Pitch Class Distributions in Turkish Classical Music

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ABSTRACT

In this paper we study the distribution of pitch classes for different makams in turkish classical music. Turkish classical music has many characteristics, such as makams that describe melodic progression, usuls that include the rhythm of a song, and forms that describe the structure of the piece. In the turkish makam, octaves are split into 53 equal intervals while in modern western music an octave is split into 12 tones. We analyze the pitch distributions of many makams based on different usuls and forms. In accordance with our hypothesis, we see that the distributions are generally homogeneous. This can be attributed to the fact that each makam dictates rules of pitch composition, and that variations in the distributions should not depend on form or usul.

INTRODUCTION

Turkish makam music features distinct melodic patterns called makam and rich rhythmic structure called usul. Turkish makam music draws its roots from a thousand year old tradition and has undergone much evolution on the way to its present state.

There are over four hundred makams that exist in turkish classical music. The majority of those makams are no longer in use today. The term makam is a name given to a whole set of rules that describe melodic progression patterns with musical scales called seyir. These musical scales are in turn founded on particular orders of intervals. By joining tetrachords and pentachords, complete scales and modes are created. Makam names vary according to pitches used as well as general direction of the melodic flow.

The next most typical characteristic of turkish classical music is the usul. Similar to makams, usuls are broad and vary in their characteristics. The term usul includes both the concept of measure and rhythm. The usuls are performed in beats and are divided into two main groups, minor usuls and major usuls. Minor usuls contain 2 to 15 beats and major usuls contain 16 to 124 beats.

One very important and interesting aspect of turkish classical music is how melodies are formed. The structure of turkish music has been influenced both by its melodic form and social structure. It is possible to divide the forms into two main classes, instrumental and vocal music. These classifications contain melodic forms of a variety of characteristics. In this work, we examine both instrumental and vocal music.

In turkish makam music theory, the octave is divided into 53 equal intervals, the makam type dictates which of these intervals are present for a given piece. The aim of this work is to determine whether or not form or usul type also influence how pitches are distributed within a makam piece. Due to the fact that form pertains to the song's structure and the fact that usul is a rhythmic concept, we do not expect either to significantly affect how pitches are distributed.

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METHODOLOGY

SymbTr Dataset

SymbTr [1] is a collection of machine readable symbolic scores aimed at performing computational studies of Turkish Makam music. It consists of 2200 pieces from 155 makams, 88 usuls, 56 forms, about 865.000 musical notes and 80 hours of nominal playback time. SymbTr-scores are provided in text, MusicXML, PDF, MIDI and mu2 formats. MusicXML is a standard open format for exchanging digital sheet music, which can be read by popular music notation software such as MuseScore, Finale and Sibelius.

Music21

Music21 [2] is an object-oriented toolkit for analyzing, searching, and transforming music in symbolic (score-based) forms. In this work we use Music21 to parse the MusicXML scores from the SymbTr dataset. By parsing the XML score in a code friendly format, we are able to easily count the occurrences of pitch classes within the Makam piece.

Procedure

One limitation of Music21 is that it was built mostly for the use of processing western music. Many key signatures of the Makam scores in the SymbTr database contain partial accidentals that are not compatible with Music21. In order to alleviate this, a simple preprocessing step was done to remove the key signature of each score in SymbTr. Despite removing the key signature, the notes within the score still maintain their chromatic information.

In order to obtain the pitch class distribution of a Makam score we use Music21 to get a list of all the notes within the score. Each note contains information related to the pitch such as note letter, octave number, and accidental. The note letter and accidental are kept for its obvious pertinence to pitch information, however the octave number is kept due to the fact that the notes of a scale extend past a single octave in Makam music[3]. We also record the note duration (by number of quarter notes) in order to weight the distribution such that longer notes are more relevant than shorter notes. We count the total number of quarter notes that a pitch class occurs in the score, while also recording the makam, usul, and form of the song. The information to determine the makam, usul, and form types for the score can be obtained from the name of the MusicXML file. We repeat this process for every song in the SymbTr dataset. The resulting distributions are stored as a JSON object containing the total number of quarter notes that a pitch class occurs for each usul and form type. The note names in the distributions are sorted alphabetically and the number of quarter notes are normalized as the percentage of pitch occurrences in the total distribution.

In order to determine how pitches are distributed differently based on form and usul type for a given makam, we calculate the standard deviation for each pitch in the makam distribution. Taking the average standard deviation of all the pitches in a makam will allow us to record which makams have the highest variance. In other words, the makam types with the highest average standard deviations of pitch distributions are more likely to contain differences in how pitches are distributed for different forms or usul types.

Results

In order to analyze which makams have the most variance, we examine the makams with the highest average standard deviations of pitches. Table 1 contains the top three and bottom three makams based on average standard deviation of all pitches for all usul types. Table 2 contains the top three and bottom three makams based on average standard deviation of all pitches for all forms.

For both Tables 1 & 2, average standard deviations of 0% were omitted when considering the bottom three makam types. This is due to the fact that some of the makams in the dataset only contain one form or usul type. Thus, in these instances, the standard deviation across the single form or usul type would always be 0% and its inclusion would be irrelevant for this analysis.

Makam	Avg. SD of Pitch Distributions
Huzi	**4.08%**
Irak	**3.40%**
Canfeza	**2.75%**
Kurdilihicazkar	**0.77%**
Nihavent	**0.70%**
Acemasiran	**0.66%**

Table 1. Most and least variant makam types, calculated using the average standard deviation of pitch distribution for all usuls.

Makam	Avg. SD of Pitch Distributions
Huzi	**4.08%**
Irak	**3.40%**
Yeni Cargah	**3.01%**
Suzinak Zirgule	**0.74%**
Huzzam	**0.72%**
Arazbar	**0.62%**

Table 2. Most and least variant makam types, calculated using the average standard deviation of pitch distribution for all forms.

The Huzi and Irak makams contain two of the most variant distributions for both usul and form based calculations. Figure 1 contains a plot of the pitch distribution for the Irak makam, where each line represents the weighted distribution for the corresponding usul type. The most interesting portion of the Irak distribution is the prevalence of F#5. The Yuruksemai usul contains 87 quarter notes of F#5, making up roughly 35% of the distribution, however the Sofyan usul contains 0 quarter notes of F#5. This is a particularly interesting finding because, by definition, the makam should be what dictates which pitches occur. In spite of this, two separate pieces from the same makam type have completely different uses of the F#5 pitch class.

The Huzzam makam contains one of the least variant distributions for form based calculations. Figure 2 contains a plot of the pitch distribution for the Huzzam makam, where each line represents the weighted distribution for the corresponding form type. Unlike the Irak makam, the Huzzam has a much more uniform distribution. This can be seen most prominently when viewing the spike for the D5 tone, which makes up over 23% of every distribution for each type of form. This type of correlation was far more common than that which was seen in Figure 1.

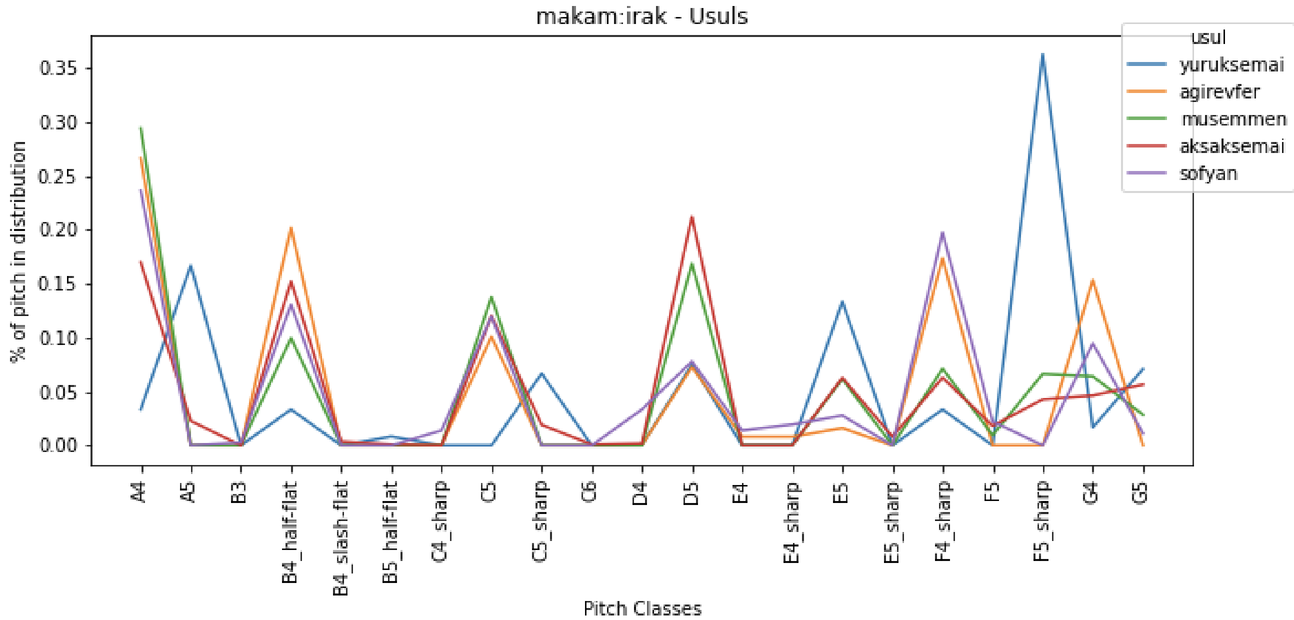

Figure 1. Pitch class distribution for the Irak makam. Each line represents the usul type. This demonstrates a pitch class distribution with high variance.

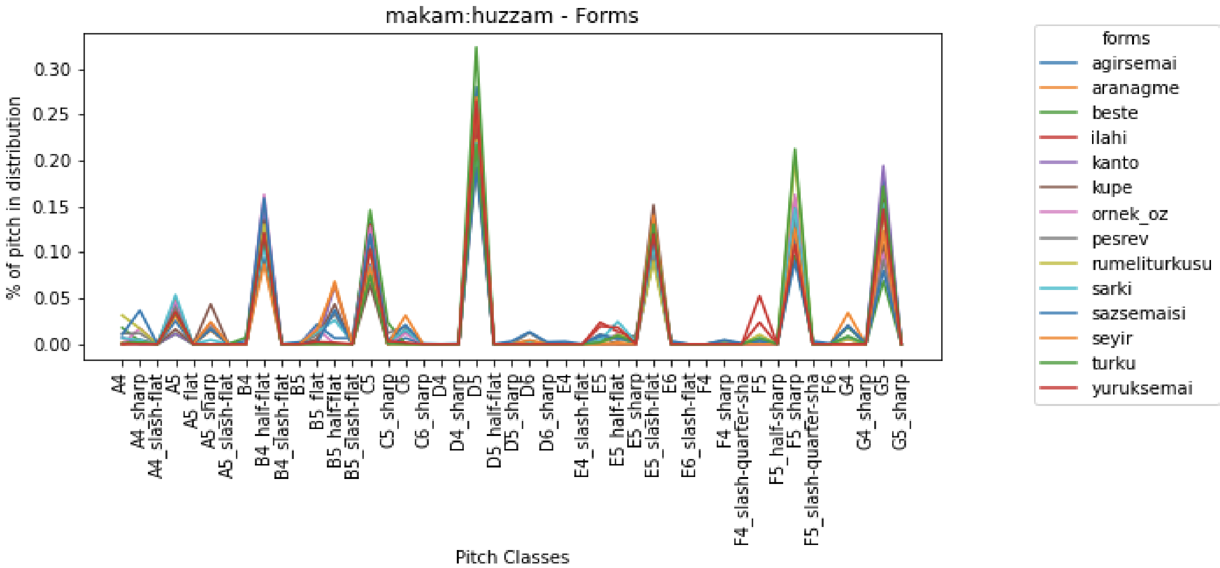

Figure 2. Pitch class distribution for the Huzzam makam. Each line represents the form type. This demonstrates a pitch class distribution with low variance.

We previously calculated the average standard deviation of pitch distributions for each form type and usul type for a given makam. Furthermore, by taking the average of all of these standard deviations we can determine whether more variance exists when comparing pitch class distributions by form or usul. Table 3 displays the results of this calculation. Overall, forms are slightly more variant than usuls, however, the difference between forms and usuls in this regard is less than one hundredth of one percent. Lastly, the average of all standard deviations is also quite small, thus it can be concluded that the difference in pitch class distributions across forms and usul is more or less negligible.

	Average of all standard deviations
forms	**0.8466%**
usuls	**0.8439%**

Table 3. Average of all of standard deviations.

Discussion

Our findings generally supported our hypothesis that we should expect uniform distributions of pitches for a given makam. This is more or less due to the fact that makam dictates how pitches occur within the melody of a piece, whereas usul is a rhythmic concept and form dictates the overall structure of the music. Makams with high variance in distributions can be attributed to small sample sizes in the dataset. In the example of the Irak makam (as seen in Figure 1), the yuruksemai usul significantly affects the standard deviation of pitch distributions, especially on F#5. It should be noted that there is only one score per usul type for this makam, and that alone could contribute to the high variance. Another possible explanation could be a mislabeling of the makam type in the dataset itself, due to the varied nature of Turkish makam music.

For the sake of reproducibility, this experiment can be replicated by using the code on github. There you can also find our results, including the pitch distributions and standard deviations, as well as plots for each pitch distribution of a makam. There may be additional examples of varying pitch class distributions worth examining further in the data we provided by implementing alternative methods for determining variance.

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