

Leaping dances in Crete: Tradition in motion

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1 Introduction

When comparing sources from various periods, the island of Crete in the Eastern Mediterranean seems to be quite a lively example for the coexistence of change and tradition. Concentrating on the second half of the 20th century, where we have a wide variety of music recordings and eye-witness accounts on music activities, we can observe that changes in several aspects related to music took place. For instance, the Cretan *líra*, a three-stringed bowed instrument, in accompaniment of the Cretan lute were the predominant musical instruments at least in Western Crete, as was *e.g.* reported by Baud-Bovy (2006) on his excursion to Crete in 1953. After that, in the 1980s, a variety of other instruments were (re-)discovered and applied in Cretan music, as for example various wind instruments such as the Cretan bagpipe, the *askobandourá*.

Parallel to this enrichment in instrumental timbre, changes in the dance repertoire took place. In the beginning of the 20th century up until the 1960s we find many indications, that Eurogenetic popular music was increasingly appreciated in Crete. We encounter several reports from the rural area of Crete, which speak of dances like Waltz and Tango being played by the local music ensembles during festivities. As far as the urban environment is concerned, instruments like the Cretan *líra* were considered to be instruments of the villagers, while European music was widely preferred (Hnaraki (2007), p.40ff). However, some time during the 1960s, this tendency seems to have been reverted, and the development in musical style took quite a different direction. This might be related to the decision of the influential musicologist Simon Karas, to consider *líra* and Cretan lute as the instruments which represent Cretan music, and not to include instruments like the violin in his highly influential radio shows for the Greek National Radio (Alsina, 2011). Kaloyanides (1975), p.39, reports that by the time of him writing his thesis, in total five different major

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dances were performed in Crete, while other local dances are referred to as lost dances, which were no longer performed. However, in the last decades, these lost dances and several other local variants are rediscovered and promoted in various environments.

By the time when I lived in Crete (2003-2010), the number of local dances that were practiced in Crete varied depending on the source. Dance teacher Vangelis Stafilas (2011) reports that in the *Likeío Ellinídon* in 2011 15 to 17 different Cretan dances are taught. The DVD “When I hear Crete” (Megalakakis & Megalakakis, 2005) contains the performances of 19 dances from Crete. During an excursion to the East of Crete in 2011, we encountered the hospitable people of the village Mochos, who presented us their own leaping dance tune. Similarly, the people from the village Gergeri in Central Crete, started promoting their own leaping dance tune during a series of festivities in 2006 (Rouvas, 2007), with the CD booklet identifying it as an “old type of dance”. Parallel to such an identification of rural communities with their own dance tunes, what is referred to by the Cretans themselves as Cretan music takes an increasingly important role in urban areas as well. For instance, the capital city of Crete Heraklion with less than 200.000 inhabitants hosts five radio stations that exclusively play Cretan music. This article pursues the attempt to shed some light on the existing variability in a specific repertoire of Cretan music, which was subject of an increased awareness in the musical practice throughout the last decades in Crete: the leaping dances (*pidichtí*) of Crete.

To this end, I combine two points of view. First, the point of view of the Cretans, represented in the form of statements that I obtained from participants in Cretan music in interviews. The above mentioned developments in Cretan music imply the definition of identities in apparently increasingly smaller geographical contexts. Still, in the book on Cretan music by Maria Hnaraki (Hnaraki, 2007), the author presents Cretan music as a way to define Cretan identity. It seems like things go even further now, and on the island of Crete, different villages or areas attempt to create their own identity by means of shaping their own musical myths and traditions. This return to the micro-local resembles a return to the more or less isolated communities of the villages, as they were part of the rural identity not much more than 50 years ago.

My second approach to this diversity is the one of an outsider, which will be supported by quantitative analysis methods in the form of computer programs that I implemented. It has been argued by several scientists, that results from musical observations should be in some way accessible to comparison, even without a deep understanding of cultural context. As the most widely discussed attempt to achieve such comparability, Alan Lomax proposed his Cantometrics system with the goal to compare singing styles in various cultures of the world (Lomax, 1968). While after that ethnomusicology took a path rather towards detailed ethnography and anthropology, we increasingly face the need to understand at least some aspects of music from an etic (*i.e.* outsider) approach. Such approaches can then enable listeners to obtain semantically meaningful information about pieces in digitized music collections of large size. Computational tools exist to differentiate Rock from Reggae, or female from male singers,

given only the sound. Now, the interesting question is, what are the acoustic cues that enable Cretans to differentiate between their dances, and can we spot these cues using uninformed computational methods? My goal is not to depreciate certain subtle differences as not significant, depending on if they are reflected in some objective measurement or not. The important point I would like to make is rather the apparently fractal structure that music similarity and difference can take, with apparently small or non-measurable differences constituting integral components of micro-local identities.

In this article, I will briefly introduce the analyzed repertoire in Section 2, where I will also describe what aspects are going to be taken into account in order to differentiate between dance tunes. The following sections refer to the three chosen aspects, which are tempo, rhythmic accent patterns and melodic motifs, respectively. Details regarding the computational analysis methods are given in separate methodology sections. These sections can be skipped by the reader without interest in the engineering background, enabling readers to focus on the musical aspects and to concentrate on the results of the comparisons. Finally, in Section 6, I will give some conclusions and further remarks.

2 Leaping dances

For my investigation, I focus on the leaping dances in Crete, in contrast to the *sirtos* dances (*i.e.* literally translated “dragging” or “shuffling”). This is motivated by the fact that throughout the last years or decades, many of such dances appeared again on stages and festivities in the island of Crete, after they were thought to be forgotten at least to some extent in the 70s. Three leaping dances are considered to be part of the Pancretan repertoire, which are the *Maleviziotis*, the *Sousta*, and the fast *Pentozalis*. Like all dances that apparently originate from the island of Crete, these dances follow a 2/4 musical meter, and as leaping dances they are characterized by a rather lively and fast performance style. Apart from these three, dances exist that are usually related to specific regions or villages by their naming. These namings can be considered a phenomenon that was established rather recently, often by people from areas different than the villages of origin for a dance. As Yannis Panagiatakis, a dancing teacher living in Heraklion, clarified that these terms represent an attempt to differentiate between the local dances (Panagiatakis, 2013). I decided to concentrate my study on the differences between some leaping dances assigned to the central and Eastern parts of Crete.

These dances are the *Anogianós* dance from the village of *Anógia* in the central Cretan *Ida* mountain area, the *Ethianós* from the village *Ethiá* in the south-central *Asteroúsia* mountains, the *Sousta* dance from the central Rethymno area, the *Maleviziótis* dance assigned to the wider area of Heraklion, and finally the *Sitiakós* from the eastern part of the island. All of these dances share certain features to varying extent, such as their musical meter, rhythmic accompaniment patterns, or similar instrumentation and performance contexts. Arguably, the largest similarity can be assumed to exist between the Malevizio-

tis and the Sitiakos. The latter is often considered to be a variety of the former *e.g.* (Panagiotakis, 2013), an assumption that is, however, vehemently negated by many musicians in the eastern parts of the island.

The question I want to pose here is what acoustic cues are contained in the music that enable listeners to recognize which dance is being played. This task is seemingly easy for the insider, as Vaggelis Stafilas describes: “You understand that with the first phrase.” While such assertions have been repeatedly given to me by various people, it remains unclear what exact aspects there are. In the interview, Vangelis stated that the melody plays the main role, but rather preferred to assign the recognition of the dance to the feature of the tone color (Greek: *chriá*) instead of the melody (Greek: *melodía*). My personal observations during listening tests related to my research on computational estimation of rhythmic similarity (Holzapfel & Stylianou, 2011) imply that experts such as dancing teachers assign a recording to a specific dance after very few seconds of listening only. Hence, their recognition seems to be driven by a large set of memorized patterns. But still, is it the melodic content that differs, or are there other cues as well? I will try to explore some steps towards this direction in my experiments.

Firstly, I will investigate how differences in tempo contribute to the classification. Some dances might be performed in generally fast or slower tempi, but apart from that pieces might differ regarding their tempo developments. That is, we will see if specific dances speed up gradually, and how quickly they do so.

Secondly, the different steps of the dances might be reflected in differing stress patterns applied by the musicians in their accompaniment. This thought was motivated by the opinion of the lute player Dimitris Sideris (Sideris, 2013), that at least for some musicians, the accompaniment of the lute puts emphasis on particular metrical accents, depending on the dance. This is in particular interesting, as the rhythmic accompaniment is very similar if not identical for all the leaping dances.

And, finally, I will determine in how far the melodies of the dances contain motivic building blocks that are unique for a specific dance and enable this way for a disambiguation of the recognition of the dance.

I will pursue all three tasks using signal processing methods, supported by manual corrections by the author. This way we can assess the influence of small nuances in tempo and stress patterns, that could not be described easily in any form of notation. For the analysis, I decided to restrict myself to a set of commercially available recordings of renowned musicians of Cretan music, in order to enable the reader to obtain access to these recordings easily. The number of samples per dance and the number of 2/4 measures per dance are given in Table 1, while a list of the used recordings is given in the Appendix. This list will serve as a reference to individual recordings throughout the text.

Dance	Number of Pieces	Number of Bars
Anogianos	4	819
Ethianos	2	396
Maleviziotis	4	953
Sousta	8	1873
Sitiakos	4	1278
Total	22	5319

Table 1: Number of samples per dance and number of measures available for the analysis in the following experiments.

3 Tempo

3.1 Methodology

In order to investigate how tempo develops in the corpus of recordings, we need to annotate the beat of the pieces, which in our case are the positions of the quarter-note pulse of the 2/4-meter. In order to accomplish the beat annotation in an automatic fashion, the beat annotation software implemented by Davies and Plumbley (2007) that is available in the Sonic Visualiser¹ software was applied, and corrected where necessary. Afterwards, the tempo $T(t)$ in beats per minute (*bpm*) at each time-instance t of a piece can be obtained using the duration between two neighboring beats b_t and b_{t+1} in seconds by calculating $T(t) = 1/(b_{t+1} - b_t) * 60$. The obtained bpm-values $T(t)$ were then median-filtered in order to compensate for eventual local inaccuracies in the manually corrected annotations. In order to be able to compare the tempo developments of different pieces, all obtained $T(t)$ were spline-interpolated to obtain a set of 200 tempo values for the whole duration of a piece. This results in a trajectory of 200 tempo values in bpm that describes the tempo development in each recording.

3.2 Results

In Figure 1 I depict tempo trajectories for four different dances². Each line represents an average over the recordings of the specific dance in our corpus. In this figure two important differences can be recognized. First, some dances differ significantly regarding their overall tempo. The Sousta is generally the slowest of the five dances, and the Maleviziotis represents the upper tempo border. The second and possibly more subtle difference lies in the way the tempo develops throughout the piece, which is reflected by the overall shape of the trajectories in Figure 1. We can see that the Sitiakos reaches a similar tempo level as

¹www.sonivisualiser.org

²Note that a curve for the Ethianos is not depicted, since only two recordings were available and an average tempo curve would be too noisy to be depicted in the figure. However, the tempo values of the Ethianos are similar to the ones of the Anogianos dance.

the Maleviziotis by the end of the performances, but usually the musicians increase the tempo more gradually in the first part than it is the case for the Maleviziotis. This is a remarkable aspect, since Maleviziotis and the Sitiako are considered variants and not strictly separate dances by many dance teachers and musicians especially in Central Crete. The greater variability in tempo and the related larger range of expressions in the dance movements support the hypothesis of the Sitiakos being the origin of the *Pidichtos* melodies (Spiridakis, 2013). Furthermore, the Sitiako is often referred to as being more mild and more lyrical (Panagiotakis, 2013), an aspect which is partly reflected in the smoothly ascending tempo curve.

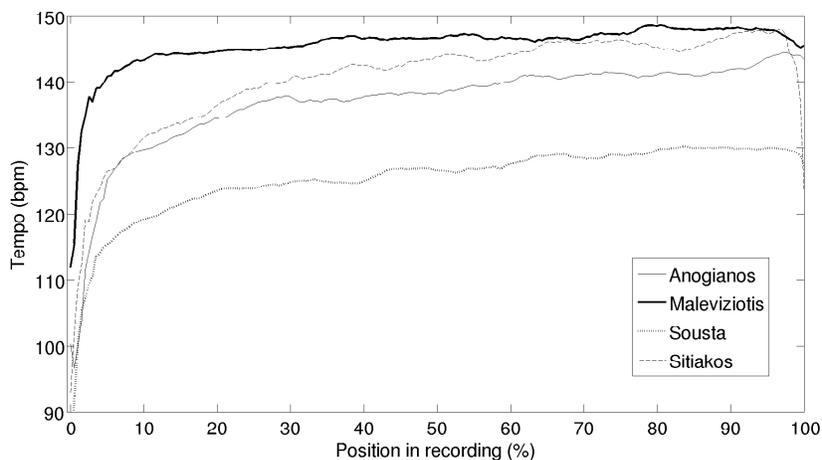


Figure 1: Mean tempo trajectories for four Cretan leaping dances or dance variants.

While the plots in Figure 1 depict the mean tempo values over a set of pieces, it is informative to have a closer look at the tempo trajectories of the individual songs as well. For the Anogianos, three of the four recordings share almost the same tempo trajectory, while only one (recording 1, see Table 2 in Appendix) is clearly slower with about 120 bpm in the mean compared to about 140 bpm for the other three recordings. This indicates the degrees of freedom the individual musicians have when interpreting the repertoire. The tempo trajectory for the Ethianos dance was obtained only from two sound recordings, one having a median tempo of 145 bpm, the other having a median tempo of 125bpm. Both are characterized by a rather stable tempo which only increases slightly mainly in the first half of the recording. The Maleviziotis pieces are performed in a generally higher tempo range than the other dances analyzed here. While the slowest performance is the recording by Kostas Papadakis (recording 9) with an average of about 135bpm, the recordings by Kostas Mountakis and Vassilis Skoulas mark the upper border in our set of recordings with mean tempi of more than 150bpm. It was observed by *líra* player Zacharias Spiridakis

that throughout the last decades, high tempi became a characteristic of the Maleviziotis, caused by the intention of the lead musician to demonstrate his skills (Spiridakis, 2013). Consistently, I observed that many recent recordings, especially when recorded during a live performance, reach tempi even higher than that.

The Sousta recordings represent the slowest tempi in our corpus. The highest tempi are encountered in a recording by Kostas Mountakis (recording 16), with a median tempo of 136 bpm and a maximum of 146 bpm by the end of the performance. Once again, as for the Anogianos, Alexandros Papadakis played the slowest Sousta piece present in our corpus, with a mean tempo of 114 bpm. Generally, the appropriate tempo for each of the dances is a matter of discussion regarding aesthetics of music performance. While for all leaping dances, a speed up was reported throughout the last decades (Stafilas, 2011), this speed up is criticized by many musicians as doing harm to the expressiveness of music and dance (Spiridakis, 2013). We could therefore interpret Kostas Mountakis with his enormous virtuosity as an influential factor for a speed-up of musicians attempting to reach or even surpass his virtuosity, while Alexandros Papadakis represents a group of musicians that, while admiring Mountakis, criticize the continuing speed-up of the leaping dances. For the Sitiakos, there was no outlier regarding shape of tempo trajectory or mean tempo values. All recordings are characterized by mean tempi around 140 bpm, with maximum values of a bit more than 150 bpm. This indicates a higher agreement among the musicians from Eastern Crete regarding an adequate performance tempo of this dance.

Concluding this section on tempo, we saw that recordings related to specific dances differ by general tempo and their tempo trajectories to some extent. Furthermore, even in our small corpus we can spot the interesting contrast between the speed-up of the leaping dances, and the choice of some musicians to reverse this tendency.

4 Accent patterns

Locations within a measure where musicians put strong emphasis tend to be aligned with *e.g.* the dance that is related to the music performance. This was observed by Krebs, Böck, and Widmer (2013) who observe a set of distinct rhythmic patterns for a set of Ballroom dances. In the context of Cretan leaping dances, however, the degrees of freedom for the rhythmic diversity are less, because all dances are assumed to have an underlying 2/4-meter, and their tempo ranges are more similar than for Ballroom dances as we saw in the previous section. Kaloyanides (1975) reports the patterns shown in Figure 2 to be the most common patterns to appear in the three leaping dances of Sousta, Maleviziotis³, and fast Pentozalis. He refers to the first pattern as the most common for the Sousta dance, while stating that the Maleviziotis makes use mainly of the first three, and the Pentozalis accompaniment is stated to make use of patterns 1 and 4. While this description creates the impression of the dances using to some

³referred to as Kastrinos by Kaloyanides

extent different patterns, in practice all of these patterns might be encountered at some point in any leaping dance.



Figure 2: Rhythmic patterns reported by Kaloyanides (1975) for Cretan leaping dances

For that reason, I will not attempt to investigate if some pattern is exclusively applied in a particular dance, as such a restrictive assumption does not embrace the flexible situation encountered in reality. I will rather attempt to investigate if there are any differences between rhythmic patterns for different dances or musicians, regarding the energy that is related to the strokes of the lute accompaniment.

4.1 Methodology

As a first step we need to annotate each recording with its sequence of beats and downbeats, *i.e.* with a sequence of time instances that specify where the downbeat (*i.e.* the “1”) and the second beat of the 2/4 meter are positioned in the recording. We have obtained the sequence of beats as described in Section 3.1, and simply mark which of the two beats in a measure marks the beginning of the measure. Then, we use the approach applied by Krebs et al. (2013) to measure the positive energy changes. In our case these energy changes are most likely to be caused by the strokes of the lute accompaniment, since most pieces do not contain any percussions or drums. These energy changes are measured with a temporal resolution of a 1/64 note, which results in a energy histogram containing 32 bins for the 32 1/64-notes within each measure. As a result we obtain accent patterns of one measure length that describe where within a measure lute onsets are likely to be located.

After obtaining these bar-length accent patterns for each individual measure in the collection, we need to obtain some insight into which patterns occur most frequently. Starting from a global perspective, the whole set of 5319 obtained measure-patterns from 22 samples was analyzed using a k-means clustering algorithm. This algorithm attempts to assign all individual patterns to one of k groups⁴. Each of these k groups can be represented by its geometrical mean, a pattern that lies in the middle of all the patterns assigned to the group. I will use these cluster centroids in order to interpret the occurrence of specific rhythmic patterns in the data.

⁴I conducted several experiments with the number of clusters k ranging from 4 to 6, with the results remaining qualitatively the same.

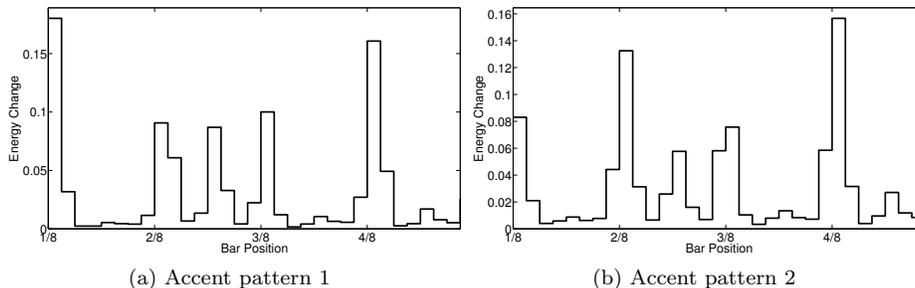


Figure 3: The two accent patterns that represent the majority of the encountered accent patterns throughout the samples.

4.2 Results

A first interesting observation was that while the beat tracking software correctly estimated the tempo of most pieces in beats per minute (bpm), it failed in many cases to position the beats in the correct phase. This means that the results in these cases were sequences of beat annotations that put the beats on the 2/8 and 4/8-accents of the meter, instead of the 1/8 and the 3/8-accents, or were even more randomly situated. I observed that the cases where automatic tracking failed were clearly biased towards certain dances, with the Maleviziotis and Anogianos dances tracked correctly in all but one case, but the Sousta and Sitiakos having a problematic tracking for a majority of the recordings. This indicates that both Maleviziotis and Anogianos are characterized by cues in the signal energy that provide a more stable alignment with the underlying beats. A similar tendency to a tracking on the off-beat was observed previously for Cretan music (Holzapfel & Stylianou, 2008), which implies that focussing on energy cues results in a high degree of metrical ambiguity for Cretan music.

In Figure 3 I depict the two most frequent patterns that represent more than 60% of the measures. The peaks in the two patterns imply that they are both represent the first rhythmic pattern shown in Figure 2, a pattern referred to as the basic laeping dance pattern by Dimitris Sideris (2013). However, the strength of the accents clearly varies; Accent pattern 1 clearly emphasizes the downbeat, which can be recognized by the large amplitude in the bin at the 1/8 bar position. Accent pattern 2 has more emphasis on the 2/8 and 4/8-accents, which means that its emphasis lies rather on the off-beat. In Figure 4 I list the frequency of these two patterns for each dance individually. It becomes apparent that pattern 1 is more frequent than pattern 2 for both Anogianos and Maleviziotis, indicating a stronger emphasis of the downbeat in these dances. Note that the magnitudes of the two bars for one dance in Figure 4 are influenced by the total number of measures for this dance, as given in Table 1. Therefore, *e.g.* the Ethianos with the smallest number of samples takes on relatively small values in Figure 4, and the relevant information lies in the difference of the bar sizes within one particular dance. We can then summarize that Ethianos,

Sousta and Sitiakos make stronger use of the “off-beat” pattern 2. For the Ethianos dance, I observed that recording 5 makes use of a relatively flat rhythmic accompaniment with strokes on each 1/8 note, a pattern rather typical for the Cretan Sirtos dance. This can be seen as an example that there is no definite rule regarding what kind of pattern to use for what dance, but that musicians choose to a wide extent according to their personal preferences. The apparently less strong emphasis of the downbeat by the Sousta accompaniment is consistent with the assumption of lute player Dimitris Sideris that the patterns of this dance might be less emphasized on the downbeat, and this way align with the movement pattern of the dance. On the other hand, it is surprising that the Sitiakos dance differs clearly from the Maleviziotis dance in making almost equal use of both patterns. This indicates, at least for our selection of music examples, a second difference between Maleviziotis and Sitiakos, apart from the different tempo curves observed in the previous section. The less accentuated emphasis of the downbeat in Sitiakos samples might be another aspect that adds to its less harsh and more playful character.

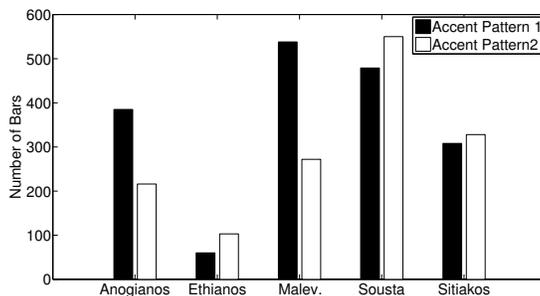


Figure 4: Number of measures assigned to the patterns depicted in Figure 3.

I would like to conclude this section with some observations regarding patterns applied in some individual recordings and the influence of the number and kinds of participating instruments in the recordings on the rhythmic patterns. In Figure 5, the most prominent accent patterns from four individual recordings are depicted, determined by applying the k-means algorithm to the individual recordings. The lute accompaniment of Kostas Mountakis changes clearly between the Maleviziotis dance pattern depicted in Figure 5a (recording number 10) and the Sousta dance pattern depicted in Figure 5b (recording number 17). The Maleviziotis pattern is related to the first pattern notated in Figure 2, while the Sousta pattern resembles a performance of pattern 4 in Figure 2. The fact that this contradicts the description of (Kaloyanides, 1975) shows that indeed the performances of the leaping dances do not assign specific patterns to the dances, but allow for a large flexibility. The two patterns depicted for the recordings by Alexandros Papadakis are both related to the basic leaping dance pattern, which is the first pattern in Figure 2. The difference between the Anogianos pattern in Figure 5c (recording number 1) and the Sousta

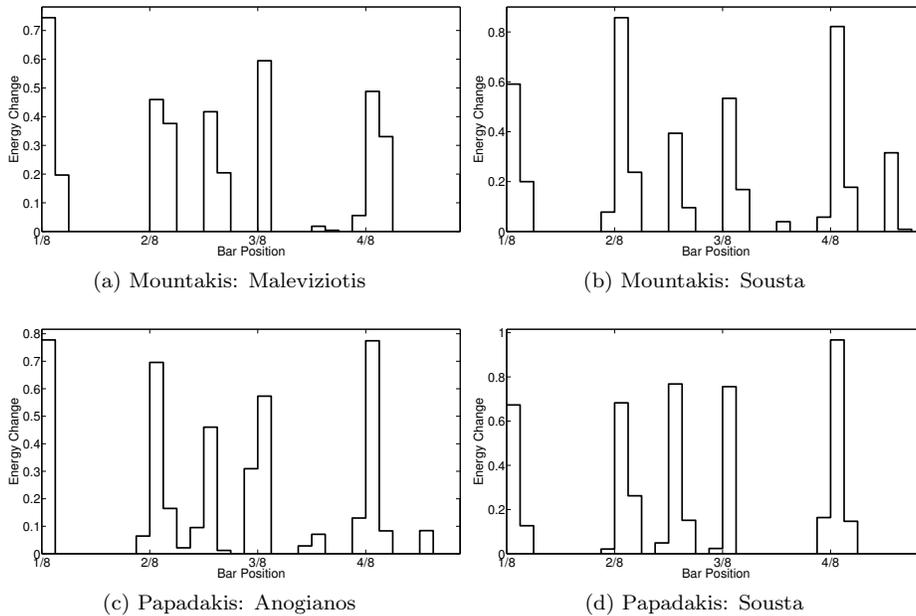


Figure 5: Most prominent accent patterns from four individual samples.

pattern in Figure 5d (recording number 12) lies in the stronger emphasis of the downbeat in the Anogianos pattern. These findings nicely match the information obtained from musicians regarding the different emphasis between the dances. However, there are examples that contradict these guidelines and make clear that the assumption of changing emphasis strongly depends on the musicians who play the accompaniment. Furthermore, while the measured patterns were obtained with state-of-the-art algorithms, it is not clear how much the measured differences relate to the differences perceived by the listener taking part in the local performances of Cretan music.

An aspect that influenced the difficulty in beat annotating our examples is the number and kinds of instruments that are playing in the individual recordings. I observed that recordings containing two lutes accompanying the melody instrument were the most stable examples as far as timing is concerned. On the other end, samples containing only a lute and the melody instrument, such as the Sousta recordings of Mountakis, had a much more dynamic timing. Furthermore, the usage of a guitar, which is traditionally more common in the east of Crete than in central Crete, adds to the diversity of rhythmic patterns, because the guitar often plays a pattern that implies a 4/4 meter and is performed in a style that is often referred to as Bassokitharo (“bass note guitar”), see the Sitiakos by Dermitzoyannis (Recording number 21). This juxtaposition of the accompaniment by Cretan lute as the typical element of especially the Maleviziotis and the Bassokitharo as typical for the Sitiakos adds to the different

character of these dances.

5 Melodic patterns

In order to compare the melodic content in the recordings, the most precise method would be a manual transcription and a subsequent analysis by a human expert, with the final goal to spot partial or complete identity of melodic patterns. Such an approach was followed by Theodosopoulou (2004), where a method for indexing melodic phrases, which are referred to as *Kontilies* in Cretan music, was proposed and applied to Cretan music. In Figure 6 a melodic phrase from a *Sousta* dance tune is depicted, and the specifier “148 α 37 β ” denotes the index of this particular phrase. The indexing refers to the melodic content the first measure (148 α) and the second measure (37 β) of the phrase, and can be used to locate repeated occurrences of melodic phrases in a transcribed collection of pieces.

The structure of Cretan as well as many other dance tunes from the Mediterranean area was described by Sarris, Kolydas, and Tzevelekos (2010) using the framework of *parataxis*. Briefly, tunes with a *parataxis* structure are built from small melodic phrases like those depicted in Figure 6. There is no composed elaboration of a melody, neither is there a clear periodic structure, according to which a musical theme is repeated. No explicit rules exist which have to be followed by the musician when stringing together melodic phrases. There are sets of melodic phrases which are interpreted in relation to their geographic origin for some of the dances such as the *sirtos*, where it is part of musical practice to combine several of these sets into a continuous performance (*seirá*). Furthermore, specific phrases and their combination are often related to a renowned musician, such as *e.g.* the *Sousta* of the *lira* player Kareklás. In general, however, it remains undocumented in how far different dances might share similar melodic phrases, or how the sequence of melodic phrases is chosen by individual artists. In order to proceed into such a direction we need to apply a suitable melodic analysis approach.

While the method of Theodosopoulou (2004) based on manual transcription and analysis can provide detailed insight into a corpus it has two disadvantages. First, it can only help to discover exact re-occurrences of a specific phrase, with even one of the notes being different leading to a different index number. Therefore, this indexing system provides no insight into the existence of similar or almost identical phrases. And, secondly, a lot of time and expertise is needed to manually transcribe and analyze a corpus, and it seems an attractive idea to evaluate how far a computational analysis guided by expertise in music can achieve meaningful results in a less time-consuming fashion.

5.1 Methodology

A computational estimation of the melody line played by the *lira* or by the violin is needed for our analysis. To this end, I applied the analysis algorithm presented

148a37β Τρ. Πε με Α' χροά (Τον. βάζση: Λα)



Figure 6: Example of a two measure melodic phrase

by Salamon and Gómez (2012), which is tailored for the task of estimating the lead melody out of a music signal that contains a lead instrument accompanied by one or more other instruments. While the obtained quality of the estimation seemed quite high for all samples in the corpus, it should be pointed out that it is far from being perfect. For that reason, I applied the algorithm that we proposed for the scope of matching two melodies (Şentürk, Holzapfel, & Serra, 2014). This algorithm takes two vectors that contain pitch values, and tries to find (partial) occurrences of the melody in the first vector in the melody described in the second vector. I will refer to the first vector as the query and the second vector as the target melody.

In order to apply the algorithm, we take advantage of the fact that we know the beats after the above described beat annotation process (see Section 3.1). This enables us to cut out individual queries of a certain length in measures. Melodic patterns in Cretan music typically have a length of either two or four measures in the analyzed dances. For that reason, I use patterns of four measure length as queries. Then I investigate if we can localize an occurrence of such a query within a different song. Note that for that the pitch values both in the query and in the target melody are transposed to be on the same tonic frequency. This enables us to compare recordings that are differently tuned, or melodic patterns that have different tonic frequencies.

The method of pattern matching (Şentürk et al., 2014) computes differences in pitch values, but allows for a certain amount of inaccuracy for the matching. To be precise, we demanded the matched melodic patterns to be at least of one measure length, and that at most a duration related to an eighth-note can be different between two matched patterns. The pitch tolerance for two pitches to be judged as identical is a quarter tone.

5.2 Results

In the experiment all sequential two-measure patterns that are contained in a song were used as a *query*, and if at least one measure of it was encountered in any other song, the dance of that positive *target* song was registered. In Figure 7 the results of this experiment are shown. Each individual bar graph shows the results when melodic query pattern stem from the dance denoted below the graph, for instance *Anogianós* for Figure 7a. Each of the five bars in an individual figure depicts the probability of a target pattern belonging to the class denoted below the bar. For instance, in Figure 7a the leftmost bar denotes the probability that a detected match to a query from the Anogianos dance

belongs to a different recording of the same dance (Anogianos). The second bar in the same figure then denotes the probability to encounter a melodic pattern from the Anogianos tune in a tune related to the Ethianos dance, and so on.

I grouped the 5 examined dances into two lines in Figure 7, because they depict two different situations. In Figures 7a to 7c, the pattern probabilities for the Anogianos, Ethianos and Sousta dances are depicted. It is apparent that in each of the three figures the bar related to the same dance is much larger than the other bars. This phenomenon is strongest for the Anogianos, followed by the Ethianos, and it demonstrates that these two dances are accompanied by music performances in which the melodies are characterized by melodic patterns that are found in that particular dance, and not in any other dance. It is interesting to point out that both Anogianos and Ethianos are dances from mountain areas of Crete that are rather remote from urban areas, with especially Anogia actively emphasizing a mentality that is in contrast to urban environments in Crete or in Greece in general, as illustrated by Hnaraki (2007). This geographic and mental diversity is reflected in the melodic building blocks of the dances of these areas very clearly.

The phenomenon that a dance makes use of its own melodic patterns almost exclusively is strong for the Sousta dance as well, with the pattern probabilities depicted in Figure 7c. The Sousta is a dance geographically assigned to the area of Rethymno, a city smaller than both Hania and Heraklion, and to its surrounding village areas. Kaloyanides (1975) states that the Sousta is a non-living dance form in the sense of continuing creativity (page 153), but nowadays it seems that this dance is again part of most performances. This seems to be related, on the one hand, to the fact that Lyra players appreciate the popular Sousta recordings by Kostas Mountakis or Antonis Kareklas. On the other hand, the Sousta is the only dance currently encountered in Crete which is a couple dance, and therefore offers the possibility of encounter and the possibility to express erotic verses (mantinades). As a couple dance, it was hypothesized *e.g.* by Vangelis Stafilas that it might have an older history as a war dance, a hypothesis which he further supported by the simplicity of the steps of the dance. While there can be no proof for this hypothesis, the strong emphasis on its own patterns within the Sousta seem to support the assumption that it is an older dance, which stands in relative isolation from other dances in terms of its melodic content.

An interesting and insightful picture can be obtained from the pattern probabilities of the Maleviziotis and the Sitiakos, as depicted in Figures 7d and Figure 7e, respectively. We can recognize the strong interrelation between Maleviziotis and Sitiakos in terms of melodic phrases. This is not astonishing, since it is emphasized by some musicians and dance teachers in Crete, that these two dances are variations of each other rather than different dances. These two dances are the two dances in which the steps are to some extent synchronous, and differ mostly in terms of their directional patterns. This proximity in the dance movement is reflected by a proximity of melodic patterns.

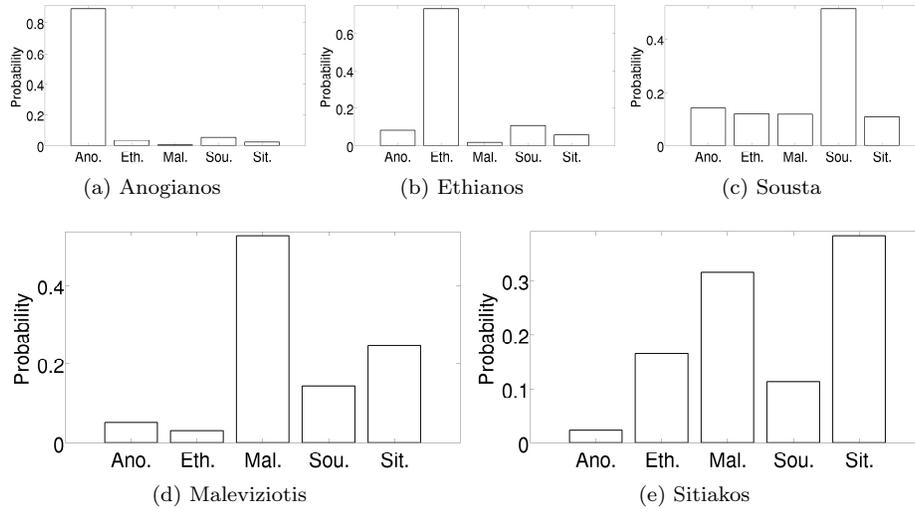


Figure 7: Distribution of the detected melodic patterns for the five dances.

6 Conclusion

Our experiments documented the fact that Cretan leaping dances can be most reliably recognized using their melodic content. While this is an observation that is very unlikely to surprise a musician from Crete, the clarity in which certain dances differ from all other dances regarding their melodic content shows a relation to their geographic origins and also motivates to further exploit the automatic analysis approach that I applied in the experiments. As a next step, the method can be applied to a larger set of recordings, including the field recordings obtained in our research, in order to obtain a collection of melodic patterns that are encountered mostly within specific dances. By transcribing these patterns we will be able to summarize the melodic content which is important to differentiate between the dance tunes. In Figure 8 some examples for typical patterns are depicted that appeared frequently in the collection used in this chapter. Each of the transcribed patterns represents an example that was detected in several recordings of a specific dance, but not in recordings of the other dances. While more general conclusions can be drawn only using a larger collection and by presenting detected patterns to Cretan musicians, all of the depicted patterns are clear markers for the dances they were found in. Locating patterns has been previously attempted by Conklin and Anagnostopoulou (2011) using existing transcriptions for analysis. However, the resulting patterns were usually shorter than the two- or four-bar length of the Cretan *kontilies* and have a less obvious musical meaning as identifier of the specific tune.

Both tempo and accent patterns can be assumed to play a smaller role in differentiating between leaping dances than melodic patterns. The accent patterns encountered in the analyzed corpus give rise to the assumption that

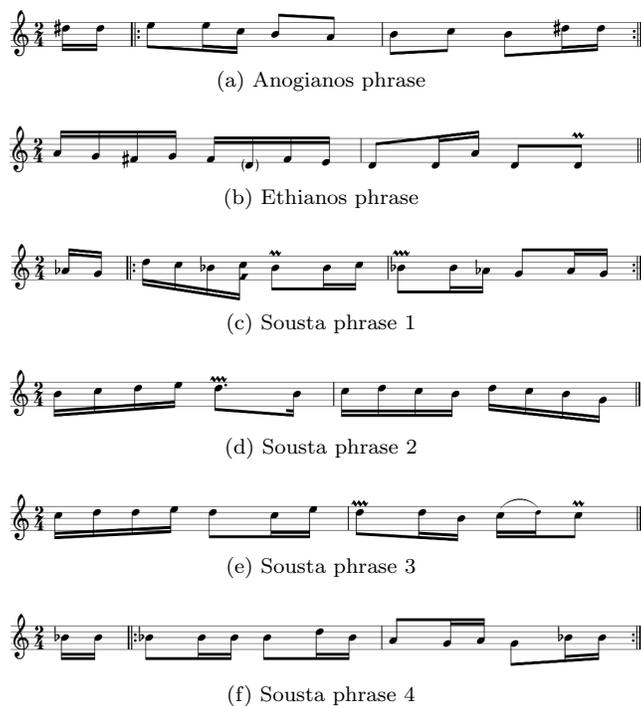


Figure 8: Some examples of phrases that occurred in different recordings of the same dance.

their variations mainly depend on the personal choice of the artist, and on the sort and number of instruments accompanying the main melodic instrument. The only interesting fact in relation between accent patterns and type of dance is that for certain dance types (Maleviziotis and Anogianos) accompanying accent patterns tend to stress the downbeat more clearly. Clearer differences are found in the tempo, where the Sousta has a significantly lower tempo than the other leaping dances, and the Maleviziotis is characterized by the fastest performance. While this finding does not reveal anything new to people familiar with Cretan music, the finding that the Sitiakos approaches high tempi in a more gradual transition than the Maleviziotis is an interesting aspect in which these two dances differ.

This brings us back to the initial observation that local communities in Crete increasingly emphasize the existence of their own local tunes and dances. While the Sitiakos is considered as a variation of the Maleviziotis by at least a large part of Cretan musicians and dance teachers, we were able to see that it has its own coloring. This coloring consists of a different tempo trajectory, a different emphasis of the beat caused *e.g.* by an accompaniment using *bassokitharo*, and finally by some of its own local melodic phrases. In all three aspects the similarity with the Maleviziotis can be considered as very high, but differences

emerge in the experiments quite descriptively.

Regarding the development of algorithmic approaches for music similarity the specified differences would escape the attention of most state-of-the-art music similarity systems. This is due to the fact that the comparison of dance tunes is usually based on the comparison of rhythmic patterns. An illustrative example can be found in my own work (Holzapfel & Stylianou, 2011), where such an approach is applied to Cretan dances. The results indicated that dances with very different rhythmic properties can be differentiated by looking at rhythmic patterns only. However, as we saw in this paper, for an understanding of leaping dances they can be only of very limited use. The results clearly demonstrate a rather subtle and diverse set of acoustic cues that serves Cretan musicians to mark the identity of a dance.

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A List of Recordings

Rec. Nr.	Dance	Artist	Track.Nr.	CD title
1	Anogianos	Alexandros Papadakis	6	Stou karaviou tin plori
2	Anogianos	Vasilis Skoulas	7	Kritika tragoudia kai chori
3	Anogianos	Yannis Chairetis	16	Anogianomonofatsiotikes Rizes
4	Anogianos	Nikiforos Aerakis	4	Vradies Arolithou Vol. 2
5	Ethianos	Konstantinos Papadakis 'Lyratsaki'	19	CD2 of Book: Asterousia mousikes fotografies
6	Ethianos	Kostas Kakoudakis	14	CD2 of Book: Asterousia mousikes fotografies
7	Maleviziotis	Alexandros Papadakis	13	Kanari mou
8	Maleviziotis	Vasilis Skoulas	17	Kritika tragoudia kai chori
9	Maleviziotis	Kostas Papadakis (Navtis)	9	Mousikes Parakatathikes
10	Maleviziotis	Kostas Mountakis	12	Rare live recordings CD2
11	Sousta	Nikos Xilouris	3	I Kriti kai ta tragoudia tis
12	Sousta	Alexandros Papadakis	11	Kanari mou
13	Sousta	Alexandros Papadakis	13	Stou karaviou tin plori
14	Sousta	Thanasis Skordalos	8	Ichografiseis Arxeiou Th. SKordalou 1972-74
15	Sousta	Kostas Mountakis	10	Rare Live Recordings CD1
16	Sousta	Kostas Mountakis	11	Rare Live Recordings CD3
17	Sousta	Kostas Mountakis	1	Rare Live Recordings CD3
18	Sousta	Manolis Lagos	12	Protomastores Vol.3
19	Sitiakos	Vangelis Vardakis	13	Anatolika tis Kritis
20	Sitiakos	Yannis Vardas	6	Mousika Apothemata
21	Sitiakos	Dermitzoyannis	8	Protomastores Vol.5
22	Sitiakos	Manolis Frangoulis	9	Me ti skepsi sti Sitia

Table 2: List of the analysed recordings

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