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C O N T E N T

Analysis of Bandish, Aalaps and Taans of Raga in Indian Classical Music Using N-grams

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Abstract : This work is an attempt to analyse three melodic components of *Raga* in the context of Indian Classical Music (ICM). These components are *Bandish*, *Aalap* and *Taan*. Every *Raga* in ICM has specific framework. The artist is supposed to abide strictly to the *Raga* framework while performing the *Raga*. We are trying to find out how well *Bandish*, *Aalap* and *Taan* represent the *Raga* framework. Considering the similarities between language and music, we have used one of the Natural Language Processing technique: n-grams for the analysis. We have considered *RagaYaman* in this study. Melodic patterns extracted from the *Bandish,Aalap* and *Taan* of the *Raga Yaman* have been used as input. These patterns are in the form of musical notations. The n-grams have been extracted from these patterns. By examining the note frequencies and the n-gram frequencies generated from the notations of *Bandishes*, *Aalaps* and *Taans* we could conclude that all three of these components are equally representative of the *Raga* framework.This study is helpful in developing a computational model of a *Raga* which may further have applications in automatic *Raga* recognition and automatic melody generation.

In the introductory part of the paper we have explained the concept of *Raga* in ICM and the components of *Raga* performance. Various attributes of a *Raga* and their meaning is also provided. The ICM notation style and symbols have been provided along with the notation style that is used in this paper. In the subsequent section the objective of the study has been stated. The 'Data' section provides information of *Raga Yaman* and information about the collected data. We have expressed our thoughts and reasoning about using the Natural Language Processing techniques like n-gram analysis for analysing music. The subsequent sections emphasise the observations, analysis and conclusion from the work.

Key Words: Indian Classical Music, *Raga*, *Bandish, Aalap*, *Taan*, *Swar, Vadi* note, *Samwadi* note, notation, n-grams, Natural Language Processing

1.0: Introduction

Indian Classical Music (ICM) is a very expressive form of music. It has a specific melodic and rhythmic structure. Melodic structure is known as *Raga* and rhythmic structure is known as *Tala*. During the Indian Classical music performance, a *Raga* is presented by the artist. Every artist improvises by using notes in the *Raga* and by keeping the framework of the *Raga* intact. *Bandish* is a composition in the *Raga*. It is a small song that provides the basic melody, around which an artist can improvise. *Aalaps and Taans* are the other melodic components using which *Bandish* is elaborated and explored within the framework of a *Raga*.An *Aalap* is performed in a slow tempo while a *Taan* has a faster tempo.

The improvisation during the performance is extempore. That is why no two performances of the same *Raga*, even two performances by the same artist, will be identical. Every *Raga* has a specific set of musical notes (*Swar*) which is represented by *Aaroh* and *Avaroh* of *Raga*. Along with *Aaroh*

and *Avaroh,* a*Raga* is characterized by several attributes. Table 1 contains the List of some of the attributes and their descriptions.

Table 1: List of attributes of the *Raga* and their meanings

Attribute	Meaning
Aaroh	A unique melodic phrase in which the notes in the *Raga* are arranged in ascending order.
Avaroh	A unique melodic phrase in which the notes in the *Raga* are arranged in descending order.
Pakad	A unique set of melodic phrases by which the *Raga* can be identified. (Catch phrase of the *Raga*) (Surendra Shetty, 2009),(H. G. Ranjani, 2011)
Vaadi note	The most important note in the *Raga*. It appears most frequently in the *Raga* rendition.
Samvaadi note	The second most important note in the *Raga*.
Anuvadi notes	The set of notes used in the *Raga* apart from *Vaadi* and *Samvaadi.*
Vivadi notes	The set of notes which should not be a part of the *Raga* rendition.
Varjya notes	Notes which are omitted form the *Raga.*
Raga-samay	A specific time that is considered as the most appropriate time to sing the Raga.
Bhava of the *Raga*	Every *Raga* is said to be capable of expressing a certain emotion and creating a certain mood.

The perceived music is documented by employing a *notation* that consists of symbols to represent notes and their variants, duration of each, and, durations of the absence of sound. Notations of the *aroha* that employ all 12 notes in ICM (specifically Hindustani Classical Music which is a north Indian Variety) are shown in Table 2 below.

Table 2: ICM style notations

Notation Style	Note symbol
ICM notation (in Roman script)	S r R g G M m P d D n N
ICM notation (a variant in *Devnagari*)	सारेरेगगममंपधधनीनी

(Note: The lowercase letters in Roman notation denote semitones, i.e., *komal* in the case of R, G, D, N and, sharp tone i.e. *teevra* in the case of M. Underlined characters in Devnagri notation represent *komal* in the case of R, G, D, N and a small vertical line above character denotes sharp tone i.e. *teevra* in the case of M)

In this study, in order to make it easier to process, we have used following notations:

- Shuddh (natural) notes are notated as S, R, G, M, P, D, N
- Komal (flat) notes are notated as r, g, d, n
- *Teevra* (sharp) note (*madhyam*) is notated as m
- (S, R, G, M, P, D, N) = notes in middle octave (*Madhya Saptak*)
- (_S, _R, _G, _M, _P, _D, _N) = notes in lower octave (*Mandra Saptak*)
- (S_, R_, G_, M_, P_, D_, N_) = notes in upper octave (*Taar Saptak*)

2.0: Objective

To analyse the note frequencies and n-gram frequencies generated from notations of *Bandishes*, *Aalaps* and *Taans* in *Raga Yaman* to examine which of these three are more representative of the *Raga* framework. The following section presents the details of data preparation and processing.

3.0 : Data

The input is a dataset of the notations of *Bandish, Aalap* and *Taan* in *Raga Yaman*. *Yaman* is a very melodious *Raga*. We found it easier to find compositions in *Yaman*. That is one of the main reasons why we chose *Yaman* for this study. Some of the *Bandishes, Aalaps* and *Taans* were obtained from a standard text book of an intermediate level Course in ICM (Deodhar, 2012). Notations of some of the *Bandishes* were generated manually. The notations which were available in the hardcopy format have been typed in manually. The size of the total data has been compiled in Table 3. The first element of the pair in a *Bandish* record is the number of lines and the second is the number of sets from where the data has been gathered.

Table 3: Size of *Bandish*, *Aalap* and *Taan* used for analysis

Raga	**Feature**		
	Bandish	**no. of *Aalaps***	**no. of *Taans***
Yaman	(103, 20)	41	34

The table 4 below contains values of attributes for*Raga Yaman*:(Deodhar, 2012)

Table 4: values of attributes for *RagaYaman*(Deodhar, 2012)

Attribute	**Meaning**
Aaroh	_N R G m D N S_
Avaroh	S_ N D P m G R S
Pakad	_N R G, R G, _N R S, P m G R, _N R S
Vaadi note	G
Samvaadi note	N
Anuvadi notes	S, R, m, P, D
Vivadi notes	R, g, M, d, n
Varjya notes	No *Varjya* note.
Raga-samay	Around 9:00 pm to 12:00 midnight
Bhava of the *Raga* (mood)	Serious

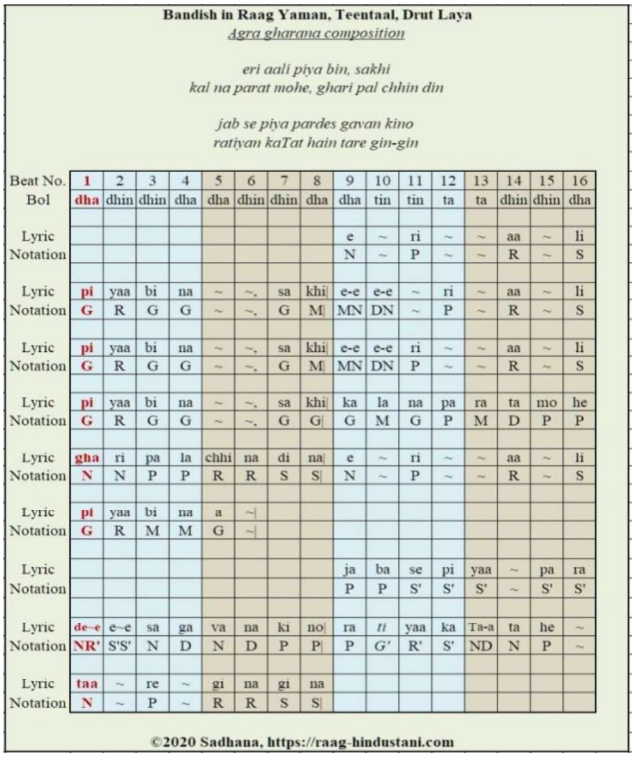

Figure 1 below provides an example of the *Bandish* and its notation in *Raga Yaman*(Sadhana, 2011).

Figure 1: Bandish and its notation in Raga Yaman(Sadhana, 2011)

4.0: NLP technique for analysis

Music isconsidered as a way to communicate as music conveys a specific emotion. This capacity of music can be considered analogous to the languages. The notes in ICM are similar to alphabets and musical phrases are similar to words, rendition of a *Raga* is similar to a write-up. These similarities in language and music motivated us to analyse components of *Raga* using natural language processing techniques. *Raga* in ICM is explored and elaborated through the phrases designed using combinations of notes in a specific

sequence. Not all such combinations are valid combinations in a specific *Raga*. *Bandish*, *Aalaps* and *Taans* being a composition in a *Raga*, should follow the *Raga* framework.

N-gram analysis has been successfully employed to capture syntactic information in diverse scripts (N. Yadav, 2010), (S. Drew, 2022), (W. Cavnar, 1994). A similar approach has been proposed here. The frequencies of notes, bigrams (patterns of two successive notes) and trigrams (patterns of three successive notes) are extracted from the notations of *Bandishes*, *Aalaps* and *Taans*. A note-frequency matrix has been constructed in which the (i, j)-th element denotes the frequency of the i-th note in the j-th component. Figure 2 is a snapshot of a note frequency matrix. *Bandish* wise note frequencies are also generated. Figure 3 below is a snapshot of *Bandish* wise note frequencies (total 20 *Bandishes*). Another matrix similar to the term-document matrix (W. Cavnar, 1994)has been constructed in which the dimensions are ngrams and components (*Bandishes*, *Aalaps* and *Taans*). The (i, j)-th element of this matrix denotes the frequency of the i-th gram in the j-th component. Figure 4 is a snapshot of the first few cells of the ngram-component (*Bandish*, *Aalap* and *Taan*) matrix.

Note Frequencies			
Notes	Bandishes	Aalaps	Taans
S	237	105	108
R	274	143	112
G	289	111	132
m	200	90	121
P	235	89	65
D	204	112	93
N	256	152	115

Figure 2: note frequency matrix

1	2	3	4	5	6	7
Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies
P : 12	N : 13	G : 13	P : 11	N : 9	P : 12	S : 15
m : 10	R : 9	P : 6	N : 15	D : 8	G : 22	G : 10
N : 17	G : 13	R : 12	D : 13	P : 10	R : 27	P : 27
D : 12	S : 5	S : 13	R : 14	m : 11	S : 18	D : 8
G : 13	D : 10	N : 10	G : 16	G : 12	N : 22	R : 10
R : 21	P : 5	D : 6	m : 12	R : 9	D : 13	N : 8
S : 7	m : 10	m : 3	S : 12	S : 7	m : 17	m : 3

8	9	10	11	12	13	14
Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies
N : 14	N : 22	N : 9	P : 17	N : 15	G : 12	N : 15
D : 8	R : 22	S : 15	D : 10	R : 17	R : 10	D : 17
P : 7	G : 24	P : 12	N : 12	G : 16	N : 13	P : 13
m : 12	P : 22	G : 16	m : 6	P : 11	S : 12	m : 20
G : 19	m : 13	R : 9	R : 11	S : 19	D : 9	G : 20
R : 22	D : 20	D : 6	G : 10	D : 11	m : 10	R : 16
S : 16	S : 17	m : 5	S : 9	m : 9	P : 8	S : 8

15	16	17	18	19	20
Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies	Note Frequencies
G : 12	N : 12	N : 7	G : 12	S : 10	N : 15
R : 10	D : 8	D : 8	R : 10	D : 4	D : 17
m : 8	P : 13	P : 17	N : 13	N : 10	P : 12
P : 7	m : 10	R : 7	S : 12	P : 5	m : 19
D : 7	G : 11	S : 12	D : 9	m : 11	G : 21
S : 7	R : 13	G : 6	m : 10	G : 11	R : 15
N : 6	S : 15	m : 1	P : 8	R : 10	S : 8

Figure 3: Bandish wise note frequencies (total 20 Bandishes)

Bi grams	Bandish	Aalap	Taan
G R	105	54	59
N D	102	29	38
R G	93	53	36
D P	91	38	46
m G	87	26	63
P m	78	38	57
G m	76	29	41
P P	67	18	0
S_ N	62	29	35
D N	61	35	41
R S	58	44	38
S_ S_	58	12	4
_N R	45	36	12
m D	45	28	38
R_ S_	41	17	23
S S	36	5	21
N R_	35	18	14
G G	34	10	3
m P	34	16	13
G_ R_	26	9	13
G P	25	5	0
S _N	24	31	7
P D	23	16	4
P G	21	0	3
R _N	21	14	4
D m	19	2	6
N S_	19	17	19
P R	17	6	0
N N	16	4	7

Tri grams	Bandish	Aalap	Taan
N D P	73	23	36
P m G	57	16	55
m G R	50	15	52
D P m	44	20	45
G R G	41	13	19
G R S	38	28	33
R G m	36	16	25
R G R	33	27	6
R S S	32	4	21
S_ N D	32	14	28
D P P	31	8	0
D N D	25	8	6
S_ S_ N	25	11	4
S_ S_ S_	25	1	0
_N R G	24	21	8
m G m	24	3	6
G m P	23	11	11
m D N	23	20	34
G m D	21	10	23
N D N	21	4	1
R_ S_ N	21	9	19
R _N R	20	10	3
N R_ S_	19	11	6
G m G	18	7	7
S_ N R_	18	11	5
P P m	17	10	0
R G G	16	7	1
G_ R_ S_	15	5	13
P P P	15	2	0

Figure 4: The ngram-component (Bandish, Aalap and Taan) matrix

5.0 Observations and Analysis

The note frequency matrix indicates that the most frequently occurring note in *Bandish*and *Taan* datasets is G, which is a *Vadi* noteof *Yaman.*Howener, the most frequently occurring note in *Aalap* dataset is N, which is a *Samvadi* noteof *Yaman.* N is the third most frequently occurring note in *Bandish* and *Taan* datasets. Considering the note frequency criteria the observations imply that *Bandish* and *Taan* are more representative components of *Raga* framework.

Bandish wise note frequencies indicate that in 10 out of 20 *Bandishes*,*Vadi* note (G) is the most frequently occurring note and in 2 of the *Bandishes*, *Samvadi* note (N) is the most frequently occurring note. In remaining 8 *Bandishes*the *Vadi* noteor *Samvadi*note is the second most frequently occurring note. This implies that 50% of the *Bandishes* follow the distribution of notes as per the *Raga* framework. However, in remaining 50% *Bandishes* as well the note distribution follows the *Raga* framework with very small difference which, as per the trained musician, could be considered acceptable.

The ngram-component (*Bandish*, *Aalap* and *Taan*) matrix indicates that the distribution of the most frequently occurring bi-grams and tri-grams is somewhat similar in all three components i.e. *Bandish*, *Aalap* and *Taan*. Considering the distribution of bi-grams and tri-grams in *Bandish*, *Aalap* and *Taan* observations imply that all three components are equally representative of *Raga* framework.

6.0 Conclusion

The objective of this work was to analyse three important components of *Raga* rendition i.e. *Bandish*, *Aalap* and *Taan*. We could successfully do it for *Raga Yaman*. However, the number of *Ragas* inICM goes to few hundred. We are aware that such a small-scale experimentis insufficient to be able to generalize the results for all those Ragas. Rather, even a single *Raga*like *Yaman*, even by following the *Raga* framework strictly, can be presented in many forms by different artists as per their creativity. That is why more data is required for more and in-depth analysis which can increase the confidence in the results. However, success of this experiment brings out a possibility of NLP for modelling a *Raga*. We showed that the data about *Bandish*, *Aalap*and *Taan* are sufficient to model a *Raga* of ICM.

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