Release 1.0.1

harmonyli.ly

Harmonical Analysis Symbols in LilyPond Scores

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Abstract

This tutorial describes how to create and embed Harmony Analysis Symbols into scores. It intends to be a handout for musicologists and other enthusiasts of harmony analyses, who use LilyPond. It documents the usage of the library harmonyli.ly by which it can develop Riemann symbols as well as symbols of the scale-step-theory). Due to the fact, that harmonyli.ly as well as this LATEX based paper is published as open source software and that its sources are part of the library harmonyli.ly, it indirectly can also teach how to embed LilyPond snippets into LATEX files.

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1 Introduction

In the beginning, there was the need to write a musicological work.

Actually, I should have had a good start: I knew already, that – at least in the humanities – there is a big difference between the Anglo-American scientific style[1] and the European resp. German standard.[2] I had already seen that it was a bit tricky to use that style in LaTeX. To close the gap that I had met, I had developed a complete LaTeX based environment for writing scientific articles and books which fulfill the sophisticated requirements of the (German) humanities in general and the standards of the musicology in particular.[3] I had published this tool as open source software[4] and described the respective (working) style.[5]

But – unfortunately – I still 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 and no tutorial, how to successfully combine which tools for getting a usable working environment. Thus, I had to interrupt my musicological work before I had started it. Previously, it was necessary to investigate the situation for not backing the wrong horse. In the end, I had written a complete analysis of the best way to embed musicological examples into LaTeX texts.[6] And I had published the respective sources als kind of open source 'software'.[7]

A preliminary result of this investigation was, that we have three back-ends for using musical notes in LaTeX: We could use the style of *ABC*-Notation

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[1] cf. The Chicago Manual of Style; Chicago and London: The University of Chicago Press, 2010: ISBN 978–0–226–10420–1, pp. 619ff.

[2] cf. *Theisen, Manuel René*: Wissenschaftliches Arbeiten. Erfolgreich bei Bachelor- und Masterarbeit; unter Mitarbeit v. Martin Theisen; München: Verlag Franz Vahlen, 2013: ISBN 978–3–8006–4636–4, pp. 147ff.

[3] cf. *Reincke, Karsten*: mycsrf; mind your Classical Scholar Research Framework; 2018 ⇒ https://fodina.de/mycsrf/ – reference download: 2018-12-21, wp.

[4] cf. *Reincke, Karsten*: Sources of 'mycsrf'; The github repository of 'mind your Classical Scholar Research Framework'; 2018 ⇒ https://github.com/kreincke/mycsrf/ – reference download: 2018-12-21, wp.

[5] cf. *Reincke, Karsten*: Dienst am Leser, Dienst am Scholaren. Über Anmerkungsapparate in Fußnoten - aber richtig: Release 2.0; (Geistes-) Wissenschaftliche Texte mit jurabib; 2018 ⇒ http://kreincke.github.io/mycsrf/examples/scholar-fono-de.pdf – reference download: 2018-12-21,.

[6] cf. *Reincke, Karsten*: Musikwissenschaft mit LaTeX. Wie man Musikbeispiele mit Open-Source-Tools in seine wissenschaftliche Texte integriert. Eine selbstreferentielle Anleitung; Eine Sichtung von Tools und Techniken um musikwissenschaftliche Texte mit LaTeX zu erzeugen. Ein Blick in die Quellen zeigt, wie man das macht, was dieses Buch vorführt und erklärt.; 2019 ⇒ http://kreincke.github.io/mycsrf/examples/latex-musicology.pdf – reference download: 2019-01-02,.

[7] cf. *Reincke, Karsten*: Quellen zu Musikwissenschaft mit LaTeX; 2019 ⇒ https://github.com/kreincke/mycsrf/tree/master/examples/musicology.de – reference download: 2019-01-02,.

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 *music-xml2ly*, 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*.[8]

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 re-implementation of *harmony* for *LilyPond* by using its LISP based language *GUILE* and the respective 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*[9] as well as to the intended target system *LilyPond*[10], 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[11]. I knew, that at that time I might have been a good programmar, 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. But at this point, a typical open source success story started.

I got a lot of hints, for instance by Leo Correia de Verdier, Phil Holmes, Urs Liska Thomas Morley, Mark Stephen Mrotek, Carl Sorensen, Saul Tobin, David Wright. I was told that Klaus Blum had already written a first version of such a tool and that it was published as Public Domain Software in the *LilyPond Snippet Repository*.[12] So I took this preliminary work, redesigned and expanded the interface, rewrote some functions and added a lot of other code. But nevertheless, my library was a derivative work of Klaus Blum's model. So – and even if it had not been necessary from a legal point of view –, I asked him whether he could

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[8] For a survey of the existing backends cf. *Reincke*: musicology.de, 2019, pp. 19ff. For a an outline of the generally possible way to combine existing tools cf. id., l.c., pp. 91f. And for the final result cf. id., l.c., pp. 100f. If you need more information about the tools mentioned in this paragraph, have a look at the respective chapters in cf. id., l.c., et passim

[9] cf. *Wegner, Dagny* a. *Arnim Wegner*: harmony.sty; 2007 ⇒ ftp://ftp.dante.de/pub/tex/macros/latex/contrib/harmony/harmony.pdf – reference download: 2018-12-21,.

[10] cf. *LilyPond Development Team*: LilyPond. Notensatz für Jedermann; o.J. [2018] ⇒ http://lilypond.org/index.de.html – reference download: 2019-01-05, wp.

[11] → https://lists.gnu.org/archive/html/lilypond-user/2019-10/msg00411.html

[12] cf. *Blum, Klaus*: Functional analysis; o.J. (2019) ⇒ http://lsr.di.unimi.it/LSR/Item?id=967 – reference download: 2019-12-01, wp.

accept that I was re-engineering his work and that I was going to release the result under a licensing construct, by which the user could choose the license he preferred, either GPL or MIT. And to my great pleasure, Klaus Blum agreed with this concept.[13]

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 output of *LilyPond*.

- You get *harmonyli.ly* as open source software[14] together with a licensing, which is explicitly approved by the copyright holders Hans Blum and me, Karsten Reincke. Hence, you can be sure of really having got the rights you need to use *harmonyli.ly*.

- You get a complete tutorial[15] which thoroughly explains

  - how to generally install and integrate *harmonyli.ly* into your work

  - how to prepare your work for using *harmonyli.ly* successfully

  - 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.[16]

- 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.

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[13] You will find the approving mail in the directory 'xtras' of the harmonyli.ly sources. (→ https://github.com/kreincke/harmonyli.ly/tree/master/xtras) Just as Klaus Blum did, also *harmonyli.ly* uses some examples offered by Neil Puttock for explaining how to use text span engraver (→ http://www.mail-archive.com/lilypond-user) and which therefore fall under the same license as any other example code which is offered by *LilyPond*.

[14] cf. *Blum, Karsten Reincke; Hans*: harmonyli,ly; 2019 ⇒ https://github.com/kreincke/harmonyli.ly – reference download: 2019-11-22, wp.

[15] cf. *Reincke, Karsten*: harmonyli.ly . Harmonical Analysis Symbols in LilyPond Scores. Tutorial; 2019 ⇒ https://kreincke.github.io/harmonyli.ly/tutorial.pdf – reference download: 2019-11-22, wp.

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

- 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 overlaps, 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:

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.[17]

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*.

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[17] 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.

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)
       (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.[18]

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[18] 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 aggravates 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 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.

3.3.1 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[19]. 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 succeding 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 succeding 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 harmonic function
(08)	**openImZoomRow**	→	starts the zoom into an intermediary *Harmony Analysis Symbol* which shall cover suspended or passing notes

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[19] → FAQ p. 35

(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 with the following eBNF grammar[20], you can embed five types of sub rows into your stream of *Harmony Analysis Symbols*[21]:

```
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

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

[21] Note: *harmonyli.ly* intends to be complete, but not correct. This – may be surprising – statement must be explained: In computer sciences, one discusses the correctness and the completeness of a process for deriving syntagms by using a semantic 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** 'sub rows' of *Harmony Analysis Symbols* which are necessary to describe the harmonic relationships of real world chords must be formable by *harmonyli.ly.*

- **not all** 'sub rows' 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 harmonic chords, then one would have a complete theory of harmonization that no longer needs the help of 'unrepresented human knowledge'. Delivering such a theory is far beyond the target of *harmonyli.ly.*
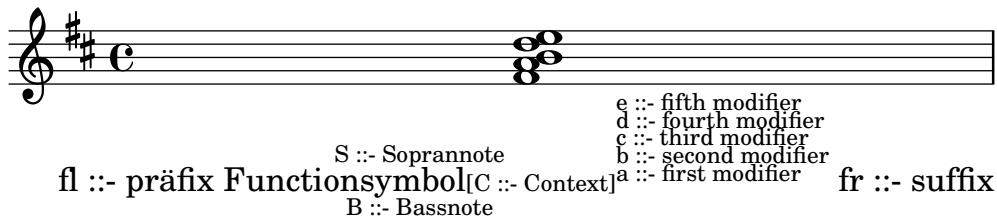
- you need not explicitly to close an opened zoom

4.3 The Syntax of a Harmony Analysis Symbol

Typical *Harmony Analysis Symbols* look like these:

$$T \quad S_3^6 \quad \underset{3}{D} \quad D_3^7 \quad \underset{7}{D^7} \quad (D_7^7) \quad D_3^7 \quad T$$
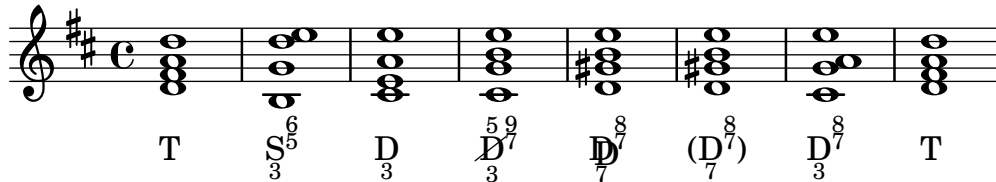
They are created by different *harmonyli.ly* functions, which – nevertheless – take the same kind of parameters[22]: The function symbol is obligatory and specified as a string argument. The other parameters are optional and handed over in a list of attributes. Let *harmonyli.ly* itself visualize the structure of a *Harmony Analysis Symbol*:

fl ::- präfix Functionsymbol[C ::- Context]ᵃ ⁱⁱ⁻ ᶠⁱʳˢᵗ ᵐᵒᵈⁱᶠⁱᵉʳ   fr ::- suffix

S ::- Soprannote
B ::- Bassnote
e ::- fifth modifier
d ::- fourth modifier
c ::- third modifier
b ::- second modifier
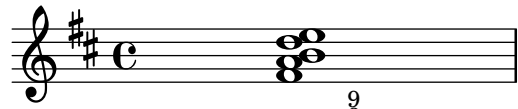
The general syntax to specify such a *Harmony Analysis Symbol* is this:

```
...
  \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
    ...
  }
```

---

[22] except `setRfHas` and `expZoomRow`
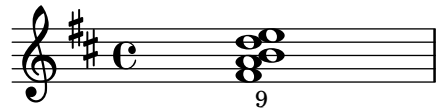
In general, you can skip the attributes which you do not want to use. And you can insert the attributes you want to use in any succession you prefer. Howsoever, the presented example would create the following output:

any-prefix T[D Major] any-suffix

For modifying this example[23] into an intermediary chord, you only must replace the function \setHas by the function \setImHas. As a result you will get this:

any-prefix (T) any-suffix

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"):

4.4 Using harmonyli.ly for scale step symbols

For demoing that you can use *harmonyli.ly* also, if you want to describe the music by the elements of scale step theory, let us shortly convert the given example into that format:

---

[23] 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.

$$\text{I} \quad \text{VI}^6_4 \quad \text{VII}^6 \quad \text{VII}^7_5 \quad \text{I}^6_{\sharp4}{}_2 \quad \text{I}^6_{\sharp4}{}_2 \quad \text{VII}^8_7 \quad \text{I}$$

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:

5.1 Inserting a Function Symbol

The majority of Anglo-American musicologists use something like the 'scale-step-theory' by which each tone of the scale and the respective chord is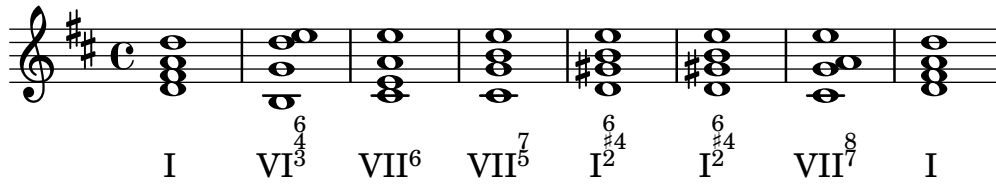 referred by the respective number (represented by a Roman numeral). Alternatively one can use the functional (harmony) theory by which the chords of a scale are referred by their harmonious functions (represented by characters).[24] Both methods can be expressed by *harmonyli.ly*: Insert the respective symbol as the first argument of the *harmonyli.ly* basic functions. If you don't need any additional specifier, add at least an empty attribution list `#'()`:
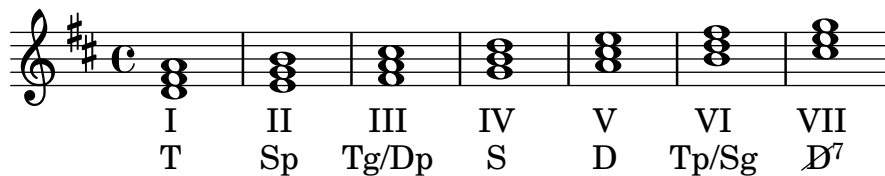

```
\version "2.18.2"

\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" #'()
```

---

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

```
      \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 {}
}
```

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"):
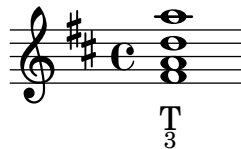

```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp < fis' a' d'' a''>1 }
  \addlyrics {


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


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

5.3 Indicating a Treble 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"`):
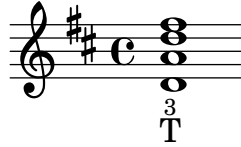

```
\version "2.18.2"
\header { tagline = "" }
\include "lilypond/harmonyli.ly"
\score {
  \new Staff { \clef "treble" \key d \major \time 4/4 \stemUp < fis' a' d'' a''>1 }
  \addlyrics {

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

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

5.4 Indicating Descant Tones

In accordance with 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 suppresses 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 $\{\flat\flat, \flat, \natural, \sharp, \times\}$[25]:

---

[25] 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 $\sharp$, - for $\flat$ and * for $\natural$.

```
\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 {}
}
```
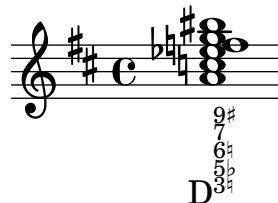
Note, the 'scale-step-theory' and the 'functional harmony analysis' use different types of numberings: In a *Harmony Analysis Symbol*, all numbers refer to the root of the chord. In a description based on the scale-step-theory, all added numbers refer to the bass tone represented by the Roman numeral. Therefore, if we describe an inversion of a chord, we have to use different numberings:
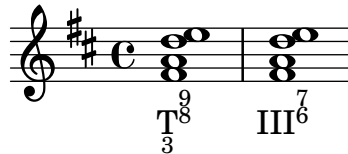
harmonyli.ly does not support you to use the correct digits. It is your task to adequately describe the chords with respect to the chosen theory.

Sometimes it is helpful, to expand your representation by a reinterpretation in accordance with 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:
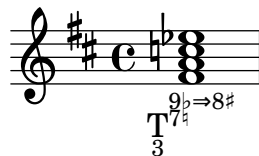
5.5 Indicating the Supression of the Root Tone

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 respective

interval). Hence, the scale-step-theory does not have the need to indicate the suppression 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 explicitly 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}
```
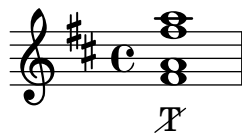
Note: Suppressing the root tone can be combined with the indication of a second-level function by adding the attribute (`"T"."dx"`) or (`"T"."xd"`) into the attribute list.

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 known 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}
```
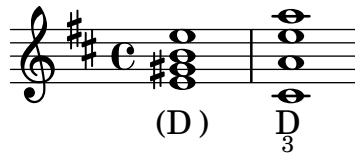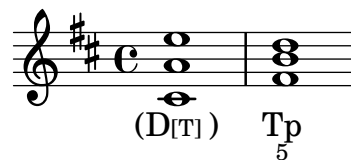
5.8 Indicating the Chord Context

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 'goodwill' understanding of their readers. Let us prove this statement by a look at the following traditionally represented deceptive cadence:
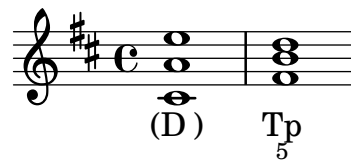
The disadvantage of such a notation is, that the reader has to know, that A major is the dominant of D major and the b minor is the relative key of D major and that in this case, therefore, the row (D) Tp represents a deceptive cadence. The representation of the harmonic analysis itself does not give him any hint. But if we found the string (D[T]) Tp indicating the context of the frist chord, we would have a clear syntactically based representation: The dominant of the tonic is followed by the relative to the tonic and that it is – by definition – a deceptive cadence:

- Every dominant D leads to its tonic T.
- All intermediary chords () refer to their successors.
- Here, 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.[26]

---

[26] Using the square brackets as an indicator for the context follows de la Motte who also saw the need to exemplify a local tonal center as something like the context of the interpretation. (cf. *Motte, Diether de la*: Harmonielehre; 16th edition. München, Kassel [... u.a.O.]: Bärenreiter Verlag & DTV, 2011: ISBN 978–3–7618–2115–2, pp. 144 et passim)

5.9 Indicating Intermediary Chains of 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 its traditional straight forward analysis:

Beyond any doubt, this analysis is correct. But it is not appropriate because of 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 could look like this:

But even this analysis does not represent, what we hear. It does not capture the functional relationship 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:

The advantage of such a sophisticated analysis strikes the eye: only this 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 Symbols* as necessary and by explicitly closing the intermediary row as it is shown here:

```
\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. The example should only prove that *harmonyli.ly* can grasp such complex relationships.

5.10 Indicating the Context of Intermediary Chains of Chords

But we must still tighten up the screw a bit more: If *harmonyli.ly* shall be able to represent deceptive cadences by indicating the expected function of an intermediary chord and the really disappointing function of the subsequent chord – as it is shown here –
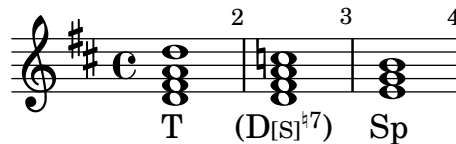
then *harmonyli.ly* must also be able to represent deceptive cadences which use intermediary chains of chords followed by a functionally disappointing relative chord:
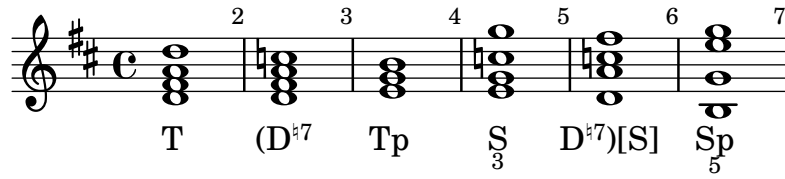
For indicating the context of an intermediary chain of chords you can use nearly the same method used for creating an intermediary chain of chords without indicating the content. But you have to add the attribute string (`"fr"."[YOUR_CONTEXT]"`) into the attribute list of the chord which closes the intermediary row:

```
\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' e'' g''>1 |}
  \addlyrics {
    \markup \setHas "T" #'(("".""))
    \markup \openImRow "D" #'(("a"."-7"))
    \markup \setHas "Tp" #'()
    \markup \setHas "S" #'(("B"."3"))


    \markup \closeImRow "D" #'(("a"."-7")("fr"."[S]"))


    \markup \setHas "Sp" #'(("B"."5"))
    }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
```

The idea behind this method is that you here use the attribute *f(illstring)r(ight)* to append an the string `"[YOUR_CONTEXT]"`

5.11 Indicating Suspended and Passing Notes

In other harmonic analyses, the musicologist wants to represent suspended or passing notes although they do not modify the underlying harmonic function. It is like he zooms in on the details of the chord. Here is an example of such a 'chordal movement':
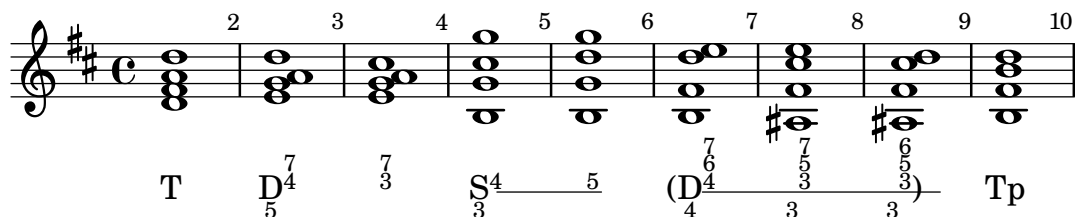
For constructing this kind of descriptions you must open a zoom row before you can expand it (`bar 2-3` and `bar 4-5`). Or you open an intermediary zoom row, expand it and close it explicitly (`bar 6-9`). If you want to create a line for indicating the zoom row graphically (`bar 4-5` and `bar 6-9`), you must call the function `\initTextSpan` before the function `\open[Im]ZoomRow`, the function `\startTextSpan` after the function `\open[Im]ZoomRow`, and the function `\stopTextSpan` after the last call of the function `\expZoomRow` respectively after having called the function `\closeImZoomRow` – as it is shown in the code of the given 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 | <  e' g' a' d''>1 | < e' g' a' cis''> |
    < b  g' cis'' g''>1 | < b  g' d'' g''>1 | < b fis' d'' e''>1 |
    < ais fis' cis'' e''>1 | < ais fis' cis'' d''>1 | < b fis' b' d''>1 |}
  \addlyrics {
    \markup \setHas "T" #'(("".""))



    % bar 2 - 3
    \markup \openZoomRow "D" #'(("B"."5")("a"."4")("b"."7"))
    \markup \expZoomRow #'(("a"."3")("b"."7"))



    % bar 4 - 5
    \initTextSpan "   "
    \markup \openZoomRow "S" #'(("B"."3")("a"."4"))
    \startTextSpan
    \markup \expZoomRow #'(("a"."5"))
    \stopTextSpan



    % bar 6 - 9
    \initTextSpan "   "
    \markup \openImZoomRow "D" #'(("B"."4")("a"."4")("b"."6")("c"."7"))
    \startTextSpan
    \markup \expZoomRow #'(("B"."3")("a"."3")("b"."5")("c"."7"))
    \markup \closeImZoomRow #'(("B"."3")("a"."3")("b"."5")("c"."6"))
    \stopTextSpan



    \markup \setHas "Tp" #'()
    }
  \layout { \context { \Lyrics \consists "Text_spanner_engraver" } }
  \midi {}
}
```

Please note:

- It is not necessary to close a normal zoom row by any specific function. But if you start with \initTextSpan before \openZoomRow, then you must call \stopTextSpan after the last \expZoomRow

- In case of a normal zoom row as well as in case of an intermediary zoom row, you may insert the function \expZoomRow as often as it is required by your chord stream.

- In accordance with the nature of a zoom row, the functions \expZoomRow and \closeImZoomRow do not accept the parameter 'function symbol'. And they do not evaluate the attribute "S".

Finally, some of you might have noticed, that the closure of an intermediary zoom row sometimes can become a bit ugly (`bar 6-9`). Let us shortly give reasons for that before we present a 'workaround':

harmonyli.ly uses the method *addlyrics* for binding the stream of symbols to the stream of chords. Hence, each markup-command – and every single word not being embedded into a markup-command – is mapped to the next chord of the voice to which the analysis has been bound.[27] On the other hand, an intermediary row is indicated by a left parenthesis as a prefix and a right parenthesis as a suffix. From the viewpoint of *LilyPond*, the connection of the symbol and its prefix resp. its suffix is that unit that is bound to a chord. But in a lyric stream, *LilyPond* only allows us to underscore such a unit as a whole, not only the 'half' of a unit or a third or – as it actually is required here – the part before the right parenthesis. That's the reason, why in this case the line in `bar 9` crosses the bracket an is drawn through to the right border of the chord.

The good message is, that you will rarely run into this visual deficiency: it only arises in case of very long notes as we used here. Hence you mostly can use this technique without any modifications.

But if you have nevertheless run into this trap, you can use a good 'workaround' to put yourself out of this misery:

- Use the method *Binding Harmony Analysis Symbols to a Hidden Voice*[28]

- Split the long note into a large note and a shorter note.

- Stop the text span before the shorter note.

- Close the intermediary row with the shorter note.

---

[27] This seems to be the place for indicating to a little trap: The method *addlyrics* automatically maps two or more notes - linked by a slur or a tie - to one word (or, in our case, to one *Harmony Analysis Symbol*). This behaviour is disirable, if one deals with the text of songs. In case of harmonic analyses it disturbs. There are two solutions: First, one can resolve the slurs resp. ties where it is necessary. Or one can use the method *Binding Harmony Analysis Symbols to a Hidden Voice* to decouple music and analysis. (→ p. 7)

[28] →p. 7

As your result you will get this:

The trick becomes understandable if we unhide the hidden voice:

Here is the respective code:

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

\header { tagline = "" }

imInfix = " " % don't forget this!

isVisible = { \stemUp
  < b  g' d'' g''>1 | < b fis' d'' e''>1 |
  < ais fis' cis'' e''>1 | < ais fis' cis'' d''>1 | < b fis' b' d''>1 |
}

isHidden = \relative d { \stemDown
  \override NoteHead.color = #red
  \override NoteColumn #'ignore-collision = ##t
  d1 | d1 | d1 | d2. d4 | d1
}

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

  \markup \setHas "S" #'(("B"."3"))
  \initTextSpan "       "
  \markup \openImZoomRow "D" #'(("B"."4")("a"."4")("b"."6")("c"."7"))
  \startTextSpan
  \markup \expZoomRow #'(("B"."3")("a"."3")("b"."5")("c"."7"))
  \markup \expZoomRow #'(("B"."3")("a"."3")("b"."5")("c"."6"))
  \stopTextSpan
  \markup \closeImZoomRow #'()
  \markup \setHas "Tp" #'()
}
```

```
\score {
  \new Staff <<
    \key d \major  \time 4/4 \clef treble
    \new Voice { \isVisible }
    % change "Voice" to "NullVoice" to make analyze voice unvisible:
    \new Voice = "inVisible" { \isHidden}
    \new Lyrics \lyricsto "inVisible" { \hasSymbols }
  >>
  \layout{ \context { \Lyrics \consists "Text_spanner_engraver" } }
}
```

5.12 Indicating Modulations

One of the most important capabilities of a language to describe harmonic relationships is the feature to represent harmonic modulations. In a modulation the current function of a chord is re-interpreted with respect to a new tonal center: In the context of `D-Major`, `e-minor` is the *relative of the subdominant*, but in the context of `C-Major`, it is the *counter relative of the tonic*. Using this ambiguity, `e-minor` can act as linking chord which connects a section written in `D-Major` with a section written in `C-Major`.
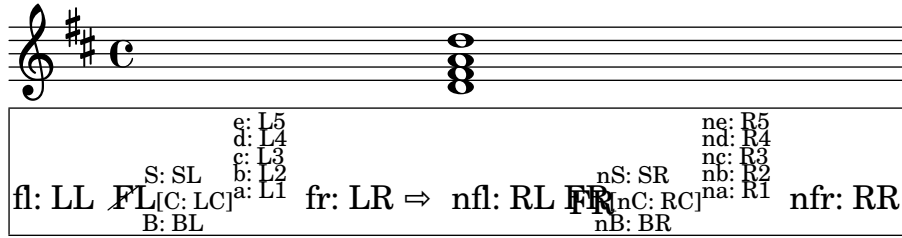
As far as we know, there still does not exist a coherently and commonly used method to indicate such harmonic reframings.[29] Therefore, we propose a straight forward approach: the two functions of the re-interpreted chord are linked by an arrow and the complete complex is outlined by a rectangle:

The complete syntax of such a reframing chord symbol can be demonstrated by using the respective function itself:

---

[29] One of the apologist of the functional harmonic theory, Hugo de la Motte, prefers to use a line-based concept with an overlapping section at the point of reframing: The first line starts with the *Harmony Analysis Symbols* related to the first tonal center up inclusively to the chord, which is reinterpreted, and is continued by blanks. The second line starts with blanks up to the beginning of the reinterpreted chord and is continued by the *Harmony Analysis Symbols* related to the second tonal center. (cf. *de la Motte*: Harmonielehre, 2011, pp. 144 et passim) For the use in a score this method is a bit unwieldy. Therefore, *harmonyli.ly* 'only' labels the reinterpreted chord added by indicating the modified context. To explicate the context by square brackets is used by de la Motte too. (cf. id., l.c., pp. 226 et passim)

This artifical symbol is created by the respective code:

```
\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' d''>1
  }
  \addlyrics {
    \markup \setRfHas
        "F/L"
        "F/R"
    #'(
        ("fl" . "fl: LL  ")
        ("T"."x")
        ("B"."B: BL")
        ("S"."S: SL")
        ("a" . "a: L1")
        ("b" . "b: L2")
        ("c" . "c: L3")
        ("d" . "d: L4")
        ("e" . "e: L5")
        ("C" . "C: LC")
        ("fr" . "  fr: LR")

        ("nfl" . " nfl: RL ")
        ("nT"."d")
        ("nB"."nB: BR")
        ("nS"."nS: SR")
        ("na" . "na: R1")
        ("nb" . "nb: R2")
        ("nc" . "nc: R3")
        ("nd" . "nd: R4")
        ("ne" . "ne: R5")
        ("nC" . "nC: RC")
        ("nfr" . "  nfr: RR")
    )

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

That it is helpful to have such a complex expressivity may be emphasized by the next example:

30

6 Just for Fun: A Last Example

Other than one seems to have thought up to now[30], the following, well-known example[31] – in toto – is obviously nothing else than a modulation from *a-minor* to

---

[30] Unfortunately, this is not the right place for discussing the meaning of the famous 'Tristan-Chord' and the history of the respective studies. The purpose of this chapter is to show that *harmonyli.ly* is indeed able to deal which such a complex research object. Nevertheless, we think it is remarkable, that even one of the latest scientific works does not use the complete arsenal of *Harmony Analysis Symbols* to exemplify the meaning of the considered positions: Petersen discusses the 'Tristan-Chord' on different pages, but neither in the text, nor in his examples, he is using the complete expressivity of the *Functional Harmony Analysis*, as it would be commensurate to the scores. (cf. *Petersen, Peter*: Isolde und Tristan: Zur musikalischen Identität der Hauptfiguren in Richard Wagners „Handlung" Tristan und Isolde; Würzburg: Königshausen u. Neumann, 2019 (= Wagner in der Diskussion Bd. 19): ISBN 978–3–8260–6796–9, pp. 48f, 50f, 56ff, 59). He stands in a line with other illustrious analyses: If one considers a central work for establishing the *Theory of Functional Harmony Analysis*, which at least informally defines the syntax and semantic of the respective symbols (cf. *de la Motte*: Harmonielehre, 2011, p. 282), then one has to state, that even its author – after having summarized some historical analyses of the 'Tristan-Chord' (cf. id., l.c., p. 225-227) – does not present his own interpretation by using his own method (cf. id., l.c., pp. 227f). How can this happen? It seem's that they do not trust their method – which is especially notable if one considers Petersen's appealing statement that 'chords and accords should ever be analyzed and interpreted as intra-events of cadences' (cf. *Petersen*: Isolde und Tristan, 2019, p. 51). We think, Petersen invocation is correct. And before we give up the theory by murmuring about a 'real meaning' which has to be captured by musicality, instead of being scientficly exemplified, we should apply the scientific theory completely. If we do so, we can directly see, that the phase model of Petersen is not adequate: Bar 1 = phase 1 is correctly taken as an 'imperfect cadence of aminor'. But taking bar 2 = phase 2 as an "Ausweichung nach C-Dur und Halbschluss auf der Dominante" (= 'modulation? to C major with an imperfect cadence) (cf. id., ibid.) does not consider, that there is a link between the 'Tristan-Chord' at the preceeding 'chord' *E major* in phase 1: the 'Tristan-Chord' can be taken as *gis minor with 'sixt ajoutée'* which is nothing else then relative of the 𝕯 of *a minor*. What can we conclude from this? We must define a sufficiently elaborated theory of harmony analyses. In the tradition of defining programming languages we must define this theory syntactically and semantically. Up to now, this has not been done for the theory of the functional harmony analyses. And then, if we apply such a theory, we will 'automatically' find the adequate interpretation - even that of the 'Tristan-Chord'.

[31] For the score cf. *anonymous*: Tristan-Chord (Score); n.Y. (2019) ⇒ https://de.wikipedia.org/wiki/Tristan-Akkord#/media/Datei:TA-NB1.jpg – reference download: 2019-12-02,, for further hints cf. *anonymous*: Tristan-Akkord; n.Y. (2019) ⇒ https://de.wikipedia.org/wiki/Tristan-Akkord – reference download: 2019-12-02,

E-Major using the a partially irritating *relative of the dominant* which is directly re-interpreted as intermediary dominant to the relative of the subdominant of the new *tonic*.

There are further facts which sustain this 'reading'[32]:

- If one – related to the 'old' tonal center *a-minor* – replaced the relative of the double dominant *gis-minor* (`bar 2`) by the double dominant *B-Major* itself, one would get the very simple semicadence: t s D 𝔇. Hence, in reality, the opening of *Tristan* contains a *deceptive semicadence* D 𝔇p. And this evokes us to hear a modulation from *a-minor* to *E-Major* t s [D → T] Dp$^6_5$. (`bar 1-2`)

- In fact, in *Tristan*, the chord *gis-minor* is enriched by its sixth *eis*. Purists would say, that it isn't the sixth, but the diminished seventh. But that's a matter of reading the score, not a matter of the auditive perception. Nevertheless one has to consider, why *eis* has not been written, but its enharmonic 'friend' *f*: This is enforced by the purpose of that tone with respect to the succeeding chord: the *f* shall lead to the next chord *fis-minor* (`bar 2, last eight`)

- The Tristan chord `gis b dis eis=f` can not only be understood as 𝔇p$^5_6$. (= gis$^5_6$.) but also as 𝔇$^7_9$. (₵is$^7_9$.) This ambiguity enables the chord also to function as an intermediary dominant to the next chord *fis-minor*.

- If one replaced the *a* (`bar 2, last eight`) by the third *fis a*, one would directly hear, that its predecessor, the *Tristan Chord* now acts as intermediary dominant 𝔇$^7_9$. to *fis-minor* because it contains the two leading tone *f* → *fis* and *gis* → *a*.

---

[32] For developing adequate harmonic analyses, reading is not enough, one has to focus on the auditive impacts.

- Of course – in fact, `bar 2, last eight` contains the single tone *a* instead of the third *fis a*, as well as `bar 1` contains only single tones instead of chords. And taking a single tone as representant of a complete chord on the first glance seems to be a bit arbitrarily. But one has to keep in mind, that – in the field – we are familiar to do so: every carnival again, we all understand a fanfare like *g c* as a row of D T In the same way, we understand the row *a f* as t s, which on the other hand evokes us that to take the succeding *e* as D Also Petersen understands the first bar (phase 1) in this sense and describes it as "Halbschluss auf der Dominante" (cf. *Petersen*: Isolde und Tristan, 2019, p. 51) . And finally, the same method of *adjuvant hearing* enables us, to link the two leading tones *f* and *gis* from the *Tristan Chord* to the single tone *a* in `bar 2` (even it is still accompanied by its fading away predecessor.)

Thus, we probably may say, that using *harmonyli.ly* makes it easier to understand the *Tristan chord* as well as writing the appropriate analysis. That's a nice result isn't it? Howsoever, here is the respective code:

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

\header { tagline = "" }

imInfix = " " % don't forget this!

trisSone =  { \stemUp
  \partial 8 \skip8 | \skip2. | gis'4.~ gis'4 a'8 | ais'8 b'4~ b'8 \skip8 \skip8 |
}

trisStwo = { \stemDown
  \partial 8 r8 | R2. | <f b dis'>2. | <e gis d'!>4.~ <e gis d'>8 r8 r8 |
}

trisBone = { \stemUp
  \partial 8 \skip8 | \skip2. | <f b gis'>4.~ <f b gis'>8 \skip8 \skip8 | \skip2. |
}

trisBtwo =  { \stemDown
  \partial 8 a8 | f'4.~ f'4 e'8 | dis'4.~ dis'8 b8\rest b8\rest | R2. |
}

trisBana =  { \stemDown
  \partial 8 c,8 | c4.~ c4 c,8 | c4.~ c4 c,8 | c,8 c,4~ c,4 r8 |
}

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

  \markup \setHas "t" #'(("C" . "a"))
  \markup \setHas "s" #'(("B"."3"))

  \markup \setRfHas "D" "T"
    #'( ("C" . "a")
        ("nC" . "E")
    )
```

```
  \markup \setRfHas "Dp" "D"
    #'( ("B"."6")("a"."5")("b"."6")
        ("nT"."x")("nB"."3")("na"."7")("nb"."9")("nC" . "Sp")("nfl" . "(")("nfr" . ")")
    )

  \markup \setHas "Sp" #'(("B"."3"))
  \initTextSpan "      "
  \markup \openZoomRow "T" #'(("a"."+4"))
  \startTextSpan
  \markup \expZoomRow  #'(("a"."5"))
  \stopTextSpan
}

trisChord = \lyricmode {
  \override LyricText.self-alignment-X = #LEFT
  \override LyricExtender.left-padding = #-0.5
  \override LyricExtender.extra-offset = #'(0 . 0.5)
  \override Score.BarNumber.break-visibility = #'#(#t #t #t)

  \markup \setHas "a" #'(("a"." ")("b"." ")("c"." ")("d"." ")("e"." "))
  \markup \setHas "d" #'(("B"."3")("a"." ")("b"." ")("c"." "))
  \markup \setHas "E" #'(("a"." ")("b"." ")("c"." "))

     \markup \setRfHas "gis" "Cis"
    #'( ("B"."6")("a"."5")("b"."6")
        ("nT"."x")("nB"."3")("na"."7")("nb"."9")
    )


  \markup \setHas "fis" #'(("B"."3")("a"." ")("b"." ")("c"." ")("d"." ")("e"." "))
  \initTextSpan "      "
  \markup \openZoomRow "E" #'(("a"."+4"))
  \startTextSpan
  \markup \expZoomRow  #'(("a"."5"))
  \stopTextSpan

}

\score {
  <<
    \new GrandStaff <<
      \time 6/8
      \new Staff <<
        \clef "treble" \key  a\minor
        \new Voice = "trisSone" { \trisSone }
        \new Voice = "trisStwo" { \trisStwo }
      >>
      \new Staff <<
        \clef "bass"\key  a\minor
        \new Voice = "trisBone" { \trisBone }
        \new Voice = "trisBtwo" { \trisBtwo }
        \new NullVoice = "trisBana" { \trisBana }
        \new Lyrics \lyricsto "trisBana" { \trisSymb }
        \new Lyrics \lyricsto "trisBana" { \trisChord }
      >>
    >>
  >>
  \layout{ \context { \Lyrics \consists "Text_spanner_engraver" } }
}
\end{lilypond}
\end{center}
```

7 Package Content

```
harmonyli.ly /*  */
 ├──AUTHORS /* reference to the copyright holder */
 ├──cadenca-functional-harmony-theory.ly /* example */
 ├──cadenca-scale-step-theory.ly /* example */
 ├──CHANGES /* changes of the major releases */
 ├──doc /* documentation */
 │   ├──Makefile /* type make to create the tutorial  */
 │   ├──source ◁ /* LATEXsources of the tutorial */
 │   └──tutorial.pdf /* latest stable version */
 ├──harmonyli.ly /* the library itself */
 ├──LICENSE.GPL /* GPL license txt */
 ├──LICENSE.MIT /* MIT license text */
 ├──LICENSING /* dual licensing files */
 ├──Makefile /* type make $f.pdf to create $.pdf */
 ├──modulation-functional-harmony-theory.ly /* example */
 ├──modulation-scale-step-theory.ly /* example */
 ├──README.md /* github markdown readme */
 ├──release /* current stable release */
 ├──sn967.ly /* refrence example */
 └──xtras /*  */
     ├──blum ◁ /* sources of Blum's original version */
     └──klaus-blum-licensing-approval.mbox /* approval mail */
```

8 FAQ

8.1 What's the purpose of the prefix / suffix?

harmonyli.ly offers the opportunity, to 'expand' a *Harmony Analysis Symbol* by a prefix and/or a suffix. You can insert such prefixes or suffixes by adding the attributes (`"fl"` . `"prefix"`) resp. (`"fr"` . `"suffix"`) into the list of attributes. In this way, you can insert verbal hints or influence *LilyPond*.

8.2 Can a I increase the distance between the parentheses and the symbol of intermediary chords?

Yes you can. Type `imInfix = " "` just before your section `score`

8.3 How can I prevent that a zoom row line starts too early?

Increase the number of blanks handed over as value of the parameter by using the function \initTextSpan " "

8.4 Does harmonyli.ly offer some abbreviations?

Yes. There are some often used *Harmony Analysis Symbols*, which *harmonyli.ly* offers as special symbols. But note, they only accept a very reduced subset of parameters:
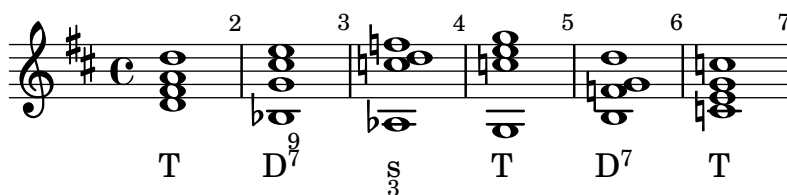
\FHAS $HAS ::- inserts the respective *Harmony Analysis Symbol*.

\FHASth $HAS ::- inserts the first inversion of a *Harmony Analysis Symbol*.

\Dsept $HAS ::- inserts a dominant plus seven.

\Dseptnone $HAS ::- inserts a dominant plus seventh and nineth.

Here is a an example:

... adn this its code:

```
\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 | <  bes g' cis'' e''>1 | < aes c'' d'' f''> |
    <  g c'' e'' g''> | <  b f' g' d'' > | < c' e' g' c''> |
    }
  \addlyrics {
    \markup \FHAS "T"
    \markup \Dseptnone
    \markup \FHASth "s"
    \markup \FHAS "T"
    \markup \Dsept
    \markup \FHAS "T"


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

8.5 can you offer a synopsis of concepts, translations, and symbols?

Yes, we[33] can:

Symbol	German	English
T	Tonika	tonic
Tp	Tonika-Parallele	relative of the tonic
Tg	Tonika-Gegenklang	counter-relative of the tonic
S	Subdominante	subdominant
Sp	Subdominant-Parallele	relative of the subdominant
Sg	Subdominant-Gegenklang	counter-relative of the subdominant
SS	Doppelsubdominante	subdominant of the subdominant
D	Dominante	dominant
Dp	Dominant-Parallele	relative of the dominant
Dg	Dominant-Gegenklang	counter-relative of the dominant
DD	Doppeldominante	dominant of the dominant

If you need translations of musical concepts, please take a look at sengpielaudio[34].

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

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

---

[33] In this context, I have first of all to thank Leo Correia de Verdier (who delivered the basic version of the following table to me) and Gregory Hollands (who led me to some respective sites)

[34] cf. *anonymous*: Musical Terms. Music Glossary Terminology Words. English/German; n.Y (2019) ⇒ http://www.sengpielaudio.com/musicalterms.htm – reference download: 2019-11-14, wp.

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anonymous: Musical Terms. Music Glossary Terminology Words. English/German; n.Y (2019), FreeWeb / HTML ⇒ http://www.sengpielaudio.com/musicalterms.htm – reference download: 2019-11-14

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