How Can Mathematics Help in Identifying a Music Style

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Abstract

A connection between occurrence of certain types of chords in a music piece and it's belonging to a concrete music style is explored. Several pieces of composers living in 18^{th} and 19^{th} century are processed by ISODATA algorithm of fuzzy clustering.

1 Introduction

A strong connection between mathematics and music can't be denied. Let's present some examples: Thousands years ago, Pythagoras had noticed, that the sound of two hammers beating at the same time is consonant, if the ratio of their weights can be expressed as a ratio of two small natural numbers. Another great mathematician, Gottfried Wilhelm Leibniz, had written: "Music is a hidden arithmetic exercise of the soul, which does not know that it is counting." An equal temperament, well-known and frequently used from the times of Johann Sebastian Bach, is an example of a geometric sequence. But still, there are many attributes of music, which can't be measured nor defined precisely. However, nowadays we do have a mathematical tool for modelling of vague linguistic notions - a fuzzy logic. In a language of fuzzy sets, we can easily interpret the expressions like 'a little', 'very', etc. This can help us in situations, when no exact measuring is possible. Aim of our research was to 'measure' the similarity of some musical pieces with two chosen ones, which presented the prototypes of romantic and classicistic music for us. We took an occurrence of certain types of chords into account and we were interested, if this is related with the music style the piece belong to.

2 The Data Processing

We have worked with piano pieces of nine composers living in 18^{th} and 19^{th} century. The data were taken from a website www.classicalarchives.com and processed in a program Analysis (see [2]). As a result, we got an occurrence of these types of triads and seventh chords (see table 1).

By this way, each piece was turned into a vector consisting of the percent occurrences of the chords. Further, we chose two pieces, which were considered to be the typical representants of individual music

major triad	minor triad
augmented triad	diminished triad
dominant seventh	major seventh
minor major seventh	minor seventh
half diminished seventh	diminished seventh
augmented seventh	

Table 1 : *The types of chords*

composer	'classicistic' pieces	'romantic' pieces
Haydn	0.683	0.317
Mozart	0.63	0.37
Beethoven	0.667	0.333
Hummel	0.7	0.3
Schubert	0.697	0.303
Schumann	0.214	0.786
Brahms	0.188	0.812
Chopin	0.29	0.71

Table 2 : *Relative frequencies of 'classicistic' and 'romantic' pieces.*

styles. Classicistic style was represented by Mozart's Piano Sonata C major, the third movement (allegro) and romantic style was represented by Chopin's Ballad g minor. Afterwards, we counted a measure of similarity of the pieces with these prototypes. For the calculation, the ISODATA algorithm was used (see [1], [4], [3]).

We got an interesting result. From the ISODATA algorithm we have obtained a fuzzy clustering - it doesn't show, whether a concrete piece is or isn't 'romantic' or 'classicistic', we only see that it is 'more romantic' or 'more classicistic'. But if we assign each piece to the class, for which the measure of similarity is bigger and then look at the composers and count, how many of their pieces were labelled as 'classicistic' or 'romantic', we get a delectable result (see table 2). We can say, that all composers (except Franz Schubert, who composed in early romantic era) have been assigned to a proper class. There are of course some surprisings as well - music of Ludwig van Beethoven and Johann Nepomuk Hummel reflects the transition from the classicistic to the romantic musical era, but seeing the table 2 we could guess, that they were typical classicistic composers. On the other hand, we have only investigated their using of certain chords. In this direction were they both still classicistic. For better results we should take into account more parameters.

3 Conclusion

Our research proved that that there is a significant connection between a music style and an occurrence of certain types of chords. Of course, other parameters should be taken into account as well. But still, it seems, that mathematics can help us to find some hidden connections in music theory.

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