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Introduction

- Music is the art of arranging sound and noise together to create harmony, melody, rhythm, and expressive content. It is organized so that humans and sometimes other living organisms can express their current emotions with it.
- Our project is a classifier that can classify songs into 10 genres namely: Blues, Classical, Country, Disco, Hiphop, Jazz, Metal, Pop, Reggae, and Rock.
- **Dataset Description:** The dataset is provided in this link (MusicGenre - Google Drive). The link contains two csv files. One with audio files with 3 second duration and the other with 30 seconds duration. There are 58 features and 1000 records. There are 100 songs from every genre (totally 1000 songs from 10 genres).
- **Classifiers Used:** We have used 5 ML classifiers namely: Support Vector Machine(SVM), K-Nearest Neighbour(KNN), Naive Bayes, Decision Tree, and Random Forest. Random Forest is an ensemble model.
- We have calculated the Accuracy, Precision, F-Measure, and Recall values with all the above mentioned classifiers for the entire dataset and each target class.
- Moreover we have integrated Boosting and Explainable AI.

Motivation

The idea originated from some of the biggest music streaming platforms in the world like Spotify, Amazon Prime Music, and Youtube Music which uses genre classification to provide music recommendations to its users.
ML algorithms can automatically tag and organize music based on genre. This helps streaming services and digital libraries to efficiently categorize and manage their vast collections of songs, making it easier for users to search and discover music.

Some of the applications of an Machine Learning based Music Genre Classifier are listed below:

1. ML models can analyze audio signals and automatically generate metadata such as genre labels, tempo, mood, and instrumentation information. This can streamline the process of annotating music datasets for researchers, musicologists, and musicians.
2. ML-powered genre classification can be used to create personalized radio stations that cater to specific music preferences. By understanding the genre preferences of listeners, radio stations can curate playlists that match their tastes, leading to a more engaging and enjoyable listening experience.
3. ML models can be integrated into DJ software and music production tools to automatically identify the genre of music tracks. This can help DJs in selecting compatible tracks for seamless mixing during live performances and assist music producers in exploring different genres during the composition process.
4. ML algorithms can analyze the popularity and trends of different music genres in specific demographics or regions. This information can be valuable for market research purposes, helping music labels, advertisers, and event organizers understand audience preferences and tailor their strategies accordingly.

Literature Survey

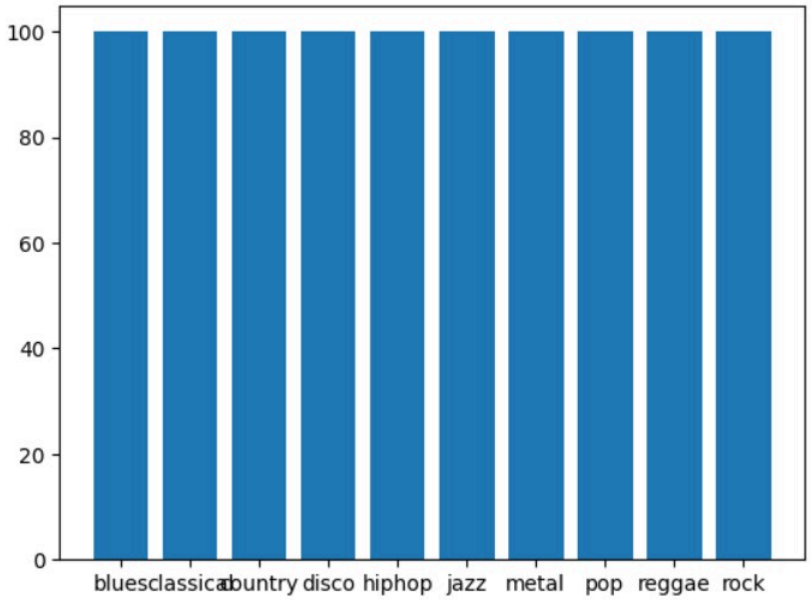
Sl.No	Year	Paper Title	Domain/Dataset	Architecture	Results	Open Problem
1	2021	Music Genre Classification: A Review of Deep-Learning and Traditional Machine-Learning Approaches.	GTZAN dataset (from Kaggle) with 1000 excerpts of thirty seconds and three seconds duration each.	K-Nearest Neighbours, Linear Logistic Regression, Multilayer Perceptron, Random Forests trees, and Support Vector Machines.	Highest accuracy is for KNN (92.69%)	30 second duration input features cannot provide better accuracy than 3 second duration input features.
2	2020	Music Genre Classification using Machine Learning	GTZAN dataset is used which has 10 classes, Blues, Classical, Country, Disco, Hip-Hop, Jazz, Pop, Metal, Reggae and Rock.	CNN, Artificial Neural Network, MLP, SVM and Decision Tree.	Highest accuracy is for CNN (91%)	The country and the rock genre were confused with other styles, although traditional and blues were easily identified.
3	2019	Music Genre Classification using Machine Learning Algorithms: A comparison.	Free Music Archive dataset [FMA paper link] which contains audio from 8000 songs arranged in a hierarchical taxonomy of 8 genres.	CNN model and the RNN(Recurrent Neural Networks) model in parallel.	CNN model got an accuracy of 88.54%	Feature based classification is performing poorly compared with image based classification.

Sl.No	Year	Paper Title	Domain/Dataset	Architecture	Results	Open Problem
4	2020	Music Genre Classification and music recommendation by using deep learning	GTZAN dataset (from Kaggle) with 1000 excerpts of thirty seconds and three seconds duration each.	MLP, Logic Regression, Random Forest, LDA, KNN, SVM. MusicRecNet is used for genre classification.	Highest accuracy is for Logic Regression (97%)	Rock genre was difficult for the classification. The reason is that rock displays some characteristics similar to other genres such as metal.
5	2020	Convolutional Neural Networks Approach for Music Genre Classification	GTZAN dataset is used which has 10 classes, Blues, Classical, Country, Disco, Hip-Hop, Jazz, Pop, Metal, Reggae and Rock.	CNN model architecture is used in this research. It is composed of 5 convolutional layers.	77% accuracy is obtained	In the confusion matrix, the Rock genre scores the lowest.

Proposed Methodology

1. **Data Preprocessing:**
    - We have applied normalization for all the entries.
    - There are no missing values in the dataset.
    - The data is split into x and y where y is the target class and x is all the features except the target class.
    - The dataset is further split in a 70:30 ratio for training and testing respectively.

The dataset is balanced.



2. **Training and testing the Model**
    - The dataset is trained for 5 classifiers separately: SVM, KNN, Naive Bayes, Decision Tree and Random Forest.
    - The model is then tested. The evaluation metrics used are Accuracy, Precision, Recall, and F-Measure.

    .

Results

The following results were obtained without boosting and feature selection.

ML Model	Accuracy	Precision	Recall	F-Measure
KNN	23.33%	24.08%	25.18%	23.88%
Naive Bayes	38.33%	52.5%	41.8%	38.9%
Decision Tree	59.67%	59.67%	59.67%	59.67%
SVM	64.49%	65.87%	65.49%	63.75%
Random Forest	78.67%	78.67%	78.67%	78.26%

For the individual target classes, the following output was obtained.

1. Using **Decision Tree**

	Precision	Recall	F-Measure
Blues	92%	80%	86%
Classical	96%	84%	90%
Country	66%	70%	68%
Disco	88%	77%	82%
Hiphop	74%	83%	78%
Jazz	69%	76%	72%

Metal	81%	90%	85%
Pop	94%	89%	91%
Reggae	72%	91%	81%
Rock	58%	48%	53%

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2. Using **Random Forest**

	Precision	**Recall**	**F-Measure**
Blues	92%	80%	86%
Classical	96%	84%	90%
Country	66%	70%	68%
Disco	88%	77%	82%
Hiphop	74%	83%	78%
Jazz	69%	76%	72%
Metal	81%	90%	85%
Pop	94%	89%	91%
Reggae	72%	91%	81%
Rock	58%	48%	53%

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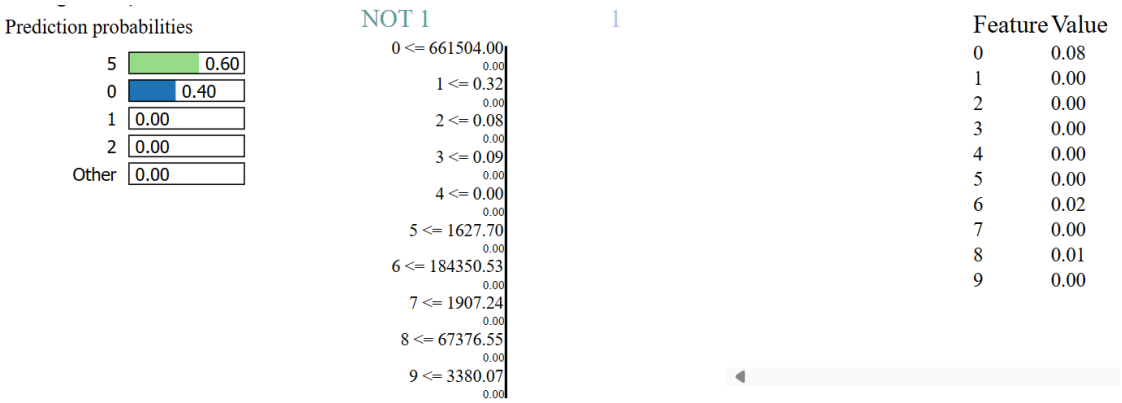
3. Using **SVM**

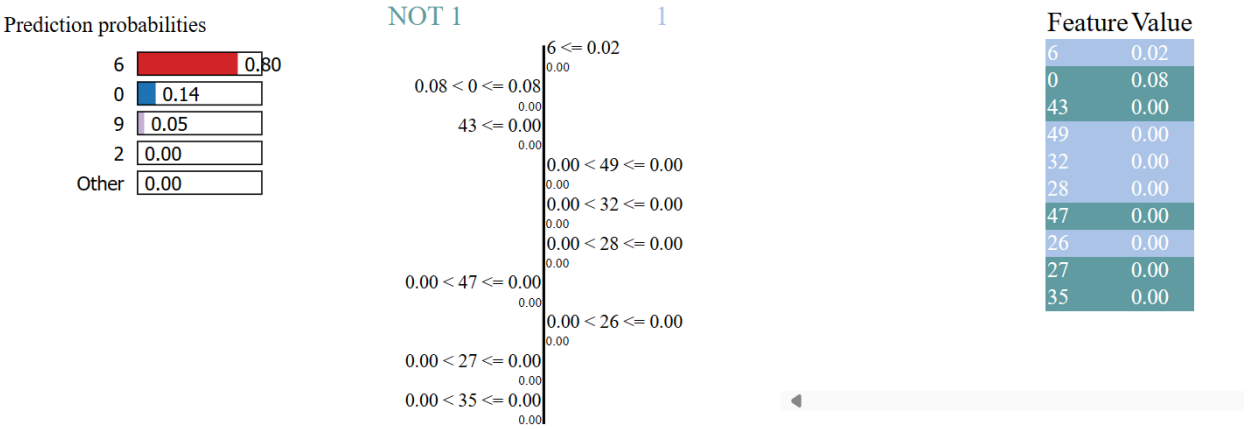
	Precision	Recall	F-Measure
Blues	48%	62%	54%
Classical	85%	100%	92%
Country	77%	61%	68%
Disco	60%	26%	36%
Hiphop	53%	56%	54%
Jazz	83.3%	88%	85%
Metal	60%	63%	85.7%
Pop	52%	80%	63%
Reggae	64%	66%	65%
Rock	60%	29%	39%

Explainable AI

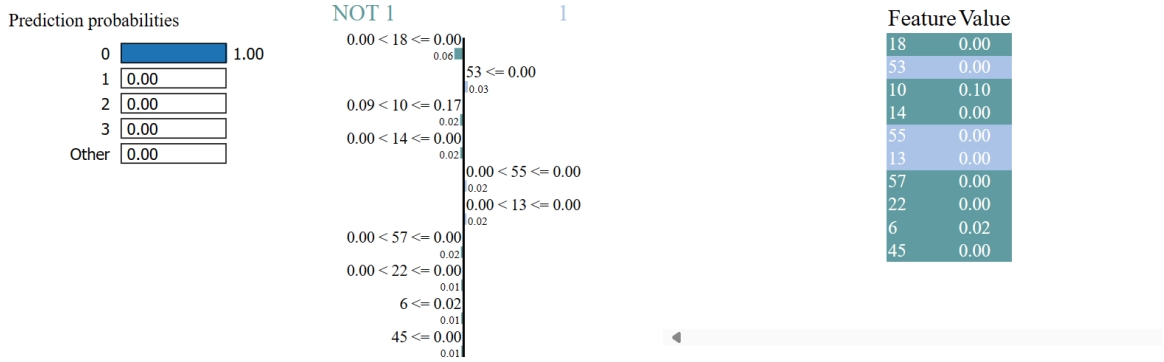
1. KNN



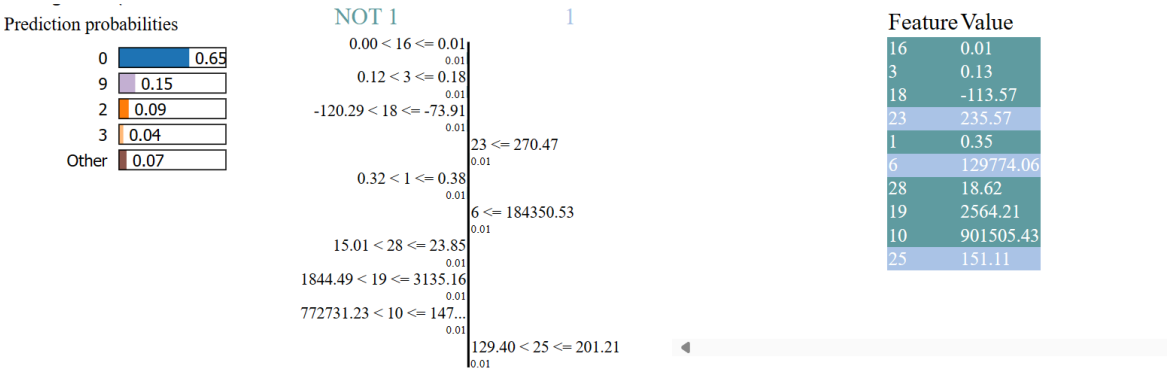
2. Naive Bayes



3. Decision Tree



4. Random Forest



Conclusion and Future Work

It has been observed that the ‘Rock’ genre was difficult for classification. The reason is that rock displays some characteristics similar to other genres such as metal. Therefore we got very less accuracy, precision, recall, f-measure values for ‘Rock’ genre.

The classifier in which we got the highest accuracy, precision, recall and f-measure is Random Forest. It is because Random forest is an ensemble model.

In conclusion, the Music Genre Classifier presents a promising solution for music recommendation and organization. By continuing to iterate and innovate upon this foundation, there is a lot of potential to further advance the capabilities and applicability of such systems in various real-world scenarios.

The future scope of this project include:

- Future research could focus on developing algorithms capable of identifying subgenres or regional variations. This could lead to more precise music recommendations and a deeper understanding of music diversity.
- Integrating multiple modalities such as audio, lyrics, album covers, and user listening patterns could enhance genre classification accuracy and robustness.
- Music pieces often belong to multiple genres simultaneously, making multi-label classification a relevant direction for future research. Developing models capable of assigning multiple genre labels to a single track could better capture the complexity and diversity of music styles.
- Future genre classification systems could prioritize user preferences and listening habits, dynamically adapting genre labels based on individual tastes and context.
- With the proliferation of streaming services and IoT devices, it can perform genre classification directly on user devices, enabling low-latency.

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