A Dynamic Music Recommendation System Based on User Feedback

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Motivation and Introduction

- In recent years, the demand for automatic music recommendations has surged, facilitating music discovery tailored to individual tastes. Examples are Spotify, Youtube Music, iTunes.
- Most popular approaches include content-based and collaborative filtering methodologies. New approaches also include AI-driven emotion-aware functions. However, challenges persist, including user interaction, cold start, and song freshness. To fill these gaps, this study seeks to develop a dynamic song recommendation system which aims to recommend popular and new songs aligned with user preferences.
- We used the million-songs dataset from a publicly available Kaggle competition (https://www.kaggle.com/datasets/undefinenull/million-song-dataset-spotify-lastfm).The dataset files includes more than 9.7 million listening history records, involving 50,683 songs and 962,037 users. Datasets are stored in SQLite database.

Exploratory Data Analysis

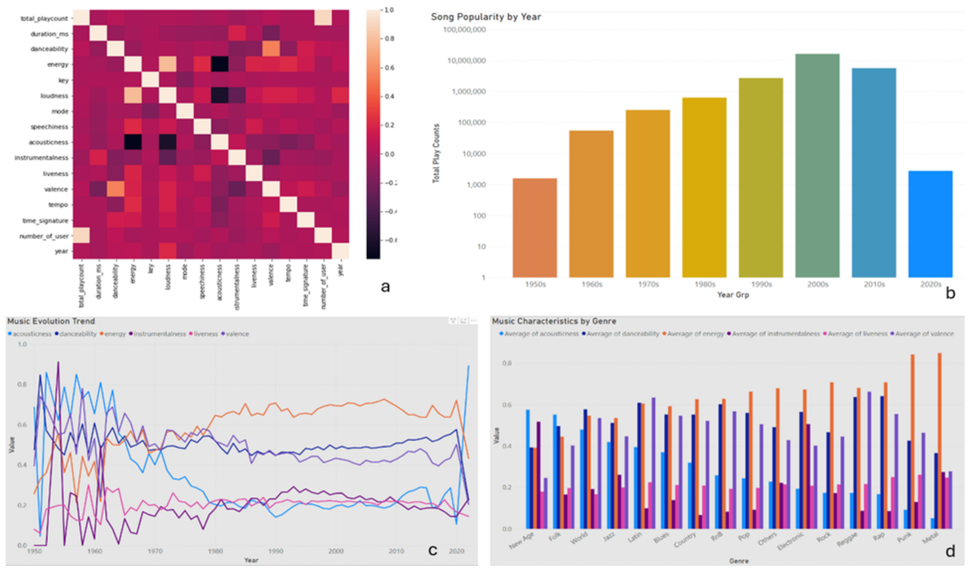

Figure 1. Exploratory Data Analysis

Exploratory Data Analysis (**Figure 1**) helps us make decisions on algorithm and data cleaning strategy. The correlation matrix chart (**Figure 1.a**) highlights parameters with stronger correlations, such as energy vs loudness, and danceability vs valence**. Figure 1.b** depicts the popularity of songs over time. Furthermore, songs produced post-1970s tend to exhibit more stable music characteristics (**Figure 1.c**). **Figure 1.d** illustrates the trend of songs' average characteristics by genre types, highlighting a negative correlation between acousticness (orange bar) and energy (blue bar) observed for these genre types.

Models and Algorithms

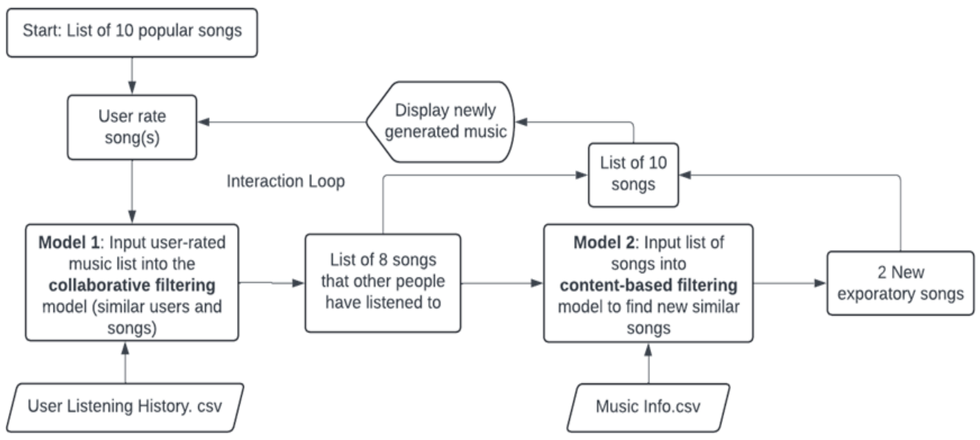

Figure 2. Flow chart of song recommendation system algorithm

Our approach to modeling involves two models: a Collaborative filtering model (**Model 1** in **Figure 2**) and a Content-based filtering model (**Model 2** in **Figure 2**). Eight songs were recommended by Collaborative filtering model based on preference of similar users via the Singular Value Decomposition (SVD) algorithm. Two more songs were recommended by Content-based model through K-Nearest-Neighbors (KNN) analysis of song attributes from the "Music Info.csv" dataset. User feedback was collected through interactive interface as shown in the **interaction loop** in **Figure 2**. It refines future suggestions, making music discovery more personalized.

Interactive Tool

We built a web service with Flask-RESTful to simplify the process of creating RESTful APIs and using front-end technologies such as HTML, CSS, and JavaScript(D3) for user interfaces and client-side functionality. Our web app dynamically recommends songs and integrates feedback. It includes a **(1)** login page, **(2)** a genre-selection page for new users, and **(3)** a personalized dashboard with a song list and music player as shown in **Figure 3**. Users log in with a unique ID are directed to the appropriate page. New users select favorite genres to receive initial suggestions, while returning users get a recommended song list in a personalized dashboard. Users can load more songs and provide feedback with play/pause and like buttons, influencing future recommendations.

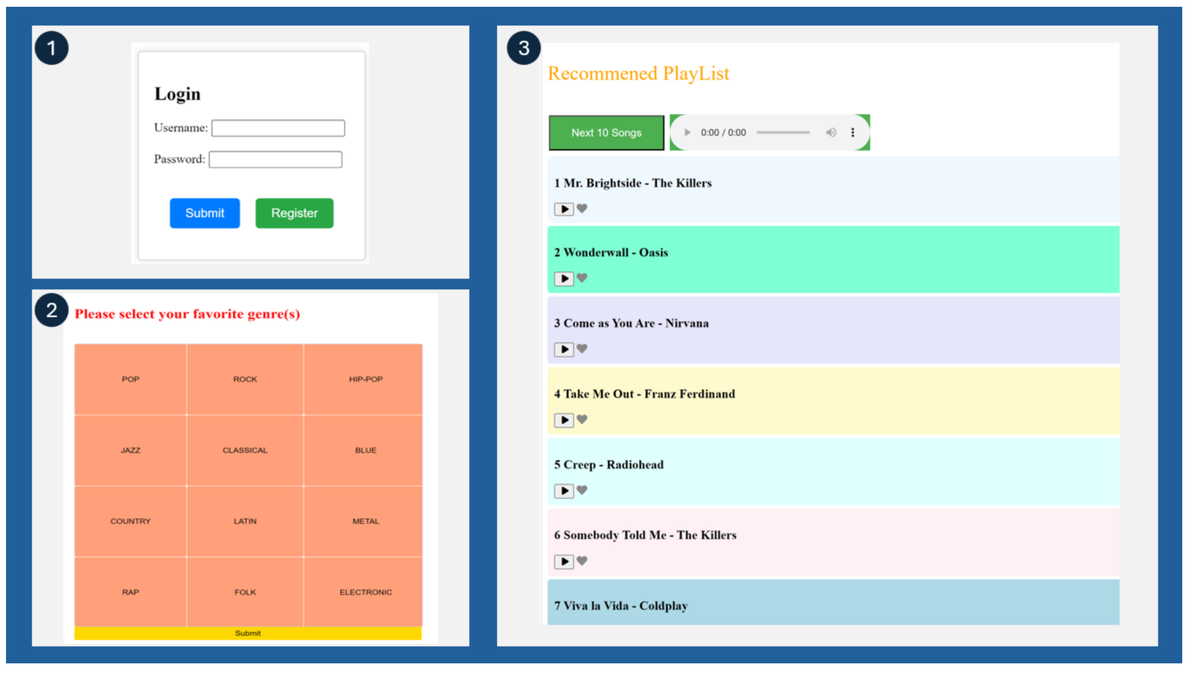

Figure 3. Innovative Interface: Dynamic song recommendation and Feedback integration (user **(1)** login page, **(2)** a cold start page for new users to choose favorite genre(s), and **(3)** a customized user dashboard containing a dynamic recommended song list with music playing and feedback function)

Evaluation of Models and Interface

Prediction Models

Model 1's prediction performance is measured using an 85/15 training/testing split and cross-validation. The prediction on the test dataset gives an RMSE value of 2.9347 and a MAE value of 1.6458. After evaluating algorithm SVD on three splits of test dataset, it gives a mean RMSE value of 2.9748, with std of 0.0018 and a man MAE value of 1.6794, with std of 0.0002. The consistent and lower values of RMSE and MAE signify superior performance, establishing them as standard benchmarks for recommendation systems.

For **Model 2**, evaluating a KNN-based music recommendation system focused on musical features is inherently challenging due to the subjective nature of music preference and the emphasis on discovery. Success in this aspect might not be fully captured by traditional metrics like accuracy or precision. Therefore, we recommend long-term user follow up and evaluation to gather information on quality of exploratory song recommendation.

Interface Evaluation

The interface was evaluated by survey 20 users. It is highly rated for its **simplicity**, **affordance**, **flexibility**, and **overall experience**. Specifically, cold start page with clickable tiles of different genre is very easy to navigate and use. In the user dashboard, the two-music player design is favored by users. The individual playing function under each recommended song makes it easy to play or pause each song without scrolling all the way to the top or bottom of the webpage. The player on the top makes it easy to know whether there is some song playing and easy to pause it without searching through the list. Users also mentioned that the "like" button (heart icon) is a simple and intuitive way to provide feedback.

Discussion and Conclusions

This study developed a dynamic song recommendation system utilizing both collaborative-filtering and content-based filtering, user feedback, and interactive interface. It aims to recommend popular and new songs aligned with user preferences, updating dynamically based on user feedback. Unlike other song recommenders, such as Spotify, Youtube music, etc., which focus on streaming of songs, our system aims at exploring new music and finding out the ones user like in a short period of time. To do that, we used the million song dataset from a publicly available Kaggle competition. We used a collaborative filtering model using SVD to identify similar users based on their listening history while 2 exploratory songs were recommended based on musical characteristics using KNN. To make it user-friendly and enjoyable to use this system, we made a dynamic interactive webapp including three webpages. The interface was highly rated for its simplicity, affordance, flexibility, and overall experience.

Future Work

(1) Some users like to use it as a music player. And the song connected with the link is a short version of the full song. Thus, it is helpful if Youtube link or Google search can be provided as a link for each recommended song in the user dashboard.
(2) To allow user to choose between listening to preferred songs or focusing on exploring new songs, the exploratory songs can be put in a separate section or be separated with a different visual.
(3) To better evaluate user satisfaction of the recommendation of exploratory songs (Model 2), we recommend conducting detailed user studies or surveys to gather qualitative feedback on user satisfaction on recommended music and track user engagement over time to understand how the model influences long-term music exploration and listening habits.