Characterisation of Composer Style using High-Level Musical Features

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ABSTRACT

We describe a preliminary study looking into the characterisation of composer style. The primary motivation of the work is an exploration of methods to automatically extract high level, musicologically valid features. Such features facilitate machine-learning based stylistic classification which, in contrast to previously published results, are more likely to yield musicological insights regarding style characteristics and compositorial techniques. We extract features from scores by Renaissance and Baroque composers, capturing their use of contrapuntal voice leading rules and musical intervals. A composer classification task is performed to test the ability of the feature sets to characterise composer style, yielding an accuracy of 66%. We conclude that although the computation of higher level musical features is challenging, it can give useful insights into characteristics of style which are not revealed by lower level features.

Categories and Subject Descriptors

J.5 [**Computer Applications**]: Arts and Humanities—*Music*

General Terms

Algorithms, Experimentation

Keywords

Machine Learning, Music, Style, Counterpoint

1. INTRODUCTION

In this paper we consider the problem of characterising the style of composers using features extracted from a symbolic representation of a score. The problem is twofold: which higher level musical features are most likely to reveal characteristic stylistic traits of individual composers, and how to

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automatically derive these features. Other approaches to the related problem of style recognition (e.g. [3],[8]) have proved rather effective for the classification task per se, but do not seem to yield high-level characterisations of the classes. We suggest that an approach embedded in music theory could yield improved results when differentiating composers who are very similar in style, and would further have the potential to proffer new insights into underlying musical processes and musical style.

We test the features' ability to characterise style via a classification experiment with the aim of identifying the composer. The experiment, described in Section 2, computes musical features extracted from scores represented in the Kern format [2]. Information about the use of species counterpoint is automatically extracted from the scores of a small set of Renaissance and Baroque composers.

The data sets extracted are processed using the WEKA [9] system to test how well composers can be identified using these features.

2. COMPOSER IDENTIFICATION FROM CONTRAPUNTAL STYLES

This experiment, which uses Kern data, analyses works from a small set of composers from the Late Renaissance (1560-1600) and Baroque periods (1600 - 1750). J.S. Bach, Buxtehude, Ruggero, Vivaldi, Monteverdi, Corelli, and Frescobaldi all adhere, to a greater or lesser extent, to the principles of strict counterpoint. The primary aim was to discover distinctive uses of counterpoint in their compositions, and test whether this could be used to differentiate between individual composers. The corpus crosses vocal and instrumental genres, for example Bach Chorales, and Buxtehude sonatas. Ten pieces were chosen for each composer with the exception of Ruggero, for whom only six pieces were available.

The Kern format was chosen for this study because it provides clear and unambiguous time signature, bar, beat and musical voicing information. The latter is an important consideration in music theory, in particular in relation to counterpoint. In early music, the allocation of notes to voices reflects the influence of the 'a capella' style, i.e. one note per voice. With advent of piano music, this rule no longer holds good, and almost all piano works contain simultaneous note clusters within a single musical voice, which affects how the interaction and progression of musical voices should be computed. (For a detailed discussion of the concept of musical voicing please refer to [1]).

Strict species counterpoint is a core subject in the theory

Intervals	
Perfect Consonance (PC)	Unison, P 5th, octave
Imperfect Consonances (IC)	3rd, 6th
Dissonance (D)	M/m 2nd, P 4th, Aug 4th, Dim 5th, M/m 7th
Motion	
Parallel (P+/P-)	Two parts move either up or down by the same number of semitones
Similar (S+/S-)	Two parts move in the same direction
Contrary (C</C>)	One part ascends, the other descends or vice versa
Oblique (Obl+/- Obu+/-)	One part moves up or down, the other is stationary

Table 1: Species Counterpoint Definitions

of music and is very well documented. Amongst the most important books in the literature are those written by Alfred Mann [6, 7] whose writing is based directly upon studies of the 1725 publication 'Gradus ad Parnassum', an influential pedagogic study written by Johann Joseph Fux. The term counterpoint denotes music of two or more voices or parts which sound simultaneously and progress according to a system of rules. Although the rules of counterpoint used in this study are drawn from the common compositional practices of early music periods, the principles of counterpoint have strongly influenced the music of master composers throughout the ages right up to the present day. This includes both the meticulous avoidance of contrapuntal procedures, as well as the reinvention of counterpoint to create a new musical language (for example see [4]). Counterpoint regulates the linear progression of individual voices in relation to each other based on the vertical intervals between them, which are defined to be concordant or discordant. For definitions of interval types and allowed linear progressions based on Sixteenth-Century practice please refer to Table 1, and for a summary of the different species of counterpoint and component rules, Table 2.

2.1 Contrapuntal and Intervallic Features

The score analyser program first parses the score data into a series of vertical notegroup objects in accordance with rhythmic information. Every new rhythmic value prompts the creation of a new vertical notegroup object, into which the values of still sounding notes are carried over. Voice and note information is stored in a note object, a sub element within a notegroup. The intervals are calculated for every pitch/part combination in the group and are stored in a 12-position vector (modulo 12). Each interval is weighted according to duration to reflect perceptual salience [5]. For example, the interval of a Perfect 5th (seven semitones) in a notegroup of a semiquaver value would result in an increment of 0.25 at position 7 of the vector; a quaver duration would cause an increment of 0.5, etc. The vector is subsequently normalised to arrive at an overall representation of the weighted interval content of the score.

For species counterpoint calculations, it would not make musical sense to compare every single notegroup slice. Many of the notegroups occurring at fractional metrical positions consist of notes held from the previous notegroup with the addition of a passing or neighbour note in another voice or voices. For this reason, only notegroups which occur at strong metrical positions, in this case on each beat of the bar, are used for contrapuntal evaluation. (In a 4/4 time signature, this would be equivalent to the notegroups

First Species
Note against note: both parts contain notes of same duration.
Begin and end on a perfect consonance (PC).
Consonant intervals only between the voices.
No parallel perfect consonances.
From one PC to another PC, proceed in contrary or oblique motion.
From a PC to an IC, proceed in any motion.
From an IC to a PC, proceed in contrary or oblique motion.
From IC to IC, proceed in any motion.

Table 2: First Species Counterpoint Rules

which occur at metrical positions of 1, 2, 3 and 4). For the corpus used, this relatively simplistic method of choosing structurally important notegroups works well; for Bach chorales, the vast majority of voice progressions take place at a crotchet to crotchet level or higher, and in more contrapuntally elaborate works important notes tend to be given metrically strong positions, even though they may elaborated into series of smaller value notes.

The counterpoint method is therefore given successive 'on the beat' notegroups from which it generates a series of features based on contrapuntal principles applied to voice pairs within notegroups. The features include the nature of the approach to a perfect consonance, whether a dissonance is properly prepared (i.e. preceded by a consonant interval containing the same note which then becomes dissonant), whether a dissonance is correctly resolved downwards by step, details of parallel intervals, and the overall distribution of contrapuntal movements (oblique / contrary / similar / parallel / other). The final data set also contains the total vertical interval content as previously described.

2.2 Analysis of Features

The average feature values for each composer are shown in Figures 1, 2, 3 , and 4. The features generated confirm that composers from the Renaissance and Baroque historical style periods embodied species counterpoint principles within their compositional technique. The counterpoint motion data (Figure 1) shows the total average percentage of species counterpoint motion types across the works analysed per composer. The difference in the level of the 'Other' category is noticeable, this category is selected when one of the voices is silent, and therefore there is no movement to record. In the case of Bach, the chorales are more homo-
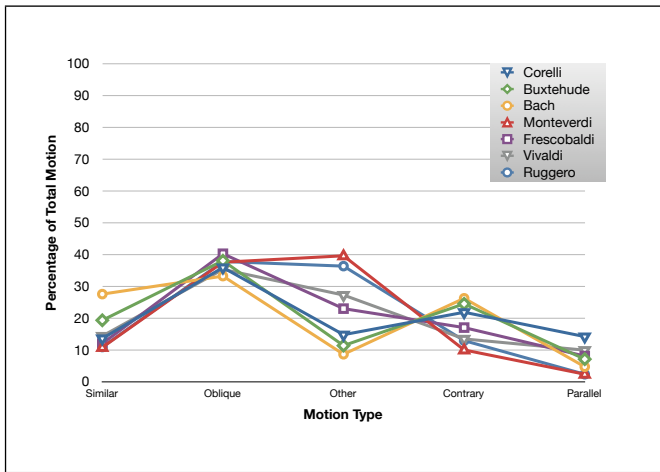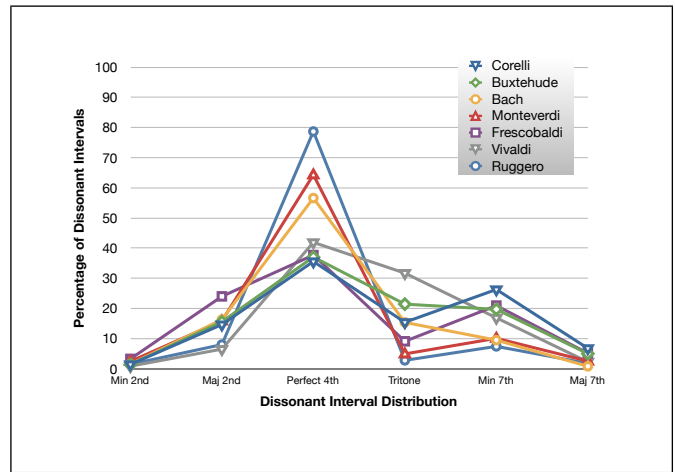
Figure 1: Counterpoint Movements.
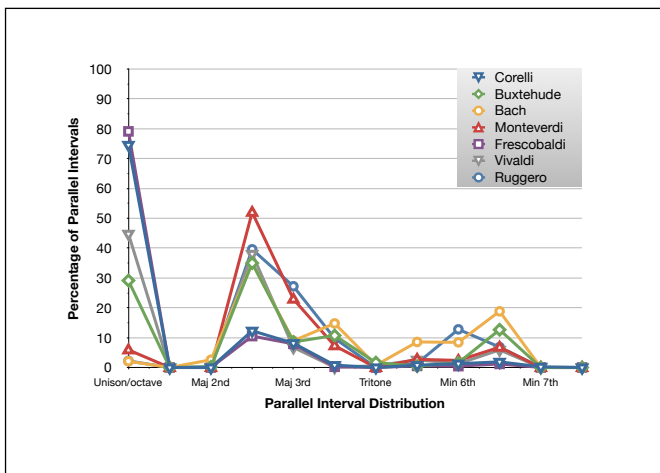

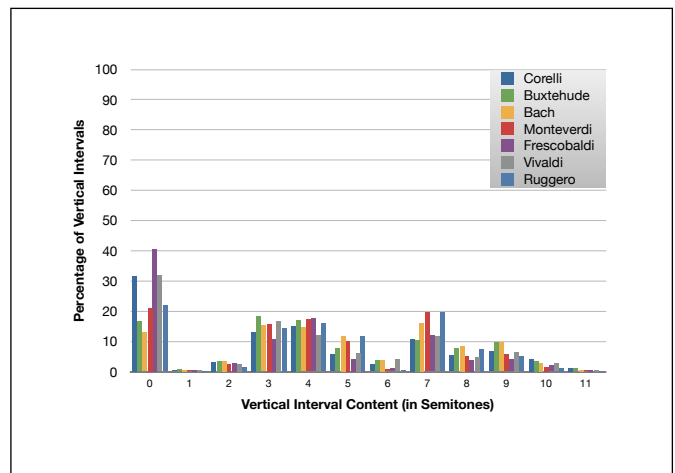Figure 2: Parallel Intervals.

Figure 3: Dissonance Distributions.

Figure 4: Kern Scores - Vertical Interval Content.

phonic than polyphonic, and consequently his results in the 'Other' category are much lower than for the more contrapuntally independent compositions of the other composers. A quick glance at the scores of, for example, Monteverdi and Corelli, validates this result, showing that there are many sections where one or more voices are resting for a number of bars at a time, in which case the 'Other' category is incremented for each beat. This category could perhaps be used in the future as a measure of the presence of polyphony versus homophony in a work.

The 'Parallels' data (Figure 2) represents the percentage total of consecutive intervals - i.e. the repeating of an interval from one notegroup voice pair to the adjacent notegroup voice pair. The output is again as expected; parallel imperfect consonances such as thirds and sixths predominate. The result for the much condemned 'tritone' interval is very low. No tritone parallels exist at all for Monteverdi although there is occasional use here for composers Bach and Buxtehude. Although the presence of a tritone interval in itself is not unusual, a tritone parallel is, thus such features are able to indicate an area of interesting harmonic movement or increased musical tension, perhaps some form of musical 'event' taking place. The data also show a high value at the

octave interval (0) for Frescobaldi and Vivaldi. An inspection of the music corroborates the data with both composers tending to double up the octave interval between the lower voices in the scores analysed.

The distribution of dissonant intervals is very similar across all of the composers (Figure 3). The dissonant interval of a perfect fourth is by far the most commonly used dissonant interval, perhaps suggesting that this interval is considered less dissonant than the others. Overall, the broad picture given by the data, is of significant commonalities in compositional technique within the test set.

The vertical interval content data (Figure 4) bears out the similarities between the compositional style of the composers rather than the characteristics which make them differ. A closer inspection of the data shows that Frescobaldi and Monteverdi are nearer together in their use of vertical intervals. Bach demonstrates a greater overall balance of usage of the interval range, with a smaller emphasis on octave and unisons, and a greater proportion of the dissonant intervals than his predecessors. This would be in keeping with general musical history, with music composed during the Baroque period having richer harmonic content. However, such distinctions are subtle.

a	b	c	d	e	f	g	classified as
6	4	0	0	0	0	0	**a** = Bach
2	3	0	3	0	1	1	**b** = Buxtehude
0	0	6	0	0	0	0	**c** = Ruggero
1	3	0	3	0	2	1	**d** = Vivaldi
0	0	1	0	9	0	0	**e** = Monteverdi
0	0	0	2	0	8	0	**f** = Corelli
0	1	0	0	0	0	9	**g** = Frescobaldi

Figure 5: Baroque Composers Confusion Matrix.

2.3 Results

The feature sets generated by the program are classified using the WEKA machine learning system using 10-fold cross validation. For both experiments, the WEKA classification algorithms which produced the best, and similar results were Naive Bayes and the J48 Decision Tree

Out of 66 pieces, 44 are correctly classified (66%), and 22 are incorrectly classified (33%).

Figure 5 shows that Bach and Buxtehude, both German Baroque composers of very similar florid contrapuntal style, are difficult to distinguish, as are Buxtehude and Vivaldi, and to a lesser extent, Vivaldi and Corelli. These three pairs account for 16 out of the 22 total errors. On the other hand, Ruggero, a composer from the Late Renaissance, is clearly identified by his almost complete lack of the tritone interval. The classification task performs well in the identification of Monteverdi, Corelli, and Frescobaldi, with 9/10, 8/10, and 9/10 pieces correctly attributed.

According to the decision tree, the composers are almost exclusively differentiated using the weighted vertical interval content data, with further selection using the data about the preparation of dissonance. What is apparent from the results is that the counterpoint data demonstrates stylistic commonalities between composers, but in its present form is insufficient for individual composer identification. The detection of the application of contrapuntal techniques shows the potential to be used in the approximation of historical style periods, and it provides a musicologically valid measure of similarity. In addition, had the goal of this experiment been to associate composers who are stylistically similar, the classification process has produced very good results, clearly showing pairs of composers who could be considered to be very close in style.

3. FUTURE WORK

We aim to develop methods to computationally recognise unique stylistic traits of composers using high-level musical features which are grounded in formal music theory. The challenge of the work is the automatic extraction of features which successfully abstract musicological constructs, and which are distinctive and sophisticated enough to yield idiomatic stylistic information.

Initial work suggests weighted vertical interval content in a score successfully indicates historical style period, and to a smaller degree, composer. However, to uncover some element of the mastery of the great composers, we need to capture the way that master composers exploit distinctive interval collections in vertical, linear, and diagonal dimen-

sions. Further research in this area could lead to some form of characterisation of the tonal language a composer employs, Debussy's use of the octatonic for example, or whether the music has a tonal centre at all.

Extensions to the counterpoint methods may include the automatic discovery of characteristic contrapuntal gestures, such as individualistic patterns of harmonic intervals, or the capture of specimen contrapuntal elaborations which could betray the 'fingerprints' of individual Renaissance or Baroque composers (i.e. those composers who use polyphonic principles as a core compositional technique). The development of these procedures could also inform about possible historical or stylistic influences within a composition.

4. CONCLUSION

We presented a classification experiments investigating the problem of composer identification using features drawn from formal music theory. It has been shown that abstracting meaningful information is challenging, however the results are showing promise for practical applications such as style recognition and music recommendation. We consider that using features which are musicologically apposite is better able to capture stylistic similarities between composers and musical works at a deep and more satisfactory level than purely statistical approaches. Using musical constructs also has the advantage of transparency, by using features with which musicians and music scholars are familiar.

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