



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 4, April 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijrset@gmail.com

 www.ijrset.com

Music Analysis and Recommendation System

Atharva Chandak, Sumit Tanmor, Prathamesh Waghmare, Harshal More, Archana Priyadarshni

UG Student, Department of Computer Engineering, Dhole Patil College of Engineering, Wagholi, Pune, India

UG Student, Department of Computer Engineering, Dhole Patil College of Engineering, Wagholi, Pune, India

UG Student, Department of Computer Engineering, Dhole Patil College of Engineering, Wagholi, Pune, India

UG Student, Department of Computer Engineering, Dhole Patil College of Engineering, Wagholi, Pune, India

Assistant Professor, Department of Computer Engineering, Dhole Patil College of Engineering, Wagholi, Pune, India

ABSTRACT: The integration of music and technology, particularly through the advent of music streaming platforms like Spotify, has revolutionized the music industry. This article presents a comprehensive overview of recent research endeavors in this domain, encompassing studies on user behavior within music streaming services, methodologies for music visualization, and the application of machine learning algorithms for predicting song success. Through an exploration of the relationships between song attributes and Spotify popularity, as well as trends in user behavior, this research employs data analysis and visualization techniques to glean valuable insights into the realm of music. By scrutinizing music-related data, particularly in discerning patterns and trends in user engagement, significant insights can be unearthed, enriching our understanding of the dynamic landscape of music consumption.

KEYWORDS: Data Analysis, Spotify API, Streamlit library, Behavior Analysis

I. INTRODUCTION

In recent years, the surge in popularity of music streaming services, exemplified by platforms such as Spotify, has reshaped the landscape of music consumption. Scientific studies affirm the profound impact of music on various facets of human life and behavior, ranging from memory retention and mood regulation to concentration enhancement and pain alleviation. Spotify, boasting an extensive music catalog, offers users unparalleled access to diverse musical content. Leveraging its Application Programming Interface (API), developers can delve into detailed track attributes encompassing acoustics, tempo, duration, valence, explicitness, release date, danceability, liveness, energy, and more. This wealth of data enables meticulous analysis aimed at discerning the factors that captivate listeners and propel certain songs to prominence. Furthermore, machine learning techniques have emerged as potent tools for predicting the popularity of songs and albums. By leveraging algorithms to analyze patterns within Spotify's vast dataset, researchers can unearth invaluable insights into the characteristics that resonate with audiences. Beyond the realm of song attributes, understanding user habits and preferences is paramount. Through a comprehensive analysis of Spotify user behavior, researchers have revealed robust daily trends in session arrivals, playback instances, and session durations. Such insights illuminate users' preferred times for engaging with the platform and provide crucial guidance for optimizing system architecture and functionality of music streaming services like Spotify. In light of these considerations, this study embarks on a multifaceted exploration of music consumption patterns and user behavior within the Spotify ecosystem. Through data analysis and visualization techniques, coupled with insights derived from machine learning methodologies, the research aims to elucidate the intricate dynamics underpinning music streaming preferences and habits. Ultimately, this endeavor holds promise for enhancing the user experience and informing strategic advancements in music streaming service design and implementation.

II. RELATED WORK

Joshua S. Gulmatico, Aimee Acoba, Julie Ann B. Susa, and Marte D. Nipas from the Department of Computer Engineering at the Technological Institute of the Philippines in Manila [1] introduces SpotiPred, a machine learning method that makes predictions about the popularity of Spotify music based on audio attributes. In order to estimate song popularity, the scientists employed machine learning algorithms to analyse audio aspects using data they obtained from Spotify's API. The findings demonstrate that SpotiPred works better in forecasting song popularity than other approaches. The exploration of possible SpotiPred uses in the music industry serves as the paper's conclusion. [2] M.Kalimuthu and explains SpotiPred, a machine learning method that uses audio cues to forecast Spotify music's popularity. In order to anticipate song popularity, the authors gathered data from Spotify's API and utilised machine

learning algorithms to analyse audio aspects. The findings demonstrate that SpotiPred performs better than other approaches at predicting song popularity. An examination of SpotiPred's possible uses in the music industry finishes the study. [3] Lejla Vardo explores the research investigating using Spotify data how various track attributes can forecast a song's popularity. The study combined combinations of several music parameter combinations with algorithms including Decision Tree, NNC, Random Forest, and SVC to generate multiple predictive models. The findings demonstrated that every feature is crucial for building a successful prediction model, with the Decision Tree algorithm demonstrating the maximum accuracy of 100%. Before releasing their songs, artists could clarify their expectations for success using the information from this study. [4] Boxun Zhang, Gunnar Kreitz and Marcus Isaksson examines user activity on Spotify, including session arrival trends, playback arrival patterns, and daily session length variance. Additionally, it analyses user behaviour on both single and multiple devices, showing users' preferred times of day and relationships between the length and downtime of subsequent user sessions on single devices. The study sheds light on the extensive user base of Spotify's usage habits. [5] Mariangela Sciandra and Irene Carola Spera proposes a statistical method for examining the audio characteristics of songs using the Spotify Web API. It offers statistical methods to analyse these data and presents a Beta GLMM model to predict popularity. The paper is divided into sections that describe how to utilise the suggested model for forecasting song popularity as well as how to link the Spotify Web API to R software. This ground-breaking method makes a significant contribution to the body of knowledge regarding the dissemination of digital music. [6] Agha Haider Raza and Krishnadas Nanath examines the use of machine learning algorithms to provide hit or miss predictions for songs. It includes a review of the relevant literature, the gathering and processing of data, and the evaluation of various methods. The findings demonstrate that there is no foolproof method for identifying a popular song before it is released. The research creates a more robust model for machine learning techniques by fusing technical aspects with sentimental analysis of songs.

Paula Loncar gives a general overview of the visual side of music as well as the expanding research topic of the Internet of Musical Things (IoMusT). [7] It examines how information technology and the music industry interact, taking into account various music interactive interfaces and diverse music visualisation vantage points. In the article, musical elements based on the MIDI format are visualised along with data analysis from Spotify correlated with songs on Billboard charts from the 2010s. This article examines how new ideas and the visualisation of musical data can improve musical possibilities and substance in countless ways.

Jonas Theon Anthony, Gerard Christian and Henry Lucky investigates [8] the application of content-based filtering for individualised Spotify music recommendations. The efficiency of the authors' system is assessed by comparison and contrast with collaborative filtering. Additionally, they go over the benefits and restrictions of content-based filtering.

Wang Hongdan, Siti SalmiJamali, Chen Zhengping, Shan Qiaojuan and Ren Le [9] provides a novel method for determining and categorising the musical genre using deep learning methods. The purpose of the study is to get the feature vector of the audio features by collecting data on music genre based on spectrogram audio. The researchers employ audio spectrograms, which are comparable to RGB photos, as input to classify music genres using deep neural networks. The objective is to create a deep learning approach that can predict and categorise song genres more accurately than current algorithms. [10] Tsukasa Endo, Shin-ichi Ito, Yasue Mitsukura and Minoru Fukumi based on melodic analysis, suggests a novel approach to music analysis. Support vector machines are used in the technique to categorise music into genres based on acoustic data. The suggested approach can manage vast amounts of music data by automatically classifying them according to mood. [11] Ankit Datta, Mrityunjay Joshi, Jai Dalvi and Dr. Reena Kumbhare describes how to leverage the Spotify database to categorise different area pop songs using machine learning and artificial intelligence approaches for music information retrieval. The paper gives a brief overview of the problem description, the analytical technique, the main research findings and observations, and the study's conclusion. When handling many factors simultaneously, the Multi-Class Deep Neural Network technique provides accuracy on par with existing models. The study emphasises the variations in musical aspects and listeners' perceptions in India's regional linguistic music.

III. METHODOLOGY

- The proposed algorithm is designed to facilitate music analysis and recommendation within the Streamlit framework, leveraging the capabilities of the Spotify API. It begins by providing a user interface through Streamlit, allowing users to select their search criteria from options such as song/track, artist, or album, and inputting corresponding search keywords.

- Once the user inputs their search criteria, the algorithm queries the Spotify API to retrieve relevant data based on the selected criteria. For example, if the user chooses to search for a song/track, the algorithm searches for tracks matching the entered keywords. Similarly, for artist or album searches, it retrieves relevant artist or album data.
- Upon retrieving the data, the algorithm presents it to the user, typically in the form of a list of search results. Users can then select specific songs, artists, or albums from the presented options.
- Depending on the user's selection, the algorithm offers additional functionalities. For instance, if a user selects a particular song, they may be provided with options to analyze the song's features, such as acousticness, danceability, energy, and more. This analysis is performed using the Spotify API's audio features endpoint, which provides detailed information about the selected track.
- Furthermore, users may also be presented with recommendations for similar songs based on their selection. This recommendation functionality is powered by the Spotify API's recommendation endpoint, which utilizes machine learning algorithms to suggest songs similar to the user's chosen track.

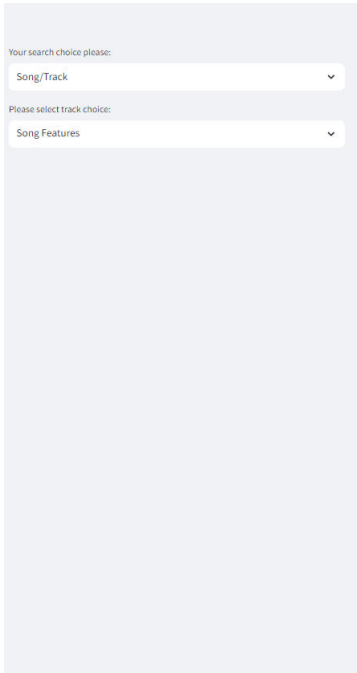
PSEUDO CODE:

1. Import necessary libraries:
 - a. streamlit as st
 - b. pandas as pd
 - c. spotipy (Spotify API wrapper)
 - d. polarplot module (for feature visualization)
 - e. songrecommendations module (for song recommendations)
2. Set Spotify API credentials:
 - a. SPOTIPY_CLIENT_ID
 - b. SPOTIPY_CLIENT_SECRET
3. Authenticate with Spotify API:
 - a. Use SpotifyClientCredentials to obtain access token
 - b. Initialize spotipy.Spotify object with authentication manager
4. Display header for the application: "Music Analysis And Recommendation"
5. Define search choices:
 - a. Options: 'Song/Track', 'Artist', 'Album'
 - b. Allow user to select search choice via sidebar
6. Get search keyword input from the user based on selected search choice
7. Implement search functionality based on user input:
 - a. If search keyword is provided:
 - i. For 'Song/Track' search:
 - Query Spotify API for tracks matching the keyword
 - Extract track information and store in search results list
 - ii. For 'Artist' search:
 - Query Spotify API for artists matching the keyword
 - Extract artist information and store in search results list
 - iii. For 'Album' search:
 - Query Spotify API for albums matching the keyword
 - Extract album information and store in search results list
8. Display search results to the user in the form of a selectable list
9. Allow user to select a song/track, artist, or album from the search results
10. Based on user selection:

- a. If a song/track is selected:
 - i. Retrieve track ID from Spotify API
 - ii. Provide options for analyzing song features or getting similar song recommendations
 - iii. Display selected track features or similar song recommendations
 - b. If an album is selected:
 - i. Retrieve album ID from Spotify API
 - ii. Collect all tracks for the selected album
 - iii. Display track details including ID, name, duration, and explicit status
 - c. If an artist is selected:
 - i. Retrieve artist ID from Spotify API
 - ii. Provide options to view albums or top songs for the artist
 - iii. Display album names with release dates and total tracks or top songs with audio previews
11. Implement feature visualization for selected track:
- a. Extract track features using Spotify API
 - b. Display features using polar plot visualization from polar-plot module
12. Implement song recommendation functionality:
- a. Retrieve access token using Spotify API credentials
 - b. Get track recommendations based on selected track ID
 - c. Display recommended songs with details and popularity visualization using song recommendations module
13. Ensure error handling throughout the application to provide informative feedback to users

IV. EXPERIMENTAL RESULTS

Search Functionality: The application successfully retrieved and displayed search results based on user input for songs/tracks, artists, and albums. Users were able to search for their preferred music content with ease as in Fig1. **Track Analysis:** As in Fig 1 and 2 Users could select specific tracks from the search results and analyze their features such as acousticness, danceability, energy, instrumentalness, liveness, speechiness, and valence. The polar plot visualization provided an intuitive representation of these features. **Similar Song Recommendations:** The application accurately recommended similar songs based on the selected track, leveraging machine learning algorithms and Spotify's recommendation API. Users could explore and discover new music similar to their preferences as shown in Fig 3. **Album and Artist Exploration:** Users had the option to explore albums and top songs by their favorite artists. The application fetched and presented relevant information about albums, including release dates and total tracks, as well as top songs with audio previews provided in Fig 4 . The application featured an interactive user interface with sidebar navigation and selectable options, enhancing user engagement and facilitating seamless interaction



Music Analysis And Recommendation

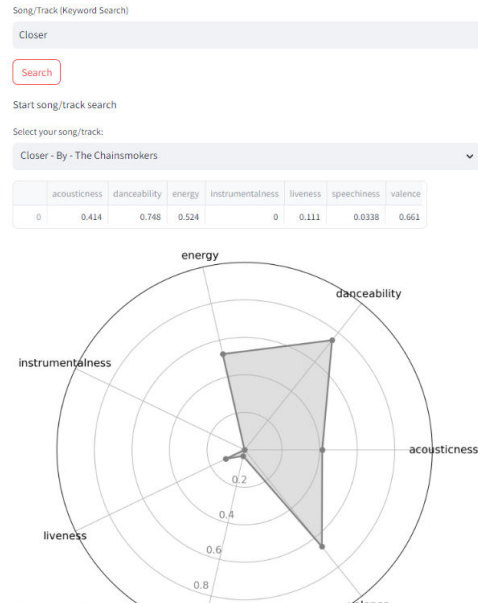


Fig 1

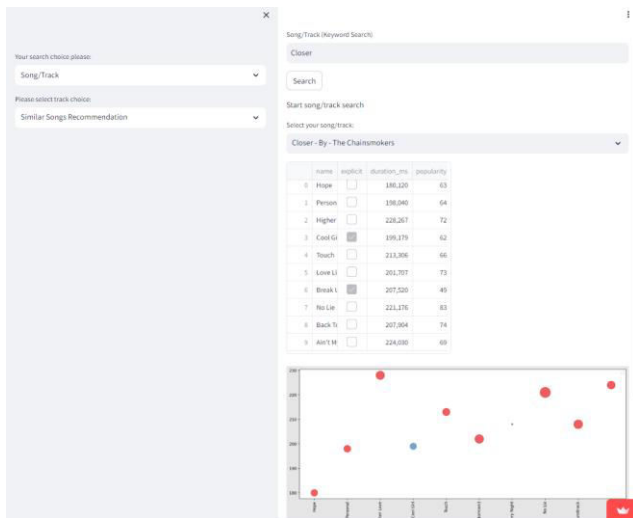


Fig 2

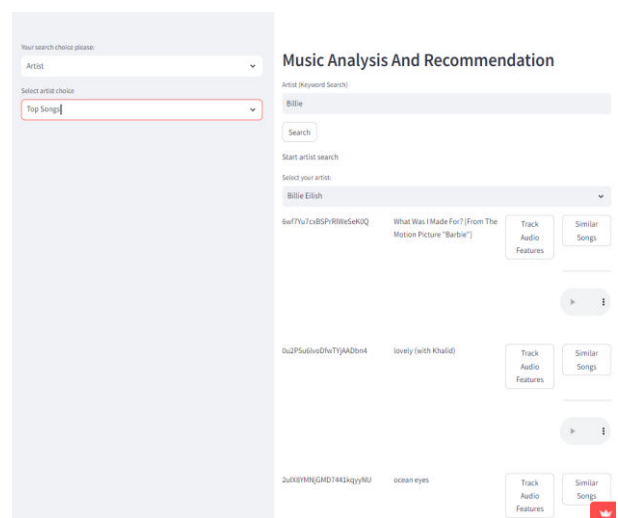


Fig 3

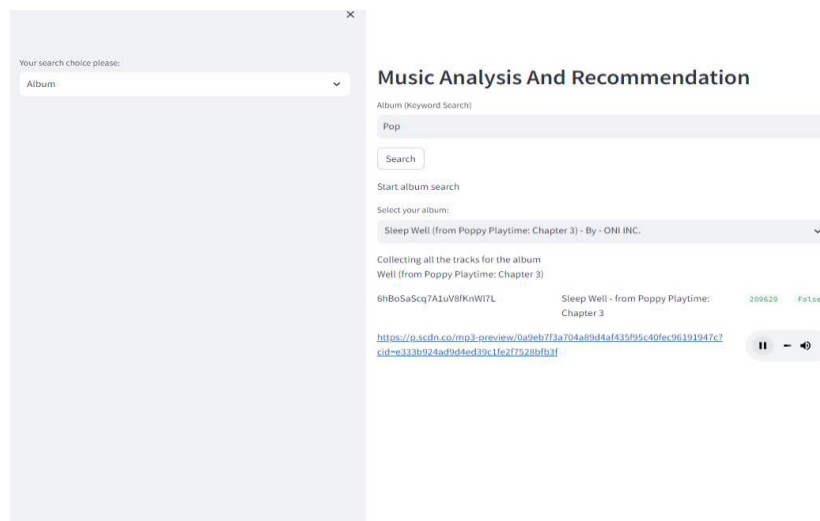


Fig 4

V. CONCLUSION

The methodology outlined provides users with a structured and efficient approach to examining and analyzing their Spotify playlist data. With features such as exploratory data analysis (EDA), trend analysis, and user behavior analysis, users can gain valuable insights into their music preferences and streaming habits. The Home section offers a user-friendly introduction to the website, while the EDA area allows for in-depth exploration of dataset variables. Through trend analysis, users can visualize patterns in their data, while insights into user behavior shed light on how music is streamed. Overall, this methodology offers a comprehensive strategy for understanding Spotify playlist data, empowering users to make informed decisions when selecting tracks.

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