ABSTRACT

This chapter offers an overview of computational research in motivic pattern extraction. The central questions underlying the topic, concerning the formalization of the motivic structures, the matching strategies and the filtering of the results, have been addressed in various ways. A detailed analysis of these problems leads to the proposal of a new methodology, which will be developed throughout the study. One main conclusion of this review is that the problems cannot be tackled using purely mathematic or geometric heuristics or classical engineering tools, but require also a detailed understanding of the multiple constraints derived by the underlying cognitive context.

INTRODUCTION

Motives are series of notes (or chords) that are highlighted in different manners, related to their temporal location (such as the beginning of a piece), the use of particular punctuations or articulations (such as silence, pitch, or timbral contrast, etc.), or their multiple repetitions throughout the piece (Lerdahl & Jackendoff, 1983; Temperley, 1988). As such, they form one of the most characteristic descriptions of music. The themes of a piece correspond to the most prominent and original motives.

A more detailed analysis shows the existence of deeper motivic structures proliferating throughout the work. Some of these cells are specific material created in the context of the piece, while others are common stylistic features, also known as “signatures”, corresponding to particular musical styles (Cope, 1996).

The automated extraction of motives in music databases is an important topic related to the domain of music knowledge discovery. First, it would enable an automated description of the melodic and rhythmic characteristics of musical
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pieces and of musical styles and genres in general. Second, the automated description allows more advanced comparisons between pieces, based on a comparison between salient structures, instead of a matching of local structural configurations that often present less perceptual or musical relevance. We may conjecture also that the motivic pattern extraction task might be beneficial to music information retrieval: the automated description of musical databases allows a reduction of the size of the search, a focus on the most salient structures and therefore a probable increase of the relevance of the results.

The motivic structure is often highly complex. Detailed analysis of the deeper motivic structures contained in music has been undertaken during the 20th century (Reti, 1951). Systematic approaches have been suggested, with the view to augmenting the analytic capabilities, both in quantitative and qualitative terms (Lerdahl & Jackendoff, 1983; Nattiez, 1990; Ruwet, 1987). Computational modeling offers the possibility to automate the process, enabling the fast annotation of large scores, and the extraction of complex and detailed structures without much effort.

The pattern discovery system described in this chapter is applied uniquely to symbolic representation (such as score or MIDI format). A direct analysis on the signal level would arouse tremendous difficulties. In fact, even when restricted to the symbolic level, the pattern extraction task still remains a difficult challenge. The pattern discovery task seems therefore too complex for a direct examination from the audio signal, but requires rather a prior transcription from the audio to the symbolic representations, in order to carry out the analysis on a conceptual level.

This chapter presents an overview of computational research in motivic pattern extraction, discusses the main underlying questions, and suggests a partial answer to the problem. We will show that the central questions underlying the topic, concerning the nature of the motivic structures, the matching strategies and the filtering of the results, have been tackled in alternative ways by the different approaches. The detailed analysis of these problems leads to the proposal of a new methodology developed throughout the study. Combinatorial redundancy constitutes, in our view, one major difficulty aroused by the task. A solution is proposed, through an adaptive filtering based on closed patterns and cyclic patterns. Important questions that need to be considered in future works concern, among others, the validation of the alternative approaches, the taking into account of complex musical configurations such as polyphony and the integration of multiple segmentation factors into one synthetic model.

MOTIVE FORMALIZATION

Definition of Motives

The basic principle of motivic pattern extraction consists of identifying several short extracts or subsequences—from one or several pieces—as instances, or occurrences, of a same model called pattern. A motivic pattern is a succession of notes that forms a melodic sequence, or motive, repeated several times in the piece or the corpus. Each pattern presents two main properties: the “intentional” property is related to the musical description common to all its occurrences; the “extensional” property corresponds to its class, that is, the set of occurrences itself (Rolland, 1999). This dichotomy between intentional and extensional properties plays a core role since it implies a Galois correspondence (Ganter & Wille, 1999) that offers interesting mathematic properties, as we will later.

A complete description of the motivic pattern extraction task requires further specifications: in particular the explicit formalization of the concept of motive and the description of the matching process. The formalization of motives is of high importance because it determines the way pattern occurrences are extracted from pieces.