Towards a generative syntax of tonal harmony (Rohrmeier, 2011)

Fabian C. Moss

Dresden Music Cognition Lab — TU Dresden

January 5, 2016

Outline

1 Introduction

2 Principles of organization

3 Formalization
- 3.1 Phrase level
- 3.2 Functional level
- 3.3 Scale-degree level
- 3.4 Surface level

4 Sample analyses

How to read a generative rule?

$$X \longrightarrow Y \quad Z$$

The rule reads as "(X rewrites as (Y followed by Z))"
not "X equals Y Z" or something.

1 Introduction

- It's all about "the **organization of chord sequences** by
  - **recursive dependencies** and
  - **substitution of functionally equivalent chords**"

  motivated by "their formalization based on **phrase-structure grammar**."
- Principles of organization:
  - Dependency principle
  - Functional heads

2 Principles of organization

1. Dependency principle
2. Functional heads

2.1 Dependency principle

- "each element (chord) in a chord sequence is **structurally connected** to its preceding or succeeding chord or chord group **in a dependency relationship**. Each group of dependent chords (which may contain more than two elements) recursively distinguishes a **head** on which the other elements of that group are dependent. The chords in a harmony sequence form recursive dependency relationships until there is **only one head for the whole sequence** or phrase."
- "harmony sequences may form **long-distance dependencies** between chords that are separated by other functional chords in between [. . .]. [. . .] **local adjacencies** between structurally unrelated chords may occur when both belong to two different dependency branches and do not share the same parent node."

2.2 Functional heads

- “chords are organized into **functional categories** which describe their tonal function which may be instantiated or modified by different chords.“
- “functional categories support the use of **abstract category variables**

$$\mathbb{R} = \{TR, DR, SR\}$$

for the three main functions instead of the scale degree representation so that the derivation of different chord sequences that are functionally identical on a higher level would reflect this similarity.”

2.2 Functional heads

- "tonic/dominant/subdominant categories would constitute **functional symbols**

$$\mathbb{F} = \{t, d, s, tp, dp, sp, tcp\}$$

that could be realized by a number of different surface chords. [. . .] there may be groups of chords that fulfil (prolongate) tonic/dominant/predominant functions as a whole constituent."

3 Formalization: levels

Rohrmeier's formalization consists of four different levels:

1. Phrase level
2. Functional level
3. Scale degree level
4. Surface level

3 Formalization: levels

Rohrmeier's formalization consists of four different levels:

1. Phrase level ($\rightarrow$ theory of musical form)
2. Functional level ($\rightarrow$ functional theory of harmony)
3. Scale degree level ($\rightarrow$ step theory of harmony)
4. Surface level ($\rightarrow$ counterpoint?)

3 Formalization: symbols

- $\mathbb{P} = \{piece, P\}$ (phrase-level symbols)
- $\mathbb{K} = \{Cmaj, Cmin, C\sharp maj, C\sharp min, D\flat maj, D\flat min...\}$ (key symbols)
- $\mathbb{R} = \{TR, DR, SR\}$ (functional region symbols)
- $\mathbb{F} = \{t, d, s, tp, dp, sp, tcp\}$ (functional terms)
- $\mathbb{S} = \{I, II, ..., V/II, V/III, ...\}$ ((relative) scale-degrees)
- $\mathbb{O} = \{Cmaj, Cmin, C^0, C^\emptyset\}$ (surface chord symbols)

3.1 Phrase level

$$piece_{key=x \in \mathbb{K}} \longrightarrow P^{+} \quad (1)$$

$$P \longrightarrow TR \quad (2)$$

- (1) states that a piece has a certain **key feature** and consists of several co-ordinated parallel (disjunct) phrases
- (2) assigns TR as a head for each phrase. Each phrase ends with a perfect authentic cadence (PAC). (Cadences mark phrase boundaries.)

??? Pieces with an overarching tonic could be modeled by only one rule:

$$piece \longrightarrow TR_{key=x \in \mathbb{K}} \quad (3)$$

Functional level

"The functional level characterizes harmonic relationships on an abstract level which only concerns **relationships between functions and keys** and describes different manipulations that may **transform functional progressions in an abstract way** before they are 'sent off' to a more surface-based representation."

1. Expansion rules
2. Substitution rules
3. Modulation rules

3.2 Functional level

"The functional level characterizes harmonic relationships on an abstract level which only concerns **relationships between functions and keys** and describes different manipulations that may **transform functional progressions in an abstract way** before they are 'sent off' to a more surface-based representation."

1. **Expansion rules**
2. Substitution rules
3. Modulation rules

3.2.1 Expansion rules

Progressive rules:

$$TR \longrightarrow DR \quad t \qquad \text{"dominant regions prepare tonics"} \tag{4}$$

$$DR \longrightarrow SR \quad d \quad \text{"predominant regions prepare dominants"} \tag{5}$$

$$TR \longrightarrow DR \quad TR \tag{6}$$

3.2.1 Funcional prolongation rule:

$$XR \longrightarrow XR \quad XR \quad \text{for any } XR \in \mathbb{R} \tag{7}$$

3.2.1 Expansion rules

Generation of elementary functional chord terms from functional regions: ("Instantiation")

$$TR \longrightarrow t \tag{8}$$

$$DR \longrightarrow d \tag{9}$$

$$SR \longrightarrow s \tag{10}$$

Rules (1)-(10) define a diatonic framework.

3.2 Functional level

1. Expansion rules
2. **Substitution rules**
3. Modulation rules

3.2.2 Substitution rules

"By a second class of derivations, each functional symbol may be replaced or substituted by their relatives or parallels"

$$t \longrightarrow tp \tag{11}$$
$$t \longrightarrow tcp \tag{12}$$
$$s \longrightarrow sp \tag{13}$$
$$d \longrightarrow dp \tag{14}$$

- **Question 1:** What is the difference between rule (11) and a hypothetical functional expansion rule (11*)

$$TR \longrightarrow tp \tag{11*}$$

- **Question 2:** Rule (12) and (14) seem contradictory
  - in major, the triad on III would have tonic *and* dominant function
  - in minor, the chord on VI would have tonic *and* subdominant function

3.2 Functional level

1. Expansion rules
2. Substitution rules
3. **Modulation rules**

3.2.3 Modulation rules

$X \in \mathbb{F}$ may be rewritten as the new (local) tonic which defines the new key according to the respective function and scale degree of X"

$$X_{key=y} \longrightarrow TR_{key=\psi(X,y)} \text{ for any } X \in \mathbb{F} \text{ and } y \in \mathbb{K} \qquad (15)$$

$$s_{key=Gmaj} \longrightarrow t_{key=\psi(s,Gmaj)=Cmaj}$$

- **Question:** Where comes the scale-degree into play?
- **Question:** Linguistic syntax does not allow for a rule like $V \longrightarrow NP$ (I think). Rule (15) crosses levels.

"This constitutes the only way in which a functional term (in $\mathbb{F}$) can reenter the [...] functional regions (in $\mathbb{R}$). The modulation rule involves **type casting**, since a functional term representing a chord (X) is assigned as the key type (in $\mathbb{K}$)."

3.2.3 Modulation rules

"rule (16) specifies the **change of mode without the change of function**. This rule is necessary to capture the phenomena of functional borrowings from the respective complementary modes"

$$X_{key=y\ maj/min} \longrightarrow X_{key=y\ min/maj} \text{ for any } X \in \mathbb{F} \text{ and } y \in \mathbb{K} \quad (16)$$

"no distinction between modulations, brief tonicizations or changes of local diatonic context. [...] difference between these phenomena is gradual and [...] the stability of a (change of) key is greater, the higher the node is located in the tree and the more children it dominates."

- **Question:** Since the key feature is present on all levels, the question arises on which level $(\mathbb{R}, \mathbb{F}, \mathbb{S})$ a modulation takes place. If rule (16) would be restricted to $\mathbb{F}$, it could as well be seen as a functional substitution rule.

3.3 Scale-degree level

- Secondary dominant rules
- Function-scale degree interface
- Typing

3.3 Scale-degree level

- **Secondary dominant rules**
- Function - scale degree interface
- Typing

3.3.1 Secondary dominant rules

$$X \longrightarrow D(X) \quad X \text{ for any } X \in \mathbb{S} \quad \text{(secondary dominant)} \tag{17}$$

$$X \longrightarrow \Delta(X) \quad X \text{ for any } X \in \mathbb{S} \quad \text{(diatonic fifth)} \tag{18}$$

$$D(X) \longrightarrow \begin{cases} V/VI/X \mid VII/VI/X & \text{if } X \text{ refers to a diminished triad} \\ V/X \mid VII/X & \text{otherwise} \end{cases} \tag{19}$$

3.3.1 Secondary dominant rules: Example

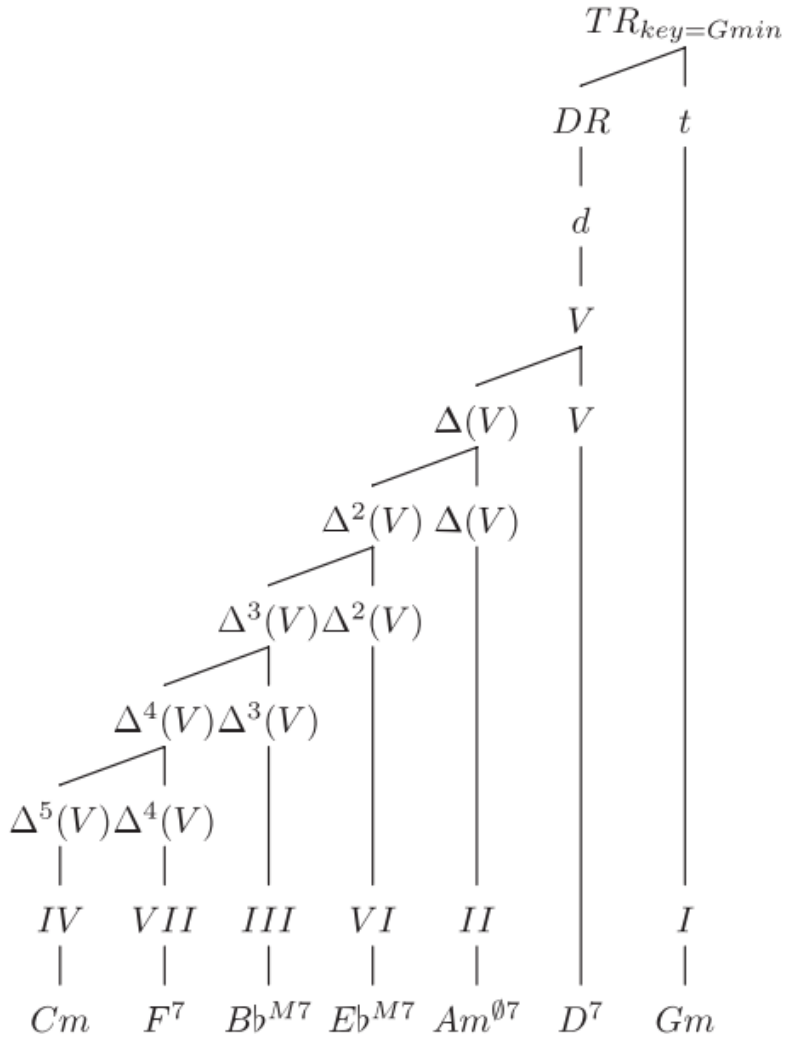

Figure 1: Tree analysis of "Autumn Leaves"

3.3.2 Function - scale degree interface

$$t \longrightarrow I \tag{20}$$

$$t \longrightarrow I\ IV\ I \tag{21}$$

$$s \longrightarrow IV \tag{22}$$

$$d \longrightarrow V, VII \tag{23}$$

$$tp \longrightarrow \begin{cases} VI & \text{if key is major} \\ III & \text{if key is minor} \end{cases} \tag{24}$$

$$dp \longrightarrow VII \quad \text{if key is minor} \tag{25}$$

$$sp \longrightarrow \begin{cases} II & \text{if key is major} \\ VI, \flat II & \text{if key is minor} \end{cases} \tag{26}$$

$$tcp \longrightarrow \begin{cases} III & \text{if key is major} \\ VI, \flat II & \text{if key is minor} \end{cases} \tag{27}$$

3.3 Scale-degree level

Possible extensions:

- voice-leading rules might be incorporated on this level
- alterations of chords also on this levels (including augmented sixth chords)
- style-specific rules

3.4 Surface level

Straight-forward translation, e.g.:

$$V^7_{key=E\flat major} \longrightarrow B\flat^7$$

Repetition of surface chords:

$$X \longrightarrow X^+ \quad \text{for any } X \in \mathbb{O} \tag{28}$$

"at a lower level than the functional rules, since a functional replication may be itself subject to another recursive transformation, whereas a mere **repetition of chords without change of function OR scale degree is regarded as a phenomenon located at a surface level which does not enter recursive expansion** and may often not even be analysed as a sequence of separate events."

4 Sample analyses

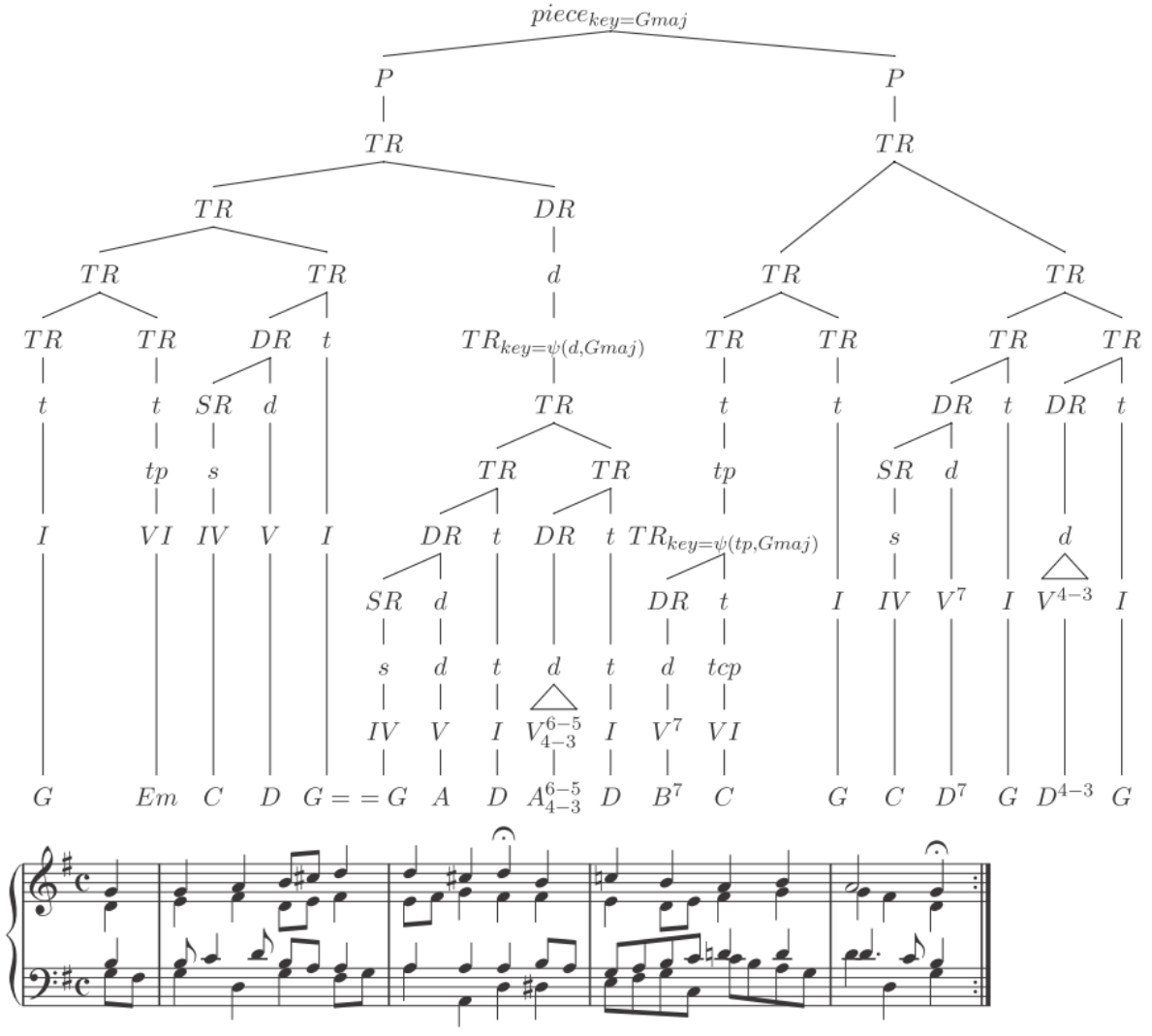

Figure 2: Tree analysis of "Ermuntre Dich, mein schwacher Geist"

4 Sample analyses

- In the GSM "the structuring into different subphrases, simple prolongational and progressive phenomena, as well as basic cadences, modulations and deceptive cadences can be accounted for."
- "the formalism expresses abstract tonal relationships between the harmonic entities. These match the **composed structure** or the **final retrospective cognitive representation** after multiple listening rather than the cognitive experience during listening"

5 Discussion

- reconcile Riemannian functional and recursive, prolongational approaches
- extension of earlier grammar models
- broaden the understanding of the relationship between harmony and musical form
- computational implementation, empirical contestability (corpus analyses), harmonic similarity through tree-matching algorithms,...
- musical-linguistic commonalities
- challenge for Markov models, n-gram models $\Rightarrow$ context-free grammar

5 Discussion

The GSM "[...] specifies a grammar that models structural dependencies rather than a cognitive system. [...] a simplistic one-to-one mapping of the generative syntax to a cognitive instantiation cannot be assumed. For instance, the objects of analysis on which the grammar is based constitute well-crafted, composed pieces of music that are designed from a bird's-eye perspective and principally independently of an online construction or perception process. [...] the cognitive reality of recursive dependencies on the largest levels (or other mathematical relationships found in scores) cannot be taken for granted. Empirical results are undecided about the cognitive reality of musical long-distance relationships. However, the grammar makes it possible to generate some explicit (structural) hypotheses about licensed progressions or predictions about expected cognitive parsing and revision processes that may be investigated in behavioural or neuroscientific ways."