Challenges in computational modeling and generation of Carnatic percussion music

1. INTRODUCTION

There is an increasing interest in developing computational strategies for the analysis, modeling and generation of non-western music. [1], [2], and [3] constitute some of the earlier examples in this area. Our earlier work [4] used an n-gram approach for modeling Carnatic percussion generation. N-gram transition probabilities up to a five-gram were estimated by counting the frequency of the strokes in the training corpus. The size of n-grams was set to up to a five-gram because we wanted to test how past information and size of accumulated memory could affect and change the generation process. The generation process used these data to generate new strokes events sequentially. Given a sequence of strokes, a stroke event was generated based on the weighting probability of the most likely stroke to follow given the previous strokes. The main drawback of this method was that it failed to successfully capture the long-term structure and grammar of this particular idiom and being only successful in capturing local and short term phrasing. In our present work, we aim to overcome these issues by introducing a new data-driven approach of modeling the tala cycle based on a set of arithmetic partitions which capture reliably the rhythmic structure of the tala. We also implement two novel grouping methods to segment the strokes into syntactic valid phrases. Based on this analysis, we developed a new application that improves the generation of South Indian rhythms and enhances the interaction of the user by adopting data visualization techniques during the generation.

2. METHODS

2.1 Dataset and preprocessing

The training corpus consisted of 23 percussion solo compositions and groove patterns in aditala (8 beat-cycle). The main difference of grooves versus compositions is that grooves consist of short groove phrases that are repetitive in nature over any tala cycle whereas compositions consist of korvais which are multi-part (usually 2) compositions that can last over multiple cycles which are repeated three times. Each part generally adheres to the rules of arithmetic progressions.

Each stroke was coded according to our traditional method described in [4]. The normalized velocity values of the strokes were obtained by computing an onset detection function [5], and estimating its amplitude level according to the strength of the stroke.

2.2 Approach

To synthesize and generate the talas, we modeled the 8-beat aditala cycle into a series of arithmetic partitions of 32 pulses, assuming a beat subdivision in 4 parts. Each partition consisted of combinations of groupings of stroke sequences that formed the duration of the talas. In our study we used 6 templates of partitions of groups of pulses (fig.1), all adding to 32 pulses. The templates of partitions have been validated in terms of the grammar and theory of this music idiom by direct discussion with Carnatic music expert musicians. Given an audio recording, first we obtain an automatic transcription of a sequence of time-aligned events of all stroke types, their durations (IOIs) and velocities. All the recordings were merged into a text corpus of sequences of strokes. Two approaches for grouping the sequences of strokes into rhythmic patterns were used. The first was based on the segmentation of strokes taking into consideration the proximity and the distance between each stroke IOI and their adjacent strokes [6]. The second one was based on a well-formed grouping dictionary of solis which are short motivic sequences of strokes. The grouped sequences of strokes from both approaches were analyzed and clustered by similarity using k-means clustering. In order to generate the talas we used groupings from the clusters that could be encountered in a cycle of a typical Carnatic percussion groove and concatenated them using the durations of the arithmetic partitions. To visualize and project the centers of the clusters in a 2D space we used the t-Distributed Stochastic Neighbor Embedding (t-SNE) method [7]. T-SNE is capable of capturing much of the local structure of the high-dimensional data, while also revealing the relationships between the centers of the clusters in a low 2D space.

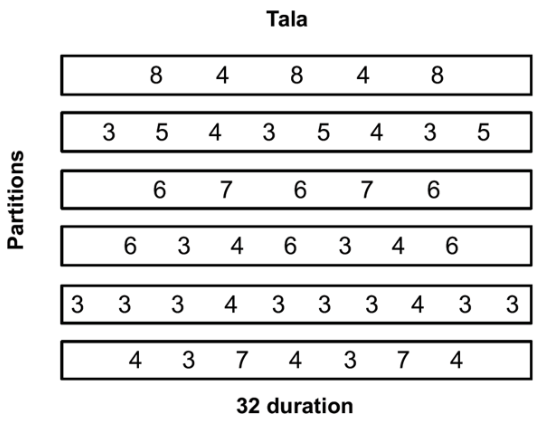

Fig. 1. Partition templates of aditala cycles.

3. RESULTS

The results from the analysis were used to develop an application (CAMEL) that can emulate Carnatic-style percussive sequences by creating rhythmic grooves. The model was implemented as a Max patch that used as inputs the partitions, the clusters of the groupings, their durations and the coordinates of the cluster centers after the t-SNE data visualization analysis. Figure 2 depicts a screenshot of the Max patch. The user can interact with the clusters of groupings by travelling in the 2D space and generate talas of preference based on a set of template partitions in various tempo of choice. He can also filter smaller rhythmic values, or create variations by having the program probabilistically choose between different stroke collections of the same duration in the cluster.

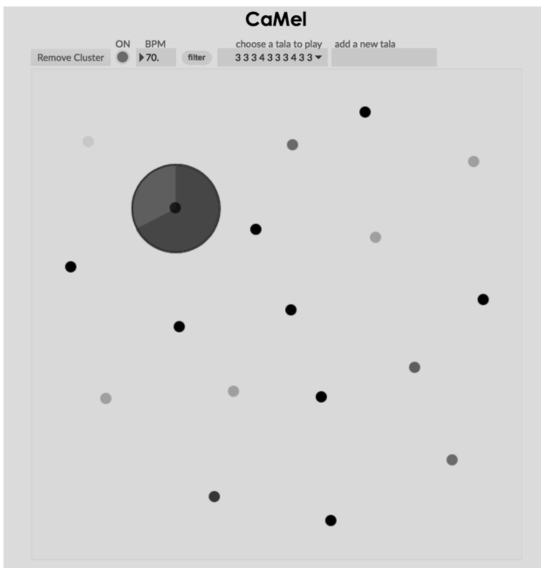

Fig. 2. User interface for CAMEL**.**

4. CONCLUSIONS

This work presents a new data-driven approach for generating new Carnatic style rhythmic patterns. The approach we adopt in this study improves previous work on Carnatic music generation by modeling the aditala cycle using a set of rules. These are based on different arithmetic partitions with a duration that sums to the length of the tala cycle. The creation of these tools can be used in music education as a means of actively enculturing lay people into this music style and interacting with musical styles beyond the Western ones. Future work will also test the method on a larger dataset of recordings and evaluate the effectiveness of the method by conducting a perceptual study using a group of professional Carnatic musicians.

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