3.2. Spatial description. Diagram for the performance

Figure 1. Diagram for the performance. (1, 2, 3, 4 speakers)

4. TECHNICAL SPECIFICATIONS

Equipment to be provided by the organizers

- clarinet
- Quadraphonic System
- 1 microphone for clarinet

5. AUDIO LINK

Link to a stereo sample and to a full version:
https://www.dropbox.com/sh/7m7fsw8ikut9se/B2Ch4mFyr1

AMPLIFYING COMPOSITIONAL INTELLIGENCE:
CREATING WITH A PSYCHOLOGICALLY-INSPIRED
GENERATIVE MUSIC SYSTEM

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ABSTRACT

We describe the Motivator, a newly developed Computer Assisted Composition (CAC) tool for generating variations of melodic motives. The motivator helps composers to make Gestalt switches in interpretation of multistable motives, generates variations that preserve structural tones in a given interpretation, and suggests variations that enhance the multistability of the motive. The tool has been used in the composition of Entanglement, a work for piano, percussion and live electronics.

1. INTRODUCTION

In Western tonal music, notes are not heard in isolation but in the context of the piece so far (and more broadly in the cultural context of the style). The function or meaning of a note depends on the context in which it appears [1, 2]. For example, the pitch C functions as tonic in C major, but as leading note in C# major. The different functions possess different qualia, and generate disparate expectations [3]. The leading tone suggests ongoing motion, perhaps tension, and creates expectation of resolution to the tonic. The tonic, on the other hand, suggests repose and resolution, and is equivocal on possible continuations.

Expectations created at a given point in a melody will thus depend on the perceived context at that point. Music theorists have long discussed metric and tonal contexts, and music perception studies, e.g. [4], have demonstrated that interpretations and expectations generated by notes, are conditioned by such contexts. The musical context of a note is multidimensional, comprising a number of distinct yet inter-related parameters. Here we focus on metre, key and harmony.

These contexts are perceptual phenomena, not present explicitly in the musical surface, but inferred from it. Patterns of musical emphasis provide evidence for certain contexts—for example (in many styles) regular recurrence of tonally stable notes hints at the downbeat, whilst a prevalence of triadic notes on strong beats suggests a particular harmony. The different musical parameters are thus intertwined.

A given passage may suggest multiple contexts for each parameter, with various configurations being mutually supportive or contradictory. Where multiple disparate configurations are mutually supportive, perceptual multistability may result. The notion of perceptual multistability comes from Gestalt psychology. For example, Figure 1 shows an example of a perceptually multistable image; it can be seen either as a black vase, or as two white faces. Often, only one interpretation is visible, until the alternate interpretation is explicitly pointed out. Then both interpretations are readily perceptible, though not simultaneously. Rather, one experiences a ‘Gestalt switch’ from one stable configuration to the other. Multistable phenomena, and corresponding Gestalt switches, are also well documented in auditory streaming [5].

Figure 1. A perceptually multistable image

Multi-stability of metric and tonal contexts is frequently evident in Western tonal music [6]. Various theorists have discussed the importance of ambiguity in music perception [7, 8], and later authors have clarified that ambiguity here should be thought of as multistability—the simultaneous strong suggestion of multiple disparate contexts, rather than simply vagueness [9, 2].

 Whilst multi-stable percepts admit only one conscious interpretation at a time, several theories of music cognition suggest that multiple plausible interpretations are maintained subconsciously [10, 3] and may all simultaneously contribute to musical affect. The role of creating suitably ambiguous material in composition is attested to by many theorists [11].

2. MUSICAL AMBIGUITY

The multi-stability of music perception leads to what is more commonly called ambiguity of musical interpretation [6]. That is, there are multiple ways of interpreting a musical passage and this leads to some ambiguity about how it is heard. We are guided in our listening by musical cues as to the structure of the work.

In particular the metric and harmonic stability of notes interacts with our perceptions of metre and key.
It's implied harmonies seem most conventional, with being metrically organised in many ways. Figure 2a this effect by accenting appropriate notes. In particular this especially possible and a performer could achieve possibilities that the passage could be heard time shifted such harmonic analysis are shown as chord symbols in likely metric interpretation are computed. Examples of harmonic movement which, in turn, depends on key.

In addition to the rhythmic grouping differences, our closure interpretation also takes account of implied harmonic movement which, in turn, depends on key. The regularity of the rhythm makes this especially possible and a performer could achieve this effect by accenting appropriate notes. In particular the 9/8 interpretation could be assumed to start with an anacrusis and then the passages would be grouped with an even more frequent occurrence of ascending or anacrusis and then the passages would be grouped with

3. STRUCTURE

Form is an important aspect of music theory. Music is structured through time, and music theory has traditionally been concerned with analysing this structure. Schenker [12] described musical structure as a top-down hierarchy rooted in the overall form, with lower levels understood as a nested series of elaborations. Each level of this hierarchy consists of an increasingly detailed series of structural tones.

In practice, Schenkerian analysis infers this hierarchical structure in a bottom-up fashion, starting from the actual musical surface, and recursively classifying notes as either structural or ornamental, with only the structural tones 'transformed' to the next higher level.

3.1. Closure

Closure, or stability, is a fundamental notion in music perception, playing a complementary role to tendency, or process.

Compositionally, closure relates to the pattern of tension and resolution, or “the general configuration of relaxation and quiescence. Melodically speaking, relaxation is associated with the decline in tension which is effected … when a progression descends at its close” [7:139].

Notions of melodic closure have long been discussed in tonal music theory, in relation to tonal stability, rhythmic repose and (implied) harmonic cadence [13]. Meyer [7], adopting a psychological perspective, married these with the Gestalt conception of closure as perceptual completion, and argued that as repeated (and nested) passage of musical structures move from incompleteness to completion they create aesthetic effect.

In order to utilise closure in the Motivator, we created a real-time measure of the ‘level of closure’. Numerous factors contribute to the overall sense of closure in Meyer’s theory. Completion of pattern (melodic, harmonic and rhythmic) is a key component. Additionally the local dynamics of various musical parameters, without reference to prior patterning, is attributed with closural power:

“Closure, the arrival at relative stability—is the result of the action and interaction among the several parameters of music. Because melody, rhythm, harmony, texture, timbre, and dynamics are relatively independent variables, some may act to create closure at a particular point in a work, while others are mobile and on-going” [7:81].

Whilst, as Caplin [13] notes, the precise mechanisms of such parametric closure are not clearly described, Myer’s student Eugene Narmour articulated a more explicit theory of parametric closure. Narmour’s conditions of closure included a number of simple and properties of note-to-note transitions: movement from a short to long duration, movement from a point of weak to strong metric emphasis, movement from dissonance to consonance, a change in registral direction, and movement from a large interval to a small interval.

3.2. Closure Evaluation of Musical Passages

To assess the level of closure at each point in the musical passage we use a weighted sum of Narmour’s conditions of closure. Given the step-wise motion and rhythmic consistency of this music the main influences on closure, or stability, are the metric emphasis and the tonal stability (measured with reference to the implied harmony). Figure 5 shows the example passage with the closure scores below each note. Because of the way we choose to calculate these (for implementation) lower scores are more closed.

This scoring process allows the identification of structural tones; those notes with particularly low scores. Varying the threshold value will change the number of structural tones. For example, a threshold of 0 will indicate 3 structural tones, while a threshold of 1 will nominate 5 tones, and a threshold of 2 allows 8 structural tones to be identified. Our generative variation processes, described in more detail later, are designed to use the specified structural tones as a skeleton around which variations are created.

Any number of the interpretations of the analysed motif can be used as the basis for closure evaluation and subsequent variation generation. Each interpretation can be the basis for multiple variations.

We suggest that these variations can present the composer with constructive creative possibilities that she may not have otherwise considered because of the psychological tendency to resist a Gestalt switch.

To facilitate the use of these processes by composers, we have implemented these analytical and generative processes in a system called The Motivator.

4. THE MOTIVATOR

The Motivator is a Computer Assisted Composition tool. It performs both generative and analytic functions aimed at assisting the composer to make Gestalt switches in their interpretation of a motive, and to facilitate the creation of tonal and metric ambiguity in their composition.

The benefit of this tool lies in the difficulty of simultaneously perceiving two (or more) contradictory contexts. As described above, human cognition tends to structure sensory stimulus into one coherent configuration, even whilst subconsciously tracking other configurations. Thus, when the composer overlook opportunities for various plausible contexts, the computer is less blinkered by a dominant interpretation.

4.1. Functionality

The motivator has several analytical and generative functions:

1. Analyse a motive by estimating metre, key and harmony to provide coherent configurations of these contexts.
2. Identify structural notes of the motive, assuming a given configuration.
3. Create variations of a motive that maintain its structure in a given context.

The composer supplies a motive, which the Motivator analyses without regard for the notated key, metre or harmony. Instead, it searches over possible context configurations for plausible and coherent interpretations. The most plausible are presented back to the composer, noted in the key, metre and harmony of the configuration. The system is also able to generate variations that respect the selected interpretation.
The metric ‘dissonance’ of particular rhythmic interpretations is discussed by London [2:90] and we will extend an example of his here to demonstrate our approach to algorithmic interpretation.

The passage notated in Figure 2 can be interpreted as being metreically organised in many ways. Figure 2a shows the passage grouped in 4/4, while Figure 2b shows it grouped in 9/8. In addition, there are possibilities that the passage could be heard time shifted to varying degrees. The regularity of the rhythm makes this especially possible and a performer could achieve this effect by accentuating appropriate notes. In particular the 9/8 interpretation could be assumed to start with an anacrusis and then the passages would be grouped with an even more frequent occurrence of ascending or descending three-note groupings, as shown in Figure 3.

In addition to the rhythmic grouping differences, our closure interpretation also takes account of implied harmonic movement which, in turn, depends on key. The likely key and then harmonic progressions of each lower levels understood as a nested series of elaborations. Each level of this hierarchy consists of an increasingly detailed series of structural tones. In practice, Schenkerian analysis infers this hierarchical structure in a bottom-up fashion, starting from the actual musical surface, and recursively classifying notes as either structural or ornamental, with only the structural tones ‘transformed’ to the next higher level.

3.1. Closure
Closure, or stability, is a fundamental notion in music perception, playing a complementary role to tendency, or process.
4.2. Analysis: Estimation of coherent configurations

For each of the musical parameters under consideration (metre, key and harmony), the system has an estimation algorithm that finds plausible values for this parameter, given a particular configuration of values for the remaining parameters. Then, to find the most coherent overall configurations, a search over this multi-dimensional parameter space is carried out via the generative technique described below. The harmony estimation technique draws on previous work on harmonic analysis using models of Bellman’s [15] approach. The metre estimation technique draws on a recent approach to previous work on harmonic analysis using models of Bellman’s [15] approach. The metre estimation technique draws on previous work on harmonic analysis using models of Bellman’s [15] approach.


4.3. Structure: Identification of stable notes

Having estimated the most probable and coherent configurations of context, the system is also able to identify stable notes. These notes are taken to outline the structure of the motive, and act as a skeletal representation. Different configurations and closure thresholds will lead to different skeletons, highlighting interesting possible re-interpretations to the composer.

4.4. Variation: Generation of motive variations

The variation algorithm operates by retaining the stable notes of the motive and recycling ornamental notes via the generative technique described below. This technique needs a way to ‘connect the dots’ again, i.e., to regenerate notes between structural tones. The variation algorithm operates by retaining the stable notes of the motive and recycling ornamental notes via the generative technique described below. This technique needs a way to ‘connect the dots’ again, i.e., to regenerate notes between structural tones.

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4.5. Generative Technique

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4.6. REFERENCES


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