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| Title | Tonal Pitch Spaceを用いた楽曲の和声解析 |
| Author(s) | 坂本, 鐘期 |
| Citation | |
| Issue Date | 2010-03 |
| Type | Thesis or Dissertation |
| Text version | author |
| URL | http://hdl.handle.net/10119/8931 |
| Rights | |
| Description | Supervisor: 東条敏, 情報科学研究科, 修士 |

Harmony Analysis of Music in Tonal Pitch Space

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February 9, 2010

Keywords: Tonal Pitch Space, harmony analysis, music, basic space, circle of fifths.

The harmony analysis is one of the basics for processing music information. For example, let's think about the arrangement. If we do without thinking much about it, its motto will not become beautiful. It will become disagreeable to hear. Because music has certain kind of rules. We think well of the harmony progress according these rules, and vice versa. These restrictions for harmony progress are tonality and cadenza. In other words, harmony depends on the context.

A lot of technique parsing the harmony is proposed. However, the room for the improvement remains in the accuracy of all analyses. In addition, traditional models could not find passing modulations. So they are difficult to apply to a Generative Theory of Tonal Music (GTTM). Nishida solved these problems by the rule-based technique that applied parsing by Head-driven Phrase Structure Grammar (HPSG) to a chord sequence. But there was another fault that analysis was difficult for against harmony progress which out of cadenza rules.

The root cause is difficulty of the harmony itself. The musical piece is generally made according to the theory of harmonics. But, the harmonics is not absolute and is often ignored by the intention of composers. The theory of harmonics is a summary of information about well progress which used in past well-known compositions. That is to say, it is experimental. Additionally, because it was made for composer, it was not assumed to use for musical analysis. However, music is not vague from its origin. Music is in the range of emotion on the surface. But, in its foundation, A mathematical structure is in hiding.

In this study, I apply Tonal Pitch Space (TPS) which is musical theory proposed by Lerdahl to harmony analysis. TPS is a approaches that reconstruct the theory of harmonics. It brought back to mathematical structures which like circle of fifths and overlap of chord tones. TPS has desired behavior which could quantify the good of harmony progress. and the quantification by TPS is similar in effect to rules of cadenza.

In this study, I performed the following two.

First, I maintained TPS. Chordal distance, the main part of TPS, is mainly constructed by 3 elements, the chromatic circle of fifths, the diatonic cycle of fifths, and the basic space. these are known mathematical music notions or its applications. Additionally, regional distance is used for correcting chordal one. It refer regional space which was built by relation of keys. Regional space has torus structure that relative keys are near.

TPS is the interesting theory because it quantifies chordal/regional distance by existing musical theory. However, the number of its implementation cases was few. In particular, the research that implements regional distance and corrected chordal distance did not exist. In this study, I modified rules of TPS for implementing easily. The modification was carefully done not to ruin an original mind.

Second, I proposed a harmony analysis system based on the TPS implementation and evaluated the system. The proposed system enumerates a list of compatible chords for chord sequence, makes a graph of candidate chord progress, quantifies chordal distance by TPS, and searches the shortest path. The shortest path is outputted as the optimal chord progress. A Dijkstra method was used for shortest path search. Graphviz format was used for the output of graph. Evaluation was performed by two ways. First experiment evaluated typical cadenza examples. I entered 19 chord sequences which were generated by typical cadenza to the proposed system. In the result, the system recognized the tonality of 18/19. And if I entered the cadenza which answered wrong with other cadenza (as the joined cadenza), the system recognized correctly. Second experiment evaluated accuracy for existing musics (Beethoven, Piano Sonatas No.19 in G minor Op.49-1 and No.20 in G major Op.49-2). In the result, the recall ratio became 83.6% to 93.1%. The recall ratio per music was 88.4%.

The proposed system recognized almost cadenza and about 88% of chord sequences in existing musics. From the evaluation experiment, it can be said that the proposed system is corresponding to the theory of harmonics and that the system has the sufficient possibility in applications. Therefore, I think I was able to show the utility of TPS.