IN SEARCH OF MOTIVE: IDENTIFICATION OF REPEATED PATTERNS IN PERFORMANCES AND THEIR STRUCTURAL CONTEXTS

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ABSTRACT

Motives are short melodic, rhythmic, and/or harmonic patterns repeated either exactly or in varied forms and have long been recognized as important elements of musical structure. Less well explored is the relationship between motives and their manifestation in performance, and the perception thereof. Expressive motives originating in performance – which we term "performance motives" – are also of considerable interest but have received scant theoretical attention.

In this paper, we present a method that combines a pattern-matching approach with Formal Concept Analysis to allow the exploration of repeating timing patterns in performance. We present the initial results of applying this method to quaver beat-timing data from performances of Chopin's Etude Op. 10, No. 3. The results identify repetitions in timing patterns in several contexts: those occurring with motivic material identifiable in the score, those with the same structural positions, those in parts played very quickly, and those not directly coinciding with any of the above.

1. INTRODUCTION AND BACKGROUND

Motives are short musical ideas characterized by particular melodic, rhythmic, and/or harmonic patterns and have long been the subject of music-analytic investigation (including [11]) and are mentioned at least in passing in many music-psychological theories (including [6]). They may be of any size but are most commonly regarded as the shortest section that still maintains its identity, while being elemental and incomplete in nature [3]. Motives have been used in score-based analytical approaches to explain the development of musical ideas in pieces and have been described as giving unity to musical works [11].

Studies of motive usually concentrate on aspects of music that can be directly understood from the score. We suggest, however, that it is equally important to explore the motivic nature of performances. This is done in order to investigate: a) how motives that can be identified in the score are performed and b) to what extent motives can be construed within the performance characteristics and whether or not these motives coincide directly with score-based ones. In this study, we develop techniques to systematically identify repetition in timing patterns as indicators of performance motives.

One of the most important elements of motives is that they are identifiable in exact and varied repetitions. Repetitions may therefore be used as signals for the presence of motives. Repetition has been much studied in score-based contexts, and the thresholds of comparison of when material is similar or different have been much discussed (including [1], [14]). In this paper, we consider only "exact" repetitions within a psychologically informed threshold [8].

Studies of performance have asserted that repetitions identifiable in the score are often not varied in performance (for example, [4]). They have often highlighted the importance of structural aspects in performance timing. Most of the observations have started, on some level, with the score, such as investigating phrase and metrical structures, and suggested that the same or similar performance patterns occur in areas with the same structural functions (including [15]).

We begin our study with performance information and investigate the relationship between patterns of repetition found in the performance and the score. A computational method to systematically identify repetitions of material throughout a piece is necessary so that the musical locations and characteristics of performance motives can be analyzed. This requires drawing on techniques that are available in other domains and tailoring them to the musical needs. Other studies using automated analysis of performances include [7].

We present a method that combines a pattern-matching approach with Formal Concept Analysis (FCA) [5] to show clusters of related repetitions. FCA is a technique for visualizing relationships between objects in terms of their common and distinct attributes. Both the objects and the attributes are user-defined.

Objects|*Attributes*	*Swims*	*Flies*	*Extinct*	*Eats Bread*
Duck	X	X		X
Sparrow		X		X
Dodo			X	

Figure 1: Example Formal Context.

Once the concepts have been determined, a line diagram can be drawn (e.g. Figure 2) consisting of objects in white boxes, attributes in grey boxes, the circles are nodes and the lines are the edges linking them, indicating the hierarchical relationships between objects in terms of their attributes.

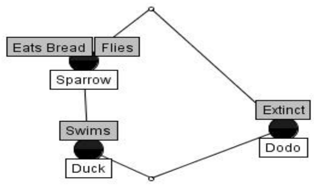


Figure 2: Line diagram of the context shown in Figure 1.

The line diagram shows concepts at nodes and the links between them as edges. At each node, only the new objects and attributes introduced at the node are shown. The diagram can thus be read so that the objects at any given node inherit all the attributes of nodes upwardly edge-reachable (plus the attributes at the node itself). It follows, therefore, that objects downwardly edge-reachable inherit the attributes of this node and those above it. FCA has been applied in many fields (see [9] for an overview of its history and applications). In this application to music, the objects are the basic cells of quaver lengths to which the rest of the cells in the piece are compared (the attributes) showing where repetition is found.

Having identified repetitions of quaver-beat timing data we then characterize them according to their location and contour. In this paper we discuss Chopin's Etude Op. 10, No 3 as a case study and concentrate on the locations of the repetitions.

2. ANALYTICAL METHOD

The method used for motivic exploration has three stages: quaver beat-timing extraction, pattern matching, and lattice generation. The first was carried out using Sonic Visualiser by tapping in time to the onsets of notes occurring on each quaver beat of each of the recorded performances. These were then corrected with Sapp's plugins [13]. The beat-quaver times were used to calculate the quaver beat lengths. When there were no note onsets on the quaver beats, the nearest quaver onsets were recorded and the resulting length was divided by the number of the missing quavers. The resulting numerical information was stored as comma-separated value data and processed by a custom tool developed in TurboDelphi™ that undertakes a pairwise comparison of "windows" of beat lengths (i.e. groups of beat lengths of varying size).

The tool provides facilities for executing multiple analyses with varying parameters of window size in terms of number of quaver beats and matching thresholds to enable concentration on different sizes of motive and degrees of similarity of repetition. It also enables global comparison according to window size (i.e. size of motive) and among performances. Formal Contexts are produced for every performance in the object-attribute list (OAL) format used by the conexp package [2]. Conexp is then used to produce the line diagrams (section 4). The objects and attributes of the Formal Contexts are the windows of beat timings: objects are the base tuples, defined as w, and attributes are the repeats of those patterns and the attributes are the repeats found elsewhere in the data, defined as c-tuples. We adopt the notation of x_y for beat positions where x is the bar number and y the quaver number in the bar.

Perceptual studies show that for two notes approximately 1000ms long, a minimum difference of 60ms is required before they can be perceived as being of different length [8]. As many of the quaver-beat lengths in the performances studied here were approximately 1000ms, 60ms was the threshold used below which two notes are considered of the same length.

3. CASE STUDIES

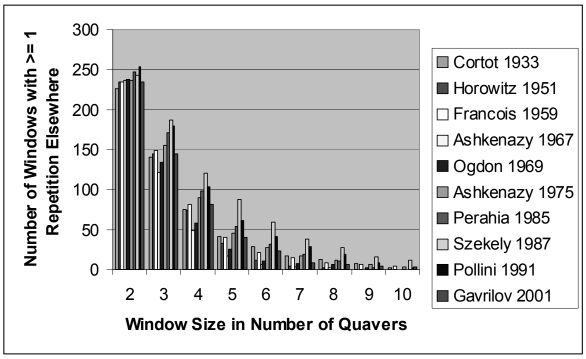
We applied our approach to the ten performances of the Chopin Etude Op. 10, No. 3 (Figure 3, appendix). The Etude is in ternary form: A - bb. 0_4 to 21_2, B - bb. 21_3 to 61, A' - bb. 62 to 77 (see score, Figure 4, appendix). The B section has twice as many bars as the A section. However, in most performances, it is played twice as fast so lasts as long as the A sections. Bars 1-5 of the A section are exactly repeated in bb. 9-14, and bb. 9-19 are exactly repeated in bb. 62-72 of the A' section which is then extended in the coda. Following [4], one would expect performance characteristics, including quaver length, to be repeated in these and other equivalent areas. The B section also differs in other ways from the A and A' sections. For example, the A and A' sections have a combination of semiquavers and longer notes in the top part of the right hand with syncopation in the left and constant semiquavers in the middle part. In contrast, there are continuous semiquavers throughout the B section.

The Etude has been analyzed from a number of perspectives. For example, Repp [10] studied 115 performances of bb. 1-5 of the piece using principal component analysis and identified at least four dominating "independent 'timing strategies'" that could be related to melodic-rhythmic grouping structure of the music and local emphasis, as well as those that do not seem to represent an alternative structural interpretation of the music but rather an alternative "gestural shaping" [10]. He found that each pianist's timing pattern could be described as a weighted combination of these strategies and idiosyncratic variation. There was a wide range of basic tempi and of degrees of tempo modulation. In part of Rink's analysis of the Etude [12] a number of recorded performances are studied as are interpretative possibilities other than those heard within the recordings. These include playing the Etude at a tempo akin to Chopin's original metronome marking, thereby avoiding the typical tempo differences between the main sections.

4. RESULTS

The application of the pattern-matching algorithm resulted in different numbers of matches depending on the performance and window size (Figure 5). Performances with less variation in tempo tend to have more repetitions. However, even these repetitions seem to be related to specific factors (section 5).

Figure 5: Showing the effect of changing window size on the



number of windows repeated elsewhere in the performances.

As exemplified by Figure 6a (appendix), there are more repetitions and longer stretches of repetition in the B than the A sections. This can be related to the faster tempo and the more regular rhythmic nature of the material of the B section, as well as the constant 60ms threshold currently used. Several characteristics of the resulting lattices are exemplified in Figure 6a illustrating different possible types of relationships including: a) many instances of windows repeating only once; b) lines of attribute inheritance where a base window repeats, for example, twice and therefore one of those repeated windows repeats once (this nesting arises as a consequence of the sliding window approach); and c) attribute sharing - where two or more base windows do not necessarily exactly repeat each other but both repeat sufficiently similarly with a third window to which they are linked, forming a cluster in the lattice. Figure 6b (appendix) exemplifies another possibility - two objects related to the same node.

5. REPETITIONS AND THEIR CHARACTERISTICS

There are general differences between the performances in tempo fluctuations, the number of repeated units and their repetitions (Figures 5 & 7). The extremes of the trends are Szekely 1987, with a very steady tempo and many repetitions, and Cortot 1933, with far fewer ones, while Ashkenazy 1967 is in between. These are used as examples in the following discussion and are referred to by the performers' names.

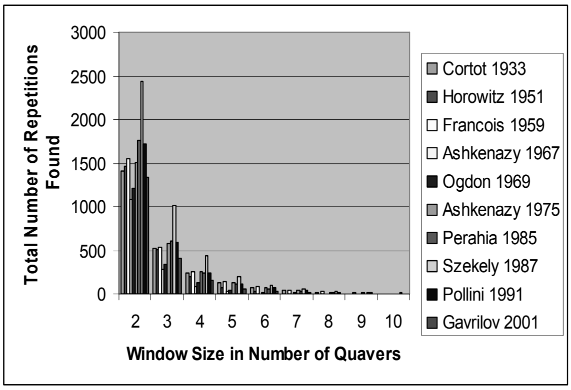


Figure 7: Showing the total number of repeats found for each window size and performance.

Several types of repetitions were identified, in terms of location and structural contexts.

Type 1) Occur with exact or varied motivic repetitions identifiable in the score and in the same structural positions
These types of repetitions can be predicted by previous literature [4]. However, in the performances the size of the repeated units varies. For example, for the Cortot the pattern of bb. 1_2 to 2_2 and 2_4_ to 4_2 is repeated in bb. 9_2 to 10_2 and 10_4 to 12_2, encompassing a large proportion of the first phrase and its repeat. Interestingly, the span of similarity, at this level of matching, is much shorter in the repetition at bb. 62-66 only occurring in bb. 12_2 to 13_2 and 65_2 to 66_2. For the Szekely, however, bb. 9_1 to 10_4 and 62_1 to 63_4 have the same patterns. For the Ashkenazy there is even less coincidence between the repetitions identified in the score and the timing repetition. For example, there is an exact repetition of bb. 2_4 to 3_4 at bb. 63_4 to 64_4 but not in bb. 9-13.

None of these performers has exact timing repetitions coinciding with all repetitions of motives identified in the score. This suggests that timing repetitions of units may be related to their position in the piece more generally and not solely to the score-based motives.

Varied repetitions identified in the score in some cases coincide with exact timing pattern repetitions. The units of varied repetition are relatively short and the timing repetition patterns rarely begin earlier or continue later than these. In some cases, varied repetitions identified in the score follow exact ones and some or all share repetitions of the same timing pattern. This occurs, for example, for the Cortot in bb. 18_1 to 18_4, 71_1 to 71_4 and 72_1 to 72_4 (Figure 8) and for the Ashkenazy in bb. 17_2 to 18_1 and bb. 18_2 to 19_1.

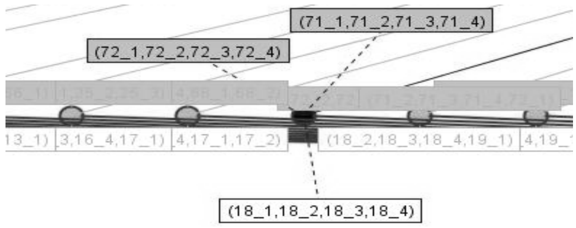


Figure 8: Extract from lattice for Cortot 1933, window size 4 quaver beats, showing repetitions of 18_1 to 18_4.

Type 2) Occur in the same structural positions but have different motivic material identifiable in the score.
Several theories of structural perception predict systematic timing variation at particular structural positions such as phrase ends or bar starts (including [9], [14]). Therefore, it could be expected that repeating structural patterns identifiable in the score would be reflected in the timing patterns. The results of the current study indicate that the largest spans of these do not reach the largest spans of Type 1. Rather, they are more closely related to shorter sections through such devices as phrase-final lengthening or the emphasis of strong beats in the bar. For example, in the Cortot, the timing pattern of bb. 10_3 to 11_2 is repeated in 62_3 to 63_1; the beat location in the bar is the same but the locations in the opening theme are different. In the Szekely, the tempo profiles of bb. 38_1 to 39_1 are repeated in 41_1 to 42_1. Though rhythmically similar and located in the same beat positions, the melodic information and grouping are different in the two areas.

Type 3) Occur during passages of relatively quick tempo
As mentioned above, the B section has continuous semiquavers and many performers play it much more quickly and steadily than the A sections (particularly bb. 38-53). There are many repetitions here that may be considered distinct from those in the slower and rhythmically more varied A sections. For example, in the Szekely, the quaver lengths of bb. 30_1 to 34_4 are repeated in bb. 34_1 and 38_4. In terms of the score, this coincides with the repetition of the whole four-bar phrase. For the Cortot, bb. 46_4 to 49_1 are repeated in bb. 49_4 to 52_1, the repetition occurring at a metrically equivalent position. Therefore, although there are more repetitions in the B section, many coincide with motives or phrases identified in the score or structurally similar areas.

Type 4) Do not seem to be immediately related to the score
There are some repetitions that do not relate so specifically to any of the above score-based or global characteristics. For example, in the Ashkenazy the patterns of bb. 7_1 to 7_4 are repeated in bb. 59_4 to 60_3. Though these occur in different metrical positions, both occur during the two bars or so preceding the return of the opening theme: the first on a syncopated first beat and the second on the upbeat. It may be that the similarity in timing is reflecting the similarity of the

heard as opposed to written accent structure as well as the more general lead-in function of these bars.

For the Szekely there are several instances in which repetitions of timing coincide with both the second and the fourth quavers of bars within the same thematic material and with material with similar rhythmic characteristics, as for example in bb. 9_2 to 9_3, 9_4 to 10_1, 62_2 to 63_3, 17_4 to 19_1, and 63_4 to 65_1 (Figure 6b, appendix). In such cases, quavers 2 and 4 of the bar seem to be treated interchangeably. This equivalence is not unique and often occurs in thematic material (such as in the Prelude of Bach's fifth Suite for Unaccompanied 'Cello, BWV 1011). As discussed above, Szekely's performance is relatively flat so there is increased probability of repetition. However, repeating units of this size do not occur continuously throughout the piece. Similarly, in the Cortot, the timing patterns of bb. 16_2 to 17_1 and 24_4 to 25_3 are the same. Both precede either a climax (bb. 16ff.) or the return of previous material (bar 24), the latter accentuated by a relatively large pitch interval.

In these cases the local, direct relationships with the score are less immediately obvious and a combination of different factors may explain these repetitions of quaver beat timings.

6. SUMMARY

The study of performances of Chopin's Etude Op. 10, No. 3, using a combination of a pattern-matching approach with Formal Concept Analysis, identified four types of repeating timing patterns. The examples of the types indicate that these coincide with a number of different characteristics of the score and that the types are related to a number of factors including: 1) global characteristics of the performance such as the general tempo; 2) general tempo within sections; 3) motivic material identifiable in the score and 4) its more general structural characteristics. Different categories dominate in different contexts. It is notable that there is not always exact matching in areas that contain score-based reasons to predict it. Of most interest with respect to this method and its contribution to the understanding of performances and performance motive are those repetitions that are not clearly predicted by the score.

Beginning with an analysis of the recordings therefore allows the systematic comparison among sections of performances and a separate categorization of features that contribute to performance timing. The different types of repetitions may lend coherence to the performance and aid listening by emphasizing different types of connections.

The results indicate the lattice presentation is an important development in the study of performance, allowing efficient and reliable identification, relation and presentation of repetition of performance timing information and different types of relationships between them. They also indicate that repetition types can be related to different characteristics: motivic, structural and temporal factors and more general aspects and combinations that may have been missed in a study beginning from the score. Performance motives may be an avenue for investigating characteristics of performances and the relationship between score and performance.

There are a number of areas for the future development of this technique including the investigation of: varied repetitions, repetitions of relative timing, changes in intensity, and lattices where the objects are a group of repeats and the attributes are score-based structural labels to further explore relationships between performance features and score-based motives.

7. ACKNOWLEDGMENTS

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Appendix