FINITE STATE MACHINE FOR ARTIFICIALLY GENERATING INDIAN CLASSICAL MUSIC

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Abstract – *Generation of Indian Classical Music has took very influenced performance in current art oriented world. We focus at a model of computer-aided south indian Classical music generation. The system implemented using the model is basically a simulation of a particular Raga's 'Arohana' and 'Avarohana.' The synthetic generator uses hand crafted bigram finite state models to create note patterns that conform to a Raga grammar. We also define a procedure that aims to measure the consistency of the compositions artificially generated by comparing them with random sequences created from unigram models. The measure makes it clear that the sequences generated by the machine are better than those generated at irregular intervals.*

Key Words: Arohana, Avrohana, Gamakas, FSM, Indian classical music.

1. INTRODUCTION

The production of computer music may be described as the procedure of creating music by artificial means, especially with the help of computers. In Carnatic Classical Music artificial music production has many consequences. The structure of various Ragas, their unique forms and their influence on human cognitive system can be artificially explored through the generation of music sequences. In addition, a Raga 's structure follows a fixed grammar or a fixed sequence of notes which govern the progression In one particular direction. This fixed grammar of the Indian Classical Music basic unit allows for mathematical modelling of its structure.

An artificial composer of Hindustani Classical Music has many uses. In some particular Raga of interest, the use of a generative system would be of great help to artists who want to explore new possibilities of improvisations. In the same Raga, a composition produced by a machine may have drastically different qualities from the one formed by a person. In vistaras or tanas, there may be interesting mixtures of notes, which a human being would probably find difficult to think of. The system would therefore help to identify new possibilities in a Raga that performers and learners have not explored.

There are many applications by the Hindustani Classical Music Artificial Composer. The use of a generative method will be of great benefit to performers who want to pursue new forms of improvisation in a specific Raga of interest. A computer-generated composition may have drastically different qualities than a human-created one, in the same Raga. There might be unusual combinations of notes in vistaras or tanas, which will certainly be difficult for a human being to think about. Therefore, such a program will help to uncover new possibilities in the Raga that have not been explored by performers and learners. There are many applications by the Hindustani Classical Music Artificial Composer.

1.1 Previous work

Over the past couple of decades several scholars have identified numerous possibilities for automatic and computer-aided music generation. The first work that appeared in the field of music creation was for realistic purposes [2], where the author claims that the use of a generative method would be of great benefit to composers in expanding the techniques of present composition and in generating various species of music through artificial means. Other efforts that need to be mentioned in this field include mathematical language-based mechanisms [3, 4, 8], generative grammar based systems [5, 9] and genetic algorithm-based frameworks [6 , 7].

In particular, several researchers have found the task of producing music to be a probabilistic model of monophonic music, represent music as a series of notes, and attempt to model music as a probability distribution, where the next note was allocated based on the probabilities of the previous note sequence and some background, such as chord, beat. Specifically, compared to a rule-based composition, we can train a particular model based on a huge number of musical corpus and allow it to explore patterns automatically.

2. INDIAN CLASSICAL MUSIC THEORY

Before we continue to explain the mathematical model on which the generative method was created, it becomes important to familiarize ourselves with a few terms and meanings. You will find the formal meanings of such concepts in [12]. We replicate some of them here.

- Raga: The Raga is an essential unit of classical Indian music. It's known as a collection of notes, and the syntax of the Raga dictates the attribute relationship of the notes.
- Arohana: Arohana is an upward series of notes accompanied by the Raga. Any ascending sequence in improvised segments of the Raga, strictly follows the trend set in Arohana.
- Avarohana: Avarohana is similarly a descending sequence of notes followed by the Raga.

The scope of notes we find span of three octaves in the prese nt work. Every note chain is a sequence of alphabets belongi ng to a definite set M, where M is the group of three sets M_{tar}, M_{madhya}, M_{mandra}, each comprising of the twelve fundamental n otes. The subscriptions tar, madhya, and mandra are respecti vely representative of the higher, medium, and lower octaves [12].

Each Raga comprises of a specific hierarchical structure of swaras or notes. Notes are termed swaras in classical Indian music. The fundamental seven notes or swaras or symbols in classical music are S (Sa), R (Re or Ri), G (Ga), M(Ma), P (Pa), D (Dha), N (Ni) that can be perceived analogous to C, D, E, F, G, B, A. In other words, we have 12 swaras or shrutis in Carnatic music, S, r, R, g, G, rn, M, p, d, D, n, and N.

3. PROBABLISTIC FINITE STATE MACHINE

For generation purposes, a probabilistic finite state machine (FSM) is developed for each of the ascending and descending vibrations for a specific Raga. The finite state algorithm can be described as a note sequence bigram model, specifying the three most frequent notes together with the corresponding probabilities that may consider a given note in a structure while moving in a specific direction.

Formally, the Arohana automaton can be understood as a series of 36 nodes (for the finite set M) representing each note. There are three outgoing edges e1, e2, e3 with probabilities p1, p2, p3 for a node named n.

$$p1 + p2 + p3 = 1$$
$$p1 > p2 > p3$$

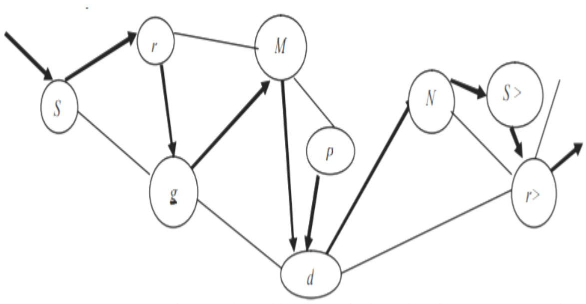

Fig.-3: Idea of states and transitions between states.

The edges point to some other (possibly null) nodes called n1, n2 and n3. That should be described as follows. Although the probability of producing the notes n1, n2 and n3 is p1, p2 and p3 in Arohana, after a note n, respectively. Almost no other note after n is permitted, while at Arohana. Similarly, the Avarohana automated system can be described.

4. OUR METHODODLOGY

In Indian classical music, there are 2 separate but very linked genres-Carnatic and Hindustani. There are two characteristics typical of Indian classical music in these two genres, namely raga and taala. For example, the taala refers to the piece 's rhythm, aadi is a taala specified by 8 beats in one cycle. Raga provides a framework that helps to generate Indian classical music using Finite State Machines. Raga is a formula for composing a piece. A raga is a collection of notes defined to formulate a complete group of music. It's characterized by a descending and rising scale. abhogi is a raagam that is defined using the following scales,

Arohana: C D D# F A C' (S R2 G2 M1 D2 S)
Avrohana: C' A F D# D C (S D2 M1 G2 R2 S)

Where, C in the next octave refers to C'. Make sure that the descending scale occurs to be the same as the ascending scale in this case but in opposite order, but that is not entirely the case. Songs based on abhogi will use these notes only, and to a great extent to these ascending and descending patterns.

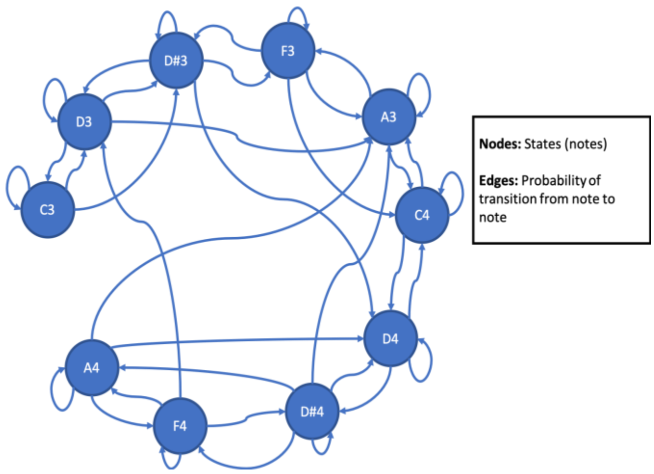

Fig.-4: Finite State Machine (FSM) for Abhogi Raga

For each raga, a finite state machine can be constructed so that, as seen in the figure above, the notes corresponding to that raga may shape the states and different octaves can be protected by assigning unique notes states in each octave. The transitions between the states are described by probabilities learned by analysis of note transitions in fragments centered on that raagam. If such an FSM is designed, we could either seed the FSM with a random note, and this dynamic system will continue to produce notes based on such probabilities of change — kind of like kalpanasawaram, for the more readers.

5. RESULT

After providing dataset of raga abhogi, FSM has generated a tune which follows exactly same pattern and characteristics as the raga abhogi has and that we had provided as training data. Moreover Taala aadi that also we have mentioned to the FSM algorithm. Simulation was done exactly what we have expected. The only shortcoming in this algorithm is missing of magic of Gamakas. Gamakas are nuances to the musical piece that are usually not annotated but are added by the musician, sometimes in an improvised fashion. This involves gliding between notes, oscillating around a note, stressing on a note etc. These beautiful nuances add emotion to the raaga and are integral to carnatic music.

6. CONCLUSION

At best, the model is as strong as the data on which it is centered and it is very challenging to get Indian carnatic music data. Like western music, carnatic music has no standard notations and it is usually taught from guru to student by notations, and the guru received from their guru. Consequently, having a corpus of annotated raga related music is very difficult.

We manually annoted the abhogi varnam in a format that would be compatible with Music21 for the purposes of this project. As a result, the current implementation can only generate abhogi in aadi taala now. However, this general framework is applicable to all raga and taala. The present system generates compositions in MIDI format. In such a system it is not possible to include meends and gamakas that are central to Hindustani Classical pieces, and therefore the actual beauty of a human performance cannot be captured in its entirety. So, this can be a scope for future work.

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