

THE USE OF MELODIC SCALES IN BOLLYWOOD MUSIC: AN EMPIRICAL STUDY

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ABSTRACT

Hindi film music, which is commonly referred to as “Bollywood” music, is one of the most popular forms of music in the world today. One of the reasons for its popularity has been the willingness of Bollywood composers to adopt and be influenced by various musical forms including Western pop, jazz, rock, and classical music. However, till date, we are unaware of any systematic quantitative analysis of how this genre has changed and evolved over the years since its inception in the early 20th century. In this paper, we study the evolution of Bollywood music with respect to the use of *melodic scales*. We analyse songs composed over seven decades using a database of top-lists, which reveals many interesting patterns. We also analyze the scale usage patterns in the music of some of the most popular composers, which clearly brings out certain idiosyncrasies and preferences of each of them.

1. INTRODUCTION

The Mumbai based Hindi language film industry, which is popularly referred to as *Bollywood*¹, produces more than 800 movies every year². Almost all Bollywood movies feature several songs that are very popular in India, and have often been termed as the heartline of Indian popular culture [1, 11]. In fact, Bollywood songs are one of the most searched items on the Web from India³. Over decades, this music has influenced lives and cultures not just in India, but across all of Asia, Africa, Eastern Europe, and more recently, North America [7]. Several scholars in the past [2] have attributed this universal popularity of Bollywood music to its great ability in assimilating various styles of music from around the world and churning out compositions of global appeal. The cultural history of Bollywood, the emergence of musical styles, genres and sub-genres, and corresponding ethnomusicological aspects have been well studied by social scientists [5, 9, 10]. How-

¹ <http://en.wikipedia.org/wiki/Bollywood>

² <http://geography.about.com/od/culturalgeography/a/bollywood.htm>

³ <http://www.google.com/intl/en/press/zeitgeist2010/regions/in.html>

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ever, as far as we know, till date there are no quantitative and statistical analysis of musical styles of Bollywood, except for a recent study that analyzes Bollywood song lyrics through computational linguistic techniques [3].

In this paper, we present a quantitative study of the relative usage and popularity of various *melodic scales* in Bollywood over a period of seven decades. We analyzed the scales used in 310 songs from 1953 to the present day, all of which have been in the top 50 hit list for the year they appeared in. Our results show that some scales have waned in popularity over the years, while some other scales have always dominated the mix. We also identified five influential music composers of Bollywood from different time periods and analyzed the usage of musical scales in their compositions. Again we noticed several interesting composer specific trends. For instance, some composers like Allahrakka Rahman and Rahul Dev Burman, show great diversity in the usage of musical scales in their compositions, while others such as Shankar-Jaikishan or Pritam Chakraborty preferred to exploit the melodic patterns of a few popular scales.

The study of melodic scales in Bollywood music is particularly interesting because since its inception in the early 20th century and until the 1960s, Hindi film songs were almost exclusively based on or inspired by Indian Classical Music (ICM). A characteristic feature of ICM is its use of a large number of scales. Hence, we expect Hindi film music to exhibit a similar diversity of scale usage than that found in the popular music of other cultures. However, the decreasing influence of ICM, and the gradually increasing influence of folk, rock, pop and blues on this genre can significantly alter the scale usage pattern over time. Thus, by studying the evolution of scale usage patterns in Bollywood, we can, in essence, objectively characterize the influence of various musical cultures as well as individual composers on Bollywood.

2. MELODIC SCALE OF A SONG

2.1 Definition of a Scale

Bollywood music, along the lines of ICM, uses the standard twelve note (in an octave) Western *chromatic scale*. Any given composition uses only a subset of these twelve notes, which can be loosely referred to as the *melodic scale* of the composition. This is a *relative scale* or *mode*-based system, where the intervals between the adjacent notes are fixed, but not the notes themselves. Once the *tonic*, the

| | | | | | | | | | | | | |
|----------|-----------|----------------------------|-----------|----------------------------|-----------|-----------|----------------------------|-----------|----------------------------|------------|----------------------------|-----------|
| NICM | <i>Sa</i> | <i>kom. Re</i> | <i>Re</i> | <i>kom. Ga</i> | <i>Ga</i> | <i>Ma</i> | <i>teevra Ma</i> | <i>Pa</i> | <i>kom. Dha</i> | <i>Dha</i> | <i>kom. Ni</i> | <i>Ni</i> |
| Notation | S | r | R | g | G | m | M | P | d | D | n | N |
| Western | <i>C</i> | <i>C# or D_b</i> | <i>D</i> | <i>D# or E_b</i> | <i>E</i> | <i>F</i> | <i>F# or G_b</i> | <i>G</i> | <i>G# or A_b</i> | <i>A</i> | <i>A# or B_b</i> | <i>B</i> |

Table 1. Names and notations of the notes in NICM along with their Western counterparts. *kom.* stands for *komal* meaning a flat note. *teevra* is a sharp note.

first note of the octave referred to as *Sa* in Indian musical traditions (equivalent to *Do* in Solfaggio), is set to a specific note (say *C* or *A_b*) the rest of the notes in the scale gets automatically defined. Table 1 introduces the names of the notes used in Indian music and the notation that we will use in this paper along with the corresponding note in Western music when the tonic is on *C*.

Like Western music, the most common scale types in ICM are *heptatonic*, i.e., consist of seven notes. Therefore, the two dominant classical musical traditions prevalent in India today, the *Hindustani* or the North Indian Classical Music (NICM) and the *Carnatic* or the South Indian Classical Music (SICM), deem the heptatonic scales to be fundamental; all other scales – *pentatonic*, *hexatonic* and (rarely) *octatonic* are considered to be derived from a parent heptatonic scale. Musicologists in both the traditions [4,6] have extensively studied and proposed the defining features of the heptatonic scales used in the respective systems. A detailed discussion on these theories is beyond the scope of this paper, though it suffices to mention here that in NICM tradition, from which Bollywood music has derived its main genetic material, a basic heptatonic scale can have only one of the two *Re*'s, *Ga*'s, *Ma*'s, *Dha*'s and *Ni*'s. This leads to 32 possible fundamental scales, of which only ten are traditionally identified as important or fundamental for deriving other scales and *ragas*⁴ [4]. These scales are referred to as *thaats*. We shall refer to these scales by their corresponding *thaat* names. However, there are some more scales that are presently used in NICM (often borrowed from popular ragas, e.g., *Charukeshi* and *Kirwani*, in SICM system). Table 2 lists all these popular heptatonic scales used in NICM. We shall refer to these scales by the name of the *thaat* if it is one of the 10 thaats described by Bhatkhande, else we will refer to them by the name of a popular *raga* based on this scale. *One should note that a raga and a scale are not equivalent, it is just a naming convention that we will follow in this paper, and henceforth all the raga names should be interpreted as the corresponding scale (set of notes) used by the raga.*

2.2 Identifying the Scale of a Song

Almost all the Bollywood songs are composed in the scales mentioned in Table 2, though some of the compositions might use a pentatonic or hexatonic scale derived from one of these heptatonic scales, and sometimes *accidentals* (notes that do not belong to the parent scale) might be employed at a certain point in the composition. Since the

⁴ A *raga* is based on an ascending and descending scale, but is characterized using many other features and evades a formal definition. See [4] for a detailed exposition.

| Scale | NICM name | Western name |
|----------------------|-------------------|--------------------------|
| S R G m P D N | <i>Bilawal</i> * | Major Diatonic |
| S R g m P D N | <i>Patdeep</i> | Melodic Minor |
| S r G m P d N | <i>Bhairav</i> * | Major Gypsy |
| S R g m P d N | <i>Kirwani</i> | Harmonic Minor |
| S R G m P D n | <i>Khamaj</i> * | Mixolydian |
| S R g m P D n | <i>Kafi</i> * | Dorian |
| S R G m P d n | <i>Charukeshi</i> | Major Minor |
| S R g m P d n | <i>Asavari</i> * | Natural Minor |
| S r g m P d n | <i>Bhairavi</i> * | Phrygian |
| S R G M P D N | <i>Kalyan</i> * | Lydian |
| S r G M P D N | <i>Marwa</i> * | Not known |
| S r G M P d N | <i>Purvi</i> * | Chromatic Hypolydian |
| S r g M P d N | <i>Todi</i> * | Chromatic Lydian Inverse |

Table 2. List of heptatonic scales used in NICM. The *Thaat* names are marked with *.

(staff) notations are not readily available for Bollywood songs⁵, we resort to music experts to identify the notes and hence the scale of a song. When the set of notes used can be easily identified as a heptatonic scale (which almost always maps to one of the scales listed in Table 2), we unambiguously mark the scale of the song with its corresponding name. Whenever a note and its flatter or sharper version are used in the same song (less than 10% in our dataset), one of the notes is marked as accidental based on the expert's intuition. This often involves looking at the frequency of usage, as the accidentals are used much less frequently than the other note which is a part of the scale. Once the accidentals are so identified, it is easy to map the rest of the notes into one of the heptatonic scales.

There are a substantial number of Bollywood compositions that use scales with fewer than seven notes. For instance, the Major Pentatonic scale – (**S R G P D**), that is used in ragas *Bhupali*, *Deshkar* etc., has been used in many Bollywood songs. This scale can be thought to be a derivative of *Kalyan*, *Bilawal* or *Khamaj*. Due to this ambiguity, we do not map pentatonic and hexatonic scales to a parent heptatonic scale; rather, we refer to those scales by the name of a popular *raga* that uses the scale. Some of the common pentatonic and hexatonic scales that we have encountered in Bollywood music (along with the names we

⁵ This is again a common feature of Indian musical traditions, where improvisations abound in all genres of classical and semi-classical music, and consequently a fixed notation is rarely used to describe the composition.

will refer to them with): **S R G P D** (*Bhupali* or the Major Pentatonic scale), **S R m P n** (*Megh* or the Suspended Pentatonic scale), **S R G P N** (*Hamsadhvani*), **S R g P D** (*Shivaranjani*) and **S R g m P n** (*Nayaki* or the Minor Hexatonic scale).

It is important to note that Bollywood songs are usually structured with a beginning *mukhda* (analogous to a chorus) followed by anywhere between one and four *antaras* (analogous to verses). Sometimes, a song may use different melodic scales in the chorus and the verses. For the purpose of this study, we study the scales used only in the chorus, since this is the most important and remembered part of a song, on which the success or popularity of a song primarily depends.

3. DATA COLLECTION METHOD

In order to study the usage pattern of scales in Bollywood songs and its evolution over the years, we want to build a dataset of songs along with their scales. Information about the year of release of the song and the composer are also necessary because our objective is to do a trend analysis and identify influences of composers on scale usage, if any. Thus, we first identify the songs that we would like to analyze, identify the scales of those songs, and then identify a set of composers who are well represented in our dataset and hence can be meaningfully studied. The dataset is publicly available at: <http://bit.ly/18Edp7Y>

3.1 Selection of Songs

There are no published authentic statistics on the number of Bollywood songs produced to date. Some crude estimates tell us that this number should be between 100,000 and 200,000. Therefore, it is impossible to manually identify the scales for even a small subset, say a randomly selected 10%, of Bollywood songs. We decided to select a subset of popular songs from every year that appeared in the year-specific top-lists. There are two reasons for this choice. First, the top songs represent the choice of the people or what was popular at a particular point of time. Second, top songs probably also have an influence on the composers and their future compositions. We selected songs from *Binaca Geetmala*⁶ charts, which published yearly top-lists from 1953 to 1994 and were the authoritative resource at the time. The lists have somewhere between 12 to 40 songs per year with more than 1000 songs in all. We chose two to three years per decade and included the top songs from those years in our dataset. We collected top-lists for 2000s from other online sources⁷.

3.2 Selection of Composers

From the list of selected songs, we identified the composers for whom we already had a substantial number of songs. These composers are (active year range for our

⁶ http://en.wikipedia.org/wiki/Binaca_Geetmala

⁷ <http://shailesh Kapoor.com/2012/01/14/top-50-bollywood-songs-of-2011/>, <http://www.bollywoodmusicradio.com/announcements/2617-top-40-songs-2005-a.html>

| Decade | 50 | 60 | 70 | 80 | 90 | 2000 | 2011- |
|--------|----|----|----|----|----|------|-------|
| #Songs | 45 | 31 | 76 | 32 | 40 | 51 | 35 |

Table 3. Number of songs selected for analysis per decade. Total number of songs is 310.

dataset is given in parentheses): Shankar-Jaikishan⁸ (1953-71), Kalyanji-Anandji⁹ (1960-81), R. D. Burman¹⁰ (1971-81), A. R. Rahman¹¹ (1992-2013, composer and Academy award winner for *Slumdog Millionaire*) and Pritam Chakraborty¹² (2004-2013). All of these have composed many hit songs over more than a decade and are considered as very influential composers who have introduced new musical styles and genres in Bollywood music [1]. Moreover, they composed during different periods of time. Hence, by studying their scale usage preferences it might be possible to gain interesting insights into the evolution of Bollywood melodies. In order to make the analysis more reliable, we then selectively included several other songs in our dataset that were composed by these five composers and that featured in the yearly top-lists.

The final dataset of songs, that was thus created, has 310 songs composed between 1953 and 2013. Table 3 reports the number of songs selected per decade in our dataset.

3.3 Scale Identification

We asked two experts, who have 10+ years of training in NICM and Bollywood music, to independently identify the scales for a randomly selected 50 songs from our dataset according to the rules specified in Sec. 2.2. The experts agreed on the scales for all the 50 songs, which indicates that scales for the songs are unambiguously identifiable, and both the experts were good at it. Hence, finally we asked only one of the two experts to identify the scales for rest of the songs in the dataset. The process takes, on an average, approximately 2 to 5 minutes per song. We intend to make this dataset publicly available for future research.

4. FINDINGS

A dataset of 310 songs spread over seven decades does not provide sufficient information to conduct a sophisticated per-year statistical analysis. Therefore, here we will report overall statistics on the temporal distribution of melodic scales, which reveal several interesting trends. Then we will move beyond gross statistical analysis, and focus on a case-by-case study of several issues that we could observe even from this limited dataset.

4.1 Overall Distribution of Scales

Fig. 1 shows the percentage of songs in the entire dataset that uses a particular melodic scale, represented as a pie-

⁸ http://en.wikipedia.org/wiki/Shankar_Jaikishan

⁹ http://en.wikipedia.org/wiki/Kalyanji_Anandji

¹⁰ http://en.wikipedia.org/wiki/R.D._Burman

¹¹ http://en.wikipedia.org/wiki/A._R._Rahman

¹² http://en.wikipedia.org/wiki/Pritam_Chakraborty

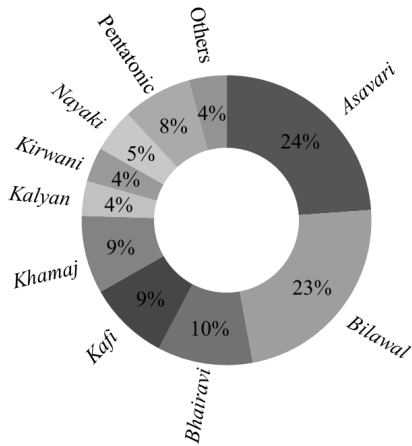


Figure 1. Distribution of Scales in our dataset.

chart. We observe that almost a quarter of the songs are composed in *Asavari* and another quarter in *Bilawal*. This is not entirely surprising because these two heptatonic scales are known to be the most popular major and minor scales across the globe. However, these statistics are indeed surprising if one considers the fact that in NICM as well as Indian folk traditions, though *Bilawal* is used quite often, use of *Asavari* and its related *ragas* is not so common. In fact, *Kalyan* and *Kafi* are by far the more popular scales presently used in NICM rather than *Asavari*.

Bhairavi, *Kafi* and *Khamaj* together cover another quarter of the songs, each being used almost equally frequently. It is surprising to see that only 4% of the songs are composed in *Kalyan*, which is otherwise a very popular scale in NICM. On the other hand, *Nayaki* and *Kirwani*, which are rarely used in NICM, are as well represented as *Kalyan*. Pentatonic scales are quite popular (8%) in Bollywood, of which the more common ones are *Bhupali* (4%), *Shivaranjani* (1%) and *Megh* (1%). We did notice a few cases where the scale used had only 3 or 4 notes, and sometimes a pentatonic or hexatonic scale that is not used in NICM or Western music. Together, these cases account for 10 songs in our dataset.

It is interesting to note that in our dataset we observe no compositions in *Bhairav*, *Marwa* and *Todi*, and only one in *Purvi*. These four scales enjoy the status of a *thaat* in NICM and are very popular in both NICM and SICM. This perhaps can be explained by the fact that these heptatonic scales have less symmetric tetrachords (see [8] for an in-depth discussion) than the six other *thaat* scales that are much more frequently used in Bollywood.

4.2 Temporal Dynamics of the Scales

Is there any significant change in the scale usage pattern over the years? To study the temporal dynamics of the scales, we computed the distribution of the scales for each decade as the fraction of the songs in a given decade that were composed in a particular scale. We observe that the scales can be broadly divided into three categories based on their temporal trends: (a) scales which did not show any drastic change in their usage pattern and have always

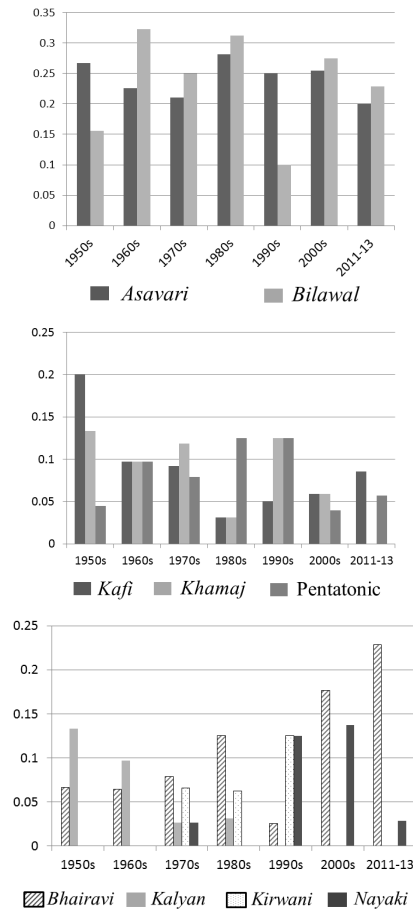


Figure 2. Change in the use of the scales over time.

been popular in Bollywood songs (i.e., always popular); (b) scales which did not show any drastic change in the trends, but were always less commonly used; and (c) scales which show drastic changes in their usage. Fig. 2 shows the trends for these three classes of scales in three different bar-charts. From the top chart one can easily see that the scales *Asavari* and *Bilawal* were always commonly used and together they accounted for half of the songs composed in any decade. The middle chart shows the trends for *Kafi*, *Khamaj* and the pentatonic scales. There are no specific observable trends (except for a drop in the use of *Kafi* as compared to the 1950s) and the minor variations are statistically insignificant. However, it is reasonable to conclude that these scales have always been in use in Bollywood songs, but only sparingly. The third set of scales represented in the lowermost chart shows several interesting trends.

We observe that the use of *Bhairavi* is steadily gaining popularity over the years, whereas the use of *Kalyan*, which was quite popular in 1950s and 60s, has steadily gone down and there is not a single composition in *Kalyan* in the dataset beyond 1980s. *Kirwani* made its appearance in 1970s and enjoyed some popularity over the next two decades, and then disappeared. Finally, *Nayaki*, which had made a brief appearance in 1970s, gained popularity in the 90s, which sustained over the next decade and beyond. Clearly, these drastic changes in the usage patterns of some

scales cannot be explained away as mere random fluctuations. These could be either due to the influence of specific music composers, cross-cultural influences, or both.

4.3 Composer-specific Trends

Table 4 reports the number of songs by a composer that uses a particular melodic scale. As one would expect, all the five composers have composed a significant number of songs in *Bilawal* and *Asavari*, the two most popular scales used in Bollywood. However, there are a couple of interesting observations that we would like to highlight here.

First, the number of distinct scales used by Kalyanji-Anandji (K-A), R. D. Burman and A. R. Rahman is much more than what we observe for the compositions of Pritam and Shankar-Jaikishan (S-J). In fact, we also noticed that even when using well-known scales like *Asavari* and *Bilawal*, R. D. Burman and A. R. Rahman have extensively used various accidentals. Hence, from the perspective of scale-usage, one can say that some of the famous Bollywood composers were inclined to experiment with scales and introduce new melodic patterns, whereas other equally famous composers focussed their attention on other components of the composition (e.g., the rhythm).

Second, the drastically changing trends for the usage of certain scales is evident from the composer-specific analysis as well. For instance, we notice an increase in the use of *Bhairavi* by Pritam, which partly explains the rise of its popularity in the 2000s and beyond. Similarly, *Nayaki* seems to have been introduced by R. D. Burman and then extensively used by more recent composers like A. R. Rahman and Pritam. On the other hand, *Kafi*, which was used to some extent by S-J and K-A has not been used by R. D. Burman or Pritam. This explains the slight drop in its use, though it is due to Rahman that it still shows up in some compositions.

There are also interesting composer-specific observations such as the strong preference towards *Bilawal* by Pritam or *Khamaj* by A. R. Rahman, which deviates from the Bollywood norms. Likewise, K-A's nearly equal preference given to a large number of scales highlights a unique characteristic of this composer duo. We will discuss the possible causes and repercussions of these findings in the next section.

5. INTERPRETATIONS AND CONJECTURES

Bollywood is a melting pot of cultures and so its music incorporates numerous influences from musical traditions all over the world. The present study on the use of melodic scales can actually provide various interesting insights about these cultural, and at times individual, influences on the music of Bollywood. Here we discuss some of *our interpretations* of the observed trends in scale usage, and make some conjectures.

Decreasing Influence of ICM. The scale usage pattern of Bollywood differs significantly from that of ICM. The gradually decreasing popularity of *Kalyan* and to some extent *Kafi*, both of which are extremely popular in ICM, clearly indicates that Bollywood is moving away from ICM.

| Scales | S-J | K-A | RDB | ARR | PC |
|-----------------|-----|-----|-----|-----|----|
| <i>Asavari</i> | 9 | 4 | 9 | 8 | 6 |
| <i>Bilawal</i> | 7 | 3 | 9 | 2 | 12 |
| <i>Khamaj</i> | 2 | 3 | 6 | 5 | 2 |
| <i>Bhairavi</i> | | 3 | 4 | 2 | 6 |
| <i>Kafi</i> | 1 | 3 | | 4 | |
| <i>Kalyan</i> | | 1 | 1 | | |
| <i>Kirwani</i> | 2 | 1 | 3 | 2 | |
| <i>Nayaki</i> | | | 3 | 3 | 5 |
| Other | 2 | 7 | 3 | 4 | 1 |
| Total | 23 | 25 | 38 | 30 | 32 |
| Distinct | 6 | 11 | 10 | 10 | 6 |

Table 4. Scale usage of five influential composers: S-J – Shankar-Jaikishan, K-A – Kalyanji-Anandji, RDB – R. D. Burman, ARR – A. R. Rahman, PC – Pritam Chakraborty. Total and Distinct respectively refers to the total number of scales analyzed for the composer and number of distinct scales found in those compositions.

On the other hand, we note that the scale usage pattern of the 1950s and 60s (*Khamaj*, *Kafi* and *Kalyan* were used equally and only slightly less than *Bilawal*) follow a trend that one would expect under a strong influence of ICM. Indeed, music by earlier composers such as Naushad, were heavily influenced by ICM¹³. Nevertheless, it is important to note that ICM-based songs are still occasionally used in the Bollywood movies, especially in period films, and we can expect this trend to continue.

Increasing Influence of Western Music. Since 1970s, Western popular music has had a steady influence on Bollywood. R. D. Burman is known for extensive use of ideas from Jazz and Blues in his compositions. His introduction of *Nayaki* – the Minor Hexatonic scale that is popularly used in Blues and other Western music – and subsequent popularity of this scale till the present day is a clear evidence of the increasing influence of the Western music. While *Bilawal* and *Asavari* are popular in ICM, they are prevalent in Western pop music as well. A deeper analysis of the recent songs composed in these scales shows that it is indeed the influence of the latter which has led to the recurrent usage of these scales.

Influence of other Musical Cultures. *Bhairavi* or the Phrygian scale, though popular in ICM, is also prevalent in the folk songs of the Middle East, some East European regions, and the Punjab and Kashmir regions of India. Most Bollywood compositions in *Bhairavi* hardly bear any resemblance to the *raga Bhairavi* or its derivatives. R. D. Burman's famous songs of the 1970s and 80s in this scale rather reflect the influence of Middle Eastern folk songs. The music of the Middle East has been and still continues to be a strong source of inspiration for Bollywood composers. R. D. Burman's compositions in *Kirwani* or the Harmonic Minor scale, another popular scale of the region,

¹³ http://chandrakantha.com/raga_raag/film_song_raga.html lists a large number of Bollywood songs based on ragas. Most of these songs were composed between 1940s and 1970s.

also show a distinct Middle Eastern influence. However, *Kirwani* is also used in Russian folk songs and early usage of this scale in Bollywood, promoted by S-J, can be traced back to its Russian inspiration. We also notice that the recent upsurge in the use of *Bhairavi*, especially in compositions by Pritam, is not related to Middle Eastern folk music, but is inspired by Punjabi folk songs. Interestingly, we observe several other *Bhairavi*-based songs composed by Pritam which do not have any apparent resemblance to either Punjabi or Middle Eastern folk songs. Nevertheless, the melodic structure of the songs clearly reveals an underlying Punjabi inspiration.

Inspiration Patterns for Composers. We observe that some composers, such as R. D. Burman, use a scale extensively within a short period of time for a large number of apparently (melodically) unrelated compositions. Such composers seem to be consciously or subconsciously guided by the same melodic inspiration, which results in compositions based on the same scale, even though the situational context of the song in the film may not demand a specific genre or regional character in the music. For instance, out of 16 songs in our dataset composed by R. D. Burman between 1971 and 73, 13 are in *Asavari* (7), *Bilawal* (4) and *Nayaki* (1) and all are clearly influenced by Blues, Rock and Western Pop. The rest are in *Khamaj* (2) and *Bhairavi* (1), and are based on South Indian and Punjabi folk songs. On the other hand, between 1980 and 81, out of the 16 compositions by him, 7 are in *Kirwani* and *Bhairavi* all reflecting distinctive Middle Eastern influence. On the other hand, for A. R. Rahman we do not see any such temporal clustering of scales between 1992 and 2005, but between 2006 and 2009, we observe a preference towards *Asavari* (5 out of 9). Surprisingly, these compositions have been inspired by Middle Eastern music and Sufi music which also use this scale, and not so much by Western pop, which is what *Asavari* is most commonly used for in Bollywood.

Diversity of Scales. Finally, we note that the number of scales used during each decade in Bollywood has been more or less constant throughout its history. To confirm this, we computed the entropy of the distribution of the scale usage for each decade, which turns out to be more or less constant. Thus, the commonly held opinion that “all Bollywood songs sound pretty much the same these days”, i.e., the melodic diversity was greater previously than it is today, is not supported by our data. This diversity is an effect of multiple influences drawn from various cultures. Of course, the sources of inspiration change over time, and so do the scale usage and melodic patterns; but the scale diversity remains high at any given point of time.

6. CONCLUSION

In this work, we created a small dataset of 310 Bollywood songs sampled from the yearly top lists and identified the melodic scales of the songs. Through an analysis of this dataset, we identified and quantified various cultural influences on Bollywood music and its composers over the years. Even though 310 songs are not sufficient for making any strong claims or observing complex cultural influ-

ences, we believe that our analysis revealed some striking facts about the scale usage patterns and has helped us to formulate interesting conjectures which can be statistically verified if one had more data.

There has been a similar study for rhythmic patterns and other features of compositions in Western popular music [12], but we do not know of any study that analyzes melodic scales for a given genre. Our next step is to study scale usage in various other musical cultures around the world as well as regional film industries and parallel musical traditions extant in India and extend the current dataset to include more Bollywood songs.

7. ACKNOWLEDGMENTS

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