Musical Grammars as the Basis of Non-Speech Audio Communication

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Abstract

Non-speech audio communication has so far been possible through a series of mappings between the message to communicate and a somewhat arbitrary representation of that message in sound. By introducing the concept of a musical grammar, it is proposed that the arbitrariness of sound design can be reduced, resulting in a much more powerful communicative medium. By studying the ways in which formal grammars have been used to describe language communication and the parallels that such approaches have with musical grammars, it is shown that highly structured and communicatively-expressive sound systems which obey the rules of music can be developed, resulting in more advanced non-speech audio communication.

1 Motivation

This poster is concerned with the possibility of developing non-speech audio signals using grammatical descriptions of musical structures. It is envisaged that this approach to sound design will have a number of advantages over current techniques. First, using a grammar imposes structure and reduces the arbitrariness of sound design. At the same time, grammars can be very expressive, resulting in broad and powerful communication. Finally, using musical conventions means that users can rely on innate musical knowledge.

Formal grammars are used extensively to describe language structures. While natural languages are notoriously difficult to characterise completely, grammars exist which can capture many of the essential aspects of languages. At the same time, grammars can be invaluable in describing and processing artificial languages (such as restricted subsets of natural languages and programming languages). It turns out that similar grammars can be used to describe many aspects of music. The basis of the work described herein is to utilise these sound-structuring grammars to provide a natural framework for representing language-based information through sound.

2 Musical Grammars

Music shares many similarities with language, not least its hierarchical structure. It is this likeness that has prompted many music theorists (such as Winograd [9]; Roads [7]; Cope [4]; Holtzman [5]; Lerdahl and Jackendoff [6]) to use formal grammars to describe musical structures in much the same way as computational linguists have done for the structure of language. As music consists of a set of interdependent dimensions (such as rhythm, pitch and harmony), a number of grammatical approaches have been suggested for each dimension. These rule-based systems can vary from defining the structure of a whole piece of music to individual notes, chord sequences and rhythms.

The form of the musical grammars is varied, but is often related to the generative grammar rules found in computational linguistics. For example, a grammar describing a set of possible variations on the twelve-bar blues has been proposed by Steedman [8]. The rules used in this grammar are rewrite rules which describe how chord symbols appearing on the left-hand side of the rule can be replaced with chord symbols on the right-hand side.

Chords are closely related to linguistic constituents such as verbs, noun phrases and sentences. They function in music in a similar way to constituents in language. In much the same way that certain verbs expect an object to follow them, particular types of chords intuitively expect related chords to resolve them. It is these relationships which are described by the grammar and are the key to a limited notion of musical correctness.

It should be noted that many of the musical grammars described in the literature have been formalised in the interests of musical analysis. In other words, the grammars are used to analyse the structures of existing pieces of music. Other grammars are designed to construct (or 'compose') new music material that is consistent with a particular musical style. For our purposes, we use a set of rules which describe a structure we want to communicate through sound. Given that structure, a set of musical grammar rules are designed that produce musically-acceptable results. The grammar rules do not model a piece of music; they model some non-music information. However, the realisation of that information forms a sequence of pitches, rhythms and durations which sounds correct musically.

3 The Poster

Although earcons, constructed according to rules devised by Blattner [1] and developed by Brewster [2, 3], can be used to convey information through sound, they are still to some extent arbitrary and obey no structural constraints on the way they combine. They are designed to avoid any musical connotations so that expectations are not created. As a result, the interpretation of an earcon must be calculated before that earcon can be deemed appropriate (or even correct) in the current context of an interaction.

The poster aims to show how by utilising musical expectation, (through the use of a musically grammatical structure), inappropriate or unexpected earcons could be recognised instinctively by our innate musical knowledge. Using a grammatical approach, a simple object/action interface is presented where a certain class of actions can be performed only on particular objects. Some actions require more than one object and therefore are described using a different grammatical category.

A mapping from the object/action grammar to the equivalent musical grammar is then described by a series of translations. Each translation maps a linguistic-based grammar rule into a suitable musical rule. Each constituent within a musical rule mimics the behaviour of its corresponding linguistic constituent.

Examples of correctly formed constructs are given, accompanied by their musical counterparts. Ungrammatical combinations of actions and/or objects are shown to be inappropriate by the 'unmusical' translation they produce.

References

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