Mapping European folksong: Geographical localization of musical features

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Retrieval and analysis

11 Mapping European Folksong: Geographical Localization of Musical Features

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www.music-cog.ohio-state.edu/cgi-bin/Mapping/map.pl

Abstract

This paper discusses issues related to encoding, displaying and analyzing geographical information pertaining to music. The authors describe how place information in the Essen Folksong Collection was transformed so that the information was available for computational and analytic tasks. They also demonstrate the display of this information on maps and announce the creation of a Web site where users can run their own analytical tasks.

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Cultural features are often difficult to identify and analyze with rigor. Cultural individuation is an important precursor for many types of musical analysis, however. Variations across cultures can be closely tied to important historical trends and events. They can be viewed both in the light of extra-musical forces and within the context of evolving musical practice. By analyzing similarities and dissimilarities across cultures it becomes possible to isolate the elements which vary and then to establish standards for significant difference.

Even as cultural differences make broad claims about music problematic, it can be equally difficult to make generalizations *within* a culture. One of the best assertions one can make about culture is that it is often correlated with geographical location and/or linguistic identity. "French" culture is largely concentrated in French-speaking areas of the world, and these can be defined geographically (Huron 1999).

The fact that culture may be correlated with place suggests that one approach to identifying possible cultural features in music is to look for musical characteristics that change systematically with respect to geography. If we find that works in one region predominantly employ trochaic meter while works in another predominantly employ iambic meter, then it is possible to state that the preference for one or another rhythmic foot is part of what distinguishes the two musical cultures.

11.1 Musical Resources for Geographical Mapping

11.1.1 The Essen Databases

One way to facilitate the study of relationships between music and culture is to provide tools that permit researchers to relate musical features to geographical location. A useful musical resource for such an approach is found in Helmut Schaffrath's *Essen Folksong Collection* (Schaffrath, 1995).[1] Developed over the course of twelve years (1982-94) at Essen University, the collection comprises thousands of monophonic transcriptions in the Essen Associative Code (EsAC). The database is particularly rich in Germanic songs. These have been collected not only in Germany but also in Austria, France, Germany, Italy, Poland, and other countries as well as from early *Liederbücher*.

[1] The Essen Folksong Collection in its original form was designed for use with the DOS relational database *AskSam*. The work discussed here used a *Humdrum* translation. The EsAC and *Humdrum* encoding systems are both described in Selfridge-Field (1997).

In addition to encoding such musical parameters as pitch, duration, meter signatures, bar lines, rests, and phrase markings, Schaffrath and his associates encoded geographical information to the extent it was available. Of the 6,251 folksongs in the collection, 895 contain geographical designations that can be resolved at the city or village level. An additional 1,696 folksongs can be resolved to the district or regional level only, and 3,002 carry only country designations. An additional 606 could not be placed with confidence. For reasons that will be explained below, there is a certain amount of overlap among categories.

11.1.2 *Humdrum* Adaptation of the Essen Data

In dealing with the geographical information in Schaffrath's database, we defined two new *Humdrum* reference records. The `!!!ARD` record attempts to systematize the location information. The `!!!ARL` record specifies latitudinal and longitudinal numerical coordinates in decimal format, usually to two significant decimal places.

In the case of a record with maximum detail about place of origin, a geographically complete *Humdrum* `!!!ARE` record (for "Der Mädchenmörder") is shown below:[2]

[2] The five sub-fields in the `!!!ARL` record are, from left to right, (1) the continent (Europe), (2) the region (southeast Europe), (3) the country (Romania), (4) the province (Siebenbürgen), and (5) the town (Mühlbach). [*Humdrum* retains the language of the country or region to which the music is indigenous.]

```
!!!ARE: Europa, Suedosteuropa, Rumaenien,
Siebenbuergen, Muehlbach
```

Many complications of categorization arise. For example, (1) a work may be found in more than one place (country, region, city, etc.). Such alternatives a separated by a semicolon:

```
!!!ARE: Europa, Mitteleuropa, Deutschland,
Hessen, Unter-Taunus, Hennethal; Limburg

!!!ARE: Europa, Mitteleuropa, Deutschland;
France, Weissenburg, Niedersteinbach
```

(2) A specific city (more rarely a country or region) may by known multiple names. German-speaking lands have been repeatedly renamed in connection with the myriad political changes of recent centuries.

(3) In such expressions as "an Alpine folksong," no country or segment within a country is specified. This kind of "region" may overlap parts of several countries without itself being any recognized political jurisdiction.

(4) There are inconsistencies in the exact format of the geographical data found. Also, the original format encodes some information implicitly.

The `!!!ARD` record explicitly lists every hierarchical level for each location. Token-separators are defined so that country name, region, and village/town can automatically be resolved.

Here is a re-encoding of the example given above with token-separators in place.

```
!!!ARD: Europa%Suedosteuropa%Romania@Siebenbuergen#
Muehlbach:
```

11.1.3 Numerical Representation of Geographical Data

For analytic purposes, geographical place-names are not nearly as useful as latitudinal and longitudinal information. The `!!!ARL` record gives a numerical translation of the verbals contents of the `!!!ARD` record, e.g.

```
!!!ARL: 45.96/23.56:
```

In conventional notation, latitude and longitude are given in the format 00°00'00", which reads degrees, minutes, and seconds, from left to right. The data presented above would read 45°57'36"N/23°33'36"W in conventional notation.

Hours and minutes are clumsy units for computers to manage; it is conventional to convert them into fractions of degrees. In addition, when dealing with degrees, computers generally interpret measurements larger than 180° as negative degrees. `!!!ARL` records therefore give East measurements as positive values, and West as negative; similarly, North locations are positive, and South locations become negative.

Both the `!!!ARD` and `!!!ARL` records permit the use of signifiers to indicate different levels of geographical precision. The signifiers are shown in Table 1.

Table 1. Geographical-precision signifiers used in !!!ARD and !!!ARL records.

%	supra-national level (e.g. Europa%)
@	national level (e.g. France@)
#	region (e.g. state or province, land, or topographical feature)
:	city or village
!	suburb
%	ambiguous
?	questionable

Where a work pertains to more than one place, or when there is an uncertainty as to which of multiple geographical places is meant, multiple !!!ARD and !!!ARL records are created.

Ambiguous locations are designated by the presence of the tilde signifier (~). !!!ARD and !!!ARL records are paired, and each !!!ARL record contains only the highest level of precision available in the corresponding !!!ARD record. The presence of these signifiers means that analyses can be restricted to certain degrees of geographical precision.

11.2 Geographical Resources

Precise latitude and longitude information is available in commercial geographical gazetteers. In recent years some of these publications have become available in electronic format (see the URL list at the end of this article). The process of looking up this information manually proved excessively tedious and error-prone. Consequently, we made use of an electronic gazetteer available on CD-ROM (*GEOname*, 1994). In order to locate latitude and longitude data for each location, we created an automated script that cross-referenced the original !!!ARE records in the Essen Folksong Collection with the *GEOname* database entries. Each gazetteer entry included country, regional, and place name information, which the script used to cull sets of potential matches. A user then manually selected the entry or entries which most closely matched the !!!ARE record, indicating ambiguities and uncertainties where appropriate. The script generated a revised *Humdrum* file with added !!!ARD and !!!ARL records before moving on to the next file.

By providing a list of possible alternatives, the user could be made aware of multiple possible interpretations of the record or other unsuspected ambiguities. There is currently no reasonable way to completely compensate for user-ignorance, however. Historical name-change data will usually not appear in a modern gazetteer, and only a person deeply familiar with the geographical region in question would be able to recognize that a particular place name probably refers to an area rather than the city that shares its name, for example. Thus, despite our best efforts, some user errors will not be identifiable.

11.3 Representing Levels of Precision

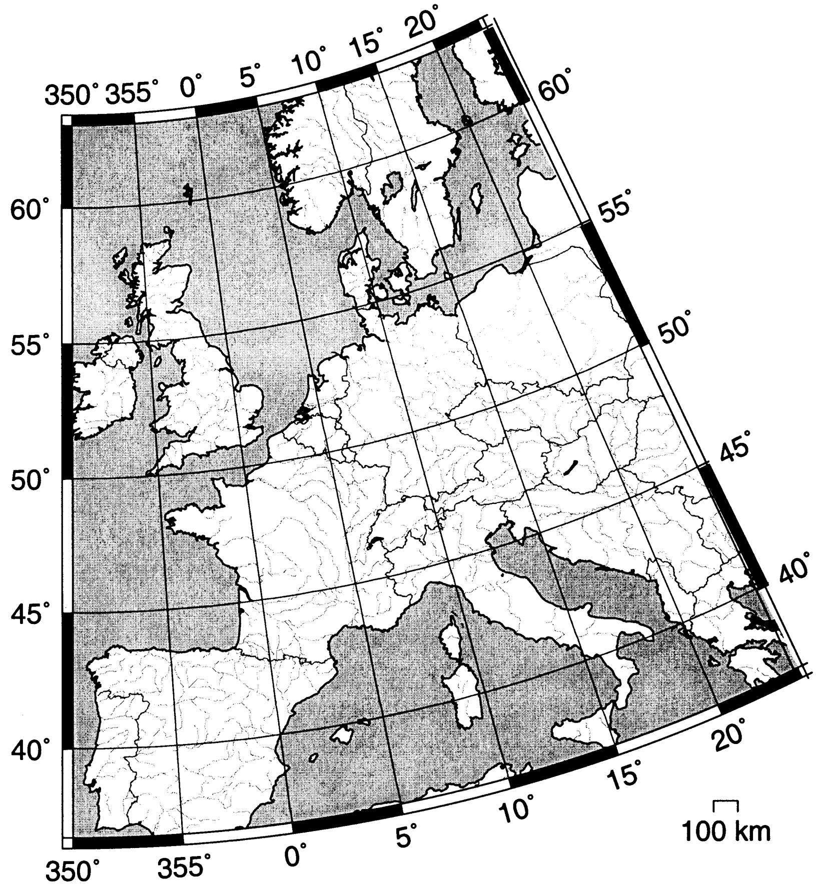
Once geographical information was available in the database, we were able to develop tools to manipulate this data. In this process, the limitations of the Essen Folksong Collection became evident. Although the database contains musical works from a dozen European countries, the vast majority of materials are German.[3] The geographical tools developed for use will be available for any future databases encoded or translated into the *Humdrum* format. Regardless of its slant, the Essen Folksong Collection represents a valuable source of information as one of the largest (if not the largest) electronic databases of folksongs yet encoded.

[3] The average of the centroids of all the countries in the database is 49.12°N (S.D. 5.23), 12.10°E (S.D. 6.67), whereas the average position of all the entries in the database is 50.81°N (S.D. 1.63), 10.62°E (S.D. 2.85). The centroid of Germany alone, by comparison, is 51.5°N, 10.5°E.

The design approach motivating the construction of the tools discussed below follows that of the *Humdrum Toolkit*. Each function is partitioned into its own tool, and tools can be used to operate on data sequentially in whatever manner is appropriate to the task at hand. Ideally, tools should be designed to pipe data to and from other tools, which allows strings of commands to be linked together. This scheme aims to avoid user interaction if at all possible, instead allowing options to be typed in along with the command itself. Unfortunately, existing Unix systems are incapable of processing the entire Essen Folksong Collection at once, and in order to work around this limitation the tools were written to read from temporary storage files as well.

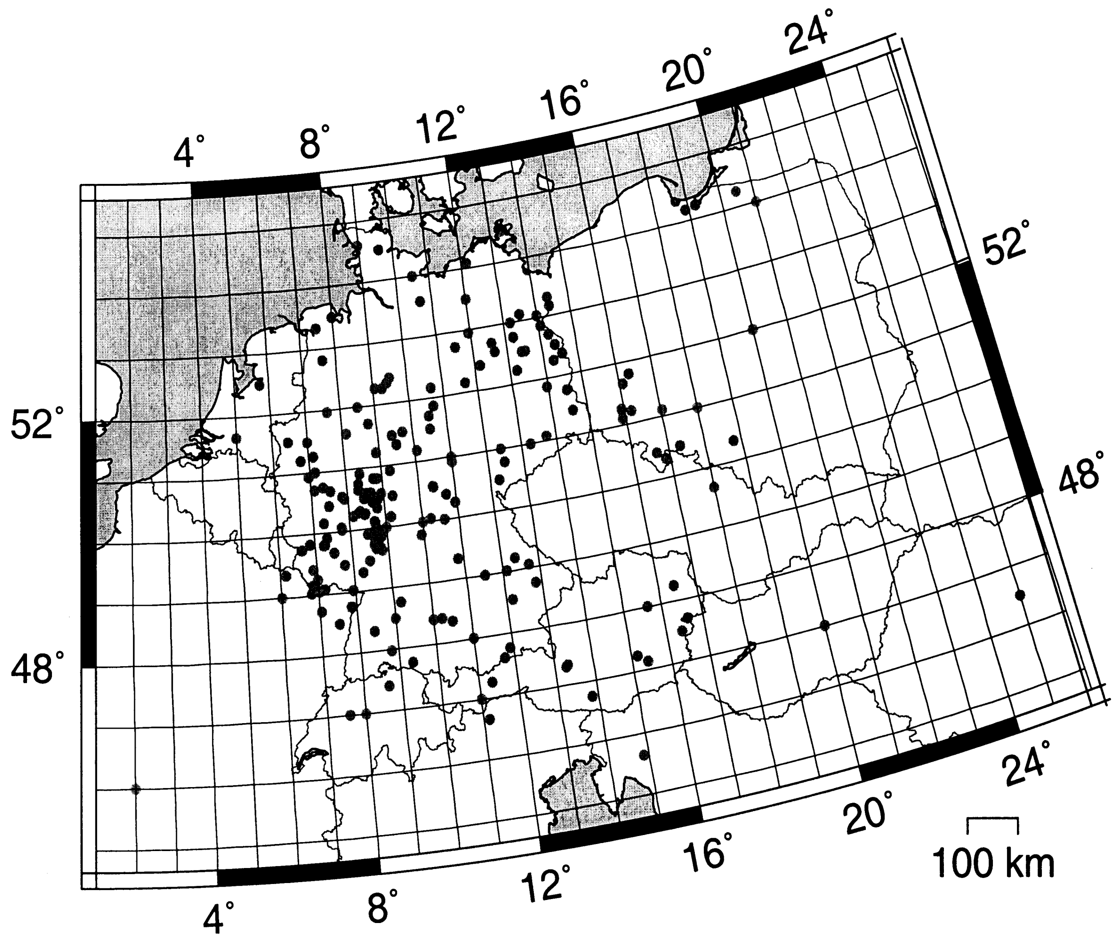
The display engine we used for the tool set is the Generic Mapping Tools (GMT) package (Wessel & Smith, 1999), a public-domain system for the dynamic creation of PostScript maps. GMT is capable of producing 22 different projections of any geographical region using its vector data of modern political boundaries and bodies of water (see Figure 1). The PostScript language is inherently layered, so GMT's tool-based design can easily incorporate many forms of data into its output. The package includes several tools for plotting musical data onto projections, which require only that the data be saved in a delimited text file.

Figure 1. A basic map of Europe and its rivers generated by GMT using the *Humdrum*-default Lambert Conformal Conic projection.



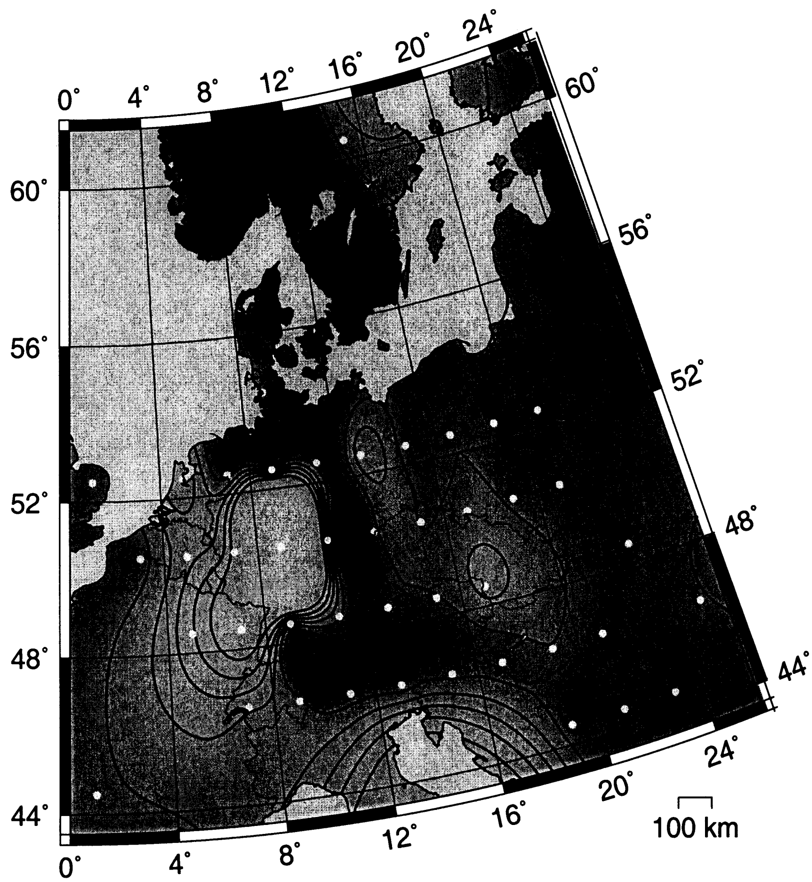
In order to extract and process the geographical data from *Humdrum* files into a format compatible with GMT, we designed the *geo* tool. Its basic function is to extract and manipulate the numerical latitude and longitude information encoded in *Humdrum* ARL reference records. More precisely, the *geo* tool processes the ARL records from a list of *Humdrum* files. Its default behavior is to output the latitude and longitude values in two columns of data, which is the format expected by the GMT plotting tools (see Figure 2).

Figure 2. A map plotting the locations of triple-meter *Lieder.*



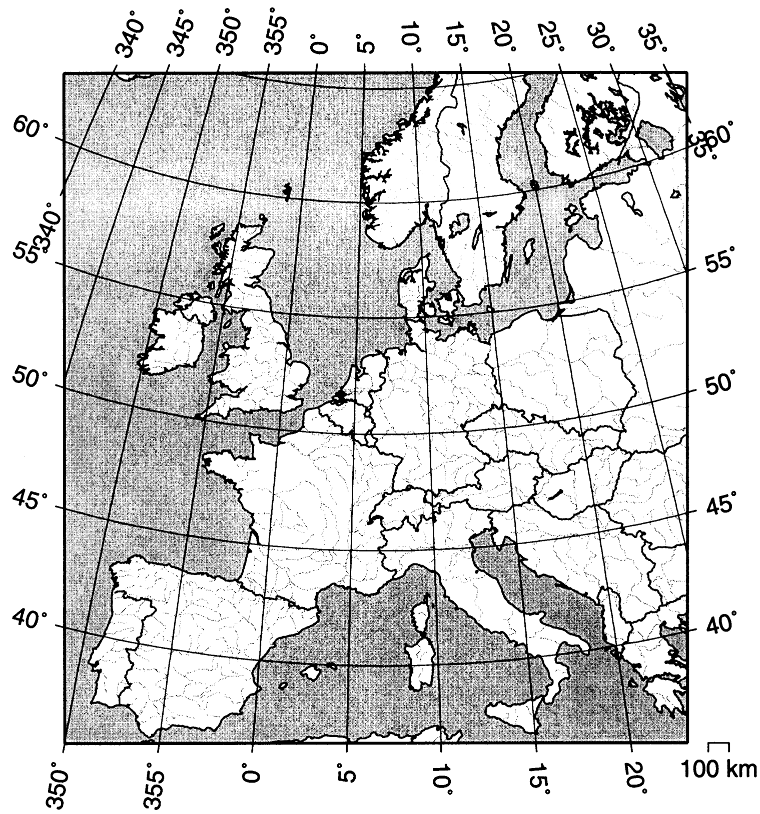
Other options will return the bounding box that contains all the data points (a necessary step in determining the appropriate size for the map), or add information from other reference records in the *Humdrum* files as a third column of data which can then be represented in terms of point size or color.

Figure 3. A density plot of minor-key works.



One particularly useful option fits all the points to a grid, and then outputs only the grid points and a third column giving the number of files (works) that fall on each point, thus roughly simulating a density graph for the data. Using the contour graphing functions of GMT, this output can then be graphed as a density topography superimposed on the geographical map, such that regions of high density are represented as light-colored areas on the map (see Figure 3).

Figure 4. Another map of Europe, using the orthographic projection.



Unfortunately, the power and flexibility of GMT gives rise to an improbably complex interface. (A typical command to plot coastlines and bodies of water reads like so much gibberish:

```
pscoast -R-10/35/36.75/63r -JG7/50/5 -B5g5 -P -A500
-Di -Lx5.25/0/50/100 -N1/1/80p -S200 -W0.5/1/0p
-Ia/0.25/150p
```

is the command to generate the map shown in Figure 4, for example.) All of the maps shown in this article were created with a small script (*map*) that packages these commands away from the sight and worry of the average user, using default values that work reasonably well for the data in the Essen Folksong Collection. In fact, for most purposes a standard set of scripts can make the entire process of creating a map almost painless, even for the typical Macintosh or Windows user (see Example 1).

Example 1. A typical use of *Humdrum* scripts to create a map; here, of the triple-meter *Lieder* in the Essen Folksong Collection. The first command identifies all of the works in the Essen FolkSong Collection that are classified as *Lieder*. The second command filters the list of *Lieder* so that only those in triple meter remain. The third command causes a postscript map to be generated and displayed.

```
$ fetch lieder
$ filt triplemeter
$ draw
$ _
```

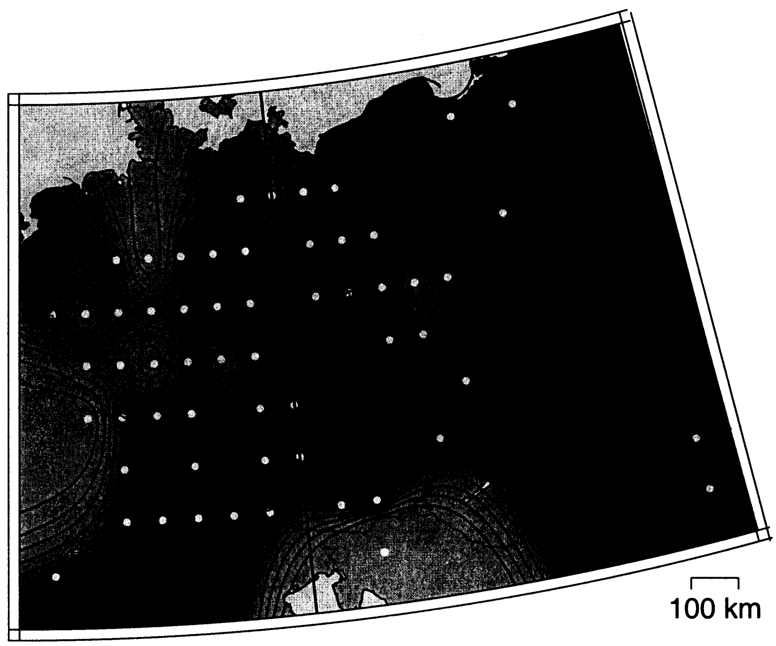
11.4 A Sample Musical Application

As an example of the sorts of uses for this software, consider the issue of phrase-end typicality. Numerous scholars have noted the tendency of phrase endings to follow formulaic patterns, more so than the rest of a melody. If certain ending patterns are more likely to occur in some geographical areas than others, and hence are indicative of a particular musical culture, mapping tools would be an excellent means of discovering such regularities. As an exemplar of the use of this software, we will briefly describe the steps a researcher might follow might follow in order to pursue some analytic intuition.

As with any statistically-oriented research question, the first step is to operationalize the definitions, which for this case means defining the expected features of phrase endings. The last note of a phrase should tend to be longer, for instance, or we might expect the penultimate note to instead be longer. Typical endings might end on the tonic, and approach it from the leading tone, or the lowered leading tone, the dominant, or the supertonic. Perhaps the typical last note is the most expected one, as suggested by Von Hippel (1999), and we have observed that phrases have a slight tendency to end lower in pitch. A researcher could choose among any number of possible features according the requirements of the question, but these suffice for the current example.

We begin the analysis by writing a series of simple scripts. The first script uses *Humdrum* commands to determine to what degree each file in the database conforms to the definitions of phrase typicality. (As an example for lovers of technical detail, our means of determining phrase-final lengthening was to group notes into phrases using *context,* convert notated rhythms to duration in seconds with *dur,* remove all other information with *rid,* and feed the result through a short Perl script to determine the direction of the last change in rhythm of each phrase.) With this information, we can now select subsets of the data according to the qualities of their phrase endings. By searching the results, we can extract a list of the files with high values for any of the features, and feed them to *map.*

Figure 5. A density-contour map of melodies for which most phrases end on the tonic.



The example shown in Figure 5 is a contour map showing the distribution of songs for which more than half of the phrases end on the tonic. By inspection, there is a dramatic tendency for these songs to occur in the east, and most of the effect seems to occur past 13°E. Although the map is provocative, by itself it tells us nothing about the significance of this phenomena, or its effect size.

Figure 6 shows a further breakdown of the data into the melodies that do and do not favor tonic phrase endings, and Table 2 provides a contingency table illustrating that the effect does appear to be quite significant.[4] Keeping this statistical caveat in mind, the maps in Figure 6

[4] As should be clear to most readers familiar with statistics, this little narrative is something of a fishing expedition, and runs into the problem of multiple tests: given enough tests, eventually something will appear significant. A total of twelve tests were run, but even when taking into account the Bonferroni correction for multiple tests, the significance level of this result would still be meaningful if many more tests were thrown into the mix.

do provide us a simple visualization of the variations in feature distributions.

Figure 6. Density distributions of melodies in the Essen Folksong Collection, divided according to tendency of phrases to end on the tonic. Only songs with positional accuracy known to the city or suburb level are included. Dot area is proportional to the number of melodies collected in that position.

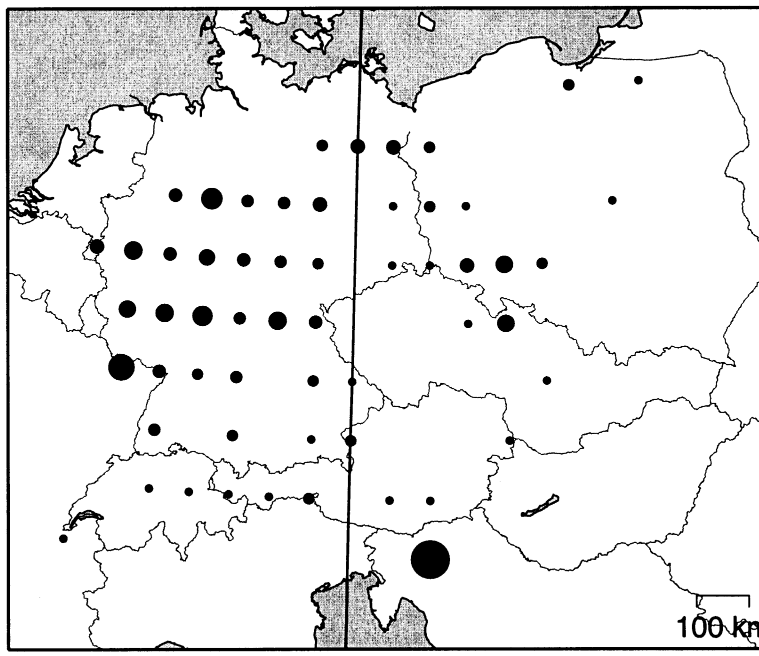


Table 2. European folk melodies west of the 13th meridian are nearly three times as likely to have most of their phrases end on a note other than the tonic.

	Western Europe	Eastern Europe
Melodies ending mostly on the tonic	172	134
Melodies ending mostly off the tonic	505	137

($\chi^2_1 = 50$, $p < 0.00001$, odds ratio: 2.9)

11.5 Conclusion

The addition of geographical information to the Schaffrath Collection, especially in numerical form, opens up innumerable possibilities for musical analysis. Mapping alone is a powerful tool for visualization, and several examples have been shown of how this can be done with relative ease. The real motivation for developing these tools, however, is for the flexible and convenient perusal of complex data. Whether for the quick visual comparison of two sets of data, or the display of complex manipulations of geographical data, mapping tools are an obvious expansion of the capabilities of computer-based music analysis.

Ethnomusicologists have long harbored hopes of having the resources to do comparative studies of the huge amounts of musical data available to them, although pragmatic constraints have prevailed against such projects. Electronic databases are beginning to realize that potential, and the tools for their analysis are growing ever more powerful and sophisticated. The task remains to find the methods and resources to encode the information that is available or yet to be collected. In creating his database, Schaffrath clearly hoped to be able to use geographical information in his analyses at some point. In the past, there was generally too little data available to carry out studies whose conclusions would be statistically reliable, and it is our hope that this situation will change in the near future.

Our work with geographical information in the Essen Folksong Collection has proved to be preliminarily very fruitful. It has also indicated some potential concerns for further data collection. Nearly five-sixths of the Essen Folksong Collection had to be discarded for analysis with resolution down to the city or village level, although Schaffrath's geographical information is much better than having no such data at all, of course. Geographical information can add considerable power to a musical data set, but this information must be recorded with careful attention to detail and consideration for further use.

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Selfridge-Field, Eleanor (1997). *Beyond MIDI: The Handbook of Musical Codes.* Cambridge, MA: The MIT Press.

Von Hippel, Paul (1999). "An Ecological Model of Melodic Expectation: Range and Mobility as Constraints Inferred by Listeners" (under review).

Wessel, Paul, and Walter H. F. Smith (1999). *Generic Mapping Tools.* [Computer software]. Available at: *imina.soest.hawaii.edu/gmt*

URLs for Place Names

U.S. Census Bureau Gazetteer
ftp.census.gov/geo/www/gazetteer/places.html

Getty Thesaurus of Geographical Names
www.gii.getty.edu/tgn_browser

Odden's Bookmarks: Gazetteers
kartoserver.frw.ruu.nl/HTML/staff/oddens/gazett.htm