Song Recommendation System Using Machine Learning Algorithms and Data Analysis

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Abstract

The present paper proposes a song recommendation system that employs machine learning methods to suggest various songs to users. By analyzing user searched song name, the system generates song recommendations similar to the user's searched song name. The proposed approach combines collaborative filtering, which recommends songs based on similar user searches, and content-based filtering, which suggests songs based on their attributes. Furthermore, a hybrid approach that integrates both techniques is utilized to generate a more comprehensive set of recommendations. The study evaluates the system's performance using precision and recall metrics, with the results indicating that the hybrid approach surpasses individual techniques. The proposed system can enhance the user experience by delivering appropriate recommendations that cater to their musical interests. In this project, we utilized a sample dataset of songs to establish relationships between users and songs. The objective was to recommend new songs to users based on their searched song. We utilized various libraries such as NumPy and Pandas to implement this project. Additionally, we employed Count Vectorizer in combination with Cosine similarity to analyze and measure the similarity between songs.

Keywords : **Collaborative filtering, Count Vectorizer, Cosine Similarity, Machine Learning methods, NumPy, Pandas, recommend new songs**

I. INTRODUCTION

In recent years, music recommendation systems have gained popularity owing to the widespread availability of music streaming services. With millions of songs available, users often struggle to choose what to listen to [1]. Music service providers also face the challenge of efficiently managing songs and helping customers discover new music through quality recommendations. As a result, there is a high demand for effective recommendation systems. Spotify and Pandora, which are prominent music streaming services are striving to build precise commercial music recommendation systems. These businesses earn their income by helping users find suitable music and charging for the effectiveness of their recommendation service. This results in a flourishing market for effective and efficient music recommendation systems. A music recommendation system utilizes Machine Learning methods to analyze user behaviour and generate tailored recommendations that align with their preferences [2]. The main objective of a song recommendation system is to offer users a relevant and diverse set of music recommendations based on their individual taste, which

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is determined by factors such as their search behaviour, similar attributes to the searched song and song ratings. Song recommendation systems use collaborative filtering and content-based filtering techniques to offer users accurate and diverse music recommendations that improve their listening experience [3]. In this research, we suggest a hybrid song recommendation system that blends both collaborative filtering and content-based filtering methods to generate more extensive and precise recommendations.

Collaborative filtering methods operate on the assumption that individuals who rate or interact similarly with music have comparable preferences for other music items [4]. Nevertheless, a significant problem with collaborative filtering is the inadequacy of evaluations due to the sparseness of the evaluation matrix. As most users only view a limited portion of the complete music library, evaluations are insufficient. In contrast, content-based filtering recommends music based on the features of each track. Combining collaborative filtering and content-based filtering techniques can result in better outcomes, as a hybrid approach offers more comprehensive and accurate recommendations.

II. LITERATURE SURVEY

With the rapid expansion of digital music services, song recommendation systems have gained popularity in recent years. These systems employ algorithms to analyze users' listening habits and provide customized music recommendations according to their preferences. This survey of literature will examine recent research on song recommendation systems.

In [5], the author delves into the internet's pivotal role in modern society and the importance of recommendation systems. It explores different recommendation algorithms, with a particular emphasis on collaborative filtering, content-based, and hybrid approaches. The report provides a detailed analysis of a music recommendation framework, outlining its methodology and limitations. The system utilizes the K-means algorithm to organize music recommendations based on user ratings and previous transactions. It highlights the efficiency of this recommender system in helping users discover music that aligns with their preferences, ultimately enhancing user experiences and decision-making.

Sharma et al. [6] emphasize the profound connection between music and emotions, as well as the advantages of tailored music suggestions. It proposes a novel neural network-based approach to song recommendation that relies on facial expressions to discern an individual's mood, making the process more efficient. This method eliminates the need for users to manually search and create playlists. The use of facial expressions as mood indicators, with input extracted from webcam or camera images, represents a unique contribution to the field of emotion-aware music recommendation systems.

Patel et al. [7] discuss the rapid evolution of music player technology, particularly in smartphones, and the challenge of personalized music selection from extensive online libraries. They emphasize the need for resource-efficient, precise recommendation systems and compare Graph-based Novelty Research, Contextual Information-Based Music Recommendation, and Smart-DJ for personalized music discovery using Douban Music's dataset. This underscores the importance of context-aware music recommendations in the digital music landscape.

Thiagarajan et al. [8] delve into music recommendation systems, which enhance song suggestions based on user preferences and context. They use tools like NumPy, Pandas, Count Vectorizer (CV), and Cosine similarity (CS) to refine recommendations. The study underscores the significance of context-aware music recommendation systems for an enhanced music discovery experience.

Mesghali et al. [9] highlight the significance of personalized music recommendations and their role in helping users discover songs that match their interests. They introduce a content-based music recommendation system using a Bi-LSTM approach, with the "Million songs" dataset. Comparing results with previous studies shows a substantial three percent improvement according to the $F1$-score metric. The survey in [9] underscores the importance of content-based recommendation systems for enhancing the user's music discovery experience.

Sarin et al. [10] say that digital media transformation has influenced the music industry and listening habits. Users have vast music choices, but selecting music for specific moods remains a challenge. The report [10] introduces "SentiSpotMusic," a sentiment-based music recommendation system using Tableau Dashboard and Spotify data. It addresses the need for adaptive recommendations based on users' moods and modern preferences.

Joel et al. [11] emphasize the importance of facial expression analysis in recognizing human emotions for music recommendations. It introduces an emotion-based music system that automates mood detection from facial input data to streamline playlist creation. The study reviews current emotion detection techniques in music and proposes an innovative approach for the Music Thespian system. It highlights the potential of emotion based music recommendations to enhance the user's music experience.

M. Rajeswari et al. [12] introducesd an AI-powered music recommendation system that tailors music suggestions to the user's emotional state. By employing speech analysis with MFCC and deep learning using Artificial Neural Networks, the system enhances music recommendations promising to transform music listening experiences and advance AI-driven music recommendation research.

Amrita Nair et al. [13] discuss the challenge of personalizing music recommendations on streaming platforms due to the dominance of mainstream music influenced by social media. It introduces an emotion-based recommendation system that employs a chatbot to assess the user's sentiment through questions. A score generated from user responses is used to create personalized playlists. The system utilizes the Spotify platform and API for recommendations, aiming to enhance music personalization based on the user's emotional state and diversify the music listening experience.

Vayadande et.al. [14] introduce a system that analyzes facial expressions using computer vision to recommend music aligned with the user's emotional state. Achieving an 84.82% accuracy rate, the system is user-friendly and versatile with applications in personalized music recommendations and enhancing public spaces. It innovatively personalizes music recommendations based on the user's emotional state.

Vitório and Silla [15] explore group music recommendations, emphasizing the need for context-based systems. It proposes a real-time group music recommendation system, evaluating various strategies and conducting experiments. The results demonstrate the system's effectiveness in enhancing playlist selection for user satisfaction in shared environments.

In this literature survey, we examined several recent studies on song recommendation systems, which employ different methodologies including collaborative filtering, semantic analysis, and deep learning algorithms to offer personalized music recommendations. The results of the evaluations indicate that the proposed systems outperform traditional collaborative filtering approaches. These investigations can aid in the development of more efficient and precise song recommendation systems in the future. These recent research papers demonstrate the ongoing development and advancement of music recommendation systems using Machine Learning, with a focus on incorporating various types of data sources and advanced Deep Learning techniques.

III. ARCHITECTURE

The following methods are suggested to anticipate song recommendation system and are shown in the flowchart (Fig. 1).

- Generating or gathering a data collection.
- Analyzing the data.

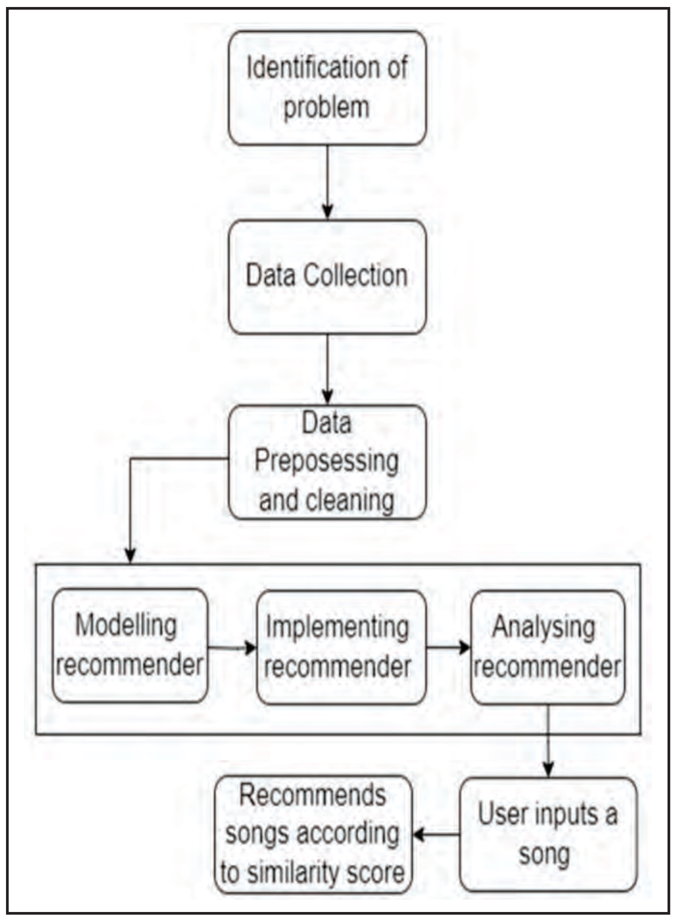

Fig. 1. Architecture of the proposed model

- Deciding which Machine Learning methods are best for song recommendation system.
- Putting the data set's Machine Learning techniques to use.
- Examining the findings.

IV. PROPOSED METHODOLOGY

1) Data Collection: The first step in building a song recommendation system is to collect a significant amount of data. This data will be used to train the model and make recommendations. We used data provided by Audio features and lyrics Spotify songs hosted by Kaggle. The given dataset consists of data on over 18,000 songs available on Spotify, including details such as the artist, album, audio features like loudness, lyrics, genres, sub-genres and more. The original dataset contained only audio features and genres, but we added lyrics to it using the genius library in R and also included information on the language of the lyrics using the Lang detect library in python. However, not all songs in the original dataset were available in this updated version due to the inability to retrieve lyrics for some of the songs. Therefore, only about half of the original songs were included in this new the dataset.

2) Data Pre-processing: After collecting the data, it is necessary to pre-process it by eliminating any duplicate or missing values and preparing it for use in the recommendation system. It may also be necessary to standardize and encode the data for easier processing and comparison. During this stage, tasks such as data cleaning, replacing missing values, and eliminating irrelevant data were performed. The Spotify data included several attributes that were not useful, such as energy, playlist ID, and duration in milliseconds, so they were removed during this stage.

```
# PREPROCESSING
data.drop(
    [
        "acousticness",
        "instrumentalness",
        "liveness",
        "valence",
        "tempo",
        "duration_ms",
        "danceability",
        "energy",
        "key",
        "loudness",
        "mode",
        "speechiness",
        "playlist_name",
        "playlist_id",
        "track_album_release_date",
    ],
    axis=1,
    inplace=True,
)
# data.info()
data.drop_duplicates(subset=["lyrics"], inplace=True)
data.duplicated(subset=["lyrics"]).sum()
data.fillna("nan", inplace=True)
# data.isnull().sum()
```

Fig. 2. Preprocessing the Data

3) Feature Extraction: Feature extraction is a critical step in Data Mining and Machine Learning which involves selecting useful variables from a dataset to improve the accuracy and performance of Machine Learning models. The correlation coefficient is used to determine which variables are important, and these are then utilized for training methods. Relevant features such as song lyrics, genre, track artist, and popularity are extracted from preprocessed data to build a model that can predict a user's preferred songs. To evaluate data mining models, the data is separated into test and training datasets, and different ratios are used to study prediction estimation. The aim of this paper is to identify the most significant variables that can improve the accuracy of music performance prediction models through various feature selection algorithms.

4) Model Training: To create a music recommendation system, a Machine Learning model is trained on extracted features using different algorithms such as collaborative filtering, content-based filtering, or hybrid filtering. Collaborative filtering uses data from similar users, while content-based filtering relies on similarities between song features. Hybrid filtering combines both techniques for more accurate recommendations. The recommendation system calculates the cosine similarity between the features of one music and another. This is done by representing the features in vector form and calculating their distance. Content-based recommendation relies solely on sound similarity and doesn't require input from the listener. The cosine similarity value ranges from –1 to 1, and recommendations are made by selecting several music tracks with the highest cosine similarity values. This research recommends five music tracks at a time, using two methods: one using only the cosine similarity value, and the other using both the cosine similarity value and music genre information. Cosine similarity measures the similarity between two or more vectors by calculating the cosine of the angle between the vectors. The formula for cosine similarity involves taking the dot product of the vectors and dividing it by the product of the Euclidean norms or magnitudes of each vector.

$$Similarity = cos(\theta) = \frac{A \,.\, B}{\|A\| \;\; \|B\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \;\; \sqrt{\sum_{i=1}^{n} B_i^2}}, \quad (1)$$

Content-based filtering utilizes the features of each item to find comparable items. Cosine similarity is calculated by taking the cosine of the angle between two non-zero vectors A and B. The range of cosine similarity values lies between 0 and 1. A score is assigned to each item based on how similar it is to all other items in the dataset. Using the properties of each song in a Spotify playlist, we calculate the average score of the entire playlist, and then suggest a song that has a similar score to the playlist but isn't in it. When two vectors are perpendicular, the cosine similarity is 0, indicating that they are orthogonal. The closer the vectors are, the more similar they are, and as a result, the

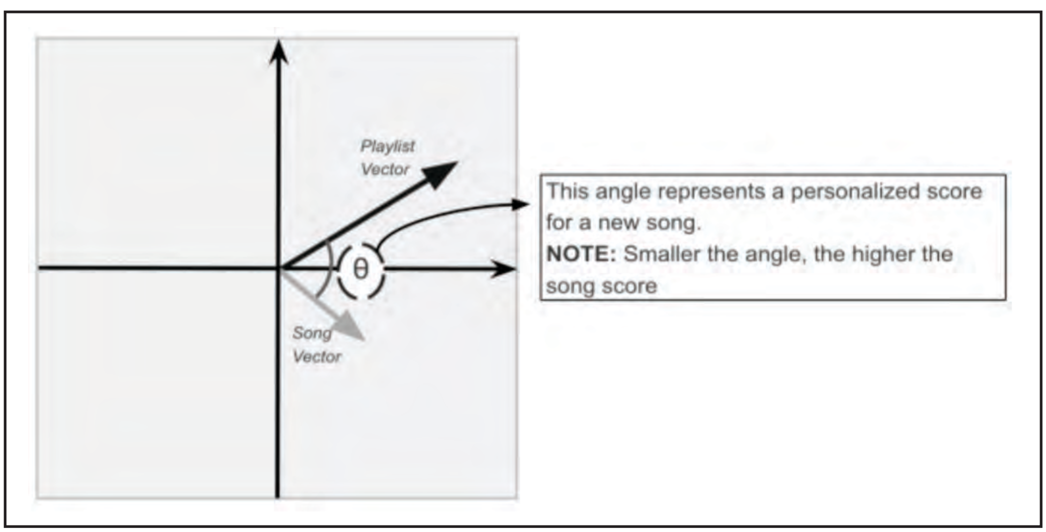

Fig. 3. Understanding Cosine Similarity

```
# VECTORIZATION
cv = CountVectorizer(max_features=1000, stop_words="english")


ps = PorterStemmer()

##Stemming of text
def stem(text):
    y = []
    for i in text.split():
        y.append(ps.stem(i))

    return " ".join(y)


data["tags"] = data["tags"].apply(stem)
vectors = cv.fit_transform(data["tags"]).toarray()

# Calculating cosine distance of the song vectors
similarity = cosine_similarity(vectors)
# print(similarity)
```

Fig. 4. Vectorization Process

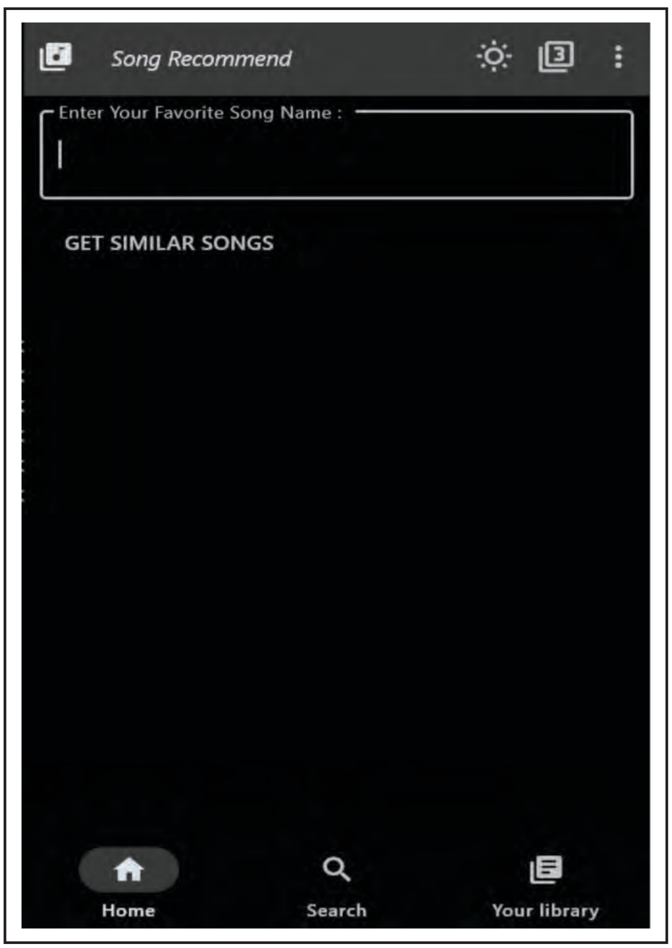

Fig. 5. First Display Page

Fig. 6. System recommending similar songs according to the user's search

similarity measurement approaches 1. Fig. 4 explains this. It shows the code for vectorization and cosine similarity of the data.

5) Evaluation: Once the model is trained, it needs to be evaluated to determine its accuracy and effectiveness in generating recommendations. This can be done by comparing the recommended songs to a user's search or surveying users on the relevance of the recommendations.

6) Deployment: Finally, the recommendation system will be deployed and integrated into a music streaming service. Users will be able to access the system through an interface, where they can input their preferences and receive personalized song recommendations. The system should also continuously learn and update its recommendations based on user feedback to improve accuracy over time.

V. RESULT AND DISCUSSION

The system uses Angular and Euclidean distance calculation techniques, the Count Vectorizer class, and cosine similarity method to recommend similar songs to the user based on the input song's key features of title, artist, and top genre. The system searches through its database of songs and retrieves values for the features of all songs, which are then transformed into a matrix of token counts. Cosine similarity is calculated between the inputt song and all other songs in the database, with the highest similarity scores indicating the most similar songs. The model then predicts the seven most similar songs based on these scores and presents them to the user on the frontend.

VI. CONCLUSION

The song recommendation system has a lot of potential for future advancements and improvements [4]. For instance, the system can be enhanced by incorporating user feedback on the recommended songs through rating or feedback provision. By doing so, the system can adjust its recommendations based on the user's preferences.

Additionally, the current system uses only title, artist, and top genre to generate recommendations. However, incorporating other features of a song such as lyrics, tempo, and mood can improve the accuracy of recommendations. Integrating the song recommendation system with popular music streaming platforms like Spotify or Apple Music can improve the system's accuracy by analyzing user listening patterns [3].

Last, the system can be improved by providing personalized recommendations based on the user's listening history, preferences, and demographics. Collecting and analyzing additional user data can help achieve this. Overall, these enhancements can make the song recommendation system more accurate and personalized for users.

To conclude, the song recommendation system is a valuable tool that effectively provides users with similar songs based on the input song's key features [4]. Nevertheless, there is always room for growth, and the system can be further refined by integrating user feedback, utilizing more song features, integrating with popular music streaming platforms, and delivering personalized recommendations based on user data. By continually refining the system, we can ensure it remains a valuable tool for music enthusiasts to discover new songs and artists.

AUTHORS' CONTRIBUTION

Prof. Anagha Patil conceptualized the research. Siddhi Kolwankar and Vinish Nagzarkar worked on literature review and collection of project information. Jayesh Wadhe worked on the architecture of the project. Harsh Sawant prepared the draft transcript. All the authors collectively finalized the paper.

CONFLICT OF INTEREST

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in the manuscript.

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