrics, release year, and genre. Pre-processing steps will include lowercasing, removing punctuation and special characters, handling missing values, and tokenization, setting a clean and uniform dataset for analysis. Then, we will conduct exploratory data analysis (EDA) prior to applying datasets to models. This will give us a clear understanding of the structure of our data. The EDA process includes the development of statistical graphs, as well as the analysis of datasets and feature summaries. Through it, we will emphasize on analyzing the most recent and relevant data and reduce the need for assumptions. This will include the use of tables, graphs, equation fitting, and the computation of characteristic values.

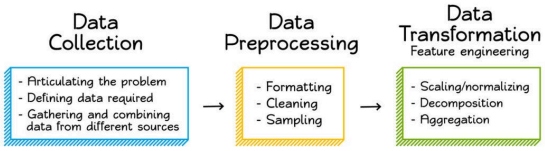

Fig. 2. Steps in Data Preparation.

B- Feature Engineering: Following the data collection & pre-processing stage, feature engineering may serve as an appropriate next step to take in order to extract valuable features from the collection of music lyrics. To begin, the raw text data has to be converted into a format that can be understood by machine learning models, such as a CSV file. Techniques like tokenization, vectorization, and sentiment scoring can be used in order to capture the linguistic and sentimental variances that are present in the lyrics. Furthermore, our analysis can

employ bag-of-words and TF-IDF vectors to transform lyrics into a numerical format understandable by ML algorithms. Advanced feature engineering will involve the integration of word embeddings, to capture deeper semantic meanings. This will prepare the data for more complex deep learning models, enabling a nuanced understanding of lyrical sentiment.

C- Model Implementation: For a more nuanced analysis, we can implement Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks. These models are adept at capturing the sequential nature of text and understanding contextual dependencies, crucial for accurate sentiment analysis of lyrics. We can then conduct a thorough comparison of the performance of baseline DM/ML models against advanced AI/deep learning models. This includes analyzing metrics, computational efficiency, and the models' ability to capture complex sentiment nuances.

D- Visualization and Interpretation: We will generate a range of visualizations, including AUC-ROC curves, and sentiment distribution charts, to interpret the models' performance comprehensively. Additionally, visualizing the neural network architecture will clearly show influential features in determining sentiment. In doing so, we will obtain quantitative and qualitative insights, ensuring a thorough understanding of how the models work to determine sentiment.

VI. Evaluation Plan

To evaluate the effectiveness of lyrical sentiment analysis we will employ a comprehensive evaluation plan encompassing multiple metrics and methodologies. Firstly, we will utilize traditional evaluation metrics such as Gini coefficient, Root Mean Square Error (RMSE) and/or Area Under the Curve of the Receiver Operating Characteristic (UAC_ROC) to quantitatively measure the performance of our sentiment analysis model.

The Gini coefficient will assess the discriminatory power of the model in distinguishing between positive, negative, and neutral sentiments. Additionally, RMSE can quantify the magnitude of errors in sentiment prediction, and AUC_ROC provides a single scalar value summarizing the performance of the classifier across a binary prediction.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} \|y(i) - \hat{y}(i)\|^2}{N}},$$

Fig. 3. Root Mean Square Error Formulae (RSME).

Furthermore, because the sentiment of lyrics could be considered subjective, qualitative evaluation techniques will be employed to complement quantitative measures. We will conduct manual annotation and validation of a subset of songs to assess the accuracy of sentiment labels assigned by the model. Moreover, leveraging crowdsourced feedback from online song reviewing sites such as 'Pitchfork' [5], 'Metacritic' [6] or, 'Rate Your Music' [7], will serve as an additional evaluation mechanism. By aggregating and analyzing reviews and ratings provided by users on these platforms, we can gather diverse perspectives and subjective evaluations regarding the sentiment of specific songs.

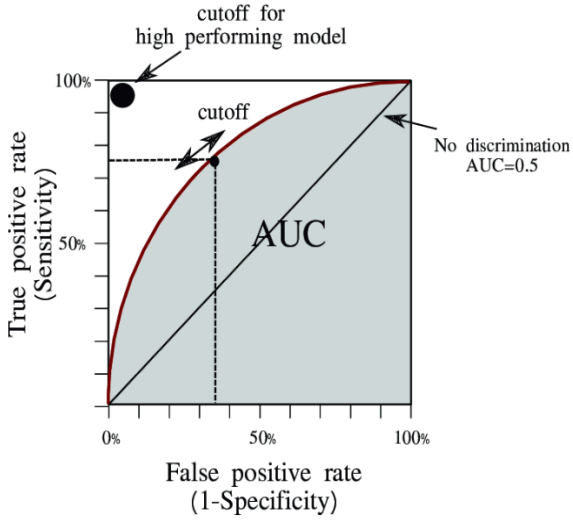

Fig. 4. Area Under the Curve of the Receiver Operating Characteristics.

This crowdsourced feedback will enhance the reliability and comprehensiveness of our sentiment analysis evaluation process, ensuring the accuracy of our findings in determining the sentimental content of songs across diverse genres and time periods. Through this multifaceted evaluation approach, we aim to ascertain the effectiveness and reliability of our sentiment analysis framework in accurately determining the sentimental tone of songs.

VII. PROJECT TIMELINE AND TASK DISTRIBUTION

The tasks division and the estimated data finished are as follows:

Task Distribution	Names	Dates
Project Study and Project Proposal	Everyone	**02/28**
Data Scraping and Pre-processing	Tanooj and Shashank	**02/22**
Feature Engineering	Tanooj and Shashank	**02/26**
Building Machine Learning Model	Pratham Gupta	**03/04**
Train networks for E2E-ABSA	Race Musgrave	**03/18**
Visualization of network Architectures	Josue Cortez	**03/30**
Analysis and the Interpretation	Ryan Skabelund	**04/10**
Presentations, Reports and Final report	Everyone	**04/22**

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