KSN musical harmony annotation format

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CHAPTER 1

Introduction

Harmony   Tonal harmony has played a central role in the Western and Western-influenced music for a few centuries, although it has first been formally described by Rameau in 1722[1]

Role of harmony in MIR

Status quo in annotation   There is currently no widely accepted standard for storing musical harmony information. Some people opted to use Harte's [ ] chord dictionary, which is quite large, but still not flexible enough for all purposes and it does not specify how to relate chords to the original musical score.

This work   In this work, we have proposed a harmony annotation standard that covers virtually all aspects from chord definitions, keys, modulations, tempo and score-to-label synchronization. The standard is meant to be used both by engineers and musicians and therefore easy to process automatically, at the same time easy to use by people not accustomed to computer technologies.

The resulting annotation format is text-based and tries to immitate real musical notation where possible; in this it resembles tha popular ABC musical notation format [ ]. This work is the result of joint effort of Prof. Hitomi Kaneko of the Toho Gakuen School of Music and her students (Kojiro Ebiko, Yu Noda, Arata Yumi), and Prof. Shigeki Sagayama of the University of Tokyo and his students (Stanisław A. Raczyński, Daisuke Kawakami).

CHAPTER 2

Notation format

2.1. KSN notation

A KSN file is a text file that contains harmonic annotation for a single piece of music. To give the reader a preview of the format, Listing 2.1 contains the full annotation for Chopin's Nocturne No. 2.

Listing 2.1: Annotation for RWC-C30 (Chopin's Nocturne No. 2)

```
1   @K=-E @M=12/8
2   11q z | I !V9'''/I I I7''' | {ii: 2V7 !V9/i i} | V7 vi:V7' vi V:!V9' | V7 I |
3   I !V9'''/I I I7''' | {ii: 2V7 !V9/i i} | V7 vi:V7' vi V:!V9' | V7 I |
4   {V: I V'} | IV iv 2I | {V: V:!V9' V:V7' V7 vi |
5   3ii 3V7 I} {-II: V7''' I'} ii:V7'' V:V7 V7 |
6   I !V9'''/I I I7''' | {ii: 2V7 !V9/i i} | V7 vi:V7' vi V:!V9' | V7 I |
7   {V: I V'} | IV iv 2I | {V: V:!V9' V:V7' V7 vi |
8   3ii 3V7 I} {-II: V7''' I'} ii:V7'' V:V7 V7 |
9   I !V9'''/I I I7''' | {ii: V7 !V9/i i} | V7 vi:V7' vi V:!V9' | V7 I |
10  iv'' I | iv'' I | 2V7''/I I V:V9+' | V7 I |
11  iv I | 2iv I V:V7' | V3!7 vi:V9' vi V:V7' | V9 V' | I | I ||
```

2.1.1. Pitch naming convention

West-European pitch naming convention is adopted in the standard. Therefore, e.g. C-major scale contains pitches named (C, D, E, F, G, A, **B**), as opposed to (C, D, E, F, G, A, **H**) used in the Central-European notation.

2.1.2. Comments

Comments begin with a percent sign % and end with a line break.

Listing 2.2: Using comments

```
1   @K=C              % this is a comment
2   I | IV | V | I || % here's another comment
```

2.1.3. Harmony data

The harmony data is essentially a sequence of: directives, chords, bar lines, modulation indicators and repetition control marks. Like in the ABC notation, bar boundaries are marked with pipe signs | and musical phrase boundaries are indicated with double pipes ||.

```
1  @K=C                % music in the key of C-major
2  I | IV | V | I ||   % a phrase ending with an authentic cadence
3  V | V | I           % further three bars
```

All the above mentioned elements must be separated from other elements by at least one white character. All additional white characters are ignored.

2.1.4. Directives

All directives start with the *at* sign @. Currently defined directives are listed in Table 2.1.

	Function	Examples
@K	Specifies the key. A single letter (A, B, C, D, E, F, G) is used to determine the pitch class of the tonic (letter notation). Uppercase letters stand for major scales and lowercase letters for minor ones. Flats are specified with a minus sign − and the sharps with a plus sign +, placed in front of the letter.	@K=+C % C♯-major @K=-d % D♭-minor
@M	Specifies the meter (time signature). The first numeral defines the number of beats per measure, while the second one the note value that constitutes a single beat. They are separated by a slash sign /.	@M=4/4 @M=12/8
@S	*Segno* (𝄋). Marks the beginning of the repetition.	
@C	*Coda* (⊕). Marks the end of the repetition.	
@F	*Fine.* Marks the ending of the piece after the second repetition.	
@DCAF	*Da capo al fine.* Directive to repeat from the beginning until the end or until fine @F, if present.	
@DCAC	*Da capo al coda.* Directive to repeat from the beginning until coda @C.	
@DSAF	*Da segno al fine.* Directive to repeat from the segno @S until the end or until fine @F, if present.	
@DSAC	*Da segno al coda.* Directive to repeat from the segno @S until the coda @C.	

Table 2.1: List of currently defined directives.

There can be more than one directive specified in a single line, separated by white characters, they can also be mixed with the harmony data in the same line. A directive may appear anywhere in the file and applies only to the harmony data that stands after it. This will happen e.g. in situations when the meter or the key changes throughout the piece.

2.1.5. Chords

A chord definition consists of eight parts, some of which are optional. They are listed and described in Table 2.2.

Element	Description	Examples	
Note value (optional)	An arabic numeral indicating note value relative to the current meter. The unit is not one beat, but depends on other note values in the current measure. If no note value is specified, a unit length is assumed.	3	Chord lasts for 3 unit lengths.
Tonicization (optional)	Short-term (only for the duration of the current chord) modulation.	V:	Chord from the dominant key.
Root modificators (optional)	See Modificators.	+	Root is raised by a semitone.
Root specifier or member note list	Roman numeral indicating scale degree relative to the current scale or an absolute chord name (in letter notation) or a list of member notes enclosed in square brackets.	V	Dominant chord.
		[C E]	Notes C and E.
Modificators (optional)	Series of marks that indicate raising, lowering, deletion or addition of tones to or from the chord. Tone in question is specified with an arabic numeral indicating number of scale steps, i.e. the generic interval from the root of the chord.	1!5+7	Root is missing, fifth is raised by a semitone and a seventh is added.
Inversion (optional)	A series of apostrophes. Their number indicates the inversion degree.	'''	Third inversion.
Added notes (optional)	A series of added notes, each preceded by an ampersand.	&2	Added second.
		&C	Added C note.
Pedal note (optional)	A pedal point, i.e. single note in pedal position added to the chord, preceded by a slash.	/I	Added tonic in pedal position.

Table 2.2: Structure of a chord definition, in order of their usage.

There are three special symbols that can be used instead of the root specifier, used for specifying lack of harmony (a rest or an auftakt) or a repetition of the previous chord. None of them allows for any modificators, inversion marks or pedal notes. They are listed in Table 2.3.

Capital letters denote major chords, while lowercase letters minor chords. All other chord types are specified by modifying the note members with tone modificators.

Symbol	Meaning
q	No chord. It can be used to pad measures in case of an upbeat (anacrusis, Auftakt) or when no chord is being played (drum solo).
z	Rest (no notes played).
_	Chord repetition mark (underscore). The previous chord declaration is repeated.

Table 2.3: Special chord markings.

Letters	Chord intervals	Examples	
capital	root (+0), major third (+4) and perfect fifth (+7)	`@K=C` `I`	C, E, G notes.
lowercase	root (+0), major third (+3) and perfect fifth (+7)	`@K=+D` `v`	A♯, C♯, E♯ notes.

Table 2.4: Two basic chord types.

2.1.6. Note value

Note values are specified according to the current meter. The unit might be a beat, but it might also be a division of a beat. To calculate the note value in beats, the whole measure must be taken into account.

```
Listing 2.4: A sample
1  \codeA{@M}=4/4        % Note values in B (beats):
2  2I IV V |     %  2B (half note), 1B (quarter note), 1B
3  @M=12/8       %
4  2V7 !V9 I |   %  6B (dotted half note),
5                %  3B (dotted quarter note), 3B
6  @M=2/4        %
7  5/4IV 3/4V |  %  5/4B (five sixteenth notes),
8                %  3/4B (three sixteenth notes)
```

The number of beats for a chord can be calculated with the following formula:

$$B_i = N \cdot L_i / \sum_{k}^{K} L_k, \tag{2.1}$$

where L_i is the note value specified for i-th symbol in the current measure, N is the number of beats per measure and K is the number of symbols in the current measure.

2.1.7. Extended chords

Extended chords are given by specifying the interval of the highest member note.

```
Listing 2.5: All possible extended chords
1  V   |  % major dominant chord
2  V7  |  % seventh dominant chord
```

```
3   V9   |   % ninth dominant chord
4   V11  |   % eleventh dominant chord
5   V13      % thirteenth dominant chord
```

All note members of the specified chord extension are present, unless specified otherwise: for example, V13 will contain: the root, the 3rd, the 5th, the 7th, the 9th, the 11th and the 13th.

2.1.8. Explicit member notes

Notes that belong to a chord may be specified explicitly using the square brackets operator [ ], which groups them into a single chord. They can be given either with Latin letters (absolute pitch class), or Roman or Arabic numerals (relative pitch class). They are separated by spaces.

Just like with the key directive, flats are specified with a minus sign − and the sharps with a plus sign +, placed in front of the letter. Apostrophes can be used to specify notes from octaves higher that than of the root.

Symbols		Meaning
letter notation	A, B, C, D, E, F, G	Absolute pitch class. Capital letters must be used.
arabic numerals	1, 2, 3, 4, 5, 6, 7	Pitch class relative to the chord root. The numeral indicates a generic interval above the root (1 = first, 2 = second, etc.).
roman numerals	I, II, III, IV, V, VI, VII	Pitch class relative to the tonic. The numeral indicates scale degree of the note (I = tonic, II = supertonic, etc.). Capital letter must be used.

Table 2.5: Three symbol sets used to implicitly specify member notes of a chord.

Listing 2.6: A sample
```
1   @K=D
2   [D +F A] |  % equivalent to I
3   [I III V] | % the same chord specified in relative terms
4   [I +F 5] |  % absolute and relative terms can be mixed
5   [V +C E'']  % E'' is two octaves higher than E
```

Explicit note members are interpreted as a non-chord with added notes:

Listing 2.7: Explicit chord members are equivalent to added notes
```
1   [C E G]=q&[C E G]
```

2.1.9. Redundand chord defitions

A single chord can be given in several equivalent forms interlaced with the equal sign =. This feature is mainly for the convenience of the human reader.

Listing 2.8: A sample
```
1   @K=C
2   V7=[G B D' F'] | IV''=[C F A]
```

2.1.10. Altered chords

Each member note can be modified with one of the following modificators:

Modificator	Meaning		Examples
+	Raising by 1 semitone	3+	raised third
++	Raising by a whole tone (2 semitones)	++F	F♯♯
−	Lowering by 1 semitone	1−	lowered root
−	Lowering by a whole tone (2 semitones)	−C	C♭♭
!	Deletion	5!	missing fifth

Table 2.6: Tone modificators.

The raising and lowering operators are generally placed before the operand with the exception of arabic numerals, which precede the operator.

Listing 2.9: A sample

```
1  @K=C
2  V3!7=[D F G] |
3  !V7=vii-=[VII II' IV']=[B D' F'] |
4  V!3!9=[V IV' VI']=[G F' A']
```

When modifying the root note, the modificator can be placed directly before the chord name. When modifying the fifth, the modificator can be placed directly after the chord name.

Listing 2.10: A sample

```
1  !V |   % root is missing, shorthand for V1!
2  V+ |   % fifth is raised, shorthand for V5+
```

2.1.11. Modulations and tonicizations

A tonicization is indicated by specifying a temporary tonic center followed by a colon mark :. The relative notes in the chord that immediately follows the tonicization command will be regarded as relative to the temporary tonic center. The tonicization does not carry over the redundancy mark =. The new tonic center can be extended to include many chords by using the curly brackets operator { }, effectively marking modulations.

Listing 2.11: A sample

```
1  % Bars 1-3 of Chopin's Nocturne No. 2
2  @K=-E @M=12/8
3  I !V9'''/I I I7''' | {ii: 2V7 !V9/i i} | V7 vi:V7' vi V:!V9'
4  % The second bar modulates to the supertonic and the third
5  % bar has two tonicizations: to the relative key and to the
6  % dominant
```

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2.1.12. Tonicizations and borrowed chords

2.1.13. Added notes

Individual notes (added tones) can be added to a chord with the ampersand operator `&` and they do not have to be enclosed in the square brackets. They can be given with either: latin letters (A, B, C, D, E, F, G), to specify the absolute pitches, arabic numerals (1, 2, 3, 4, 5, 6, 7), to specify pitches relative to the chord root, or with roman numerals (I, II, III, IV, V, VI, VII), to specify pitches relative to the tonic.

Listing 2.12: A sample

```
1  @K=C
2  I3!&2&4=[C D F G] | vi&[V]=vi&[G]
```

2.1.14. Pedal notes

If an added note is at the pedal position, the slash operator `/` can be used. This can be used to mark e.g. pedal point. Because only a single note can be added to the chord in this manner, the square brackets are not used.

Listing 2.13: A sample

```
1  @K=C
2  V/I=[C G B D']
3  V3!7/I=[C D F G]
```

A pedal point can be added to several chords at the same time using the grouping operator `{ }` and the addition operator `&`. In this case, the pedal note can be preceded by the number of time units it lasts and it needs to be surrounded by square brackets.

Listing 2.14: A sample

```
1  @K=C @M=2/4
2  [8V]&{V7 I V vi | iii IV I V |}
```

2.1.15. Passing chords

Passing chords (both diatonic and chromatic) are market with parentheses around them. For example:

Listing 2.15: A sample

```
1  % The first 4 bars of Brahms' The Hungarian Dance No.5
2  @K=+f @M=2/4
3  i (i'') | i (i'') | !V9'''/i (!V9''') | i (i'') |
```

2.1.16. Repetitions and jumps

The simplest way to specify repeats is to use the repetition operators: `| :`, `: |`, `|| :` and `: ||`. These operators are used in place of the bar lines `|`, so only entire measures can be repeated in this manner. To denote repetitions of measure fragments, a parenthesis versions of these operators are used: `(:` and `:)`. Note that that the opening repetition mark may be skipped and in that case it is assumed to be placed at the beginning of the harmony stream. If a closing mark appears in the same place as an opening mark for another repetition, they can collapse to form a `: || :` mark. Alternative endings are marked using `|[1` and `:|[2` marks.

Repetition operator	Meaning
| : ... : |	Repetition of entire measures.
|| : ... : ||	The same as | : ... : |, but used in place of phrase boundary marks ||.
: || :	Equivalent of : |||| :.
|| : ... |[1 ... : |[2	Alternative repetition endings.

Table 2.7: Repetition operators.

Listing 2.16: A sample

```
1   I | IV ||: V |[1 IV :|[2 I ||
2   % This is equivalent to:
3   I | IV | V | IV | V | I ||
```

Additionally, repetition directives can be used to specify repeats and they take precedence over the repetition operators. For list of repetition directives, see Table 2.1.

CHAPTER 3

KSN package content

The structure of the database:

```
  Code  Source code for KSN-related software..
  └─ KSNR  GNU R package for loading, processing and converting KSN
            data..
└─ Harmony
  ├─ KSN
  ├─ LAB
  ├─ MIDI
  └─ CSV
  Documentation
  ├─ Fonts
  ├─ Images
  └─ Sounds
  Reference
  ├─ Scores
  ├─ MIDI
  └─ Barlines
└─ Joint
```
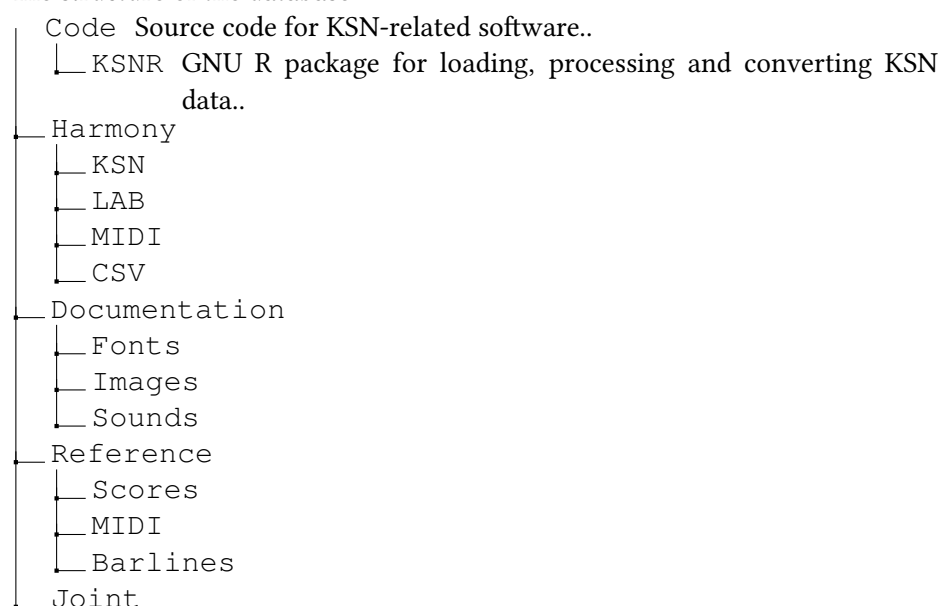
3.1. Table annotation format

The above annotation format is extremely flexible, but for many applications too complicated and requires a specialized parser. For that reason, the annotation is also provided in a simplified, CSV[1]-based format, hereby refered to as the "table format". It must be emphasized, however, that the table format does not contain all the information of the KSN format (e.g. repetitions).

This format was devised based on the following assumptions:

- It should be a text format easily importable to Matlab, GNU R, MS Excel, OpenOffice Calc, etc.

- It should contain as much information compared to KSN as possible.

- It should only use numeric values for ease of processing, i.e., all elements should either be real numbers or missing values (`NA/NULL`).

---

[1]CSV — Comma Separated Value (text-based format supported by most data-processing environments).

3.1.1. Basic data format

A basic set of fields is described in the table below:

Ticks are $1/96^{\text{th}}$ of a whole note. This number has been chosen to avoid fractional lengths. Of course it is still possible (though highly improbable) to have fractions, and therefore a smaller tick value may be considered.

Three length descriptors are used in order to be able to restore the time signature $\dfrac{M}{B}$:

$$M = \frac{Beats}{Measures}, \tag{3.1}$$

$$B = 96 \cdot \frac{Beats}{Ticks}. \tag{3.2}$$

It might seem redundant to include the length descriptors for each line, but the time signature can change throughout the piece of music, and it can easily be tracked this way.

The key (current tonal center) is represented by a signature and a mode (in contrast to tonic+mode representation) to retain the enharmonically equivalent keys (like B♮-major and C♭-major).

3.1.2. Extended data format

The data format can be supplemented with redundant fields for easier processing.

3.2. Example

Let us observe the KSN labels for the file RWC-C24A (click to play the sound!):

```
1   %
2   % RWC-MDB-C-2001 No.24-1
3   %
4   @K=G @M=3/4
5   % bars 1-16
6    I | I' | IV! | I!' | V3!7'' | I! | V! I!' I! | V3!7 | I' | I | IV! | I' | 2V
         3!7'' (!V') | 2I! I!' | ii!' 2V | I |
7   % bars 17-32
8    I! | V' | 2vi! vi!7 | {V: V! | V | IV!' I! !V' | 2I V! } | V7 | I' | IV | !I'
         ii! I! | V | V | IV!' I! !V' | I I!' V! | I ||
```

Listing 3.1: A sample

Table 3.3: Table format for the harmony of RWC-C24A.

Measures	Beats	Ticks	Signature	Mode	Degree	Type	Inversion	Root	Second	Third	Fourth	Fifth	Sixth	Seventh	Ninth	Eleventh	Thirteenth	Fifteenth	Added	Pedal
1	3	36	-2	1	1	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
1	3	36	-2	1	5	1	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA	
1	3	36	-2	1	6	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA	
1	3	36	-2	1	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA	
0.67	2	24	-2	1	6	0	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA	
0.33	1	12	-2	1	5	0	2	NA	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA	
0.67	2	24	-2	1	1	1	1	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA	
0.33	1	12	-2	1	1	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	

0.67	2	24	-2	1	5	0	1	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
1	3	36	-2	1	1	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	1	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	6	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
1	3	36	-3	1	5	0	1	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	0	2	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	1	NA	NA	0	NA	NA	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	2	1	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	0	1	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	1	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	1	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	6	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.67	2	24	-2	1	6	0	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	5	0	2	NA	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.67	2	24	-2	1	1	1	1	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.67	2	24	-2	1	5	0	1	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
1	3	36	-2	1	1	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	1	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	6	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
1	3	36	-3	1	5	0	1	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	0	2	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	1	NA	NA	0	NA	NA	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	2	1	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	0	1	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	0	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	6	0	1	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-1	0	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
1	3	36	-2	0	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	6	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	4	0	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	1	0	2	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	2	1	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	1	0	2	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	4	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	0	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-3	1	5	0	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	4	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	5	0	2	NA	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
2	6	72	-2	1	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	4	1	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	2	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	2	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	1	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	4	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	1	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	0	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	6	0	1	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA

0.33	1	12	-2	0	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-1	0	5	0	0	0	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
1	3	36	-2	0	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	6	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	4	0	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	1	0	2	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	2	1	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	1	0	2	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	4	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	0	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	0	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-3	1	5	0	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	4	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	1	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	5	0	2	NA	NA	0	NA	0	NA	0	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	6	72	-2	1	5	0	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	4	1	1	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	2	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	2	1	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	1	1	1	1	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	4	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA
0.33	1	12	-2	1	5	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	3	36	-2	1	1	1	0	0	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA

3.3. Parser implementation in GNU R

3.4. Reference scores

3.5. Reference MIDI scores

	Field name	Description
Time	Measures	Length of the chord in bars.
	Beats	Length of the chord in beats.
	Ticks	Length of the chord in ticks. 48 ticks = a whole note.
Key	Signature	Number of flats (negative values) or sharps (positive values) in the key signature. $-7,...,0, 1,...,7$.
	Mode	Musical mode. 0 for the major, 1 for a minor mode.
Chord	Degree	Diatonic scale degree. A value between 1 (tonic) and 7 (leading tone) or NA for a non-chord.
	Type	Chord type. 0 for major and 1 for minor.
	Inversion	Chord inversion. 0, 1, ...
	Root	Root modification. 0 for no change, non-zero values for lowering or raising by the given number of semitones, and NA for a missing root.
	Second	Modification of the diatonic second. See Root field.
	Third	Modification of the diatonic third. See Root field.
	Fourth	Modification of the diatonic fourth. See Root field.
	Fifth	Modification of the diatonic fifth. See Root field.
	Sixth	Modification of the diatonic sixth. See Root field.
	Seventh	Modification of the diatonic seventh. See Root field.
	Ninth	Modification of the diatonic ninth. See Root field.
	Eleventh	Modification of the diatonic eleventh. See Root field.
	Thirteenth	Modification of the diatonic thirteenth. See Root field.
	Added1	First added chromatic tone. An absolute pitch class (0 for C, 1 for C♯, etc.) or NA if there are no added notes.
	Added2	Second added chromatic tone. See Added1 field.
	Added3	Third added chromatic tone. See Added1 field.
	Pedal	Pedal note. Absolute pitch class, 0 for C, 1 for C♯, etc., or NA if not present.
	Passing	1 if the chord is a passing chord, NA otherwise.

Table 3.1: Columns of the basic table format for chord annotation.

Johann Sebastian Bach
Menuet in G-major, BWV Anh. 114
RWC-C24A

Figure 3.1: Score for RWC-C24A annotated with KSN-style harmony labels.

	Field name	**Description**
Time	Measure sum	Cumulative sum of lengths in bars. This holds information about the beginning of the chord.
	Beat sum	Cumulative sum of lengths in beats.
	Tick sum	Cumulative sum of lengths in ticks.
	Beats per measure	Number of beats in one measure (upper part of the time signature).
	Ticks per beat	Note value of 1 beat, in ticks (lower part of the time signature).
Key	Tonic	Tonal center of the key. Absolute pitch class: 0 for C, 1 for C♯, etc.
Chord	Absolute root	Chord root as an absolute pitch class: 0 for C, 1 for C♯, etc.

Table 3.2: Columns of the extended table format for chord annotation.

Bibliography

[1] J.P. Rameau. *Treatise on harmony.* 1722. 2