Tutorial

Release 0.1

harmonyli.ly

Harmonical Analysis Symbols in LilyPond Scores

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Contents

1 Introduction

As so often - in the beginning there was a need: I had to write a musicological work.

Actually, I had a good starting point: I knew, that there was an Anglo-American scientific style which heavily differed from the European resp. German standard in the humanities. To close that gap, I had already created a LaTeX environment for writing scientific articles and books which even fulfilled the very sophisticated requirements of the humanities in general and the standards of the musicology in particular. I had documented that work, had explained and justified that style of writing and published the result as open source software.

Unfortunately, I did not know, how to embed snippets of musical scores into a LaTeX file. Trawling through the web delivered a bulk of tools and methods, but no manual, how to do so, and no tutorial, how to successfully combine which tools for getting a usable working environment. Therefore, I started an investigation. And again, I published my work as a kind of open source software.

A preliminary result of this investigation was, that we had three backends for using musical notes in LaTeX: We could use the style of *ABC*-Notation and would only be able to integrate very simple harmony analysis symbols into our exemplifying score. Or we could use a combination of *LaTeX, MusixTeX, and harmony* which offered excellent and sophisticated results, but enforced us, to use the very complex and difficult typesetting language *MusicTeX* without being supported by any good (semi-)graphical Editor. Or we could use the well established coding environment *LilyPond* and its LaTeX-integration tool *lilypondbook* together with at least two excellent semi-graphical Editors like *Frescobaldi* or *Elysium*. Moreover, if we were willing to use converters like *musicxml2ly*, we could also use the genuine graphic editor *MuseScore*. But then, we would again not be able to insert harmony analysis symbols on a level which matches the state of the art and which was fulfilled by the LaTeX tool *harmony*.

At that point I knew, what was possible. But I did not want to respect the result. Using *LaTeX, MusixTeX, and harmony* would decrease my productivity in an unacceptable manner. So, I started a reimplementation of *harmony* for *LilyPond* by using its LISP based language *GUILE* and the respectives techniques for expanding this score edition system. I decided to name it *harmonyli.ly*, because this name would give credits to the LaTeX based idea generator *harmony* as well as to the intended target system *LilyPond*, which I had learned to love. My result worked. But its appearance was not on the level I preferred to achieve.

So, I asked the *LilyPond* community for feedback. I knew, that at that time I might have been a good programmer, an expert of musical theory, and an adept of Free and Open Source Software and its spirit, but I certainly was not familiar with the internals of *LilyPond*, its 'biotope' of additional tools and its history. From this point, a typical open source success-story started.

I got a lot of hints, for instance by .... And I was told the ... had already written a first version of such a tool and that it was published as Public Domain Software in the *LilyPond Snippet Repository*. So I took this preliminary work, redesigned and expanded the interface, rewrote some functions and added a lot of other code. But nevertheless, my work was a derivative work of Hand Blum's work. So – and even if it had not been necessary from a legal point of view –, I asked him whether he could agree that I re-engineered his work and that I released the result under a licensing construct, by which the user could chose the license he prefered, either GPL or MIT. And to my great pleasure, Hans Blum agreed with this concept.

That was the way by which you now obtain three results, which should not be undervalued:

- With *harmonyli.ly*, you get a technique to enrich your scores by harmony analysis symbols on a level, which is as expressive as it is required by the musicology and as beautiful as it necessary for not disturbing the excellent outpout of *LilyPond*.

- You get *harmonyli.ly* as open source software. And the act of licensing is explicitly approved by the copyright holders Hans Blum and me, Karsten Reincke. hence, you can be sure also to get the rights to use *harmonyli.ly*.
- You get a complete tutorial which thoroughly explains
  - how to generally install and integrate *harmonyli.ly*into your work
  - how to prepare your work for using *harmonyli.ly*successfuly
  - how to create the particular *Harmony Analysis Symbols* required by the musicology.

And the way of learning how to use *harmonyli.ly* starts now:

2 Installation & Integration

- Clone the *harmonyli.ly* repository or download and extract the *harmonyli.ly* zip archive by using the respective (github) commands.[1]
- Copy the file `harmonyli.ly` somewhere into your file system.
- Insert the command `\include "YOUR_PATH_TO/harmonyli.ly"` into your *LilyPond* file above the first `score{...}` section.
- Expand your `layout{...}` section by the line `\context{\Lyrics \consists "Text_spanner_engraver"}`.

3 Application & Utilization

harmonyli.ly uses the lyrics technique of *LilyPond* to embed the *Harmony Analysis Symbols* into the *LilyPond* score. The benefit is that *LilyPond* itself aligns the music notes and the respective analysis symbols: it prevents horizontal overlappings, if a *Harmony Analysis Symbol* is longer than the respective note.

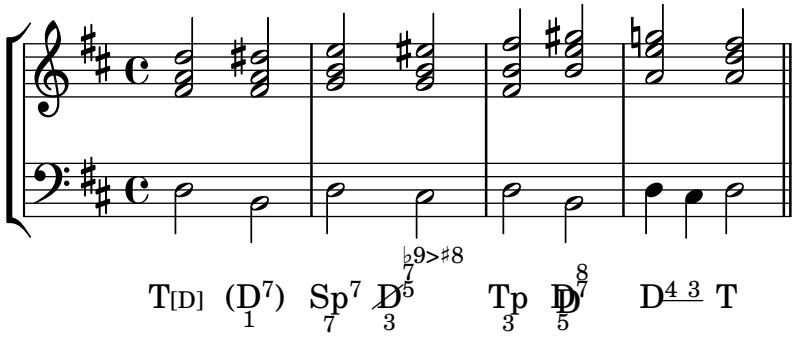
As a little disadvantage *harmonyli.ly* needs a dedicated voice to which the row of *Harmony Analysis Symbols* can be bound. After having set up your *LilyPond* file as described above you have three opportunities to fulfill this condition:

3.1 Binding Harmony Analysis Symbols to a Real Voice

Linking *Harmony Analysis Symbols* to a really used staff is straight forward:

[1] → https://github.com/kreincke/harmonyli.ly

3.1.1 Example



3.1.2 Code

```
\version "2.18.2"
\header { tagline = "" }
\include "harmonyli.ly"
\score {
  \new StaffGroup {
    \time 4/4
    <<
      \new Staff {
        \relative d' {
          \clef "treble" \key d \major \stemUp
          < fis a d>2 < fis a dis> < g b e> < g b eis>2 |
          < fis b fis'>2 < b e gis> < a e' g!> < a d fis>2 \bar "||"
      } }

      \new Staff {
        \relative d {
          \clef "bass" \key d \major \stemDown
          d2 b d cis  | d b d4 cis4 d2 \bar "||"
      } }

      \addlyrics {
          \markup \setHas "T" #'(("C"."D")("fr" . " "))
          \markup \setImHas "D" #'(("B"."1")("a" . "7")("fr" . " "))
          \markup \setHas "Sp" #'(("B"."7")("a" . "7")("fl" . " ")("fr" . " "))
          \markup \setHas "D" #'(("T"."x")("B"."3")
                                 ("a" . "5")("b" . "7")("c" . "-9>+8")("fr" . " "))
          \markup \setHas "Tp" #'(("B"."3")("fl" . " ")("fr" . " "))
          \markup \setHas "D" #'(("T"."d")("B"."5")("a" . "7")("b" . "8")
                                 ("fr" . " "))
          \initTextSpan "   "
          \markup \openZoomRow "D" #'(("a"."4")("fl" . " "))
          \startTextSpan
          \markup \expZoomRow #'(("a"."3")("fr" . " "))
          \stopTextSpan
          \markup \setHas "T" #'(("fr" . " "))
        }
    >>
  }
  \layout { \context{\Lyrics\consists "Text_spanner_engraver"} }
  \midi {}
}
```

3.1.3 Description

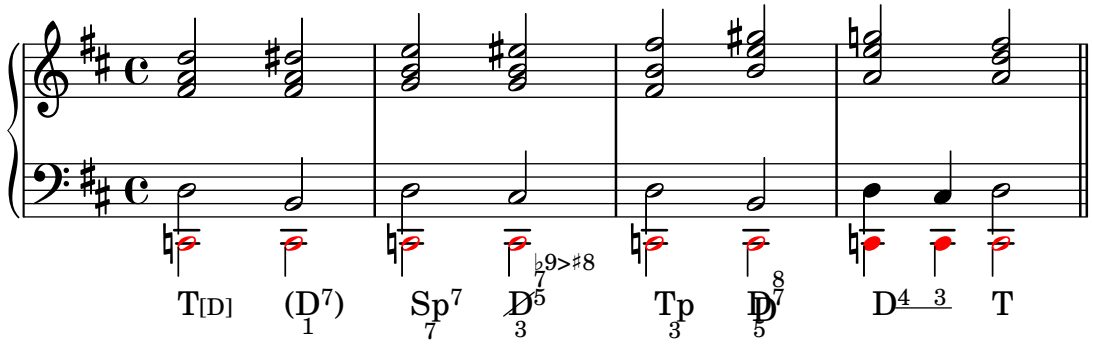
This example contains a descant staff and a bass voice. To the letter one, it appends the section `addlyrics`, which contains for each note of the bass voice one specific *Harmony Analysis Symbol*. If you do not want to use such a 1:1 relation between notes and *Harmony Analysis Symbols*, you can use one of the other methods.

3.2 Binding Harmony Analysis Symbols to a Hidden Voice

Linking the *Harmony Analysis Symbols* to an invisible voice is a bit tricky: First, you must design your staff as a staff with several voices. Then you inscribe a (mostly very deep) 'artificial' voice into that staff and bind the symbols to that 'artificial' voice.[2]

This method is good for a score with a large amplitude of pitches (as some romantic piano pieces use): by applying the method you can enforce a larger distance between the used notes and the *Harmony Analysis Symbols*.

3.2.1 Example



3.2.2 Code

```
\version "2.18.2"
\include "lilypond/harmonyli.ly"

\paper {
  indent = 0
  ragged-right = ##f
  system-system-spacing #'basic-distance = #20
  score-system-spacing =
    #'((basic-distance . 12)
```

[2] For demonstrating this option, we have colored the 'hidden' voice. If you change the string `new Voice = "AnalysisSubline"` into `new NullVoice = "AnalysisSubline"`, the voice becomes really invisble.

```
       (minimum-distance . 6)
       (padding . 1)
       (stretchability . 12))
}

\header { tagline = "" }

global  = { \key d \major  \time 4/4}

descant = \relative c' {
  \clef treble \stemUp \global
  < fis a d>2 < fis a dis> < g b e> < g b eis>2 |
  < fis b fis'>2 < b e gis> < a e' g!> < a d fis>2 \bar "||"
}

bass = \relative c {
  \clef bass \stemNeutral \global
  d2 b d cis  | d b d4 cis4 d2 \bar "||"
}

hasRhythmHidden =
\relative c, {
  \clef bass \stemDown \global
  \override NoteHead.color = #red
  \override NoteColumn #'ignore-collision = ##t
  c2 c | c c | c c | c4 c4 c2 \bar "||"
}

hasSymbols = \lyricmode {
  \override LyricText.self-alignment-X = #LEFT
  \override LyricExtender.left-padding = #-0.5
  \override LyricExtender.extra-offset = #'(0 . 0.5)

  \markup \setHas "T" #'(("C"."D")("fr" . " "))
  \markup \setImHas "D" #'(("B"."1")("a" . "7")("fr" . " "))
  \markup \setHas "Sp" #'(("B"."7")("a" . "7")("fl" . " ")("fr" . " "))
  \markup \setHas "D" #'(("T"."x")("B"."3")("a" . "5")("b" . "7")
                         ("c" . "-9>+8")("fr" . " "))
  \markup \setHas "Tp" #'(("B"."3")("fl" . " ")("fr" . " "))
  \markup \setHas "D" #'(("T"."d")("B"."5")("a" . "7")("b" . "8")
                         ("fr" . " "))
  \initTextSpan "    "
  \markup \openZoomRow "D" #'(("a"."4")("fl" . " "))
  \startTextSpan
  \markup \expZoomRow #'(("a"."3")("fr" . " "))
  \stopTextSpan
  \markup \setHas "T" #'(("fr" . " "))
}

\score {
  <<
    \new GrandStaff <<
      \new Staff = upper
      \with { printPartCombineTexts = ##f }
      { <<
          \descant
        >>
      }
      \new Staff = lower
      \new Voice = "Musical Bass"
      \with { printPartCombineTexts = ##f }
      { <<
          \bass
          % change "Voice" to "NullVoice" to make analyze voice unvisible:
          \new Voice = "AnalysisSubline" {\shiftOff  \hasRhythmHidden}
```

```
        \new Lyrics \lyricsto "AnalysisSubline" \hasSymbols
      >>
    }
  >>
>>
\layout{ \context { \Lyrics \consists "Text_spanner_engraver" } }
}
```

3.2.3 Description

This example uses four voices in four variables: the right hand voice (`= descant`), the left hand voice (`= bass`), the hidden voice defining the rhythmical granularity of the analysis (`= hasRhythmHidden`) and the respective stream of *Harmony Analysis Symbols* (`= hasSymbols`). Inside of the section `\score...` the 'sounding' bass and the 'virtual' voice *AnalysisSubline* are inserted into the left hand staff. And the stream of *Harmony Analysis Symbols* `\hasSymbols` is bound to that 'virtual' voice by using the command `\lyristico` and a reference by name.[3]

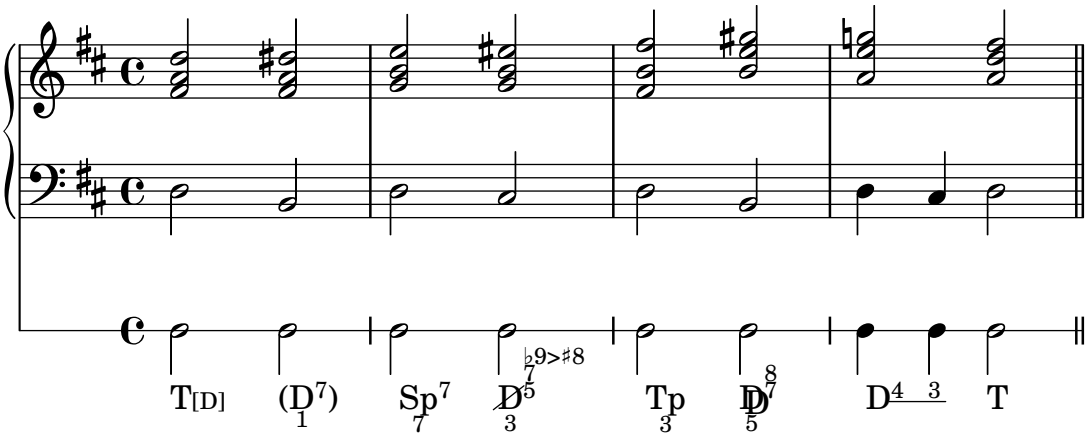
3.3 Binding Harmony Analysis Symbols to a Dedicated 'Analysis' Staff

Binding the *Harmony Analysis Symbols* to a specific *analysis* staff is straight forward again: you must create a voice in a special staff which only represents the rhythm.

This method is good for scores with many staves (like those of symphonies etc.): it simplifies to ignore the harmonically irrelevant passing notes.

[3] Due to fact, that the *Harmony Analysis Symbols* appear under the analysis staff, it sometimes happens, that next part of your score (after the system 'linefeed') is visually not sufficiently separated from the preceding system. That agravates to read the score fluently. For increasing or decreasing the distance between the system lines, you can play around with the values inserted into the section `\page{...}`

3.3.1 Example



3.3.2 Code

```
\version "2.18.2"
\include "lilypond/harmonyli.ly"

\paper {
  indent = 0
  ragged-right = ##f
  system-system-spacing #'basic-distance = #20
  score-system-spacing =
    #'((basic-distance . 12)
       (minimum-distance . 6)
       (padding . 1)
       (stretchability . 12))
}

\header { tagline = "" }

global  = { \key d \major  \time 4/4}

descant = \relative c' {
  \clef treble \stemUp \global
  < fis a d>2 < fis a dis> < g b e> < g b eis>2 |
  < fis b fis'>2 < b e gis> < a e' g!> < a d fis>2 \bar "||"
}

bass = \relative c {
  \clef bass \stemNeutral \global
  d2 b d cis  | d b d4 cis4 d2 \bar "||"
}

hasRhythm = \relative c {
  \stemDown \global
  c2 c | c c | c c | c4 c4 c2 \bar "||"
}

hasSymbols = \lyricmode {
  \override LyricText.self-alignment-X = #LEFT
  \override LyricExtender.left-padding = #-0.5
  \override LyricExtender.extra-offset = #'(0 . 0.5)

  \markup \setHas "T" #'(("C"."D")("fr" . " "))
```

```
  \markup \setImHas "D" #'(("B"."1")("a" . "7")("fr" . " "))
  \markup \setHas "Sp" #'(("B"."7")("a" . "7")("fl" . " ")("fr" . " "))
  \markup \setHas "D" #'(("T"."x")("B"."3")("a" . "5")("b" . "7")
                         ("c" . "+9>-8")("fr" . " "))
  \markup \setHas "Tp" #'(("B"."3")("fl" . " ")("fr" . " "))
  \markup \setHas "D" #'(("T"."d")("B"."5")("a" . "7")("b" . "8")
                         ("fr" . " "))
  \initTextSpan "    "
  \markup \openZoomRow "D" #'(("a"."4")("fl" . " "))
  \startTextSpan
  \markup \expZoomRow #'(("a"."3")("fr" . " "))
  \stopTextSpan
  \markup \setHas "T" #'(("fr" . " "))
}

\score {
  <<
    \new GrandStaff <<
      \new Staff = upper
      \with { printPartCombineTexts = ##f }{\descant}
      \new Staff = lower
      \with { printPartCombineTexts = ##f }{\bass}
    >>
    \new RhythmicStaff = analysis
    \with { printPartCombineTexts = ##f }
    {
      <<
      \new Voice = "AnalysisLine" { \hasRhythm}
      \new Lyrics \lyricsto "AnalysisLine" \hasSymbols
      >>
    }
  >>

  \layout{ \context{\Lyrics\consists "Text_spanner_engraver"}}
}
```

3.3.3 Description

In general, this third example follows the ideas of the second. But it does not inscribe the sounding bass and the 'virtual' analysis voice into the same staff. Instead of this, each of them gets its own staff. And again, the stream of *Harmony Analysis Symbols* is linked to the analysis voice *hasRhythm* by the command `\lyristico` and a name reference.

4 Harmony Analysis Symbols

After having generally explained how to integrate and use *harmonyli.ly*, we can now discuss, how particular *Harmony Analysis Symbols* are generated by *harmonyli.ly* commands. For that purpose, *harmonyli.ly* offers two interfaces: the basic *harmonyli.ly* functions and some often used instantiations. This chapter describes the general interface:

4.1 The basic harmonyli.ly-functions

The basic interface of *harmonyli.ly* contains nine functions:

(01)	**setHas**	→	inserts a *Harmony Analysis Symbol*.
(02)	**setImHas**	→	inserts an *Intermediary Harmony Analysis Symbol* whose function refers to the root of the successing chord instead of being determined by the keynote.
(03)	**setRfHas**	→	inserts a *Reframing Harmony Analysis Symbol* as it is required by modulations: the function of a chord – determined by the current tonal center – is reinterpreted as a function in the context of the next tonal center
(04)	**openImRow**	→	starts an intermediary chain of *Harmony Analysis Symbols* where each chord of the chain refers to the root of chord which follows the chain
(05)	**closeImRow**	→	closes an intermediary chain of *Harmony Analysis Symbols* and indicates, that the root of the directly successing chord is the tonal center of that chain
(06)	**openZoomRow**	→	starts the zoom into a *Harmony Analysis Symbol* which shall cover suspended or passing notes
(07)	**expZoomRow**	→	expands an opened *Harmony Analysis Symbol* by a description of suspended or passing notes which do not modify the current harmonical function
(08)	**openImZoomRow**	→	starts the zoom into an intermediary *Harmony Analysis Symbol* which shall cover suspended or passing notes
(09)	**closeImZoomRow**	→	closes the zoom into a intermediary *Harmony Analysis Symbol* which covers suspended or passing notes

4.2 How to combine these harmonyli.ly-functions correctly

In accordance to the following eBNF grammer[4], you can embed five types of subrows into your stream of *Harmony Analysis Symbols*[5]:

```
HasStream ::- ( setHas | setImHas | setRfHas |
                openImRow, setHas*, closeImRow |
                openZoomRow, expZoomRow+ |
                openImZoomRow, expZoomRow*, closeImZoomRow )+
```

These production rules inidicate, that

- you may use the 'normal' *Harmony Analysis Symbols* – may it be a simple *Harmony Analysis Symbol,* an intermediary *Harmony Analysis Symbol,* or a reframing *Harmony Analysis Symbol* – without having to consider its predecessors or successors
- you must close an opened intermediate row and between the opening and the closing element of that chain you can insert as many normal *Harmony Analysis Symbols* as you want
- you need not explicitly to close an opened zoom

[4] for details → https://en.wikipedia.org/wiki/Extended_Backus%E2%80%93Naur_form and/or https://en.wikipedia.org/wiki/Backus-Naur_form

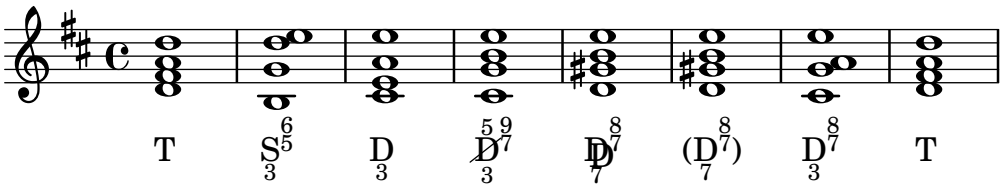
[5] Note: *harmonyli.ly* intends to be complete, but not correct. This – maybe surprising – statement must be explained: In computer sciences one discusses the correctness and the completeness of a process for deriving syntagms by using a semantical interpretation of each derivable syntagm. The construct (language and process) is **complete**, if for any intended real world object a syntagm can be derived which refers to that real world element. And the construct is **correct** if each derivable syntagm refers to a real world object. For human beings in general and musicologist in particular it is more important to use a **complete** language (of *Harmony Analysis Symbols*) than using a correct language: We want to know that we can express whatever we want to express, because our language is complete. And we can avoid wrong / meaningless syntagms manually, so that the fact, that our language is not correct (in the sense of computer languages) does not matter. Therefore, we want to say that

- **all** 'subrows' of *Harmony Analysis Symbols* which are necessary to describe the harmonic relationships of real world chords must be formulatable by *harmonyli.ly.*
- **not all** 'subrows' of *Harmony Analysis Symbols* which can be generated by *harmonyli.ly* necessarily describe possible chord chains.

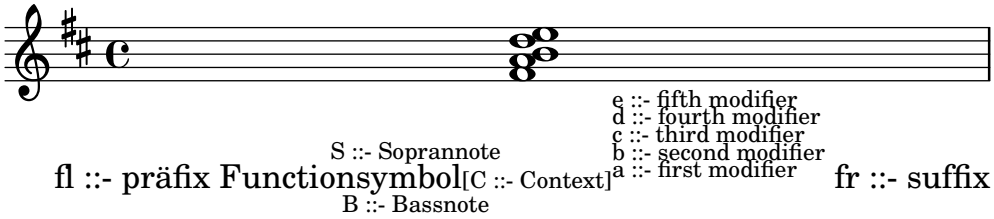
A last remark: If one had a correct and complete language for describing streams of harmonical chords, then one would have a complete theory of harmonization which no longer needs the help of 'unrepresented human knowledge'. Delivering such a theory is far beyond the target of *harmonyli.ly.*

4.3 The Syntax of a Harmony Analysis Symbol

Typical *Harmony Analysis Symbols* look like these:



They are created by different *harmonyli.ly* functions, which – nevertheless – take the same kind of parameters[6]: The function symbol is obligatoric and specified as string argument. The other parameters are optional and handed over in a list of attributes. Let *harmonyli.ly* itself visualize the structure of a *Harmony Analysis Symbol*:

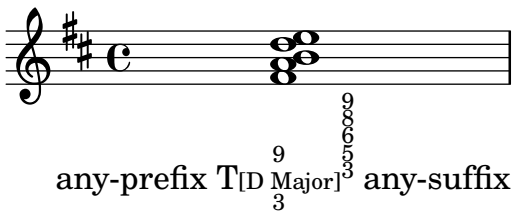


The general syntax to specify such a *Harmony Analysis Symbol* is this:

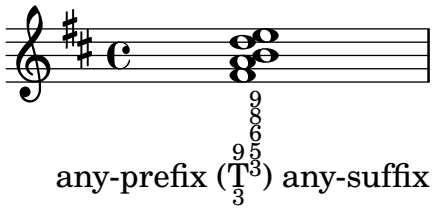
```
...
  \addlyrics {
    ...
    \setHas
      "T"             ; the function symbol
      #               ; indicator to read the following syntagm as scheme term
      `               ; indicator to evalute the syntagm and insert the result
      (               ; start of the syntagm 'attribute list'
        ("B" . "3")   ; insert a bass note 3
        ("S" . "8")   ; insert a sopran note 8
        ("C" ."D Major") ; explicate the keynote as reference
        ("a" . "3")   ; insert the lowest number beside the functional symbol
        ("b" . "5")   ; insert the second number beside the functional symbol
        ("c" . "6")   ; insert the third number beside the functional symbol
        ("d" . "8")   ; insert the fourth number beside the functional symbol
        ("e" . "9")   ; insert the fifth number beside the functional symbol
        ("fl" ."any-prefix ") ; insert a prefix before the harmony analysis symbol
        ("fr" ." any-suffix") ; insert a suffix after the harmony analysis symbol
      )               ; end of the attribute list
    ...
  }
```

[6] except `setRfHas` and `expZoomRow`

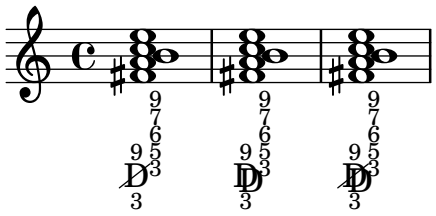
In general, you can skip the attributes which you do not want to use. And you can insert the attributes you want to use in any succession you prefer. Howsoever, the presented example would create the following output:



For modifying this example[7] into an intermediary chord, you only must replace the function `\setHas` by the function `\setImHas`. As the result you will get this:



If you want to cross out the functional symbol for indicating that the root is not part of the chord or if you want to double the functional symbol for indicating that it is a second level function or if you want to indicate both aspects, simply add the attribute `("T"."x")` respectively `("T"."d")` respectively `("T"."dx")` or `("T"."xd")`:



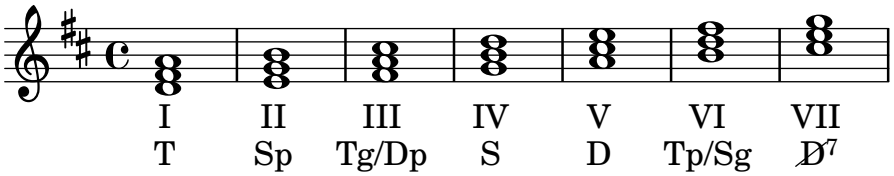
5 Harmony Analysis Symbols: Simple and Complex Examples

After having explained the general methods to create a *Harmony Analysis Symbol*, we can now show how one can fulfill specific musical needs by these techniques:

[7] Later, we will explicitly describe the purpose of this feature 'explicating the context'. Up to that point we will ignore this opportunity in our examples.

5.1 Inserting a Function Symbol

The majority of Anglo-Saxonian musicologists use something like the 'scale-step-theory' by which each tone of scale and the respective chord is referred by the respective number (represented by a Roman numeral). Alternatively one can use the functional (harmony) theory by which the chords of a scale are referred by their harmonical functions (represented by characters).[8] Both methods can be expressed by *harmonyli.ly*: Insert the respective symbol as first argument of the *harmonyli.ly* basic functions. If you don't need any additional specifier, add at least an empty attribution list `#'()`:



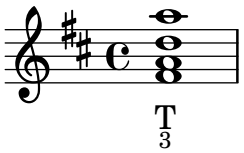

```
\version "2.18.2"

\header { tagline = "" }
\include "lilypond/harmonyli.ly"

\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp
    < d' fis' a'>1
    < e' g' b' >1
    < fis' a' cis'' >1
    < g' b' d'' >1
    < a' cis'' e'' >1
    < b' d'' fis'' >1
    < cis'' e'' g'' >1
  }
  \addlyrics {
    \markup \setHas "I" #'()
    \markup \setHas "II" #'()
    \markup \setHas "III" #'()
    \markup \setHas "IV" #'()
    \markup \setHas "V" #'()
    \markup \setHas "VI" #'()
    \markup \setHas "VII" #'()
  }
  \addlyrics {
    \markup \setHas "T" #'()
    \markup \setHas "Sp" #'()
    \markup \setHas "Tg/Dp" #'()
    \markup \setHas "S" #'()
    \markup \setHas "D" #'()
    \markup \setHas "Tp/Sg" #'()
    \markup \setHas "D" #'(("T"."x")("a" . "7"))
  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
```

[8] for dedails cf. *anonymous*: Function (music); n.Y (2019) ⇒ https://en.wikipedia.org/wiki/Function_(music) – reference download: 2019-11-14, wp.

5.2 Indicating a Bass Note

In the context of the scale-step-theory, the bass note is referred by the Roman numeral which is inserted as a functional symbol. Hence, the scale-step-theory does not have the need to additionally indicate the bass note.

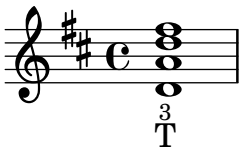
In the context of the functional harmony theory the chord is referred by its function. By default the respective symbol implies that the root is the bass note and that the chord uses the third and the fifth. Therefore, the bass note of a described chord is only revealed if it is not the root of the chord. For indicating the bass note expand the attribute list by the string `("B"."YOUR_NUMBER")`:




```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp < fis' a' d'' a''>1 }
  \addlyrics {

    \markup \setHas "T" #'(("B"."3"))

  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
\end{lilypond}
\end{center}
```

5.3 Indicating a Sopran Note

Sometimes, a musicologist wants to explicitly specify the highest tone of a chord. For indicating the 'soprano' note expand the attribute list by the string `("S"."YOUR_NUMBER")`:



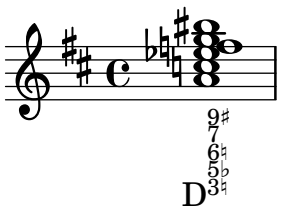

```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp < fis' a' d'' a''>1 }
  \addlyrics {
```

```
    \markup \setHas "T" #'(("S"."3"))

  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
\end{lilypond}
\end{center}
```

5.4 Indicating Descant Tones

In accordance to the method for writing a basso continuo, both theories explicitly display the numbers of those chord tones which shall be used, but which are not covered by the default rule 'take 1+3+5+8'. And with respect to the other composition rule 'by default combine thirds' each number implictly supresses its predecessor and successor. Hence, if the chord contains a second, the two respective adjacent numbers must be revealed.

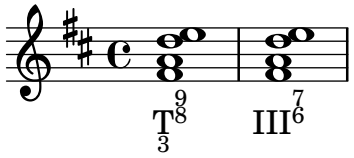
harmonyli.ly allows you to add up to five deviating tones by inserting the strings `("a"."YOUR_NUMBER")`, ..., `("e"."YOUR_NUMBER")` into the attribute list. Additionally, these numbers can be altered by using the standard UTF8 / unicode signs {𝄫, ♭, ♮, ♯, 𝄪}[9]:




```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp
    < a' c'' es'' f'' g'' bis''>1
  }
  \addlyrics {

    \markup \setHas "D" #'(("a"."3*")("b"."5-")("c"."6*")("d"."7")("e"."9+"))

  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
```

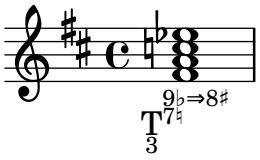
[9] We use the LaTeX command `\verbatim` for showing the *LilyPond* code which creates the example. Unfortunately, we can not use special Unicode signs in these sections. As a substitute we use `+` for ♯, `-` for ♭ and `*` for ♮.

Note, the 'scale-step-theory' and the 'functional harmony analysis' use different types of numberings: In a *Harmony Analysis Symbol*, all numbers refer to the root of the chord. In a description based on the scale-step-theory, all added numbers refer the bass tone represented by the Roman numeral. Therefore, if we describe an inversion of a chord, we have to use different numberings:



harmonyli.ly does not support you to use the correct digits. It is your task to adequately describe the chords with respect to the chosen theory.

Sometimes it is helpful, to expand your representation by a reinterpretation in accordance to an enharmonic change. The parameters 'a', ...,'e' can be bound to strings, not only to (altered) numbers. So, you are able also to create constructs like this:

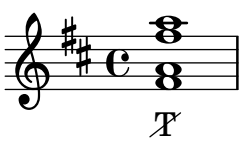


5.5 Indicating the Supression of the Root Tone

In the context of the scale-step-theory, the bass note is referred by the Roman numeral which is inserted as a functional symbol. And each tone of the chord is described by the distance to that bass tone (= by the number of the respectiv intervall). Hence, the scale-step-theory does not have the need to indicate the supression of the root tone.

In the context of the functional harmony theory the chord is referred by its function. By default the respective symbol implies that the root is the bass note and that the chord uses the third and the fifth. But in some cases you want to indicate, that the chord does not use its root, but only the other explitcitly or implicitly specified tones.

For indicating that the chord does not contain its root, insert the string `("T"."x")` into the attribute list:



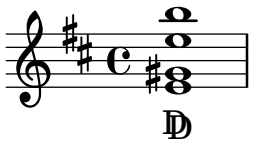
```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp < fis' a' fis'' a''>1 }
  \addlyrics {


    \markup \setHas "T" #'(("T"."x"))


  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
\end{lilypond}
\end{center}
```

Note: Suppressing the root tone can be combined with the indication of a second level function by adding the attribute `("T"."dx")` or `("T"."xd")` into the attribute list.

5.6 Indicating a Second Level Functions

The functional harmony analysis also knows the second level function *double dominant*. *harmonyli.ly* offers the opportunity to double all functional symbols for creating any second level function symbol.

For indicating that the chord fulfills a second level function, insert the string `("T"."d")` into the attribute list:



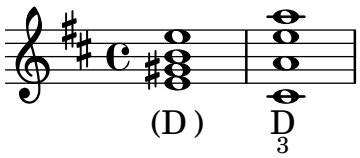
```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp < e' gis' h'' e''>1 }
  \addlyrics {


    \markup \setHas "D" #'(("T"."d"))


  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
\end{lilypond}
\end{center}
```

Note: Suppressing the root tone can be combined with the indication of a second level function by using the attribute `("T"."dx")` or `("T"."xd")`.

5.7 Indicating Intermediary Chords

In the functional harmony theory, by default each function refers to the keynote: In a *D Major* piece, *A Major* is taken as dominant. In an *E Major* piece, *A Major* is taken as subdominant. But sometimes, the musicologist must indicate that a chord has a function with respect to the root of the succeeding chord instead of being determined by the keynote. Such chords are know as intermediary chords.

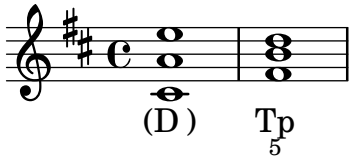
For indicating that a single chord is an intermediary chord and that its function refers to the root of its successors, use the function `\setImHas` instead of `\setHas`:



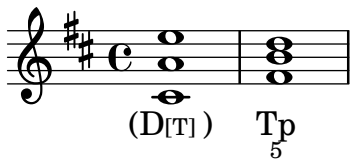

```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp
  < e' gis' b' e''>1 < cis' a' e'' a''>1  }
  \addlyrics {


    \setImHas "D" #'()


    \markup \setHas "D" #'(("B"."3")) }
  }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
\end{lilypond}
\end{center}
```

5.8 Indicating the Chord Context

The common use of intermediary chords leads attentive musicologists to the conclusion, that the syntax of the functional harmony theory is still not sufficiently designed. They know that their analyses sometimes unfortunately depend on an underlying 'good will' understanding of their readers. Let us prove this statement by a look at the following traditionally represented deceptive cadence:



The disadvantage of such a notation is, that the reader has to know, that A major is the dominant of D major and the b minor is the relative key of D major and that in this case therefore the row `(D) Tp` represents a deceptive cadence. The representation of the harmonical analysis does not give him any hint. But if we found the string `(D[T]) Tp`, which could indicate the context of a chord, we would have a clear representation which would syntactically indicate that the dominant to the tonic is followed by the relative to the tonic and that therefore the definition of a deceptive cadence is fulfilled:



If one uses such a representation for a deceptive cadence, then one can directly argue from the definitions and the facts to the existence of a deceptive cadence:

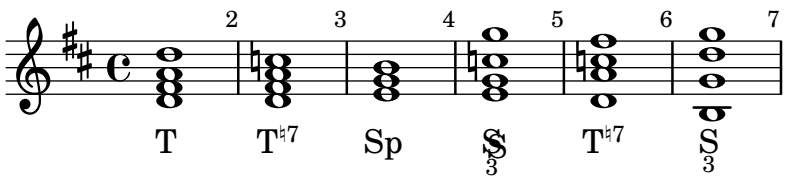
- Every dominant `D` leads to its tonic `T`.
- An intermediary chord `()` refers to the successor.
- In he current case, the successor is not the expected tonic, but the relative tonic.
- Hence it is not a cadence, but a deceptive cadence `(D) Tp`

For indicating the context of a specific function you must expand the attribute list by the string `("C"."YOUR_CONTEXT")`. The context can either be another function or the root of a key.

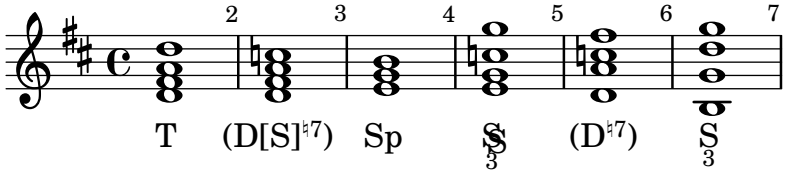
5.9 Indicating Intermediary Chains Chords

Sometimes, the musicologist has not only to indicate a single intermediary chord, but an intermediary chain of chords where each chord of this chain refers to the successor of the chain.

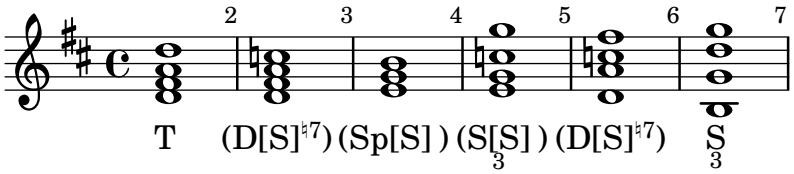
For deriving this need, let us first present an example and a traditional straight forward analysis:



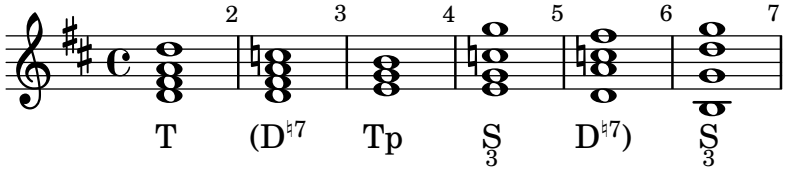
Beyond any doubt, this analysis is correct. But it is not appropriate because it does not consider the leading quality of the decreased seventh in bar 2 and bar 5. An analysis which better covers our auditive understandings would be this:



But even this analysis does not represent, what we hear. It does not capture the functional releationshop of `e-minor` in bar 3 and `C-Major` in bar 4 which is established by the three common tones. So, a better interpretation would also represent the chords in bar 3 and 4 with respect to the chord in bar 6:



And here, we can directly see that all chords from bar 2 to bar 5 functionally refer to the chord in bar 6. Hence we hear an intermediary chain of chords. *harmonyli.ly* shall be able to represent such rows as it is shown by the next interpretation:



Here you can see the advantage of such a sophisticated analysis: only our last interpretation syntactically represents the fact that we hear a deceptive cadence in the row and that the complete chain of chords from bar 2 to 6 as a unit fulfills the function of a subdomain.

Intermediary chains of chords can be created by explicitly open an intermediary row, by inserting as many simple *Harmony Analysis Symbol* as necessary and by explicitly closing the intermediary row as it is chown in this example:

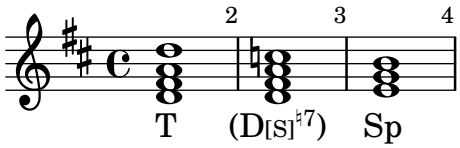
```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp
```

```
    \override Score.BarNumber.break-visibility = #'#(#t #t #t)
    < d' fis' a' d''>1 | <  d' fis' a' c''>1 | < e' g' b'> |
    < e' g' c'' g''>1 | < d' a' c'' fis''>1 | < b g' d'' g''>1 |}
  \addlyrics {
    \markup \setHas "T" #'(("."."))


    \markup \openImRow "D" #'(("a"."-7")


    \markup \setHas "Tp" #'()
    \markup \setHas "S" #'(("B"."3"))


    \markup closeImRow "D" #'(("a"."-7")


    \markup \setHas "S" #'(("B"."3"))
    }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
```

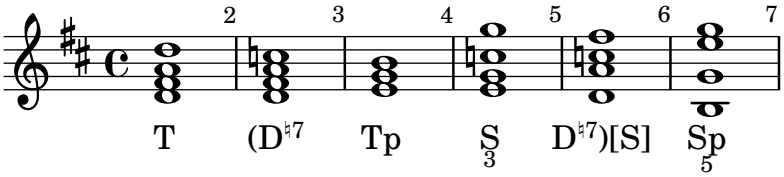
Please keep in mind: It is not necessary that you agree with our analysis. But we wanted to prove that *harmonyli.ly* can grasp such complex relationships.

5.10 Indicating the Context of Intermediary Chains of Chords

Now we must tighten up the screw a bit more: If *harmonyli.ly* shall be able to represent deceptive candences by indicating the expected function of an intermediary chord and the real disappointing function of the successing chord – as it is shown here –



then *harmonyli.ly* must also be able to represent deceptive cadences which use intermediary chains of chords followed by a functionally disappointing relative chord :



Periodicals, Shortcuts, and Overlapping Abbreviations

cf. ..... confer / compare
ibid. ..... ibidem = latin for 'at the same place'
id. ..... idem = latin for 'the same', be it a man, woman or a group...
l.c. ..... loco citato = latin for 'in the place cited'
wp. ..... webpage / webdocument without any internal (page)numbering

References

anonymous: Degree (music); n.Y (2019), FreeWeb / HTML ⇒ https://de.wikipedia.org/wiki/Stufentheorie_(Harmonik) – reference download: 2019-11-14
This article – written in English – describes some basic concepts of the scale degree theory,

anonymous: Function (music); n.Y (2019), FreeWeb / HTML ⇒ https://en.wikipedia.org/wiki/Function_(music) – reference download: 2019-11-14
This article – written in German – describes the harmonical function theory and also contains simple and complex examples for the shape of functional harmonical analysis symbols.

anonymous: Funktionstheorie [in der Musikwissenschaft]; n.Y (2019), FreeWeb / HTML ⇒ https://de.wikipedia.org/wiki/Funktionstheorie – reference download: 2019-11-14
This article – written in German – describes the harmonical function theory and also contains simple and complex examples for the shape of functional harmonical analysis symbols.

anonymous: Musiklehre: Stufen- und Funktionstheorie; n.Y (2019), FreeWeb / HTML ⇒ https://de.wikibooks.org/wiki/Musiklehre:_Stufen-_und_Funktionstheorie – reference download: 2019-11-14

This article – written in German – explains some basic concepts of the harmonical analysis.

anonymous: Stufentheorie (Harmonik); n.Y (2019), FreeWeb / HTML ⇒ https://de.wikipedia.org/wiki/Stufentheorie_(Harmonik) – reference download: 2019-11-14

This article – written in German – describes the harmonical scale-step-theory and contains simple and complex examples for the shape of harmonical scale step analysis symbols.

Gardner, Matthew a. *Sara Springfeld*: Musikwissenschaftliches Arbeiten. Eine Einführung; 2nd edition. Kassel: Bärenreiter-Verlag, 2018 (= Bärenreiter Studienbücher Musik), Print: ISBN 978–3–7618–2249–4

Die aktuellste Einführung in die Musikwissenschaft

Grabner, Hermann: Allgemeine Musiklehre; mit einem Nachtrag v. Diether de la Motte; 11th edition. Kassel, Basel [... u.a.O.]: Bärenreiter Verlag, 1974, Print: ISBN 3–7618–0061–4

Das Standardwerk der Musikanalyse, das nicht erst heute mit hoher Auflagennummer erscheint, sondern auch schon vor 50 Jahren so erschienen ist - also im wahrsten Sinne des Wortes: ein Jahrhundertwerk.

Krämer, Thomas: Harmonielehre im Selbststudium; 5th edition. Wiesbaden, Leipzip u. Paris: Breitkopf & Härtel, 2009, Print: ISBN 978–3–7651–0261–5

Das 'Übungsbuch' zum neueren 'Lehrbuch der harmonischen Analyse' - sozusagen.

Krämer, Thomas: Lehrbuch der harmonischen Analyse. 2., verbesserte Aufl.; Wiesbaden, Leipzip u. Paris: Breitkopf & Härtel, 2012, Print: ISBN 978–3–7651–0305–6

Ein neueres Lehrbuch, das die Zusammenhänge der Tonalität zugänglich macht.

Mantel, Gerhard: Intonation; Spielräume für Streicher; Mainz, London, [... u.a.O]: Schott, 2005 (= Studienbuch Musik), Print: ISBN 3–7957–8729–7

Ein Buch, das die Grenzen der systematischen Tonalität anhand der Intonation bei Streichinstrumenten verdeutlicht: um sauber zu spielen, muss man an der richtigen Stellen auf die richtige Weise falsch spielen.

Michels, Ulrich: dtv-Atlas zur Musik. Tafeln und Texte; Systematischer Teil [u.] Historischer Teil: Von den Anfängen bis zur Renaissance; 5th edition. München, Kassel [... u.a.O.]: DTV & Bärenreiter Verlag, 1980, Print: ISBN 3–423–03022–4

Auch ein Standardwerk für alles, was zur systematischen Musiktheorie gehört.

Motte, Diether de la: Harmonielehre; 16th edition. München, Kassel [... u.a.O.]: Bärenreiter Verlag & DTV, 2011, Print: ISBN 978–3–7618–2115–2

Nach Grabner das nächste, kommende Jahrhundertwerk zur Harmonieanalyse, das mit seiner Verlagerung des Schwerpunktes in die Funktionstheorie einen wesentlichen Fortschritt gegenüber älteren Lehrwerken bedeutete.

References

Schlosser, Joachim: Wissenschaftliche Arbeiten schreiben mit LaTeX. Leitfaden für Einsteiger. 6., überarb. Aufl.; Frechen: mitp Verlag, 2016, Print: ISBN 978–3–95845–289–3

Eine sehr praxisnahe Einführung in die Nutzung von LaTeX als Werkzeug zum Schreiben (wissenschaftlicher) Texte. Die durchaus spannende Frage, wie und warum das Wissenschaftliche das Schreiben wissenschaftlicher Texte prägt, bleibt ungestellt.

Voß, Herbert: Die wissenschaftliche Arbeit mit LaTeX; unter Verwendung von LuaTeX, KOMA-Script und Biber/BibLaTeX; Berlin: Lehmanns Media, 2018 (= dante), Print: ISBN 978–3–86541–946–0

Eine sehr praktische Einführung in LaTeX, die sich auf die Erstellung wissenschaftlicher Texte konzentriert. Einziger kleiner Wermutstropfen ist die eher mathematisch orientiert Vorgabe, wie wissenschaftliche Texte auszusehen hätten. Die Geisteswissenschaft ist – wie so oft – irgendwie nur 'mitgemeint'.