**Project Report: Music Genre Classification**

**1. Introduction**

Music genre classification is a fundamental task in music information retrieval. The objective of this project was to develop a machine learning model capable of automatically identifying and classifying the genre of a music track based on its audio features. The primary goal was to build a robust classifier that could accurately categorize songs into one of the 10 distinct genres from the GTZAN dataset.

**2. Abstract**

This project focuses on the development of a music genre classification system using a supervised machine learning approach. The system was built using the GTZAN dataset, a standard collection of music files for this task. Audio features, specifically Mel-Frequency Cepstral Coefficients (MFCCs), along with other spectral features, were extracted from the dataset. A Convolutional Neural Network (CNN) was chosen as the primary classification model due to its effectiveness in pattern recognition from sequential data. The model was trained, evaluated, and saved to a file for future use. The final system is a Python-based application that can load an audio file, extract its features, and predict its genre with a high degree of accuracy.

**3. Tools Used**

The project was developed using a combination of Python libraries and a well-known dataset.

* **Python:** The core programming language used for the entire project.
* **Librosa:** An open-source Python library used for audio analysis and feature extraction, including MFCCs.
* **Pandas:** Used for efficient data manipulation and analysis, primarily for handling the pre-extracted features from the CSV file.
* **Scikit-Learn:** A powerful machine learning library used for data preprocessing (e.g., StandardScaler, LabelEncoder) and for building and evaluating the initial baseline model, the RandomForestClassifier.
* **TensorFlow/Keras:** The deep learning framework used to build, train, and evaluate the Convolutional Neural Network (CNN) model for more advanced and accurate classification.
* **Jupyter Notebook:** The interactive environment used for developing and testing the code step-by-step.

**4. Steps Involved in Building the Project**

The project was built through a structured, multi-step process to ensure a robust and functional outcome.

1. **Dataset Acquisition:** The GTZAN dataset was used for this project. This dataset contains 10 genres, with 100 audio files per genre. Pre-extracted features were used from a provided CSV file for efficiency.
2. **Data Preprocessing:** The feature data was loaded using the pandas library. The categorical genre labels were converted to numerical values using LabelEncoder. The feature values were then normalized using StandardScaler to prepare them for the model. The data was split into training and testing sets to prevent overfitting.
3. **Model Building (CNN):** A Convolutional Neural Network (CNN) was constructed using the Keras deep learning framework. The model architecture included Conv1D and MaxPooling1D layers to learn patterns from the audio features, followed by Dense layers for classification.
4. **Model Training:** The CNN was trained on the preprocessed training data over a series of epochs. The model's performance was monitored on the validation data to ensure it was learning effectively.
5. **Model Evaluation and Saving:** After training, the model was evaluated on the test set to determine its accuracy. The trained model, along with the scaler and label\_encoder, were saved to disk using joblib and model.save(), allowing the model to be used later for predictions without needing to be retrained.
6. **Prediction Script Development:** A final Python script was created to demonstrate the model's functionality. This script takes a new audio file, extracts its features, scales them using the saved scaler, and then uses the saved model to predict the music genre.

**5. Conclusion**

The project successfully delivered a machine learning model capable of classifying music genres from audio features. The CNN model achieved a high level of accuracy on the test data, demonstrating the effectiveness of deep learning for audio classification tasks. The final deliverable is a complete, well-documented codebase that can be easily used to predict the genre of any new audio file. This project provides a strong foundation in audio signal processing and deep learning, validating the skills required for developing real-world AI applications.