Finding Changes in the Tonic of Indian Classical Music

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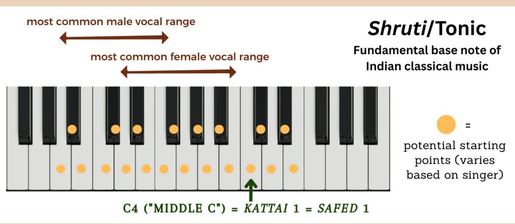
INTRODUCTION



Mel Frequency Cepstral Coefficients (MFCCs) are commonly used in speech recognition, and can be applied to music audio.
Use the **Mel Scale**, a scale closer to the human perception of music than measured frequencies.

Past studies on Indian classical music and tonic are outdated and use older strategies and data analysis techniques. Given the rise of newer deep learning and audio analysis techniques, a fresh look at tonics and their effect on Mel Frequency Cepstral Coefficients is needed. In order to automate Indian classical music analysis, information about tonic, the basis of the art form, is critical.

RESEARCH METHODOLOGIES

Indian Classical Music Dataset
Permission given to use dataset compiled for previous research by Gulati, S., et al. (2014)
Over **1,500** snippets of both Carnatic (South Indian) and Hindustani (North Indian) music

Google Colaboratory + Jupyter Notebooks
Google Colab: data analysis and ML tool - cloud-based Jupyter Notebooks
Jupyter Notebook: application to run notebooks (code & RTE) via web browser

Python Libraries
pandas: used for data analysis & data science, with data structures & operations
scikit-learn: machine learning library, including algorithms like t-SNE and PCA

Principal Component Analysis (PCA)
Dimensionality-reduction method to analyze large datasets & lots of features
Linear method to reduce number of variables, but keep most of the information

t-Distributed Stochastic Neighbor Embedding (t-SNE)
Reducing the dimensions of large datasets, captures non-linear dependencies
Usually, PCA is used to reduce dimensions reasonably before using t-SNE

ACKNOWLEDGEMENTS / REFERENCES

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Works Cited:

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Chordia, P., & Şentürk, S. (2013). Joint recognition of raag and tonic in north indian music. *Computer Music Journal*, *37*(3), 82-98. https://doi.org/10.1162/COMJ_a_00194

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DATA AND FINDINGS

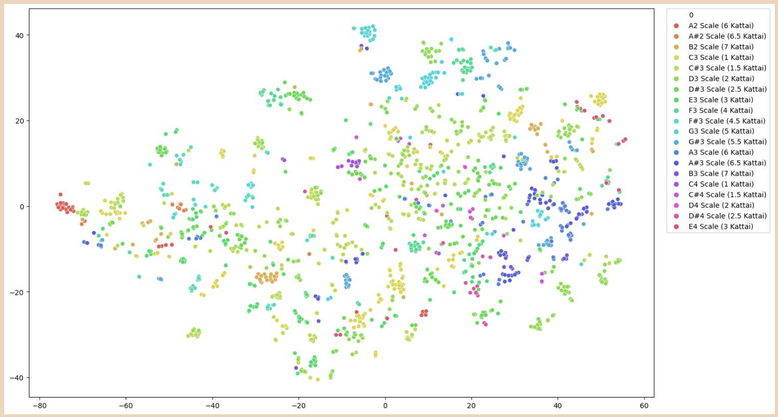


Figure 1: A plot of the data after performing PCA to reduce from 1212 dimensions to 25 dimensions, and then performing t-SNE to reduce from 25 dimensions to 2 dimensions. Each color indicates a different tonic.
e.g. B3 Scale (7 Kattai) is colored in purple

The most clustering can be seen on this plot when compared to the other four plots.

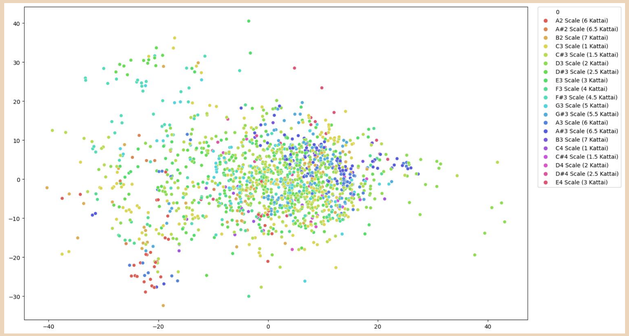


Fig. 2: Performing PCA (1212 to 2 dimensions)

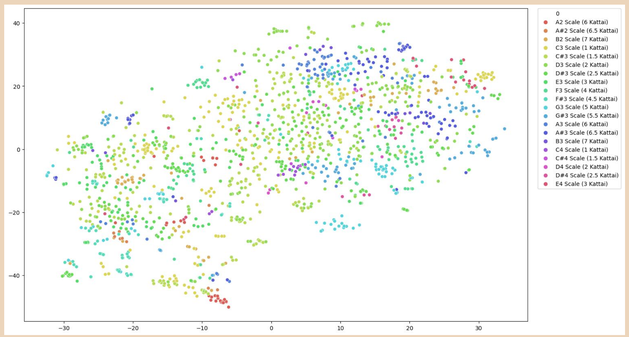


Fig. 3: Performing t-SNE (1212 to 2 dimensions)

Fig. 4: Performing PCA (1212 to 50 dimensions) then t-SNE (50 to 2)

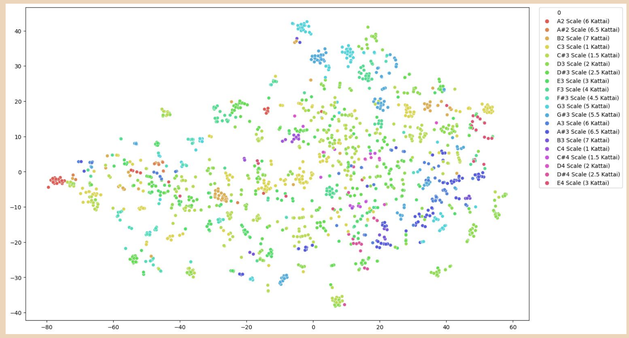
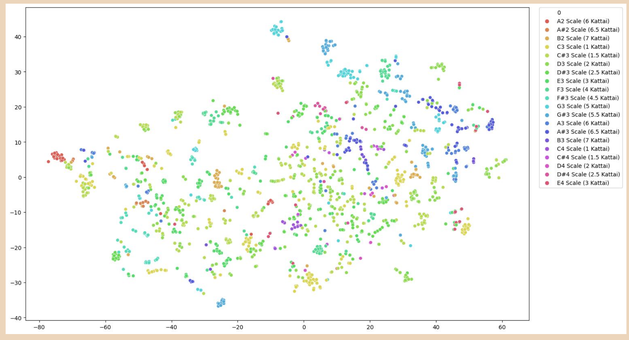


Fig. 5: Performing PCA (1212 to 10 dimensions) then t-SNE (10 to 2)



CONCLUSIONS AND ANALYSIS

- PCA keeps pseudo-MFCCs instead of the real 1212 MFCCs
- t-SNE is better at preserving the data given – non-linear
- Performing PCA (25 components) before performing t-SNE produced the best clustering
  - There are 1187 MFCCs that do not help to determine tonic.
- Clusters are spread out across feature space
  - Other factors affect MFCCs more than tonic

IMPLICATIONS AND NEXT STEPS

This data shows that computing power can be saved → Only ~25 pseudo-MFCCs can help with tonic identification – Storing the other pseudo-MFCCs is not necessary

Next, I will build a tonic identification system → Other factors that affect tonic even more than MFCCs could be explored further
– Using data from spectrograms