Harmony analysis in Tension-Relaxation structure and HPSG

Toshiyuki Murata (210093)

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

February 13, 2004

Keywords: HPSG, Cadence analysis, Tension-Relaxation structure.

In this paper, we propose an extension of the musical cadence analysis. Many approaches of treating music on a computer are studied in recent years. These studies can expect various applications.

In this paper, the structure of music is analyzed based on the knowledge acquired from score, and we aim at composition support or acquisition of musical knowledge. In order for us to treat music on a computer, it is necessary to express musical knowledge as rules. As a theory that describes musical knowledge, we employ harmonics that is the theory of classic Western music. In the formal theory of music, tonality, chords, and cadences constitute the harmony structure. The tonality is a set of the notes. Notes that constitute tonality construct the chord. And a cadence connects some chords. Harmonics is the music theory that describes the connection method of chords. Although harmonics is the theory for composition, it is also applicable also to analysis. In this paper, cadence is discovered from a music using the knowledge of harmonics. A cadence is one completed phrase, and that is a musical minimum unit. Although a chain of cadences makes music, some music violates a chain of cadences structure, because harmonics is not absolute, and the music exists which deviated from harmonics. From this reason, we desire a system which can exchange of musical knowledge easily analyze. Moreover, the knowledge of harmonics is described in the form of a prohibition rule. We examine the

knowledge representation form, which can describe the complicated rules of harmonics efficiently.

In this paper, we propose cadence analysis by HPSG (Head-driven Phrase Structure Grammar). HPSG is the grammar theory of restriction base. The knowledge of harmonics is described in the form of prohibition rules, and the grammar theory of restriction base is effective in such rules. HPSG consists of dictionary rules by the feature structure that can describe abundant information, and rules of grammar. HPSG can receive by rewriting dictionary rules, even if behaviors of some words are changed. This means that it is easy to replace knowledge if needed. Moreover, the knowledge representation by the feature structure is effective in representing complicated music knowledge.

Music has a hierarchical structure which is similar with the structure of natural language. Moreover, the concept of the head in HPSG is also applicable to harmonics. The head of harmonics is the most important chord in cadence. We regard a chord as a word, and a cadence as a phrase, and generation rules of cadence as grammatical rules. We analyze music by analysing syntactic on chord sequences.

There are some special rules for harmonics. For example, there are imperfect cadences, changing chord, etc. Those are the important elements in music analysis, although they are un-analyzable under the usual cadence rules. Imperfect cadence appears, when music modulates. And changing chord is a special chord progress. For example, the sequence of chords included changing chord, such as "I - ii - I - V -I" , and so on. These are un-analyzable under usual cadence rules. We define imperfect cadence, changing chord, etc, and make them an-analyzable.

Then, we prepare loosened rules of harmonics, in order to analyze cadences in violation of rules of harmonics, because some music violate the rules of cadence, and such music are un-analyzable in the knowledge of harmonics. We prepare three kinds of rules. The first rules obey the knowledge of harmonics completely. The second and third rules loosen knowledge of harmonics gradually. However, the cadences analyzed by using second and third rules have deviated from the knowledge of harmonics. Such cadences have high possibility to be recognized. We give likelihood values to the recognized cadences, and we use them for the judgment of the correctness

of cadence. The likelihood value given to a cadence by the following two methods. First, likelihood value is acquired from the rule of the applied harmonics. Next, likelihood value is calculated from tension-relaxation structure analysis that is one in the theory of Generative Theory of Tonal Music (GTTM) defined by Lerdahl. By the first method, we give large likelihood to cadences recognized under the severe rules of restrictions. Tension-relaxation structure analysis performed to cadences recognized in cadence analysis.

The structure which begins with a tension and finishes with a relaxation can be considered as a phrase. We assume that the composition scope of a cadence and the composition scope of the phrases of tension-relaxation structure coincide. And tension-relaxation structure analysis performed to cadences recognized in cadence analysis. The cadence that has recognized as a tension-relaxation structure meets a musical flow. We add likelihood value to cadences that have recognized as tension-relaxation structures. When a phrase is analyzed in multiple tonalities, we examine likelihood values of harmonics rules and tension-relaxation structures.

We define connection rules of chords, and chords described by using the feature structure. Moreover, we define concept of musical head and complement. ID-schema and principles used also the feature structure as was used in natural language analysis.

We experimented Mozart: Piano Sonata in C, and Mozart: Serenade No13 G Major and Beethoven: Piano Sonata Op49, No2. Three files of XML and chord information files and the composition scope information file of chords are used for the experiment. These are the information that can be easily acquired from a score. The recall and precision of cadences in each rules evaluated from the result of analysis. Moreover, we evaluated the correctness of tension-relaxation structure.

The result of our experiment showed that the cadence analysis was correctly recognized, and the analysis on special chords progress of imperfect cadence, and changing chord, etc, are also correctly recognized. Moreover, we found that tension-relaxation structure analysis was also effective to some extent.