Improvement of Grouping Rule Application in Implementing GTTM

Takeshi Touyou (110086)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 14, 2003

Keywords: GTTM, Grouping Structure Analysis, Voice Separation, DP Matching.

In recent years, applications of the computer in various reserch fields is increasing, for the performance of a computer has improved. And the research on music using the computer is also increasing. For example, there are automatic accompaniment, automatic transcription, music searching, automatic composition, and composition support.

We can recognize the musical piece that is listened to for the first time "It is the melody felt comfortable" or "I think that this tone has missed here." Why is it? As for such Research cognitive activity on music, have been done by many researchers. However, the feelings to the music which we have differ from person to person, it is very difficult to analyze a structure for a subjective music recognition from an objective viewpoint. Since there are such problems, the research on the music knowledge representation and music structural analysis treating a score has scarcely reported.

Generative Theory of Tonal Music (GTTM), written by Fred Lerdahl and Ray Jackendoff, is one of the theories that analyzes the structure of music from scores and explains the process of human recognition objectively. The automation on the computer of this theory is expected for various reasons. GTTM aims at describing the cognitive contents from the musical intuition which a listener with experience of tonal music has in common. The theoretical base of GTTM is in the music analysis theory of Schenker,

and Chomsky's generative grammar. Both of the theories are intended to analyze in hierarchical structures. Lerdahl and Jackendoff applied the tree structure analysis technique of Chomsky's to music analysis in GTTM.

If the analysis of a musical piece by GTTM is automated, making a music search engine with the technique different from the old one, the application to an automatic accompaniment system, etc. are expected. GTTM consists of four sub-theories, that is, Grouping Structure, Metrical Structure, Time-span Reduction, and Prolongation Reduction. Each theory is divided into rules called Well-Formedness Rule and a Preference Rule, and each rules is itemized. The itemization could become one of the reasons to implement on a computer. However, GTTM is not the theory aiming at automation by the computer. Many problems are left behind for the automation. The followings are the typical problems.

The analysis of the music of polyphony may not be analyzed correctly, because all music are expected to be essentially homophony. The interpretation of a rule becomes ambiguous because expression of a rule is natural language. The itemized rules don't have a priority. In spite of writing "strongly prefer to choose the progression as a cadence", nothing is described about tonality analysis.

In addition, there is also some problems about the data form treated by the automation program to implement. In this research, SMF (Standard MIDI File) easily got from the Internet is used as the input data. SMF has only data of onset time, volume, and duration. In other words, SMF does not have data of staff notation and bar line which the score has.

The purpose of this research is to implement a system which analyzes grouping structures using SMF as input data. In GTTM, analysis of grouping structure consists of Grouping Well-Formedness Rules (GWFR) and Grouping Preference Rules (GPR). It is GPR which we have to implement for automation. GPR consists of seven rules in all. We consider six rules from GPR1 to GPR6. The followings are new techniques proposed by this paper.

- We show a method to analyze a music which consists of polyphony. We introduce the predicate called κ_s for dividing polyphony into a set of monophonies, and separate voices using this predicate.

- We show the solution about the ambiguity of rules.
  Rules with ambiguous expression are found in the GPR. We solve the problem by prarameterizing.

- We propose the solution about the priority of rules.
  We propose about the order of application of six rules.

- We apply the algorithm which finds note sequences with the similar structure to GTTM.
  We implement the system for finding the similar note sequence which appears repeatedly using DP matching in a music. DP matching is often used for image processing, speech recognition, etc. We propose the method of applying this algorithm for GPR6 in this thesis.

We implemented the solution of the problem by JAVA. This system outputs text data. This system uses XML files as data in the interim step of analysis. We analyzed some classical musics as an input. We checked the grouping structure which has hierarchical structure from results. We automated analysis of grouping structure in GTTM. However, It is not enough to implement a system. We found that if other theories were not added, the rule of GTTM cannot be implemented. For example, We added voice separation and pattern recognition algorithm in this paper.