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### **Concerning the Problems of Computer Analysis in Investigations of Melodics of Folk Songs**

Statistical methods are often applied in the morphological study of folk music. They not only help to achieve more objective results but also span larger and consequently more representative groups of songs. The computer programmes which perform automatic melodic analysis make these procedures a lot easier. The ANA programme, a part of the MAPPET (Music input, Analysis and Playback Programme for EsAC Transcriptions) package developed by Barbara Jesser of Essen University, is one of the easiest ones and does not require programming skills. Before its application, the melodies to be analysed have to be encoded in EsAC (Essener Assoziativ Code), also developed at Essen University (as part of a project conducted by Helmut Schaffrath). The best computer programme to enter data is Rip (developed by Ulrich Franzke from Bochum); it shows the score, plays the melody and automatically detects errors in EsAC coding (errors may result in excluding the incorrectly encoded melodies from analysis or, if the number of erroneously encoded melodies is high, there is even a possibility of blocking the programme).

ANA allows us to analyse 12 features of given melody (all of them or a few chosen):

1. Inventory of intervals
2. Inventory of durations
3. Inventory of pitches
4. Rhythmic incipit

5. Scale and mode
6. Range
7. Stressed tones
8. Cadential tones
9. Form (pitch)
10. Form (rhythm)
11. Form (contour)
12. Up/downbeat of phrases

In the first three options the results are given in percentage, which has its limitations: in statistics the base for calculating percentage should be no smaller than 50. This requirement can only be fulfilled by Option 1 provided that the melody is long enough to contain 50 intervals, which is a rare phenomenon in folk songs. However, this limitation does not prevent us observing some general tendencies within the analysed features. The use of somewhat “strained” values is also necessary for the purpose of comparison.

During my article I shall discuss the usefulness of ANA in the study of melody in folk songs and especially in the analysis of their melodic structure<sup>1</sup>. The programme’s capability to analyse intervals (Option 1), scale steps (Option 3), range (Option 6), cadential tones (Option 8) and contour of the melodic line (Option 11) is particularly valuable in this type of research.

A juxtaposition of the intervals which make up a melody (Option 1) shows two important features of melodic style: the quantitative and qualitative relation of the ascending intervals to the descending ones, and the frequency of different intervallic steps. The first of these features shows a general vertical direction in the song’s melodic line<sup>2</sup>. By applying this criterion as well as

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<sup>1</sup> An attempt to use the tonal options of ANA in Cassubian songs analysis (from: Ludwik BIELAWSKI, Aurelia Mioduchowska *Kaszuby [Cassubia region]*, part 1–3, volume 2 of the series *Polska pieśń i muzyka ludowa. Źródła i materiały [Polish folk song and music. Sources and materials]*. Ed. Ludwik Bielawski, Warszawa 1997–1998) was made by Ewa DAHLIG ‘Z zagadnień komputerowej archiwizacji i analizy melodii ludowych’ [From computer archives and analysis of folk melodies] *Muzyka* XLIV 1999 no 2, pp. 101–14. In her article, she also discussed in brief the other computer music programmes developed at Essen University (and the EsAC code).

<sup>2</sup> In this case, verticality denotes pitch. The melodic line develops in a sound environment represented by the system of co-ordinates  $x, y$ , in which the horizontal axis denotes time progress and the vertical axis stands for pitch movement.

observing the first culmination point in a given melody, we can divide the Polish stanzaic folk songs into the following melodic styles: descending, arched, ascending, mountaineer's style (which is in fact an extreme form of the descending style) and recitative style<sup>3</sup>.

The assignment of melodies to different melodic styles differs from region to region. It is also related to the genre: the descending style dominates in old ritual songs from rural areas of eastern Poland or in mountaineer's 'couplets', the arched style is characteristic for Polish ballads, whereas the ascending style is to be found in more recent songs originating from the so called 'northern and western territories' which, historically speaking, developed under German influence. The styles distinguished by melodic structure correspond with particular tonal and metrorhythmical features as well as with genres classified according to their contents and functionality. Thanks to this classification the songs may be arranged in a relatively chronological order. Thus we could say that the melodies in the descending style belong to the oldest repertoire, while those composed in the ascending style are the newest. Naturally, these phenomena, so conspicuous in Polish folk songs, echo much wider processes in the development of European folk melody. Then is demonstrated by research on the stylistic variability of melody in the songs with a long history and wide popularity in Europe, such as ballads<sup>4</sup>.

The way in which we calculate the relation between the number of ascending and descending intervals depends on the method of research and the song material in question. If we examine the progress of the melodic line at the level of intervalic steps and treat the melody as a starting point, we may subtract or divide the sums of the two types of intervals (ascending and descending) which make up the melody under analysis. The former is offered by ANA (Option1). Apart from comparing the number of unison, ascending and descending intervals, and the sums of the ascending and descending intervals, the programme gives also the result of

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<sup>3</sup> See Zbigniew Jerzy PRZEREMBSKI *Style i formy melodyczne polskich pieśni ludowych* [*Melodic styles and melodic forms of Polish folk songs*]. Warszawa 1994.

<sup>4</sup> See Zbigniew Jerzy PRZEREMBSKI 'Melodic forms of Polish folk ballads. A comparative approach'. *Historische Volksmusikforschung*. Ed. Doris Stockmann, Annette Erler, Göttingen 1994, pp. 55–61.

the subtraction of these sums. All the numbers denote percentages calculated in relation to the general number of intervals present in the analysed melody (the number of intervals is also produced by Option 1). The varying relation between the ascending and descending intervals within different melodic styles is more conspicuously shown by the quotient of the sums of these types of intervals. Yet it has to be noted that both ways of calculating the relations between ascending and descending intervals give us merely quantitative information, that is, they relate to the number of intervals while ignoring their type (or size). Some types of melodic structures or styles display a clear difference between the size and the vertical direction of intervals within and between the separate parts of the song. In this case, it is better to take under consideration the division of the melody. The melodies in the mountaineer's style may serve as an example. Their most conspicuous feature is the descending progress of the inner melodic line, which means that the descending form appears chiefly within melodic verses. The positioning of verses in the sound environment does not have to be descending – they may run in the same registers or even ascending-wise. The melodic verses of mountaineer's songs are made up of small, descending intervals. These verses separate greater and ascending intervals. Were we to use Option 1 of ANA, we should save each melodic verse of the song (in EsAC code) as a separate record.

What distinguishes melodic styles is the types of intervals a melody is composed of. In the older stanzaic songs the melodic line is usually made up of small intervals (unison, seconds). As far as Polish folk music is concerned, this feature distinguishes the recitative style (which is self evident), the ritual narrow-range melodies in descending style, as well as the mountaineer's melodies which are characterized by a relatively large ambitus<sup>5</sup>. In the older

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<sup>5</sup> An average compass of a melody in mountaineer's style is the Major seventh, 28,4% of the melodies have an octave ambitus or even larger, while the small intervalic steps appearing within verses (unison, Minor second, Major second) make on an average 82,4% of the intervals. There are some melodic forms of this style where the number of intervalic steps which appear within verses makes more than 90% of the intervals and may even reach 95,2%. The percent values quoted here refer to the examined batch of 6377 Polish folk songs (see Z. J. PRZEREMBSKI *Style i formy melodyczne...*, op. cit., pp. 36 and 39–42).

melodic styles we can observe a difference in quality between the intervals which appear within and between song verses. This phenomenon was mentioned earlier, when discussing the mountaineer's style. Therefore, during the computer analysis of this particular type of melody, it is sensible to save each melodic verse separately (in EsAC code). Such a procedure was suggested earlier, when discussing the relation between the ascending and descending intervals. However, what one obtains thanks to this method is only a list of those intervals which appear within the melodic verses. In more recent melodic styles, the intervals within verses are often thirds (more often than in the older melodic styles). Moreover, the intervals between melodic verses tend to be diminished as their function of separating and dividing the melody into parts is taken over by more sophisticated means. One of the numerical specifications produced by Option 1 is the number of bars in a melody. Moreover, ANA is able to specify the number of melodic verses of the song encoded in EsAC. The result appears in the KEY slot.

An important feature of melodic style is the frequency of sounds which correspond to the subsequent steps of the tonal scale. Option 3 of ANA calculates the percentage of these frequencies. The recurrence of the melody's culmination has a particular significance. It is much more frequent in the descending style than in the arched or especially in the ascending style. The frequency of the culmination sound which amounts to at least 10% appears in every fourth melody in the descending style, every tenth in the arched style and every twentieth in the ascending style. In more than half of the arched melodies and three quarters of the ascending melodies the culmination sound amounts to less than 5% of the sounds in general. A conspicuous dependence has been observed between the step of the tonal scale in which the melody reaches its peak and the melodic style. The Polish folk songs have a general tendency to culminate on the 5<sup>th</sup>, the 6<sup>th</sup> or the 7<sup>th</sup> step of the tonal scale. Research has shown that they do so in 80, 1% of melodies in the descending style, 64,4% in the arched style and only 49,6% in the ascending style. The arched and ascending styles exhibit a strong tendency to culminate on the 9<sup>th</sup> and 10<sup>th</sup> step (respectively 14,8% and 15,7%), which is a rare phenomenon in Polish folk songs. The culmination on the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, or 4<sup>th</sup> step is also a specific feature of the ascending style (27,6%) which results from its complex subtonic structure.

A melodic style is characterized by a tendency to display specific ambitus values. In Polish folk songs these values are usually extreme and differ from those frequently met. The ambitus of the Major sixth and smaller appears most frequently in the descending style (13,3%) and most rarely in the ascending style (9,9%) whereas the ambitus of the Minor tenth and higher emerges rather seldom in the descending style (9,9%) and most often in the ascending style (13,5%). Although on a smaller scale, the relation between melodic style and some specific ambitus values also appears in the songs which exhibit a compass of a melody from the Minor seventh to the Major ninth: this is a dominating feature of the Polish folk songs (76,6%–76,8%). But also here, the descending style shows a tendency to smaller compasses, contrary to the ascending style where the compasses are greater.

While measuring the compass of a melody, ANA shows too its lowest and highest sound (Option 6). Thanks to this data it is possible to measure the descent of the melody with the use of the Kolinski's method. This particular method treats a melody as a whole and does not take into account its division into parts. It is used to denominate a relative descent – the relation and difference ('level formula' and 'level shift') between the first and the last sound depending on the lowest and the highest sound of the melody (the ambitus is presented as a standard hundred-step scale)<sup>6</sup>. The discussed option of ANA may be used in the analysis of melodic form. Yet to do this, one has to save particular melodic verses separately (in EsAC code). In order to define the melodic form it is necessary to indicate the highest pitch of the melodic verses. The melodic form is understood as a number of possibilities to shape the melodic line in the sound environment which is both defined and limited by the relations between separate parts of the melody: the melodic verses. These pitch relations are examined in the perspective of the vertical shape of the melodic line. The main task is therefore to compare the relative pitch in specific verses from the standpoint of the order scale<sup>7</sup>. The main indicator of a given verse's level is its highest pitch (verse's culmination).

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<sup>6</sup> See Mieczysław KOLIŃSKI 'Ethnomusicology, its problems and methods'. *Ethnomusicology-Newsletters* 1957 no 10, pp. 1–7.

<sup>7</sup> The order scale relates to the level of measurement of the examined phenomena.

A juxtaposition of the verses' cadences (Option 8) is of primary importance in Hungarian ethnomusicology, especially in Bartok's method<sup>8</sup> and, to a smaller extent, in Járdányi's even though the latter deals with a more general specification of the melody's vertical direction resulting from an intuitive comparison between the progresses of the first and the last melodic verse in the sound environment (in categories of the order scale: 'lower', 'equal', 'higher')<sup>9</sup>.

The last feature analysed by ANA I have chosen to discuss is the contour of the melodic line in specified (in EsAC code) melodic verses (Option 11). Nine types of contours have been distinguished here together with an additional category called "undefinable contour". These are the types and their designating symbols:

1. / ascending;
2. \ descending;
3. — repetition;
4. ^ convex arch (1 peak);
5. V concave arch (1 bottom);
6. ~ 1 peak — 1 bottom;
7. S 1 bottom — 1 peak;
8. M 2 peaks — 1 bottom;
9. W 2 bottoms — 1 peak;
10. \$ undefinable.

According to Helmut Schaffrath<sup>10</sup>, one can theoretically obtain 30 different types of contours by combining the symbols with the letters 'd' (descending) or 'a' (ascending). For obvious reasons the

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It makes possible to order or arrange a category according to the level of appearance of the examined feature without defining precisely its intensity (see Hubert M. BLALOCK *Social Statistics*. New York, Toronto, London 1960). The working categories of the order scale are for example 'lower' or 'higher' which reflect the placement of melodic verses in the sound environment at this stage of the melodic form's substantiation.

<sup>8</sup> See Béla BARTÓK *Das ungarische Volkslied. Versuch einer Systematisierung der ungarischen Bauernmelodien* Berlin 1925, (*A magyar népdal*. Budapest 1924), and Béla BARTÓK *Serbo-Croatian folk songs*. New York 1951.

<sup>9</sup> See Pál JÁRDÁNYI *Magyar népdaltípusok*, part 1–2. Budapest 1961; P. JÁRDÁNYI *Ungarische Volksliedtypen*. Budapest 1964; P. JÁRDÁNYI 'Die neue Ordnung der ungarischen Volkslieder'. *Methoden der Klassifikation von Volksliedweisen*. Ed. Oskár Elschek, Doris Stockmann Bratislava 1969, pp. 123–133.

<sup>10</sup> Helmut SCHAFFRATH *Representation of one part melodies, computer aided analysis and music databases in Essen*. Essen 1991, pp. 16–17.

letters cannot be added to the first three types, therefore the maximum number one can practically obtain is 24. What we get here is a combination of the two basic aspects of the melodic line, that is, its shape and its vertical direction. An observation of specified parts of the melody (melodic verse's) allows us to identify a much higher number of contour types than it would be possible by treating the melodic line as a whole<sup>11</sup>. The huge number of contour types seems to overcome ANA's possibilities. This is especially true in regard to the complex category of various sinuous contours (6–9) which are indicated by the programme with a great inconsistency. For all practical reasons then, it is better to classify all those types (6–9) together as a sinuous contour (descending, ascending, or equal).

The types of contour depend to a certain extent on the melodic style. It is not only the convergence of vertical directions which is important here (descending contour is the most frequent in the descending style, equal contour – in arched style and ascending contour – in ascending style) but the shapes as well. For example, in Polish folk songs the sinuous shapes occur more frequently in the descending and arched style and seldom in the ascending style.

To sum up, we could say that ANA is a useful tool to analyse some stylistic features of folk song melodics. Should it also prove useful for the study of more complex phenomena like the melodic form, it is recommendable to equip Options 1 and 4 with proper means to analyse not only the melody as a whole but its separate parts (melodic verse's) as well. Naturally, this postulate is addressed to the author of the programme. It would help to exclude the necessity to save song verses in separate files (in EsAC code). In the study of melodics it is necessary to observe the correlation between melodic and tonal, metro-rhythmical, form (viewed from the angle of their musical substance) features thanks to which the remaining analytical criteria offered by ANA are equally useful.

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<sup>11</sup> The notion of the melodic line as a graphic representation of melodics was introduced by Ernst TOCH (*Melodielehre. Ein Beitrag zur Musiktheorie*. Berlin 1923, pp. 10–79) who also distinguished three types of the melodic line: 'Gerade', 'Wellenlinie' and 'Elastizität'. The number of shapes was expanded by his followers.

Musical examples of Polish folk songs in different melodic styles (descending-mountaineer's, arched and ascending) with melodies encoded in EsAC and analysis of program ANA

Example 1. (descending-mountaineer's melodic style).



Ej, na <sup>u</sup>orawskiej pyrci k<sup>u</sup>ozicka sie krynci,  
|: <sup>u</sup>oj, k<sup>u</sup>ozicka, nie kryńć sa, strzelem ci do s<sup>e</sup>rca :| .

CUT[Ej, na orawskiej pyrci]  
SRC[Sadownik 1971: 259 No 1]  
KEY[exam-1 16 G 2/4] ZZ[3]  
MEL[7b\_6b5\_ 6b5\_43\_ 4\_{5\_4} 6b5\_{3\_2\_} 1\_\_  
5\_45\_ 43\_21\_ -7b\_3\_ 43\_2\_ 1\_\_  
5\_43\_ 43\_21\_ 2\_5\_43\_2\_ 1\_\_ //]

1. Inventory of intervals: unison, ascending (capital letters), descending (small letters), intervals greater than octave (8L), sum of the ascending intervals (SI), sum of the descending intervals (si), small ascending intervals (SA), small descending intervals (sd), greater ascending intervals (LA), greater descending intervals (ld), subtraction of the ascending and descending intervals (dt), sum of the intervals - absolute value (ABS), number of bars (SB)

UN[0] 2S[10] 2M[8] 3S[3] 3M[0] 4P[3] 4A[3] 5P[5] 6S[0] 6M[0] 7S[0] 7M[0]  
8P[0] 8L[0] SI[30] ABS[40] SA[18] LA[13] SB[15]  
2s[23] 2m[45] 3s[3] 3m[0] 4p[0] 4a[0] 5p[0] 6s[0] 6m[0] 7s[0] 7m[0] 8p[0]  
8l[0]  
si[70] dt[-40] sd[68] ld[3]

3. Inventory of pitches

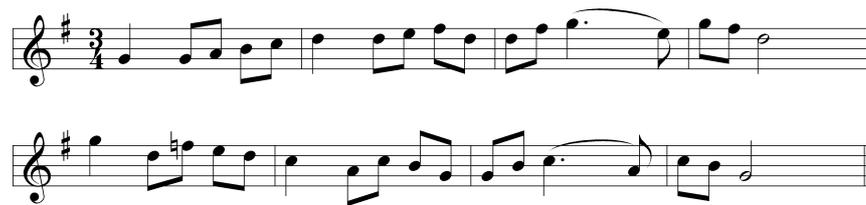
M1[12] M2M[0] M2[15] M3M[0] M3[20] M4[22] M4A[0] M5[20] M6M[7]  
M6[0] M7M[2] M7[0] U1[0] U2M[0] U2[0] U3M[0] U3[0] HD[0]

6. Range  
[8] (-7b, 7b)

8. Cadential tones  
[111]

11. Countour of melodic verses  
[Sd\_Sd\_Sd\_]

Example 2. (arched melodic style).



Tam za Warszawą, tam za Warszawą na błoni, na błoni  
wywija Jasio, wywija Jasio na koniu, na koniu.

CUT[Tam za Warszawą]  
SRC[Kolberg 1961: 154 No 12h]  
KEY[exam-2 08 G 3/4] ZZ[4]  
MEL[1\_1234 5\_5675  
57+1\_6 +175\_  
+1\_57b65 4\_2431  
134\_.2 431\_//]

1. Inventory of intervals: unison, ascending (capital letters), descending (small letters), intervals greater than octave (8L), sum of the ascending intervals (SI), sum of the descending intervals (si), small ascending intervals (SA), small descending intervals (sd), greater ascending intervals (LA), greater descending intervals (ld), subtraction of the ascending and descending intervals (dt), sum of the intervals – absolute value (ABS), number of bars (SB).

UN[12] 2S[9] 2M[15] 3S[12] 3M[6] 4P[3] 4A[0] 5P[0] 6S[0] 6M[0] 7S[0]  
7M[0] 8P[0] 8L[0]  
SI[45] ABS[33] SA[24] LA[21] SB[8]  
2s[12] 2m[6] 3s[9] 3m[12] 4p[3] 4a[0] 5p[0] 6s[0] 6m[0] 7s[0] 7m[0] 8p[0]  
8l[0]  
si[42] dt[+3] sd[18] ld[24]

3. Inventory of pitches

M1[15] M2M[0] M2[9] M3M[0] M3[12] M4[15] M4A[0] M5[21] M6M[0]  
M6[9] M7M[3] M7[9] U1[9] U2M[0] U2[0] U3M[0] U3[0] HD[0]

6. Range

[8] (1, +1)

8. Cadential tones

[5511]

11. Countour of melodic verses

[^a\_^\_Sd\_^\_]

Example 3. (ascending melodic style).

*♩* = 69

Co sie stało naszej Ewce,  
że una mi robić nie chce;  
a jak jo ji dom gymbusi,  
to mi Ewka robić musi.

CUT[Co sie stało naszej Ewce]

SRC[Kania 1975: 37 No 35]

KEY[exam-3 08 G 3/4] ZZ[8]

MEL[1\_2 3-5\_  
1\_2 3-5\_  
1\_2 {34}5  
{43}1 2-50  
4\_5 66\_  
4\_5 6+1\_  
5\_+1 5\_4  
3\_1 2-50 //]

1. Inventory of intervals: unison, ascending (capital letters), descending (small letters), intervals greater than octave (8L), sum of the ascending intervals (SI), sum of the descending intervals (si), small ascending intervals (SA), small descending intervals (sd), greater ascending intervals (LA), greater descending intervals (ld), subtraction of the ascending and descending intervals (dt), sum of the intervals – absolute value (ABS), number of bars (SB).

UN[3] 2S[3] 2M[39] 3S[3] 3M[0] 4P[9] 4A[0] 5P[0] 6S[0] 6M[0] 7S[3] 7M[0]  
8P[0] 8L[0] SI[58] ABS[33] SA[42] LA[15] SB[8]  
2s[6] 2m[6] 3s[0] 3m[9] 4p[6] 4a[0] 5p[6] 6s[0] 6m[6] 7s[0] 7m[0] 8p[0]  
8l[0]  
si[39] dt[+19] sd[12] ld[27]

3. Inventory of pitches

M1[15] M2M[0] M2[15] M3M[0] M3[15] M4[15] M4A[0] M5[15] M6M[0]  
M6[9] M7M[0] M7[0] U1[6] U2M[0] U2[0] U3M[0] U3[0] HD[0]

6. Range

[11] (-5, +1)

8. Cadential tones

[-5-55-56+14-5]

11. Countour of melodic verses

['^d\_^d/\_/\_\\_\/\_/\_/\_—\_\\_\]

#### Sources of musical examples

1. *Pieśni Podhala. Antologia* [*Songs from Podhale region. Anthology*]. Ed. Jan Sadownik, Kraków <sup>2</sup>1971 (Kraków <sup>1</sup>1957), p. 259 no 1.
2. Oskar KOLBERG *Pieśni ludu polskiego* [*Songs of the Polish folk*]. Wrocław-Kraków-Warszawa <sup>2</sup>1961 (Warszawa <sup>1</sup>1867), p. 154 no 12h.
3. Wincenty KANIA *Piosenki lubuskie* [*Songs from Ziemia Lubuska region*]. Kraków 1975, p. 37 no 35.