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# When Science Facilitates Art

## [Designing A Computer Based System To Simulate Music Rendered By Tabla ]

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**ABSTRACT:**

*This paper was born out of a seminar on linking music with science conducted in AKIMSS Solapur in 2007. The purpose of this short piece is to lay down the foundation for creating an algorithm and a computer based system to decipher table music. Being a principal musical instrument in the repertoire of Hindustani Classical Music good table players are hard to find. Hence if a system for table is developed, the author (himself an amateur table player) argues a lot of musical accompaniment will be facilitated).*

**BACKGROUND :**

In the Indian context we believe that along with four Vedas there is fifth Veda which is devoted to music. It is said that Narada was the founder of music and that Lord Ganesh was master of 64 vidyas(arts), six shastra and 18 puranas. Lord Krishna was master of "Flute" and Goddess Swaraswati was master of "Veena". Lord Shankar was famous for his "Tandav Nurta". It is also accepted that music is one of the 64 arts that everybody loves. It is accepted that "omkar" is the first word created in the environment which is formed by air vibration and this omkar takes the form of "nadbhrma" which is a source of music. This "omkar" is a source of different swaras like "Sa" ,"Re", "Ga", "ma" etc. . Raga is one of the most beautiful creations in Indian classical music; each raga is played at different times depending on the mood. Time and mood itself inspires different combination of swars that lead to specific raga. After Then due to different vibrations, different frequencies and amplitude, and timbre we could identify different instrument like harmonium, tabla, veena, sitar. Indian

classical music is very mature and proved its greatness all over the world. Indian classical music is basically divided into two parts- vocal and instrumental. Learning any of them is very difficult and it requires riyaz (continues practice). Any type of music can be learned only through the master (Guru) which is an important tradition in Indian Music. Every Guru belongs as "gharana" based on the affiliation of his guru. Thus Indian classical music is basically "gharana based". This equally holds true in case of tabla. This research proposes to develop software that would play tabla as expertly as a human expert would play. There are six "gharanas"in tabla namely Delhi, Lacnow, Farukabad, Ajrada, Banaras and Punjab. Each "ghrana has its own style of composition of method of playing bol. One of most common aspect in all these "gharanas" are "taal".

*Talas*, are cyclical rhythms used to support as melodic performance. There are dozens of *talas*, but about ten are found in standard performances. *talas* are distinguished by number of counts (e.g., 6, 7, 10, 12, 16), internal division (e.g., 2+3+2+3 or 4+2+4), and a recognizable baseline of sounds known as *theka*. They incorporate other unique intricacies as well. Half and quarter beats are markedly used in the structures of some *talas* and impressive *laykari* ("rhythmic play;" e.g., 5 against 4, 7 against 5, 10 against 7) is used as an adjunct to standard timekeeping. Appropriately, *talas* are generally rendered on the *tabla*. This pair of drums, famous for its wide yet refined gamut, is capable of creating dazzling clarity and subtle dynamics.

Indian classical music is defined by two basic elements - it must follow a Raga (classical mode), and a specific rhythm, the Taal. In any Indian classical composition, the music is based on a drone, that is a continual pitch that sounds throughout the concert, which is a tonic. This acts as a point of reference for everything that follows, a home base that the musician returns to after a flight of improvisation. The result is a melodic structure that is easily recognizable, yet infinitely variable.

**PROBLEM DEFINITION** :

The Problem considered for this research paper is to design and develop a software as digital tool, that can generate different tal, bol, chakrdhar, and theka similar to that generated by a tabla when played by any tabla player.

The development of software considers to two questions that are the main focus of the proposed research which are.

- *How* the ability to make music ( to play tabla ) can be attained ?
- *How* this ability to can be used to enhance our music creation with tabla?

This is a practice-based research and the first challenge is to develop a suitable methodological framework for this work.

**METHODOLOGY**

The proposed research would take the following approach:

a. Look outside the core literature for ideas and methods which can be productive
b. Develop a theoretical framework.
c. Build software and use digital tools to enable desired practical results.

Despite computer music being recognized as a multidisciplinary subject since its inception, benefits accrue from work that expands this inclusiveness and open-endedness. In scientific fields, Wilson [5] writes of factions from each of the various science disciplines moving towards a synthesis of the subjects in an attempt to take a look at the whole. Similarly Norris [6] argues the usefulness in adapting an interdisciplinary approach and moving away from the traditional divisions of academic "disciplines" (although he urges that it is are wrong to think that these boundaries exist only to act as artificial barriers). Gell-Mann [7] states that it is important to supplement highly specialised research with serious attempts at taking a coarse look at the whole of a complex practice.

The philosophical basis of the proposed work can be associated with the movement known as Critical Realism that originates with the work of Roy Bhaskar [8]. Roughly speaking, Critical Realism states that our beliefs are socially produced; our knowledge is transient and situated in historical time. However, it also says that there exists a reality independent of 'individuals' and that the world has a structure which makes science possible. Digital tools are crucial in enabling the pragmatic aims of this research.

Computer music can be defined to be the process of creating music by artificial means, specifically with the help of computers. Artificial generation of music has many implications for Hindustani Classical Music. The structure of different *talas,* their specific characteristics and their effect on the human cognitive system can be explored by generation of music sequences artificially. Moreover, the structure of a *taal* follows a fixed grammar or a fixed sequence of bols that govern the progression in some specific direction. This fixed grammar of the basic unit of Indian Classical Music enables one to model its structure computationally.

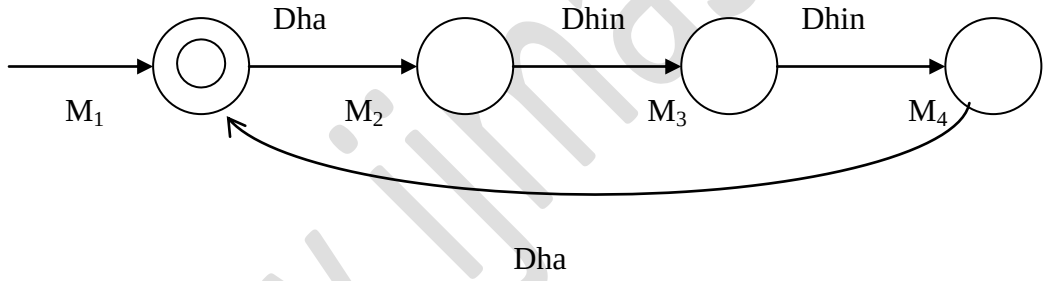
There are several applications of an artificial composer of Hindustani Classical Music. The use of a generative system would be of great help to performers who want to explore new avenues of improvisations in some particular *tala* of interest. A computer generated composition may have radically different qualities from a human created one, in the same taal. There may be interesting combinations of bols in peshkar, kaida and then palate, which probably would be difficult for a human being to think of. Such a system would thus help in finding out new possibilities in a taal, which have not been explored by performers and learners. Another motivation in developing a generator using a particular model is the discovery of the characters of different taal, especially the complexity of a computational framework (grammar) that can fully specify the entire musicality of a *taal*. For example, A *taal* may produce the effect it normally does on an audience only because of the structure of its *bol* and its *matra* , Such *taal* may not be totally specified by simply modeling its *bol* and *matra* , and might call for more detailed treatment. Many such dimensions of Hindustani Classical Music can be explored through a generative system.

In this proposed work, probabilistic finite state automata will be designed to generate compositions in certain *talas.* The finite state models help in deciding probable transitions

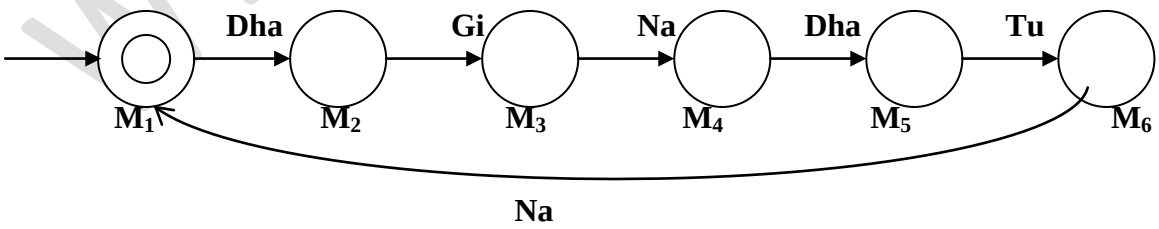
from a particular *matra* to another that conform to the grammar of the concerned *taal*. Later on future such models can be automatically trained from a sufficiently large set of existing compositions in a *taal*. a method for testing the 'quality' of a generated composition shall be proposed, which may show that the generator has outperformed a random composer, but may be inferior to some human composers.

## MATHEMATICAL MODEL OF THE GENERATOR

The mathematical model behind the generative system is a finite state machine (FSM) which models the entire set of talas, peshkar, mukhada etc based on different bols. The FSM is built for a particular taal and is translated to an algorithm to generate a unique music sequence. The following subsections describe this mathematical model of some talas in detail.




**Tal – Trital (16 matra – Cycle of 4x4 matras**




**Tal – Dadra - 6 matra cycle**

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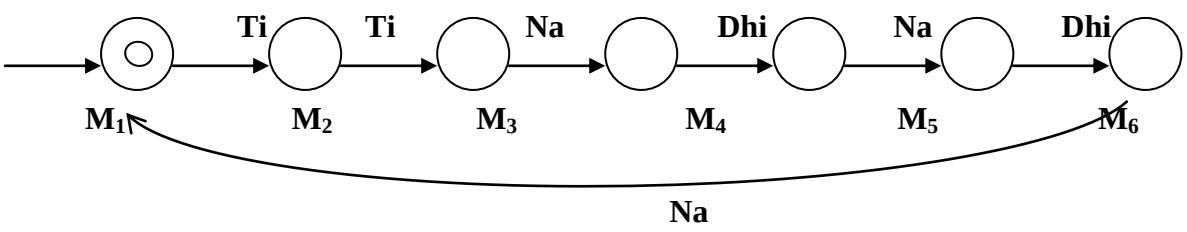
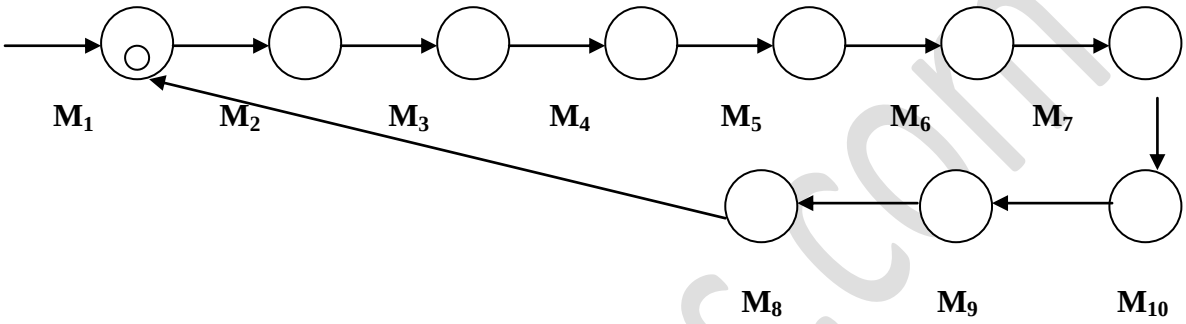



**Tal – Rupak - 7 matra cycle**




**Tal – Zaptal - 10 matra cycle**

## BASIC TERMS AND DEFINITIONS:

Before describing the mathematical model based on which the proposed generative system will be developed, familiarization with a few terms and definitions are essential. The formal definitions of these terms can be found in [09]. Here we reproduce some of them.

- *Taal:* The *taal* is the basic unit of Indian tabla Instrument. It is defined to be a set of number of bol and the adjacency relationship of the bol is governed by the *tala's* grammar.
- *Matra: matra* is the ascending sequence of equal time interval that the *taal* follows.
- *Sama* : The first time interval.
- *Kala :* The last time interval.

## PREVIOUS WORK

Computational modelling of Hindustani Classical Music, its analysis and synthesis has been explored by H. V. Sahasrabuddhe [1] for the first time from the perspective of Indian music.

The approach involved the use of a finite state automaton built from given examples of performances, which can later generate reasonably good compositions in a *Raga*. Sahasrabuddhe claims that automatic as well as computer-assisted composition is possible with the above model. However a complete generative system has not been described in his work.

Very little work has taken place in the area of applying techniques from computational musicology and artificial intelligence to the realm of Indian classical music. Of special interest to us is the work done by Sahasrabuddhe et al. [2, 3]. In their work, ragas have been modelled as finite automata which were constructed using information codified in standard texts on classical music. This approach was used to generate new samples of the raga, which were technically correct and were indistinguishable from compositions made by humans

Hidden Markov Models [4] are now widely used to model signals whose functions are not known. A raga too can be considered to be a class of signals and can be modelled as an HMM. The advantage of this approach is the similarity it has with the finite automata formalism suggested above.

**CONCLUSION :**

It is possible that we can design and build a software to generate as digital tool, that can generate different tal, bol, chakrdhar, and theka similar to that generated by a tabla when played by any tabla player. From the Finite State Machine diagram we can go for state transistion diagram and then we can write algorithm for generation of music. Thus this idea gives for building a software to generate different tal, bol etc. and thereby taking a gaint step for Hindustani Classical Music

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