ATTA: IMPLEMENTING GTTM ON A COMPUTER

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ABSTRACT

We have been discussing the design principle for the implementation of GTTM and presented the semi-automatic generation techniques of grouping structure, metrical structure, and time-span tree, and the searching method for the optimal parameter value assignments. In ISMIR2007, we organize a tutorial session on the techniques for implementing music theory GTTM for summarizing our work and report it to relevant participants of the conference. Since the time of the tutorial session is not enough, we demonstrate a working automatic time-span tree analyzer ATTA in a demo session. ATTA is an integration of our work done so far; by looking at the ATTA demonstration or using ATTA, people will be able to understand the techniques for implementing GTTM as well as GTTM itself in more detail.

1. INTRODUCTION

Music theory, in particular for a piece written as a score, gives us a methodology for analyzing and understanding a piece, and it explains deep structure, musical knowledge, experience, and skills in a comprehensive way. We believe that implementing such a music theory on a computer would bring great benefits to the MIR research. Since analysis results by a music theory can be considered as the expressions of the musical semantics of a piece, there is a possibility that musical semantic computing at a symbol level can be made more precise and consistent. Therefore, the advances in musical semantic computing will be beneficial to those who are working on various kinds of music applications. Formalizing and mechanizing music theories is one of the primary concerns in computational musicology, and the researchers in the field are recently paying more attention to the elaborating music theories through experiences of implementing a working system based on the theories. Furthermore, since the analyzer based on our techniques may be helpful for educational use in music courses for understanding and composing music.

We believe that the generative theory of tonal music (GTTM) [1] is the most promising theory for mechanizing and developing a support system, thanks to three of its features. The first feature is that it uses rules to describe musical insight and knowledge obtained by investigating the musical structures and relations occurring in a piece of music. The second feature is that GTTM is designed to consistently represent multiple aspects of music in a single framework. The third feature is that GTTM has been developed based on the concept of reduction. We argue that the proper way of taking into account deep structures is to adopt the concept of reduction [2, 3].

2. EXGTTM

To get music theory GTTM to operate on a computer, however, we must overcome some widely recognized fundamental difficulties. One is giving an ambiguous concept a firm definition, and the other is supplementing the lack of necessary concepts (externalization). Here, note that we distinguish two kinds of ambiguity in music analysis: one involves the musical understanding of humans, and the other concerns the representation of a music theory.

In our approach, we extend GTTM by full externalization and parameterization and propose a machine-excutable extension of GTTM, exGTTM. This externalization in mechanizing GTTM includes introducing an algorithm for generating a hierarchical structure of the time-span tree in the mixed manner of top-down and bottom-up. Such an algorithm has not been presented for GTTM. The parameterization includes introducing a parameter controlling the priorities of rules to avoid a conflict among the rules as well as parameters for controlling the shape of the hierarchical time-span tree.

The significance of full externalization and parameterization is twofold: precise controllability and coverage of the correct results. Whenever we find a correct result that exGTTM cannot generate, we introduce new parameters for exGTTM and give them proper values so that it can generate the correct result. In this way, we repeatedly externalize and introduce new parameters until we can obtain all of the results that humans consider correct. In total, we have introduced 15 parameters for grouping-structure analysis, 18 for metrical-structure analysis, and 13 for time-span reduction. We think that full externalization and parameterization is an important intermediate step toward a fully automatic GTTM analyzer. Based on the above consideration, we have presented the semi-automatic generation techniques of grouping structure [4], metrical structure [5], and time-span tree [6], and the searching method for the optimal parameter value assignments [7].

3. ATTA

We developed a working automatic time-span tree analyzer, called ATTA, which realizes exGTTM. Figure 1 is the overview of the ATTA, which consists of a grouping structure analyzer, a metrical structure analyzer, and a time-span tree analyzer. The features of ATTA contain: an XML-based data structure, programming in Perl, and a Java-based GUI (Figure 2).

4. ANALISYS RESULTS BY ATTA

Figure 3 shows the analysis results of two pieces, which

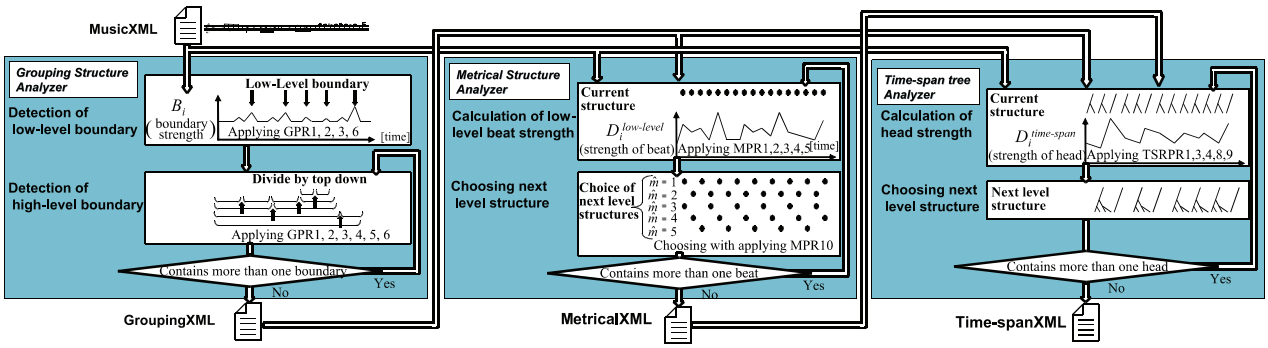

Figure 1. Processing flow of ATTA.

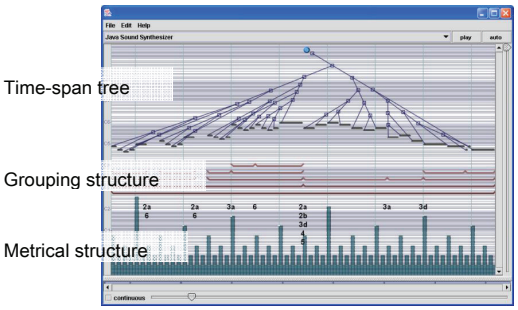

Figure 2. ATTA: automatic time-span tree analyzer.

are generated with the same parameter values, Beethoven's Turkish March, and English Traditional, Green Sleeves. The numbers shown around the branches of the trees in the figure indicate the rule numbers that hold. By comparing the two pieces, we interestingly find the similarity between the two, where the same rules hold. At present, the parameters are configured by hand, because the optimal values of the parameters depend on a piece of music.

5. CONCLUSION

We briefly present a machine-executable extention of GTTM, exGTTM, and a working automatic time-span tree analyzer, ATTA, which realizes exGTTM. We would like to contribute to the MIR research through mechanizing a music theory. In the demo session of ISMIR2007, we look forward to demonstrating ATTA and discussing the techniques for implementing GTTM.

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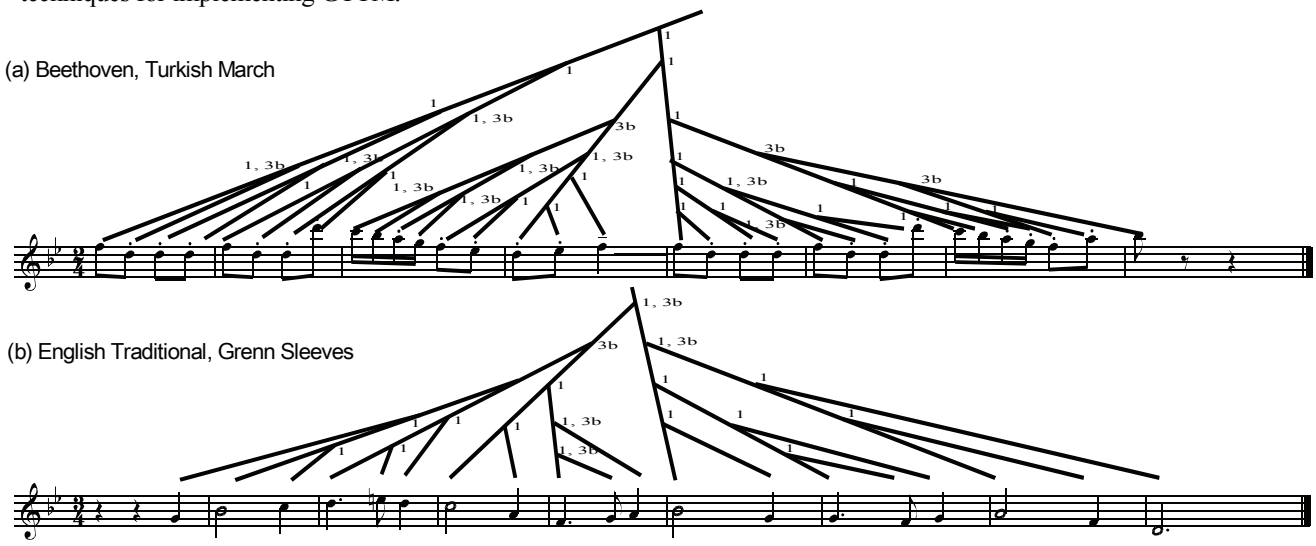

Figure 3. Analysis results of two pieces having the same parameter sets.