Raga Classification

Binary classification model for Indian classical music scales

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Agenda

1. **INTRODUCTION:** Background and Business Problem
2. **DATA OVERVIEW:** Dataset Description
3. **DATA PREPARATION:** Data Pre-processing
4. **RESULTS:** Model Performance
5. **FUTURE EXTENSIONS:** Recap and Next Steps

Executive Summary

Objective

Build binary classification model to identify “major”: and “minor” raga (indian musical scales).

Major: Bhoopali, Malkuan, Sarang, Yaman
Minor: Asawari, Bhageshree, Darbari Kanada, Bhairavi

Methodology

This project includes 2 models: baseline and iterative model post from Random Search parameter tuning.

FInal model produced 92% accuracy.

Data Overview

Sourced from Kaggle, included 80 samples which fell under 8 Ragas (classes).

Data was expanded by splitting samples in 30 sec clips and converted to mel spectrograms to fed in CNN

Future Work

Expand on the starting established this project. A hybrid model using a combination of LSTM and CNN may hold the most promise for this problem statement.

Business Problem: Bridging the gap in learning Indian Classical Music

Indian classical music of the **one of oldest music systems i**n the world. It's renown for extremely rich and complex music system which requires years of dedicated training to master. Limited number of qualified teachers and the intricacies of this art form pose **challenges in transferring its knowledge** to a wider audience.

Exploring the idea of building a **raga classification model** opens up opportunities for artists as their music composition can tap into the wide range of melodic variations and combinations that have not be exposed to mainstream or western music.

What is a Raga?

It is a melodic framework that defines the tonal structure, melodic patterns, and emotional characteristics of a musical composition.

Similar to the Western Dorian scale, raga is based off 7 notes

Sa. Re, Ga, Ma, Pa, Da, Ni

Each raga holds a different combinations and variations of these notes, There are 72 parent ragas within Indian classical music.

Data sourced from Kaggle included samples of 8 ragas, which can be classified into major (uplifting) and minor (soothing) scales

Data Overview

- Sourced from Kaggle
- Included **8 Ragas (classes)**: Asawari, Bageshree, Bhairavi, Bhoopali, Darbari Kanada, Malkauns, Vrindavani Sarang, Yaman
- Out of the **80 total samples**, 40 samples are vocal and 40 samples are played on violin
- These audio files contain both male and female singers and are a mix of different voice qualities.

Binary Classification

Category 1: Major Ragas

- Bhoopali
- Malkauns
- Sarang
- Yaman

Category 2: Minor Ragas

- Asawari
- Bageshree
- Bhairavi
- Darbari Kanada

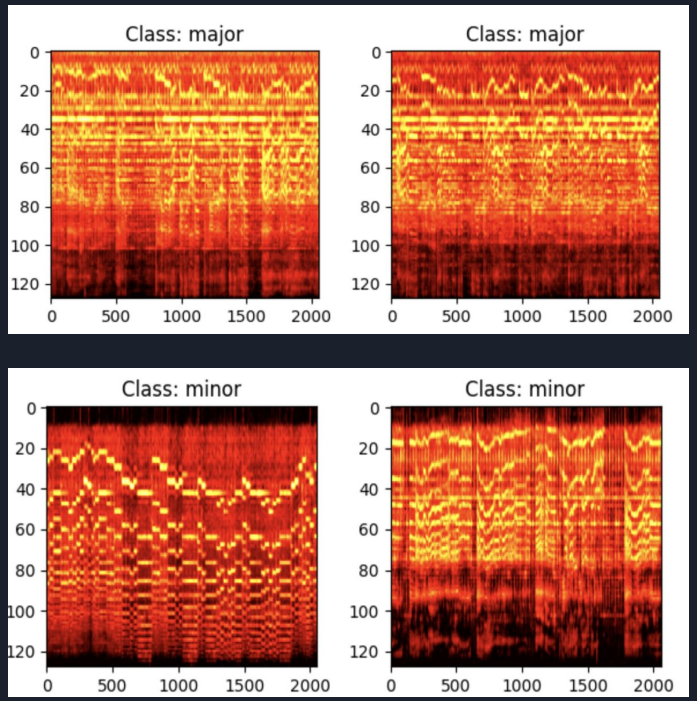
To build an initial model, I simplified the classification into a binary classification problem: Major vs Minor.

- **Major** ragas have a more joyful and uplifting character. They tend to **emphasize the notes straight notes.**
- The **minor** ragas tend to emphasize **altered or flattened notes**, which evokes tones such as longing or melancholy.

Audio data was standardized and converted into mel spectrograms to extract existential features

Data Pre-Processing

1. **Standardize Duration**: Split audio files in to 30 sec clips.
2. **Pitch normalization:** Normalized the audio data to a common tonic pitch, C, using pitch shifting since the original vocals were performed in different shrutis or pitches
3. **Mel spectrogram calculation**: Generated mel spectrogram for each normalized audio sample. Mel spectrograms provide a visual representation of the audio's frequency content, emphasizing the perceptually relevant information for classification.



Sample Mel Spectrograms for "major" and "minor"ragas

X axis represents time, Y represents frequency. Brighter color indicate higher intensity or frequency. Dark indicates lower frequency.

We see that the "minor" images includes darker colors which aligns with the soothing nature of those scales

The baseline CNN model exhibited poor performance, achieving only 47% accuracy on unseen data

Baseline Model

Model consists of a convolutional layer followed by max pooling, flattening, and two dense layers with a sigmoid activation function.

- Training Accuracy: 53.58%
- Test Accuracy: 47.62%

Confusion matrix, Figure 2, shows model is only outputting/predicting 1 (minor).

- 1 = minor
- 0 = major

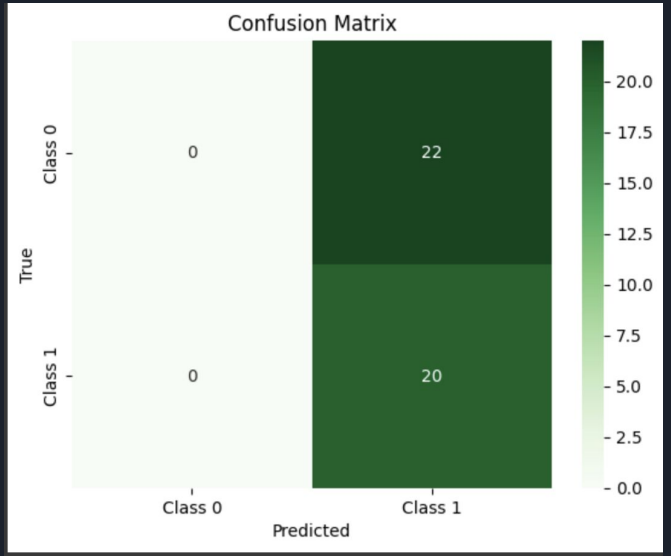


Figure 2: Test - Confusion Matrix for Baseline Model

Parameter tuning boosted model to 92% accuracy by optimizing the learning rate and increasing the number of filters

Utilized Random Search to conduct hyperparameter tuning. Increase epochs (10), larger number of filters (128), smaller kernel size (3x3), and lower learning rate (0.0001) resulted in better performance.

Best Model output:

- Test Accuracy: 92.85%
- F1 score: 91.8% - a high level of precision and recall performance.

Model does show slight signs of overfitting as training accuracy is 99%,, with validation accuracy at 92%

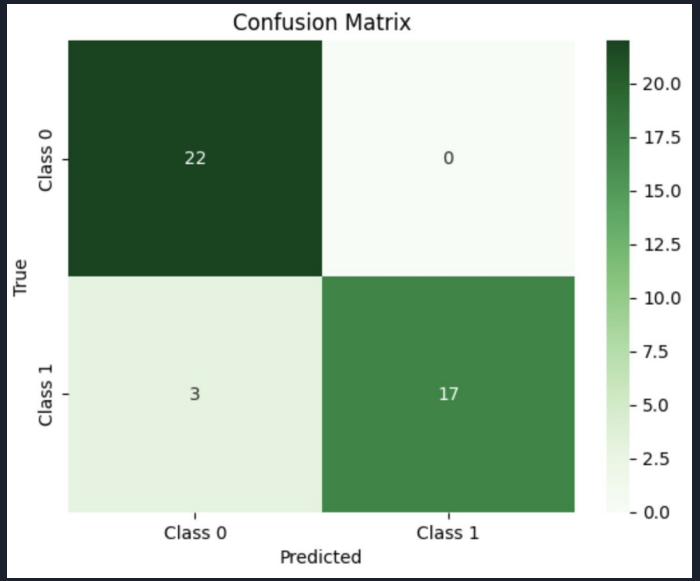


Figure 3: Test - Confusion Matrix for Best Model

Future Work

Desired Model Improvements

1. Build different network architectures, using a deeper or wider convolutional neural network
2. Use different activation functions for the network.
3. Utilizing/testing variations of regulation techniques
4. Test performance of other models, specifically RNN/LSTM in conjunction with CNN. The combinations leverage both the sequential patterns of a raga along with its frequency undulations.

Future Extensions

1. Expand to classifying the specific ragas.
2. Incorporating additional data sources such as lyrics, music notation, or artist information to enhance the classification accuracy and improve the understanding of ragas.
3. Increase dataset with more music/better quality samples from youtube. Some audio clip has noise that overpowered the singer.

Thank you

Repository

Github: https://github.com/nvgopal/NGOPAL_ML_FINAL/

Data:
https://www.kaggle.com/datasets/kcwaghmarewaghmare/indian-music-raga?resource=download

Reference:
https://medium.com/@blogsupport/deep-learning-based-raga-classification-in-carnatic-music-e499018ea1b7