AN EXPLORATION OF INTERVALLIC CORRELATION WITHIN TURKISH MAKAM - AUDIO AND MUSIC PROCESSING LAB - (ETHNO)MUSICOLOGY MODULE 2023

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ABSTRACT

We present a computational ethnomusicology study focusing on a data-driven approach aiming to analyze and classify Turkish makams based on their melodic structure. We compute the intervalic histogram of makam scores within the SymbTr dataset.

The intervalic histograms, generated by counting the frequency of occurrence for each interval between consecutive notes within the recordings, make up the features used to realize the classification task.

We apply simple machine learning algorithms and obtain coherent results with little to no parametric fine-tuning. The K-Nearest Neighbor + Linear Discriminant Analysis (KNN + LDA) model classifies with 87% accuracy, approaching state-of-the-art results.

This paper contributes to the field of ethnomusicology by presenting a quantitative method for analyzing makam structures and providing a new classification system based on intervalic histograms. The findings shed light on the relationships between makams and offer insights into the connection between melodic characteristics of Turkish classical music and the sociocultural landscape surrounding it.

1. INTRODUCTION

The study of Turkish makam music underscores the importance of understanding the complex relationships between music and culture, and the ways in which music can serve as a reflection of broader cultural values and traditions. Makam originates from a large region expanding from the Balkans to Kazakhstan, Iran and North Africa. A makam generally refers to a set of rules for melodic composition using a particular scale, which can exhibit diverse characteristics depending on its geographical origin [1].

1.1 Turkish makams

Turkish makams consist of scales formed from an octave with 53 equal subdivisions (Referred to as the 53-TET-Theory) [2]. Each makam is made from one scale formed by a selection of these subdivisions. Certain scale degrees are emphasized, while a system of melodic rules guides the compositional structure. In recent years researchers have begun to study Turkish makam music using techniques from statistics, signal processing, and computational score analysis in order to better understand the concepts, origin and its relation to Turkish Culture [1].

1.2 Prior research

Many previous attempts have been made to characterize different makam based on the occurrence of specific notes or scalar tonics. However, very little information exists in the literature regarding the occurrence of specific intervals between notes which make up a melody. Karaosmanoğlu in [1] identifies the 13 most common intervals across 155 distinct makams that are in the SymbTr dataset.

1.3 Current research

In this paper, we aim to understand the importance of intervalic occurrence in Turkish makam music. We analyze the occurrence of the 13 most common intervals across the whole melody for any given composition. With this, we hope to observe a correlation between each makam and its most common intervals, with the goal of better understanding the characteristics most integral to their cultural and musical identity.

2. METHODOLOGY

For this study, we base ourselves on a collection of machine-readable symbolic scores aimed at performing computational studies of Turkish makam music called SymbTr [1] presented in [1]. This collection consists of 2200 scores from 155 different makams. We showcase an example of the SymbTr format in Figure 1.

The numerical values corresponding to the columns 'Nota53' relate to the pitch information from the 53-TET theory we follow in this study.

We choose not to work with the entire dataset, but rather on a selection of scores from the 10 (value chosen arbitrarily) makams which appear most frequently. These scores form the dataset for the current study.

[1] https://github.com/MTG/SymbTr

Sira	Kod	Nota53	NotaAE	Koma53	KomaAE	Pay	Payda	Ms	LNS	Bas	Soz1	Offset
1	51			0	0	8	8	0	17	0	Düyek	0.0
2	9	Do5	C5	318	318	1	4	714	95	96	Al	0.25
3	9	Fa5	F5	340	340	3	16	536	99	96	dan	0.4375
4	9	Mi5	E5	336	336	1	16	179	95	96		0.5
5	9	Sol5	G5	349	349	1	16	179	99	96	ma	0.5625
6	9	Fa5	F5	340	340	1	16	179	99	96		0.625
7	9	Fa5	F5	340	340	1	16	179	99	96		0.6875
8	9	Mi5	E5	336	336	1	16	179	99	96		0.75
9	9	Fa5	F5	340	340	1	4	714	100	96		1.0
10	9	Fa5	F5	340	340	1	8	357	95	96		1.125
11	9	Mi5	E5	336	336	1	16	179	99	96	dün	1.1875
12	9	Fa5	F5	340	340	1	16	179	99	96		1.25
13	9	Mi5	E5	336	336	1	8	357	99	96		1.375
14	9	Re5	D5	327	327	1	8	357	99	96		1.5

Figure 1. Example of the SymbTr format

Interval	Value
Augmented Second Descending (accidental)	-13
Augmented Second Descending	-12
Whole Tone Descending	-9
Minor Whole Tone Descending	-8
Apotome Descending	-5
Limma Descending	-4
Unison	0
Limma	4
Apotome	5
Minor Whole Tone	8
Whole Tone	9
Augmented Second	12
Augmented Second (accidental)	13
Perfect Fourth	22

Table 1. Intervals considered in this study

From this internal dataset, we compute the intervalic histograms of every score. Each data point in a histogram represents one occurrence of an interval between two consecutive notes. Based on [1], we restrict our study to the intervals presented in Table 1.

We then apply various standard models on our intervalic histogram database in order to realize the classification of the various makams.

3. RESULTS

3.1 Creation of the database

The SymbTr dataset is not equally proportioned in terms of makams. Figure 2 shows the total number of scores per makam in the SymbTr dataset.

The amount of scores per makam ranges from [1; 157], with a mean value of 14.1935 scores, a standard deviation of 27.6342, and a variance of 768.611. This shows an important disparity in terms of scores per makam.

In order to maximize our chances of obtaining empirically significant results, we restrain our study to the 10 makams with the most occurrences in the SymbTr dataset.

The minimum amount of scores for the makams we consider is 70 (*kurdilihicazkar*). To balance our data, we randomly select 70 scores from the 9 remaining makams. Our internal dataset is therefore presented in Table 2.

For each of the scores in the dataset, we compute the intervalic histogram, and store the percentage values in our database. An example is presented in Figure 3

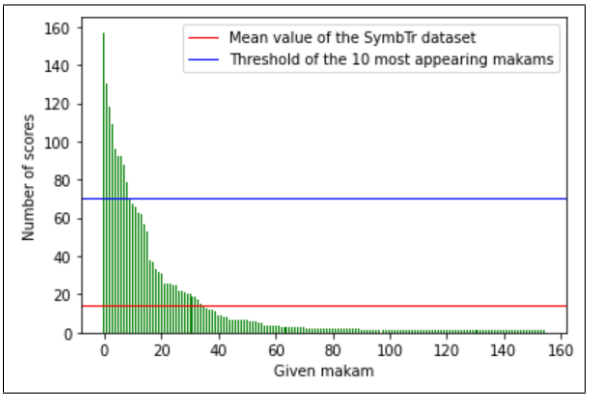

Figure 2. Number of scores per given makam in the SymbTr dataset

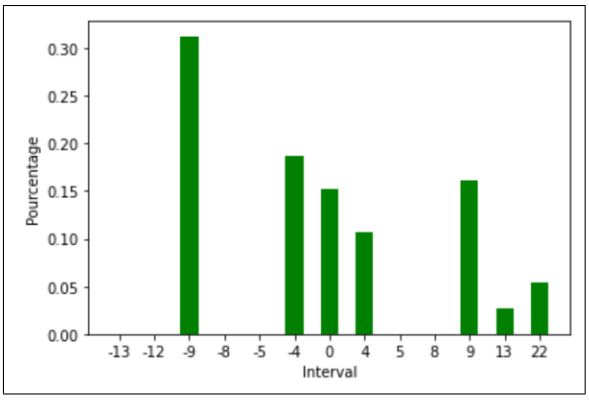

Figure 3. Intervalic histogram for a given SymbTr score

Amount / Makam	SymbTr	Our dataset
hicaz	157	70
hicazkar	79	70
huseyni	92	70
huzzam	96	70
kurdilihicazkar	70	70
mahur	88	70
nihavent	130	70
rast	109	70
segah	92	70
ussak	118	70

Table 2. Composition of our internal dataset

Model	Accuracy
NuSVC	0.62
SVC	0.61
LogisticRegression	0.61
RandomForestClassifier	0.60
LinearSVC	0.59
LGBMClassifier	0.58
KNeighborsClassifier	0.59
ExtraTreesClassifier	0.57
LinearDiscriminantAnalysis	0.58
CalibratedClassifierCV	0.55
NearestCentroid	0.57
GaussianNB	0.57
QuadraticDiscriminantAnalysis	0.55
XGBClassifier	0.55
RidgeClassifierCV	0.54
RidgeClassifier	0.54
BaggingClassifier	0.55
BernoulliNB	0.53
SGDClassifier	0.51
LabelPropagation	0.49
LabelSpreading	0.49
DecisionTreeClassifier	0.47
PassiveAggressiveClassifier	0.46
Perceptron	0.42
ExtraTreeClassifier	0.38
AdaBoostClassifier	0.16
DummyClassifier	0.06

Table 3. Results of LazyPredict

3.2 Classification using LazyPredict

LazyPredict [2] is an Open Source library that allows to quickly compute basic models for a classification task. There is no fine-tuning, and it helps to quickly identify which models could be interesting to work with.

We present the results obtained in Table 3

3.3 Classification using SVM

Spectral Vector Machine (or SVM) is a type of machine learning algorithm that is among the most widely used for the classification of statistical problems, according to Himani Bhavsar and Al. in [5]

The resulting accuracy is 57.14%, and the resulting confusion matrix obtained is showed in Figure 4

3.4 Classification using KNN & LDA

K-Nearest Neighbors (KNN) and Linear Discriminant Analysis (LDA) are two machine learning algorithms that are used for classification tasks. We combine them together in a pipeline to improve their accuracy, and we present the results for several values of k in Table 4.

In Figure 5, we present the confusion matrix corresponding to the highest accuracy obtained : 0.87 for a k-value of 1, while combining the kNN and the LDA algorithms. In Figure 6, we present the resulting LDA projection. This matrix shows the weights of every interval for every makam after the LDA training, allowing us to understand a little better how the various makams are distinguished.

[2] https://github.com/shankarpandala/lazypredict

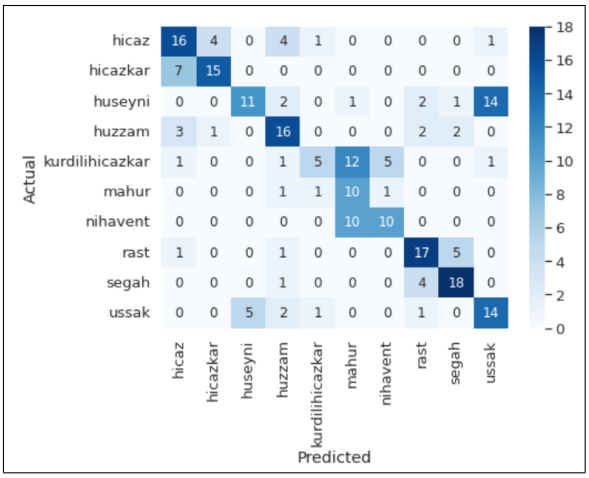

Figure 4. Confusion matrix for the SVM algorithm

k value	kNN	kNN + LDA
1	0.84	0.87
2	0.73	0.74
3	0.67	0.71
5	0.64	0.72
10	0.66	0.68
25	0.66	0.70

Table 4. Accuracy of kNN & kNN+LDA classifications for different values of k

4. DISCUSSION

4.1 Computational Analysis

The goal of our research was to explore a novel method for the classification of Turkish makams. Our results provide low effort, state-of-the-art support for a possible correlation between each makam and the prevalence of specific intervals. By combining K-Nearest Neighbors and Linear Discriminant Analysis, we were able to classify the makams with a high level of accuracy (87%, which is close to the results obtained by Ünal Erdemin and Al. in [2] and by Mehmet Eminin Aktas and Al. [6]. These results could be improved with additional fine-tuning of the parameters used for each model, or by trying other models/methods. Additionally, this classification method could be improved with the addition of more makams as well as more instances of each makam.

4.2 Sociocultural Significance

Turkish makam music is a highly organized and systematic art form which has retained a strong identity and cultural significance throughout centuries of sociocultural change.

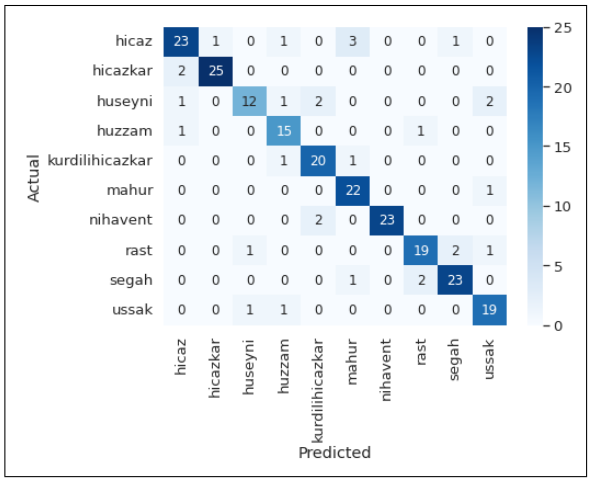

Figure 5. Confusion matrix for the kNN + LDA algorithms (k=1)

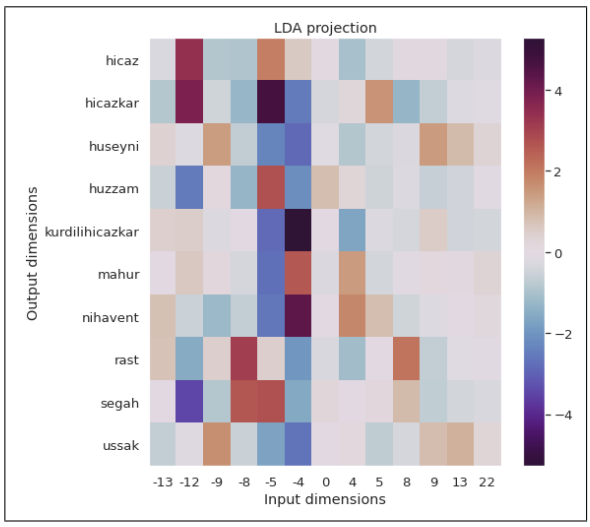

Figure 6. Importance (weight) of interval for each Makam during the kNN + LDA classification task

The use of specific intervals and the emphasis on their repetition within a given makam conveys the importance of structure and tradition in this music. Melodies are likely to have a distinctive and recognizable character based on the specific interval patterns associated with each makam. This could be an important factor in its enduring cultural significance.

Despite the rigid and systematic approach to composition and performance, there remains room for interpretation and adaptability embedded into the structure of each makam. While each makam is associated with one scale, the rules for melodic development may contain intentional ambiguities. For example, the makam *Uşşak* is introduced and concluded with a cadence on the tonic (*Dügah*), but the rules for melodic development within each composition are to be completed in no specific order and without obligation [7]. Our results indicate that a makam can retain a strong melodic identity even after accounting for structural ambiguity within the melodic development.

According to Ali Ergur and Al. in [4], makam music has maintained its identity throughout centuries of modernization and adaptation. The makam traditions existed long before the arrival of Western standardizations such as distance or time measurements, and the technical symbolism of music. Before Western notation was incorporated into makam theory, much of the practice was transmitted orally from master to student. Even after significant modernization, some aspects, such as the learning of makam scales, are most effectively learned through oral instruction. Despite opposition to modernization within the Ottoman Empire during the 18th and 19th centuries, makam music experienced a period of significant change. The most notable indicator of change can be observed in the simplification of rhythmic patterns. While later *usûls* were played more slowly, a contradictory movement towards dense melodic structures emerged in order to fill the musical void. This change enabled the emergence of individuality and originality as popular qualities in makam music, rather than the emphasis of repetitive melodic character [3, 4]. The tendency for intervalic similarity within each makam demonstrates the ability to retain an identity which transcends movement away from melodic similarity, as mediated by the sociocultural changes which occurred throughout the history of the art form.

5. REFERENCES

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