

A Model of Musical Motifs

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Outline

- 1 Motivation
- 2 The Motif Model
- 3 Conclusion

Introduction: Music Constraint Programming

Research field

- Computational modelling of composition
- Explicitly modelling compositional knowledge

Successful technique: constraint programming

- User states music theory model – computer generates music which complies with this theory
- Music theory: a set of rules (constraints) applied to unknowns (variables) in solution score
- Highly declarative definition (e.g. simple combination of music theories by conjunction)
- Efficient solvers

Research Goal

Long-term objective modelling of explicit knowledge of melody composition and musical form

Present goal modelling of fundamental melodic/formal concept:
musical motifs as constraint satisfaction problem

Motif Components

$a \text{ motif} := \langle \text{representation}, \text{description}, \text{variation} \rangle$

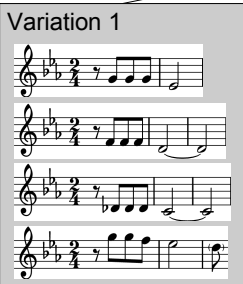
A motif consists of

- **Representation**: stores score information
- **Description**: specifies motif's identity (e.g. a vs. b)
- **Variation**: specifies motif's variation (e.g. a^1 vs. a^2)

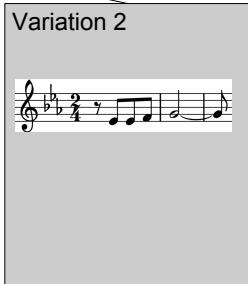
Example: Beethoven's Symphony No. 5

Motif a

Variation 1

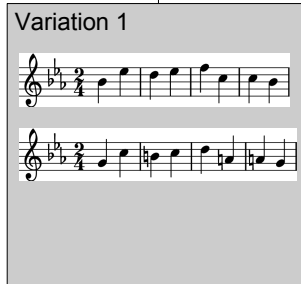


Variation 2



Motif b

Variation 1



The diagram illustrates the Motif Model for Beethoven's Symphony No. 5. It shows two motifs, Motif a and Motif b, each with its own variations. Motif a is shown in two variations: Variation 1 (four staves) and Variation 2 (one staff). Motif b is shown in one variation: Variation 1 (two staves). The music is in G major (one sharp) and 2/4 time.

Motif Components: the Details

- **Representation (contains variables):** instance of some music representation
- Description (is variable): symbolic description (feature-value pairs)
- Variation (is variable):
 - function constraining relation between representation and description
 - convenient variant: feature-function pairs

Music Representation

- Music representation ‘factored out’
- Requirements for the employed representation
 - Support for variables
 - Hierarchic representation: motifs are separate objects
 - Interface for accessing score information

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Motif Description

General form

$$a \text{ description} := \langle \textit{feature}_1: \textit{variable list}_1 \\ \textit{feature}_2: \textit{variable list}_2 \\ \dots \rangle$$

$$\textit{description} := \bigvee \textit{description}_a, \textit{description}_b, \dots$$

Beethoven example

$$\textit{description}_a := \langle \textit{durations}: (\text{♪}, \text{♪}, \text{♪}, (\bigvee \text{♩}, \dots, \circ)) \\ \textit{pitch contour}: (\rightarrow, (\bigvee \rightarrow, \searrow), \searrow) \rangle$$

$$\textit{description}_b := \langle \textit{durations}: (\text{♩}, \text{♩}, \text{♩}, \text{♩}, \text{♩}, \text{♩}, \text{♩}, \text{♩}) \\ \textit{scale degree intervals}: (3, -1, 1, 1, -3, 0, -1) \rangle$$

Motif Components: the Details

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- Description (is variable): symbolic description (feature-value pairs)
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Motif Variation

General Form

$$a \text{ variation} := \langle \begin{array}{l} \textit{feature}_1 : \textit{function}_1 : \textit{motif} \rightarrow \textit{variable list}_1 \\ \textit{feature}_2 : \textit{function}_2 : \textit{motif} \rightarrow \textit{variable list}_2 \\ \dots \end{array} \rangle$$
$$\textit{variation} := \bigvee \textit{variation}_1, \textit{variation}_2, \dots$$

Variable lists at matching features of description and variation are constrained to be equal.

Motif Variation (continued)

Beethoven Example

```
variation1 := ⟨durations: getNoteDurations  
              pitch contour: getPitchContour  
              scale degree intervals: getScaleDegreeIntervals⟩  
variation2 := ⟨durations: getNoteDurations  
              pitch contour: myPitchContourTransformation⟩  
myPitchContourTransformation(myMotif) :=  
  getDescription(myMotif) = descriptiona  
  ∧ inverse(getPitchContour(myMotif))
```

Discussion

Motif model **very flexible**: allows for

- Score generation from a motivic analysis
- Application of various similarity formalisms (e.g. pitch contour equivalence)
- Non-motivic sections: non-motivic variation function constrains nothing
- Contrapunctual combinations: motif description is searched for
- Combination with various other music theories (e.g. harmony, counterpoint)

Efficient implementation in Strasheela (implemented in Oz): uses constraint propagation and supports user-definable search strategy.

Conclusion

The motif model constrains relation between three motif properties

- Its score **representation**
- Its symbolic **description** (specifying its identity)
- Its **variation**: constraining relation between representation and description