Naad-Nartan
Journal of Dance & music

UGC-CARE Listed ISSN: 2349-4654
Volume : 12, Issue-1, January 2024

Harmony of tradition and technology : Exploring the evolution of computational methods in Carnatic music

Priyadarshini S

Research Scholar, Department of Music, Dance & Fine Arts, Sri Padmavati Mahila Visvavidyalayam, Tirupati

Prof. RNS Saileswari

Department of Music, Dance & Fine Arts, Sri Padmavati Mahila Visvavidyalayam,Tirupati

Abstract

This article explores the progress made in using computational techniques for music. The goal of this study is to uncover advancements in applied methods that address aspects of Carnatic music, such as recognizing ragas generating compositions and analyzing performances. By employing these methods, musicians, scholars and those interested can gain insights into the intricacies of this musical tradition. To study this, an examination of existing data was undertaken. Additionally, specific computational tools and algorithms developed for this purpose were studied. The findings of this investigation emphasize the significance of techniques in music by enhancing the creative and research endeavors of music experts and practitioners alike.

Keywords: Carnatic music, Computational methods, raga identification, data mining, machine learning, signal processing

Research Paper

Introduction

The Tradition

With a history that spans centuries, Carnatic music is deeply rooted in tradition. Its intricate musical arrangements, patterns, and spiritual essence set it apart. In the past learning music was primarily, through tradition with students relying on their ears and years of training to grasp and perform compositions. While these methods are invaluable they do have limitations when it comes to scalability and objective analysis. However thanks to advancements there have been innovations in studying and practicing Carnatic music. The focus of this research is to explore how computational methods can contribute to aspects of music such as identifying ragas, generating compositions, and analyzing performances. By leveraging these techniques this study aims to provide insights, for musicians and researchers alike.

Objectives of the study

The main objectives of this study are:

- To trace the development of computational techniques in Carnatic music.
- To explore various techniques used in music recognition, music generation, and performance analysis.
- To assess the importance of these computational techniques in enhancing the creative research efforts of music scholars and composers.

Hypothesis

The fusion of methods such as data mining, machine learning and signal processing has brought about a transformation in the exploration and utilization of Carnatic music. These methods have the potential to improve the recognition of ragas, aid in generating compositions and offer analysis thereby leading to a profound comprehension.

Research Methodology

To address these objectives, a comprehensive review of existing data is done. A literature review encompasses a survey of computational tools constructed and algorithms developed explicitly for Carnatic music analysis. Further, the possibility of implementation of any one of the tools by a layman without a technical

background is checked. The findings would emphasize the role of computational advancements in supporting and enhancing the efforts of music specialists and musicians.

The Emergence of Computational Methods

The use of computational technologies in the music industry has become more significant in recent years. The Electronic and Software Industry has contributed a lot to the growth of the music industry. The music available in the cassettes, gramophone recordings, and CDs are collected and processed to match the current music standards. Among the methods used to process music data are data mining, machine learning, and signal processing. They have opened up new lines of inquiry and education in the world of music.

Examining the research done in this area, three general categories may be identified–

1. **Analysis of Prerecorded Music and Data:** This entails looking at already recorded music and data using specially created algorithms that use filters, to classify, and arrange them in the appropriate order.
2. **Composition of Music/Electronic Music:** This category encompasses the creation and composition of music within the genre.
3. **Notation Recognition:** This section focuses on identifying and interpreting notations.

Early Stages of Computational Music Analysis

The majority of musical research was conducted using analog technology before the 1970s. Vinyl records and magnetic tapes were two common analog media used for audio recordings. When working with audio data, researchers frequently had to manually transcribe and annotate them, which was a labor and time-intensive procedure.

In the 1960s, early researchers in computer science and musicology started to investigate the idea of music notation recognition. These endeavors aimed to create mechanisms capable of transforming scanned or photographed sheet music into digital representations. When the first image scanners became available for research institutes, the Massachusetts Institute of Technology began to apply optical music identification on printed sheet music in the late 1960s (Kassler, 250–254).

In the 1960s - 1970s, basic pitch detectors were developed. These systems could identify key sounds in a single-note audio recording. These early algorithms laid the foundation for advanced phonological analysis techniques. Early composing tools, such as Max Matthews' Music IV, became available. These techniques enabled musicians to play in a methodical manner. However, because of its resilience, it has mostly been utilized in experimental and learning environments.

The early 1980s saw the birth of the musical instrument digital interface (MIDI)[1] standard, which enabled digital control of instruments and components. MIDI technology allowed for the construction of digital repertoires as well as a standardized means of sharing musical information between computers and electrical devices.

The employment of computer technology in music increased between 1990 and 2000. It was also implemented in Carnatic music. During this time, significant developments in digital technology, music software, and computers for music analysis took place.

The digitization of audio recordings of Carnatic music concerts was a major development in this era. This required transferring analog tapes to digital media. Researchers now had more options to deal with big data[2] thanks to digital audio, allowing for more sophisticated analysis and experimentation.

Computational Techniques in Carnatic Music Analysis

Data Collection and Preprocessing

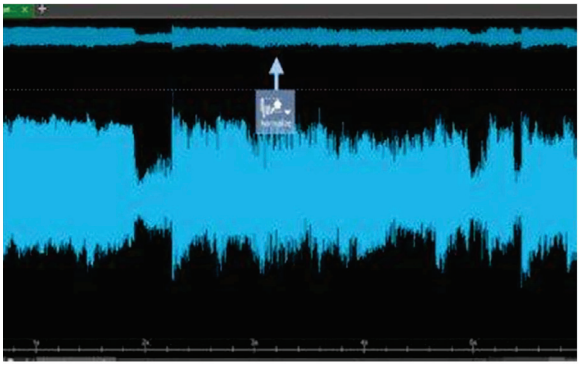
One of the main difficulties in pre-recorded data analysis is digitizing audio recordings using computational techniques and building analytical datasets.[3] Numerous issues that need fresh research strategies arise from the computational analysis of Carnatic music (Koduri et al.[4] Techniques for preprocessing are those that improve the audio data's quality and eliminate noise. Techniques including filtering, normalizing, segmentation, feature extraction, and encoding are employed to eliminate noise, extract pertinent information, and enhance the precision of analysis and modeling.

For the purpose of collecting and classifying the data, metadata[5] related to audio recordings and compositions—such as artist names, details on raga and tala, concert dates, and locations—is crucial. Data may comprise vocal and instrumental performances, depending on the objectives of the study, in order to examine the variations in interpretation and style between these two categories of performances. Occasionally, scholars gather other data modalities, such as written descriptions, video recordings, and lyrics, in order to enhance their study and contextual comprehension of the music.

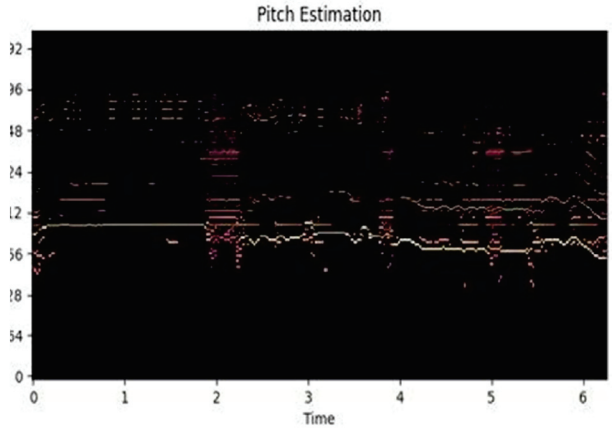
Raga Identification and Classification

Ragas, the melodic frameworks in Carnatic music, are central to its identity. Computational methods have been developed to automatically identify and classify ragas from audio recordings. These methods analyze pitch, tonal patterns, and other musical features to determine the raga being performed.

[The researcher has been able to try the AI tool ChatGPT for generating a code to analyze the pitch of a sample music file, which is a sample of her ongoing PhD research on Bangalore composers. The singer is Prof.Nagamani Srinath who has sung one of her compositions.ChatGPT generated a Python script,[6] which when run on the sample music file gave the following pitch distribution.



Pic 1. Audio sample



Pic 2. Pitch Estimation

Music Information Retrieval

MIR-Music information Retrieval is one such field in which much research is done regarding Music classification, Music source separation and instrument recognition, and Automatic music transcription. Typically, a signal processing system is composed of many modules, such as segmentation, feature extraction, model creation, and decoding.

SVM-Based Raga Recognition

Machine learning has made machine support vectors (SVM)[7] useful for raga recognition. By using the retrieved characteristics to train the SVM models, the researchers were able to discriminate between ragas with encouraging results (Patil & Kulmethe).

Deep Learning Applications

Deep learning approaches are used in raga recognition, specifically Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs). Improved recognition accuracy resulted from deep learning models' successful automated learning of hierarchical representations of audio input.[8]

Composition Generation Using AI and Machine Learning

While Western music might have already progressed much into this domain, Indian music is still waiting to be explored. Although some ideas are already gaining attention like the "Automatic Music Generation of Indian Classical Music based on Raga"[9] in which various machine learning techniques are being employed, including LSTM, RBM, GCA, FSM, and GAN producing new music that is stylistically and acoustically similar to the Indian classical music present in the training dataset.

Notation Software

Like other music traditions, Carnatic music also has developed its musicography, out of which, a notation system called Sargam is most commonly practiced. The Sargam notation scheme which enables easy music notation storage, publishing, and retrieval using computers is developed. iSargam[10] (Mammen et al.) is the only music notation encoding system developed for Indian music notation. More research work has to happen in this field.

The integration of modern-day technology in music education and performance

From the time the semiconductor industry started, the electronic industry has also uplifted the music industry. The first tanpura from Radel Electronics came to light in 1979. Devices required for recording, storing, and propagation of music have developed to such an extent that everything is available at their fingertips. Many versions of the electronic instruments have come up. Also, the programming software required for music has grown multifolds. Various apps are available to play tanpura, metronome, and table or a mridangam saath for the artist.

Due to the extensive research going on in this field, common music players like Amazon Music and Spotify are using Machine Learning and AI to come up with user-specific playlists. Technique analysis is one way AI is changing performance in Western music. AI systems may evaluate recordings or live performances using sophisticated algorithms to provide artists with comprehensive feedback on their dynamics, articulation, intonation, and rhythm. Research is also being done on using AI as an accompanist for a live music performance[11] (Dannenberg).

Challenges and Limitations

When incorporating technical aspects into research on Carnatic music, there are challenges and limitations.

- Initially, there can be limitations on the quantity of high-quality audio data available for processing, particularly for rare historical recordings.
- Furthermore, the cultural and social nuances of Carnatic music may be challenging for computer algorithms to fully represent.
- And last, in the developing subject of human-computer interaction in music research, researchers need to strike a balance between automating music and preserving the human element.

Future Directions

As technology advances, future methods of Computation in Carnatic music are promising. Researchers are investigating how to incorporate real-time analytics into performance, giving musicians instant feedback during rehearsals and live performances. Additionally, cross-disciplinary collaborations between computer scientists, musicians, and musicologists will foster innovation in this area. Notation Software exclusive for Indian Classical Music and availability of it across devices would be very helpful for musicians and students. Signal processing applications exclusively to cater to Indian music would add significantly in preserving the old music data and sharing it among the common platforms of social media would enrich the collection.

Conclusion

For scholars, performers, and lovers alike, the seamless fusion of tradition and technology in Carnatic music analysis offers an intriguing new frontier. Our knowledge of ragas, composition, and performance in this age-old tradition has been enhanced by computational approaches. The potential for more research and creativity at the nexus of tradition and technology is limitless, despite ongoing obstacles. Computational techniques will surely be essential to maintaining and developing this treasured cultural legacy as we seek to solve the riddles of Carnatic music.

Footnotes

1. A broad range of electronic musical instruments, computers, and associated audio equipment can be connected to one another for the purpose of performing, editing, and recording music. MIDI (Musical Instrument Digital Interface) is a technological standard that specifies a communication protocol, digital interface, and electrical connections.
2. Big data refers to data sets that are too large or complex to be dealt with by traditional data-processing application software.
3. Dataset is a Collection of data
4. https://www.researchgate.net/publication/220723348_Computational_Approaches_for_the_Understanding_of_Melody_in_Carnatic_Music
5. Metadata is the information providing data and not the content itself.
6. https://drive.google.com/drive/folders/1HOwA5GNwkDZshz8WEmsj5M4zPXX80Wir?usp=drive_link
7. Support vector machines, which examine data for regression analysis and classification, are supervised max-margin models with corresponding learning algorithms in machine learning.
8. https://www.linkedin.com/pulse/identifying-ragas-carnatic-music-machine-learning-sridhar-ravikoti
9. https://ieeexplore.ieee.org/document/10126388/authors#authors
10. https://www.researchgate.net/publication/294728395_iSargam_music_notation_representation_for_Indian_Carnatic_music
11. https://www.cs.cmu.edu/~rbd/papers/sbcm2000.pdf

References

Kassler, Michael. "Optical Character-Recognition of Printed Music: A Review of Two Dissertations." Perspectives of New Music, vol. 11, no. 1, 1972, pp. 250–54. JSTOR, https://doi.or0g/10.2307/832471.

Koduri, Gopala Krishna, et al. "Computational Approaches for the Understanding of Melody in Carnatic Music.". Proceedings of the 12th International Society for Music Information Retrieval Conference, ISMIR 2011. 263-268.

www.researchgate.net/publication/220723348_Computational_Approaches_for_the_Understanding_of_Melody_in_Carnatic_Music

Geetha, T., V. Exploiting Carnatic Music Characteristics for Music Content Identification. 2 Jan. 2012, hdl.handle.net/10603/25329.

R, Vijayakumar. Automatic Recognition and Classification of Carnatic Ragas. 13 Oct. 2016, hdl.handle.net/10603/111461.

Patil, Mangal, and Maheshwari Kulmethe. "RAGA IDENTIFICATION BY USING SVM CLASSIFIER." ResearchGate, Nov. 2022, www.researchgate.net/publication/371540407_RAGA_IDENTIFICATION_BY_USING_SVM_CLASSIFIER.

Ravikoti, Sridhar. Identifying Ragas in Carnatic Music With Machine Learning. 7 Feb. 2021, www.linkedin.com/pulse/identifying-ragas-carnatic-music-machine-learning-sridhar-ravikoti.

S. Adhikary, M. S. M, S. S. K, S. Bhat and K. P. L, "Automatic Music Generation of Indian Classical Music based on Raga," 2023 IEEE 8th International Conference for Convergence in Technology (I2CT), Lonavla, India, 2023, pp. 1-7, doi: 10.1109/I2CT57861.2023.10126388.

Mammen, Stanly, et al. "iSargam: Music Notation Representation for Indian Carnatic Music." EURASIP Journal on Audio, Speech, and Music Processing, vol. 2016, no. 1, 16 Feb. 2016, doi:10.1186/s13636-016-0083-z.

Dannenberg, Roger B., "Artificial Intelligence, Machine Learning, and Music Understanding,"in Proceedings of the Brazilian Symposium on Computer Music (SBCM2000), Curitiba, Brazil, 2000.