Classification and Comparison of Different Folk Music Traditions Using Self Learning Algorithms

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Abstract

The results of a comparative analysis of 25 folk song databases are summarized in this paper. The method of the analysis was based on self organizing mapping and multidimensional scaling algorithms. The results show a clear system of deterministic contacts of the cultures. De concrete common musical forms of different cultures can also be studied.

Methods

The analysis was based on automatic comparison of the melody contour, characterized by equidistant pitch samples (see Figure 1.). The number of the pitch samples was a pre-defined constant value, independently of the time duration of the individual songs, and all melodies were transposed to the same final tone G [1]. Thus, each melody of our folksong database was described by a multidimensional vector, pointing to a point of a multidimensional "melody space". The basic idea of the analysis is that the melodies of a given musical culture construct a special point system in the melody space, and the musical principles determining the musical forms in the given culture may be mapped into the spatial structure of this point system. In other words, the dense as well as sparse areas of the point system can be traced back to musical reasons.

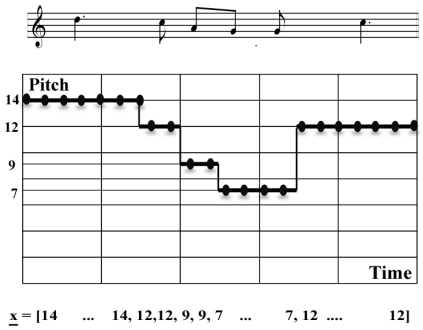

Figure 1: *Representation of the melody contour as a multidimensional vector.*

In order to map the structure of this multidimensional system to a plane, we applied a special version of a widely used artificial intelligence, the so-called self organising map [2], [3], [4]. This tool allowed us to divide the melodies of a given culture into contour type classes, and to determine the mean contour vectors characterising these classes (see Figure 2).

Our database contains digital notations of 25 cultures, counting 1000 – 2500 melodies by culture. The studied cultures are as follows: Chinese, Mongolian, Kyrghyz, Mari-Chuvash-Tatar-Votiac (Volga

Region), Sicilian, Bulgarian, Azeri, Anatolian, Karachay, Hungarian, Slovak, Moravian, Romanian, Polish (Cassubian), Finnish, Norwegian, German, Luxembourgish, French, Dutch, Irish-Scottish-English, Spanish, Dakota, Komi, Hanti.

As a first step, we determined the contour type collections for the 25 cultures. Thus, we received 25 collections counting 400 – 550 averaged contour types by culture. The number of contour types was fitted to the special features of the databases [1]. After that, we trained a further large self organising map with the unified set of the 25 contour type collections, in order to determine the wholeness of typical melody contours appearing in any of our 25 collections.

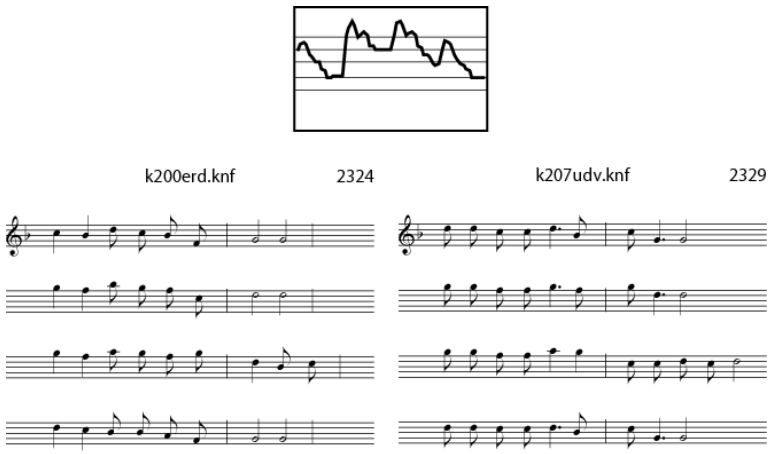

Figure 2: *A Hungarian contour type vector having learned by the SOM and two melodies belonging to the type.*

It is easy to see that any of the 25 cultures can be imagined as a subset of the resulting great common collection. Really, the classification of the 25 cultures draws different patterns on the common map (see Figure 3). The probability of the deterministic contacts of the cultures can be estimated by analysing the overlaps of the national/areal patterns. Being in possession of the size of the great common contour type collection (*N*), the sizes of its two national/areal subsets (*A* and *B*), as well as the size of their intersection (*X*), the measure of the relationship between these cultures can be expressed by a probability as follows [5].
As a first step we compute the probability of the event that a random choice of two subsets with sizes *A* and *B* from the set of size *N* results in an intersection of size *x*, as

$$p(x) = \binom{N}{x} \frac{\binom{N-x}{A-x}\binom{N-A}{B-x}}{\binom{N}{A}\binom{N}{B}}. \qquad (1)$$

Using this probability density function, the probability of the event, that the size of the intersection is less than *X*, is expressed as

$$P(X) = \sum_{x=1}^{X-1} p(x). \qquad (2)$$

A high value of this probability ($P(X) \approx 1$) indicates that the number of common melody types in the two corpora is much higher than the expected value in case of random correlations. Consequently the similarity, manifested by such high intersection of two corpora, cannot be a product of occasional coincidences of independent musical evolutions. It can be stated in such cases of similarity that the common musical characteristics implicate a historical or present, immediate or intermediate cultural interaction, that is, the established relationship is necessarily deterministic.

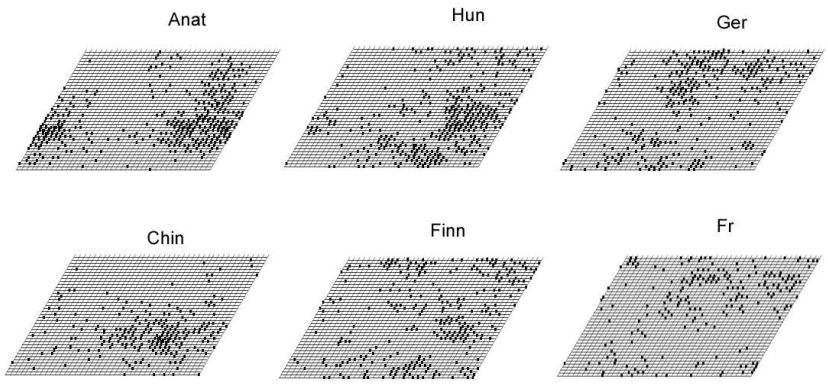

Figure 3: *Excited area of the common self organising map by 6 different cultures.*

The above contact probabilities can be calculated for any pair of the 25 cultures. The distance between the i-th and j-th cultures can be characterised by $D_{i,j} = 1 - P_{i,j}$, where $P_{i,j}$ is calculated using equations 1 and 2. Using these data, the system of connections of the 25 cultures can be visualised on a plane by multidimensional scaling [6]: The requirement that the distances between the points representing the *i*-th and *j*-th cultures in the plane ($d_{i,j}$) should optimally correspond to the distances $D_{i,j}$ is formulated as

$$E(D_{i,j} - d_{i,j})^2 = \min, \qquad (3)$$

where *E* denotes the expectation operator for *i* and *j*.

Results

The structure of the connections of the 25 cultures was demonstrated on a graph using the above mentioned method. The nodes indicate that the probability of a deterministic contact between the connected cultures is higher than 0.95. The graph shows certain well defined families of the musical cultures (see Figure 4). We also demonstrated some melody contour types being equally characteristic in two neighbouring families. For example, an important common feature of the "Eastern" and "Southern-Turkish" families is the dominance of descending melody lines with high ambitus, while Hungarian, Slovak, Moravian, Irish-Scottish-English (ISA), as well as Finnish cultures are connected by the common domed melody structures with ascending fifth transposition. At the same time, plagal melody contours are equally frequent in ISA, Finnish, Norwegian, Moravian and Western cultures.

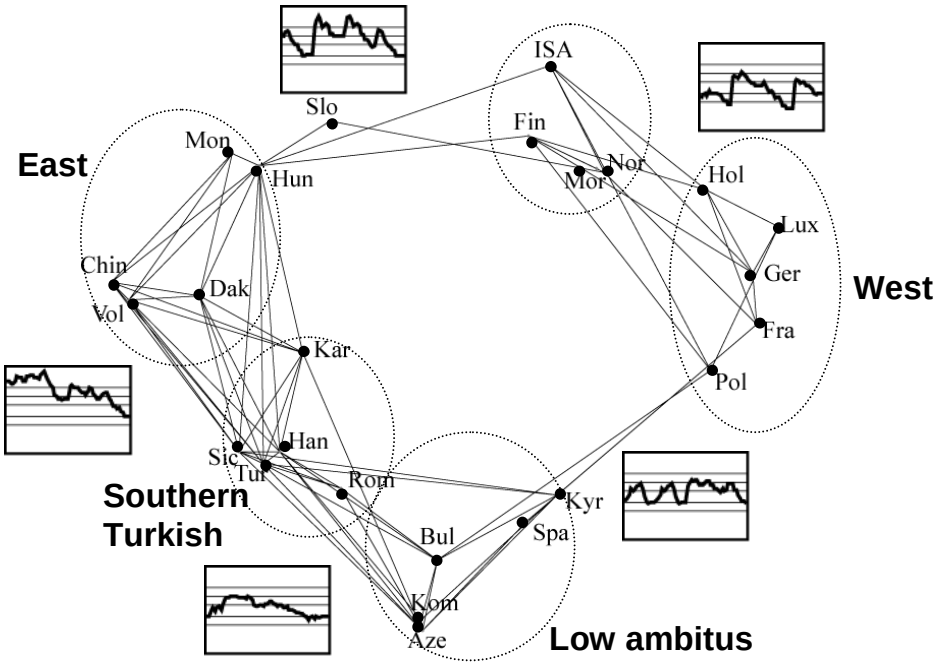

Figure 4: *The system of relations of 25 musical cultures in Eurasia and North America.*

References

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