A SYMBOLIC DATASET OF TURKISH MAKAM MUSIC PHRASES

M. Kemal Karaosmanoğlu
Yıldız Technical University, Istanbul
kkara@yildiz.edu.tr

Barış Bozkurt
Bahçeşehir University, Istanbul
baris.bozkurt@bahcesehir.edu.tr

Andre Holzapfel
Boğaziçi University, Istanbul
andre.holzapfel@boun.edu.tr

Nilgün Doğrusöz Dişiaçık
Istanbul Technical University, Istanbul
dogrusozn@itu.edu.tr

1. ABSTRACT

One of the basic needs for computational studies of traditional music is the availability of free datasets. This study presents a large machine-readable dataset of Turkish makam music scores segmented into phrases by experts of this music. The segmentation facilitates computational research on melodic similarity between phrases, and relation between melodic phrasing and meter, rarely studied topics due to unavailability of data resources.

2. INTRODUCTION

One of the rarely studied topics for Turkish makam music (TMM) is the structure inherent in its melodies. Indeed, as shown by Öztürk (2011), a large part of makam literature emphasizes the importance of "melody". Yet, computational studies dedicated to analysis of melody for TMM are mainly limited to n-gram and pitch class distribution based studies such as (Yener, 2004, Ünal et al, 2014). Such studies are agnostic to the structures of melodies, and focus on purely on observed intervals.

To fill this gap, we decided to collect a database of manually segmented melodic phrases. In the literature on Turkish makam music (e.g. (Kılınçarslan, 2006, Eroy, 2010, Gönül, 2010)), melodic analysis of a piece mainly involves the melodic phrase segmentation on scores followed by the labeling of the phrases with (tri - tetra - penta) chords used (which does not need to be one-to-one) and a further study of the functions within the makam. Our database contains melodic phrase boundaries and for a limited portion also the chord labels.

While such melodic analysis practice is part of the conservatory education today, in the TMM musicology literature, we do not find any explicitly formalized methodology for it. Hence, for the segmentation process, we preferred to give no specific instructions to the experts and asked them to perform the task as they would do it for melodic analysis of a piece. Three experts who received their education from different institutes / conservatories conducted the segmentation into phrases.

In the following sections we explain the design and the content of the database. In addition, we discuss potential computational studies that can make use of this data.

3. DATABASE DESIGN

The dataset is designed to contain pieces of the Turkish makam repertoire:

i) Composed in the most commonly used makams (Çevikoğlu, 2007): Acemaşiran, Beyati, Buselik, Hicaz, Hicazkar, Hüseyni, Hüzzam, Kürdilihicazkar, Mahur, Muhayyer, Neva, Nihavent, Rast, Saba, Segah and Uşşak,

ii) With a uniform distribution in time, from 17th century to today, dividing four main periods,

iii) From well-known composers such as Itri, Dede Efendi, Hacı Arif Bey and Sadettin Kaynak.

Nr.	Period	Composer
I	(…- 1750]	Itri
II	(1750-1850]	Dede Efendi
III	(1850-1930]	Hacı Arif Bey
IV	(1930-…]	Sadettin Kaynak

Overall, a set of 480 pieces was collected consisting of 30 pieces for each of the 16 distinct makams by rewriting the pieces using Mus2 microtonal notation software (http://www.mus2.com.tr/) in the Arel notation (Arel, 1968) and further converting this data to the machine readable text format of SymbTr (Karaosmanoğlu, 2012). Three experts were asked to mark the phrase boundaries and çeşni/geçki modulations on printed scores, as they would do it for makam melodic analysis. One of the experts completed the task and the other two could label only half of the scores. So each piece was labeled by at least one expert. Their segmentations of phrase boundaries and çeşni/geçki modulations were manually exported to the machine-readable format using a custom-designed interface. Table I summarizes the size of the data.

	Number of pieces	Number of phrases
Expert 1	488	20 293
Expert 2	200	4 312
Expert 3	201	6 757
Total	**889**	**31 362**

Table I. Size of the database

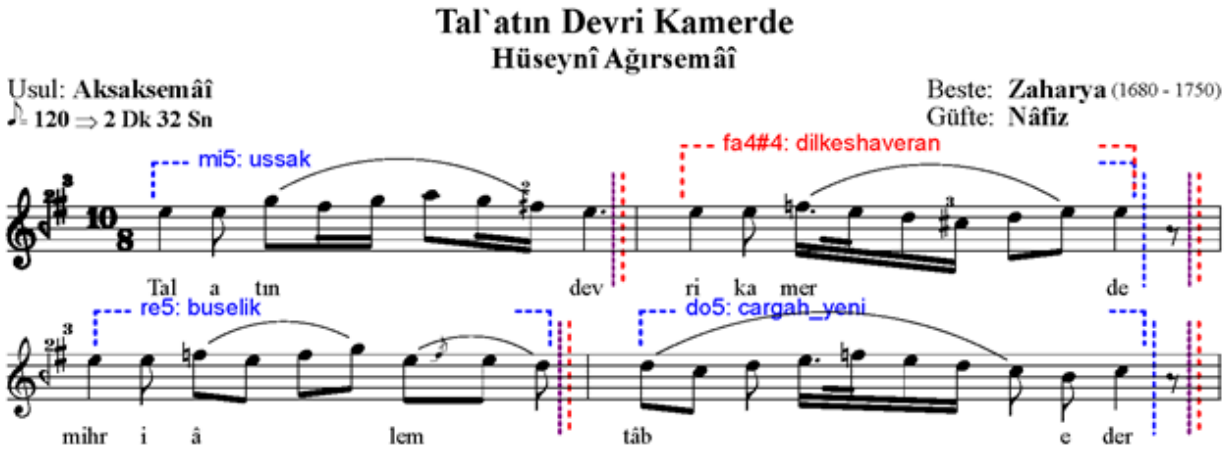

Figure 1. Example excerpt of a score

Code	NoteName	NoteName	Pitch	Pitch	Num.	Denum.	Ms	LNS	VelOn	Lyrics	Offset
9	Mi5	E5	336	336	1	4	1000	95	96	Tal	0.2
9	Mi5	E5	336	336	1	8	500	95	96	A	0.3
9	Sol5	G5	349	349	1	8	500	99	96	tın	0.4
…	…	…	…	…	…	…	…	…	…	…	…
9	Sol5	G5	349	349	1	16	250	99	96		0.65
9	Fa5#2	F5#1	342	341	1	16	250	95	96		0.7
9	Mi5	E5	336	336	3	8	1500	95	96	dev	1
53											1
54										dilkeshaveran@fa5#5	1
9	Mi5	E5	336	336	1	4	1000	95	96	ri	1.2
9	Mi5	E5	336	336	1	8	500	95	96	ka	1.3
…	…	…	…	…	…	…	…	…	…	…	…
9	Mi5	E5	336	336	1	8	500	95	96		1.7
9	Mi5	E5	336	336	1	4	1000	95	96	de	1.9
53											1.9
9			-1	-1	1	8	500	100			2

Table II. Machine-readable format of the dataset for the example in Figure 1 for one of the experts (red labels)

In Figure 1 and Table II we present a short example from the dataset. Machine readable files are in SymbTr format and basically contain *pitch* (columns 2 – 5), *duration* (columns 6 – 8, 12) and *lyric* (column 11) information for each note in a piece. It also includes microtonal pitch information which is an important feature for TMM. For this specific study, segmentation and çeşni/geçki information are added as separate lines (colored in Table II). So in the new format, each line contains information for a note or segmentation. This format is very similar to SymbTr and hence basics of the format is not explained in detail. New features are:

New *codes* (first column) are added to specify the type of segmentation: 53 for phrase boundary, 54 for the start of a *geçki*/*çeşni* label (the type of *çeşni* is specified in the *lyrics* column), 55 pointing the end of a *geçki*/*çeşni* label.

The dataset is shared along with Matlab code for importing the data into the standard format used by MIDI Toolbox (Eerola & Toiviainen, 2004) (while keeping the microtonal pitch information) so that melodic analysis tools available in the Toolbox can be easily used on the data. In addition to the symbolic data in text file format and computer codes, scanned images of the scores with manual segmentations are also shared.

The database can be accessed on:
http://akademik.bahcesehir.edu.tr/~bbozkurt/112E162_en.html
or http://www.rhythmos.org/shareddata/turkishphrases.html

In order to check for the degree of mutual agreement between the annotations, we conducted a comparison of the data obtained from the three experts. In Table III, we present F-measures obtained as a measure of match between each set of annotations. The first and the third expert agree on boundaries with an F-measure of 0.78. The second expert preferred comparatively longer phrases hence the corresponding F-measures are lower. As we discuss in the next section, there is a high agreement across the annotations conducted by the three experts considering phrase boundary choices with respect to makam pitches and usul beats.

	Precision	Recall	F-measure
Expert 1 vs 2	0.46	0.80	0.57
Expert 1 vs 3	0.74	0.85	0.78
Expert 2 vs 3	0.86	0.37	0.51

Table III. Measure of consistency between 3 experts

4. COMPUTATIONAL STUDIES

This dataset has been recently used in two computational studies: a study on automatic melodic segmentation (Bozkurt et al., 2014) and a study on characterization of segmented phrases (Bozkurt & Karaçalı, 2014). Below, we discuss parts of these studies and other observations on the data, in order to indicate potential research problems where the database can be of use.

4.1 Relation between phrase and meter

While the tonal content of Turkish makam music is guided by the modal framework of the *makam*, the metrical structure is implied by the *usul*. An usul is a rhythmic pattern that contains a series of strokes. While the length of such a pattern can be interpreted as defining the time signature of a piece, the locations of the strokes within the usul give further guidance for the rhythmic elaboration of a piece. As we showed by analyzing a large corpus of machine-readable notations of Turkish makam music (Holzapfel, 2014), note onsets and note durations tend to be related to the positions of the strokes in an usul. However, it is also evident from the results in (Holzapfel, 2014) that the metrical structure implied by onsets and durations is less clearly stratified than for Eurogenetic popular or classical music. This means, that given only the positions and durations of individual notes, we will necessarily do worse in tracking the temporal structure in Turkish music than in beat tracking of Eurogenetic popular music. In the oral tradition of Turkish makam music, the learning/memorization of pieces involves first learning and internalizing the usul pattern and then further memorizing the melodies in relation to the usul pattern (Behar, 1998). While we did not find any theoretical study discussing the link between the phrase boundaries and rhythmic cycles, our private communication with makam music experts revealed that melodic boundaries and usul cycles are strongly correlated.

A preliminary study on phrase and meter is carried out to compare phrase boundary positions with note onset positions for the Aksak usul. The Aksak usul is notated using a 9/8 time signature (Figure 2), and the stroke positions and accents of the usul are indicated by dotted lines in Figure 3a. The bold bars indicate the probability to encounter a phrase onset at the denoted location. It can be seen that the existence of a phrase boundary is a very strong indicator of the downbeat (*i.e.* the beginning of a measure), since it has a probability of almost 0.35, much higher than for the other locations. This result is consistent for all frequent short usul, with one remarkable exception. This exception is given by the *Ağıraksak*, an usul that is formally the same as the Aksak, but that is related to a slower tempo than Aksak and is usually notated as 9/4. The example in Figure 3b shows that the phrasing in Ağıraksak deviates widely from Aksak, even though the usul strokes are theoretically the same.

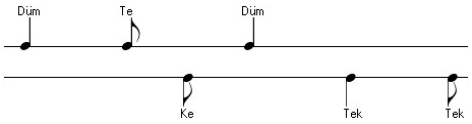

Figure 2. Symbolic description of the Aksak usul

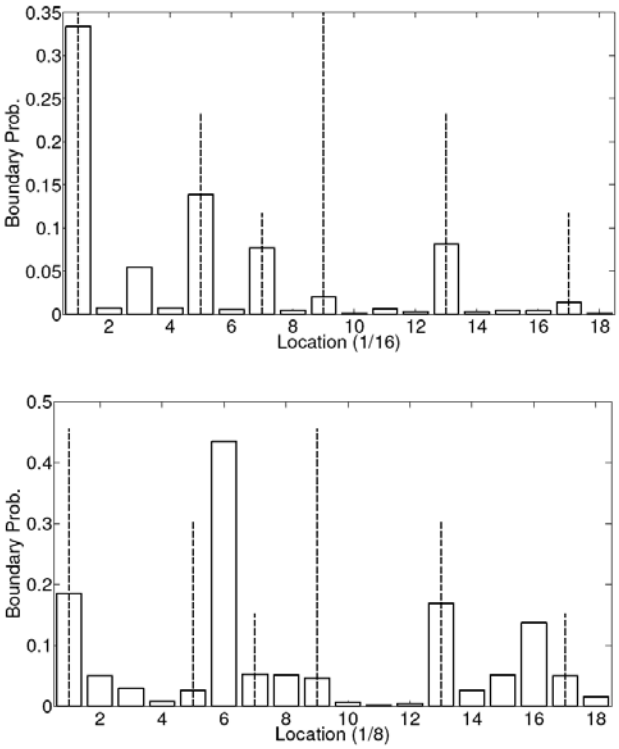

Figure 3. Location of annotated phrase onsets for Aksak and Ağıraksak.

Some of the research questions that raise immediately after these observations are: how can we explain the peculiarities of phrasing in the Aksak family? How can long usuls (of length 28 and 32) be subdivided into groups according to the annotated melodic phrasing? How this phrasing relates with the rhythmic structure encountered in the stroke sequences of these long usul? Is it possible to include phrasing in a model structure and phrase length as a constraint for tempo and beat tracking? Using the data presented in this paper, we can investigate in how far phrase information has the potential to improve automatic tempo/beat tracking on Turkish music. In our current research we develop generative models for this task, which combine assumptions about tempo development and rhythmic structure into a high-dimensional state-space. We aim at enhancing this model by including phrase information as a further high-level layer.

4.2 Phrase boundary distributions with respect to makam pitches

In (Bozkurt et al., 2014), a data-driven approach for automatic melodic phrase segmentation is proposed where the problem of segmentation is considered as a classification problem; each note is classified to be at a phrase boundary or not based on features computed from

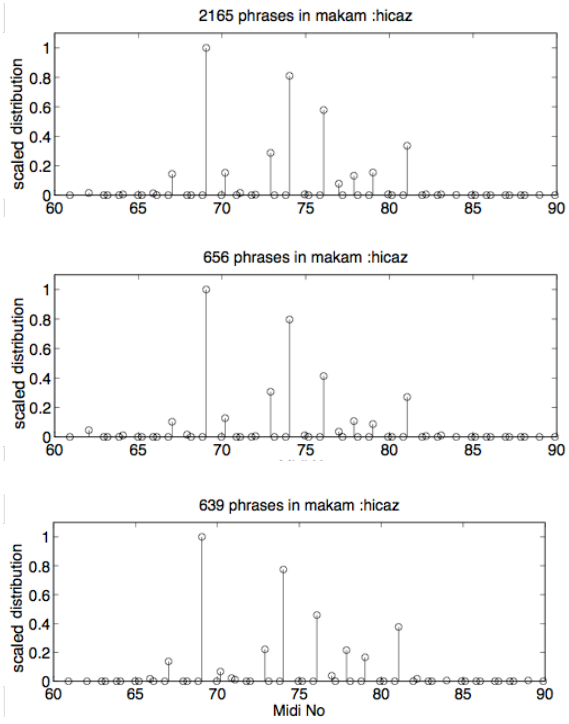

Figure 4. Feature values (scaled distributions) computed with respect to pitches of makam Hicaz from the three datasets.

the data. The feature vector computed for each note in the melody contains values of decision functions used in four state-of-the-art melodic segmentation techniques together with two novel features. The novel features are derived from probabilities of a note to appear at the boundary based on the makam and the usul of the piece. The probabilities are obtained from phrase boundary distributions computed for makam pitches and usul beats. The tests show that these new features carry complementary information to features from the literature and their inclusion in the feature vector results in a statistically significant improvement for the automatic segmentation task.

Our proposal of such features is motivated by the observation on our phrase annotated dataset that phrase boundaries are strongly correlated with the hierarchy of makam pitches and usul beats. In Figure 4, we present the phrase boundary features (computed as the scaled version of makam distributions) computed with respect to Hicaz makam pitches for the three annotators.

The first observation is that the distributions obtained from different annotators are very similar, indicating that all experts made similar choices with respect to these parameters. It is interesting to observe that this consistency holds to a very large extent for the three annotators for all makams and usuls. These distributions (both plots and data as Matlab file) are shared together with the database.

We observe that for makam Hicaz, the *karar* (tonic) pitch (A4, MIDI No: 69.06) appears as the most frequent phrase boundary (ending note). The second most frequent phrase boundary note is the *güçlü* (D5, MIDI No: 74.04). Similar observations hold for the rest of the makams in terms of hierarchies of scale degrees and frequent phrase ending notes. This supports the claims of Ayari (2005) that the hierarchy of makam pitches and phrase boundaries are related.

The interrelations between the metrical structure and grouping have been previously discussed by Lerdahl & Jackendoff (1983) and taken into consideration by Temperley (2001) for automatic melodic segmentation. While the link between phrase boundaries and hierarchies of makam pitch and usul beats is used in a data-driven approach effectively for an automatic task, the underlying phenomenon between phrasing and rhythmic cycle and pitch hierarchies is yet to be explored with a musicological perspective. Our database includes content in 16 makams and 10 usuls, which provides a large diversity for a systematic study of the interrelations between meter and melodic phrasing in Turkish music.

4.3 Phrase boundaries and personal style

We have carried out preliminary studies of relations between phrase boundaries and makam pitches on subsets of the database. Our observations suggest that the phrase boundary distributions, grouped with respect to composer and makam, provide important clues to understanding the makam concept and compositional choices of phrasing. Here, we present one simple example on makam Segah.

Comparing phrase distributions with respect to

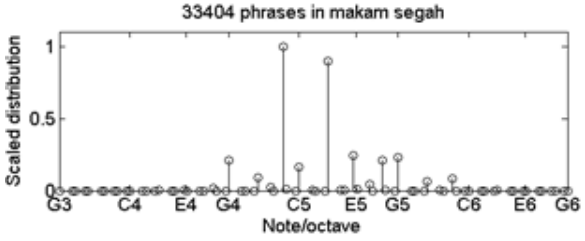

Figure 5. Feature values (scaled phrase boundary distributions) for all Segah pieces from the first dataset.

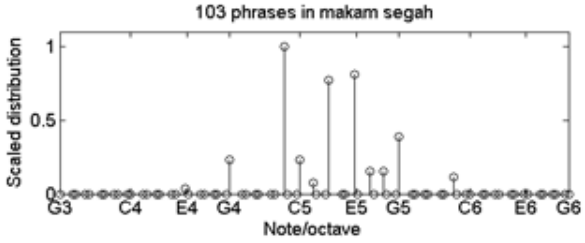

Figure 6. Feature values (scaled phrase boundary distributions) computed from Sadettin Kaynak's Segah pieces from the same dataset.

makam pitches for several subsets containing only compositions from a specific composer, we observe that distributions for compositions of Sadettin Kaynak stand out to be specifically different. In Figures 5 and 6, we present distributions for all Segah pieces and those of Sadetting Kaynak in the first data set.

The peculiarity of the subset including only Sadettin Kaynak's Segah pieces is the existence of many phrase boundaries on E5b pitch (in addition to the expected frequent boundaries on segah pitch B4 (the tonic) and on neva pitch D5 (the dominant)), which is not observed for other composers' data. The hierarchy of pitches can theoretically identify a makam but then these characteristic elements can be deliberately ignored by some composers like Sadettin Kaynak, a reformist composer.

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