Random Music Generator

Abstract: Ragas in Hindustani classical music are characterized by certain structures. The most obvious one is the set of frequencies allowed in a certain raga. Assuming 12 basic frequencies, each raga uses a subset (not necessarily proper subset) of these 12 frequencies. We shall refer to a frequency as a 'note'. Further, when composing tunes in a raga, there are certain notes that are allowed when notes are increasing in their frequencies (aaroha) and certain other notes when they are decreasing in frequency (avroha). Some ragas are more complicated in that when notes are increasing in frequency there are certain notes from which one must 'descend', i.e., use lower frequency notes and then continue the 'ascent' of increasing frequency notes. This last structure is also called the 'chalan' of the raga. Further, some notes are granted greater relative time than others, often called 'nyas' notes.

Given the above structures, an interesting question is the following: are these structures sufficiently well defined for a computer to 'compose' tunes in a certain raga? We shall begin addressing the above question in the rest of this article.

Structures describing a raga: Let us denote by ψ, the ordered set of notes allowed in a raga. ψ is a subset (not necessarily proper) of the 12 basic notes. Let the 12 basic notes be denoted by elements of U, i.e., $U = \{s, r_l, r, g_l, g, m, m_u, p, d_l, d, n_l, n\}$. We shall denote similar notes in the next octave with boldface letters and those in the lower octave by mathfrak letters. The set U is the 'universe' of notes allowed. Any tune is now a sequence of notes from the set U. We now define a transition matrix C which defines 'allowed' transitions from one note to another note in a raga. C is an $n \times n$ matrix where n is the cardinality of ψ. The entry C_{ij} denotes the probability of transition from note ψ_j to ψ_i, where, ψ_i is the i^{th} element of the ordered set ψ. It is then clear for instance that the j^{th} column of C denotes the transition probabilities from ψ_j to all other notes in ψ. This matrix C now allows us to model 'chalan' to some extent. For instance, if a certain raga has a 'chalan' in which if the tune is at a note g and the tune must increase to m before descending to r, then, the column for g will have zero probability for the row corresponding to r. Similarly, if a note ψ_i is such that the raga does not suggest a 'nyas' at that note, then the entry ψ_{ii} can be set to zero in C.

As an example, let us consider the raga 'bhoop'. Here $\psi = \{\mathfrak{s}, \mathfrak{r}, \mathfrak{g}, \mathfrak{p}, \mathfrak{d}, s, r, g, p, d, \mathbf{s}, \mathbf{r}, \mathbf{g}, \mathbf{p}, \mathbf{d}\}$. C here will be a 15×15 matrix. Suppose we decide that one can transition from one note to another note which is at most 4 notes away. So from s one can transition to any note in $\mathfrak{r}, \mathfrak{g}, \mathfrak{p}, \mathfrak{d}, s, r, g, p, d$. This would mean that the 6^{th} column of C will have zero entries in the first row and the last five rows. All the others can be considered equally probable. So C_{*6} would look like the following matrix
$\left[0, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, \frac{1}{9}, 0, 0, 0, 0, 0\right]^T$.

Similarly we can define transition probabilities in the other columns of C. A rudimentary random music generator would now work as follows. Assume one starts out with note ψ_i.

1. Pick column i of C.
2. From the distribution in C_{*i} pick a note ψ_j randomly.
3. Repeat step 1 with column j of C.

Open questions

The above algorithm would produce notes that are technically from raga 'bhoop'. There are of course quite a few questions now. For instance, how does one bring in some form of rhythm? One proposal is to assume some beat, say a 16 beat sequence, and choose one note every beat with the constraint that the last two beats, beat 15 and 16, end up with one of the following notes $\{s, p\}$ two times. This would model a 'nyas' at the end of every 'avartan'. Note that now the problem is a bit more complex. How does one choose notes as beat 15 approaches so that $\{s, p\}$ are within the set of notes allowed by the matrix C at beat 14?

Producing audible music

Finally, once a sequence of notes is produced as suggested above, one can then feed them into some instrument like a synthesiser to produce audible music.