SYMBOLIC REPRESENTATION OF MUSICAL CHORDS: A PROPOSED SYNTAX FOR TEXT ANNOTATIONS

Christopher Harte, Mark Sandler and Samer Abdallah
Centre for Digital Music
Queen Mary, University of London
Mile End Road, London, UK
`christopher.harte@elec.qmul.ac.uk`

Emilia Gómez
Music Technology Group
IUA, Universitat Pompeu Fabra
Barcelona, Spain
`emilia.gomez@iua.upf.es`

ABSTRACT

In this paper we propose a text represention for musical chord symbols that is simple and intuitive for musically trained individuals to write and understand, yet highly structured and unambiguous to parse with computer programs.

When designing feature extraction algorithms, it is important to have a hand annotated test set providing a ground truth to compare results against. Hand labelling of chords in music files is a long and arduous task and there is no standard annotation methodology, which causes difficulties sharing with existing annotations. In this paper we address this problem by defining a rigid, context-independent syntax for representing chord symbols in text, supported with a new database of annotations using this system.

Keywords: Music, Chords, Harmony, Notation, Annotation

1 INTRODUCTION

When dealing with large digital music collections, it becomes necessary to develop technology capable of dealing with these collections in a meaningful way. Much effort within the music information retrieval community is devoted to automatically describing the content of MIDI and audio recordings.

Harmony is one of the main axes of music description. Many researchers in this field try to automatically describe the harmonic content of a piece of music, see for instance Fujishima (1999); Harte and Sandler (2005); Sheh and Ellis (2003); Yoshioka et al. (2004). There is no standard methodology for chord annotation. When designing chord detection algorithms, the lack of annotated databases makes evaluation and comparison of results difficult. This problem is not specific to harmonic analy-

sis, but is relevant in many areas of MIR related research. We attempt to address this problem by proposing a rigidly structured general annotation system for chords. Such an annotation system will afford researchers the opportunity to share annotated files easily. The system presented here is easy for musically trained individuals to write and understand, yet simple and unambiguous to parse with computer programs.

We also provide a reference database of annotations for songs from The Beatles back catalogue using this representation at the Centre for Digital Music website.The annotations are in `.lab` transcription file format, compatible with the open source wave file editor *Wavesurfer* Sjölander and Beskow (2000); Gouyon et al. (2004).

In the background section we discuss some of the notation methods used in different parts of the music community. In classical western harmony notation, a style developed for score analysis, certain chord symbols depend upon the musical key context for their full meaning to be apparent. In contrast, jazz and popular music notations are more commonly used for performance and are generally more explicit in their meaning to avoid being misread. Text file annotations are often a straight translation of an individual's preferred musical notation to the nearest textual equivalent. This lack of standardisation can cause many problems when other people come to read and interpret the annotated symbols. To address this problem, we introduce a general logical model for a musical chord in Section 3. This is used in Section 4 to define the rules and syntax for a representation for chords in flat text with a formalised description of the syntax given in Backus-Naur Form (BNF) Ledgard and Marcotty (1981). Section 5 covers the use of our representation in making an annotation database using Wavesurfer and Matlab tools for manipulating the transcription files it produces.

2 BACKGROUND

When two or more notes are played simultaneously, a chord is produced. In Western tonal music, any musical chord may be represented with the following information:

- The *root* note of the chord; the note upon which the chord is built.

- Its type or *quality*, defined by the component intervals that make up the chord relative to the root.

- Its *inversion*, defined by the degree of the chord played as its bass note.

These parameters remain consistent for all the different ways in which notes of a particular chord may be played, or *voiced* Taylor (1989).

2.1 Styles of Notation

There are many styles of harmony and chord notation in music. These conventions can vary not only across genres but also within them. To illustrate some of the variation in chord notation methods, several styles are shown for the short excerpt of music in Figure 1(a).

2.1.1 Figured Bass

The first style, in Figure 1(b) is the Baroque *Figured Bass*. This was a system of figures written underneath a bass line indicating which intervals should be played above the bass note to complete the correct harmony Taylor (1989).

2.1.2 Classical Harmony Analysis

In classical Western harmony analysis, chord notation was developed to show the sequential aspects of harmony or *harmonic progression* rather than just the particular chord or sonority at any given instant Tagg (2003). Figure 1(c) shows Roman numeral style notation. Chords are labelled according to the position of their root note within the scale related to the current key Taylor (1989). Inversions are marked with 'b' for first inversion, 'c' for second inversion and so on if the chord has further degrees. The notation shown in Figure 1(d) with letters denoting the root notes of chords is also common in classical analysis. In both cases major chords are shown with uppercase characters and minor chords in lowercase.

In classical notation, because chords are notated in the context of a given key, certain properties are implied rather than explicitly marked. For example, in a major key, the seventh degree of the key scale is a major seventh interval, so in marking a tonic major seventh chord 'I^7' with a superscript 7, the major seventh is implied. However, a dominant seventh chord, by definition, contains a minor seventh interval but it is also marked with a superscript 7 'V^7' (see second bar of the example in Figure 1(c)). In the Roman numerals system it is clear that 'V^7' is a dominant chord but when using letters as shown in Figure 1(d) this can become a source of ambiguity. The extract is in the key of C major so the first chord is marked C^7 but the dominant chord in the second bar is marked G^7. If the key context is lost from this notation, which is a possibility if storing these symbols in a text file, then there can be no sure way of telling which quality of seventh chord the transcriber intended without trying to infer the context from the chord progression.

2.1.3 Jazz and Popular Music

In popular music and jazz, the role of chord symbols is more tailored for use in performance, with jazz musicians in particular often playing at sight. For this reason chords are notated in a much more explicit manner so that musicians need spend the minimum of time and thought to correctly work out what they are required to play. The

Figure 1: A short extract of music in C major with different harmony notations: a) Musical score b) Figured bass, c) Classical Roman numeral, d) Classical letter, e) Typical Popular music guitar style, f) Typical jazz notation

qualities of chords are marked explicitly but the markings that are used vary widely and it is hard to find two people who agree on a preferred style for every chord type.

The first chord of the example in Figure 1(a), a C major seventh, may be marked as CM7, CMaj7, or $C^{\triangle 7}$ Coker (1964) as seen in Figure 1(e) and 1(f). The second chord in the example, a D minor seventh, may be marked Dm7, Dmin7 and D^{-7}. The G seventh chord in the second bar can be marked G7 or G^7 or sometimes Gdom7, although this last marking is often incorrectly applied in cases where the seventh chord does not actually function as a dominant chord. Inversions are most often denoted by an oblique stroke (/) followed by the bass note to be played. This can be seen with the inverted F major chords, F/C and F/A, at the end of the first bar of the example Taylor (1989).

Ambiguity between chord symbols can occur when translated to flat text if the notation convention used by the transcriber is not given. For example, if an annotation contains the symbol A7, this could be a seventh chord in jazz notation or in classical notation if in the key of D. However, it could also be a major seventh chord in classical notation if in the keys of A or E major. It is to avoid this kind of ambiguity that we propose the adoption of the chord symbol representation outlined in the following sections.

3 A MODEL FOR MUSICAL CHORDS

We now define a model to represent chords unambiguously and independent of key context. The root is defined as a *note* element which has an absolute pitch class value. The list of component intervals and the bass note are defined as *degrees*, relative to the root note. A diagram of this model is shown in Figure 2.

We define seven *natural* note names (letters A to G, eqn. 1), which correspond to the white keys on a piano
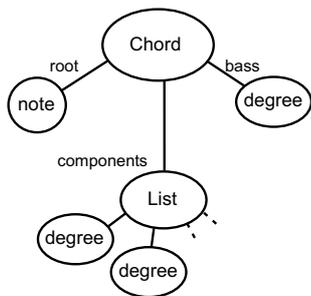
Figure 2: Model for chord definition

Figure 4: Example model of a first inversion C minor-seventh chord

keyboard. We also define thirteen *intervals* (numbers 1 to 13, eqn. 2), which correspond to the major diatonic intervals (i.e. they are either major or perfect) up to one octave plus a sixth (shown in Figure 3). To allow correct spelling of enharmonics we also define two *modifier* operators, sharp and flat. Thus:

$$natural \quad = \quad \{A \mid B \mid C \mid D \mid E \mid F \mid G\} \qquad (1)$$

$$interval \quad = \quad \{1 \mid 2 \mid 3 \cdots 11 \mid 12 \mid 13\} \qquad (2)$$

$$modifier \quad = \quad sharp \mid flat \qquad (3)$$

Naturals and intervals may be operated on by these modifiers. In this way, notes and degrees may be defined as:

$$note \quad = \quad natural \mid modifier(note) \qquad (4)$$

$$degree \quad = \quad interval \mid modifier(degree) \qquad (5)$$

An example model of a chord is shown in Figure 4. The chord in the example is a C minor seventh chord in first inversion. The root of this chord is a C. The component intervals are a minor third, a perfect fifth and a minor seventh ($\flat$3, 5, $\flat$7). The bass note of a first inversion chord is its 3rd degree, which in this example is an E$\flat$.

The sharp and flat modifiers allow proper enharmonic spelling of notes and intervals. This is important in cases such as the diminished seventh chord (comprising the musical intervals $\flat$3, $\flat$5, $\flat\flat$7) which contains a diminished seventh interval (a major seventh interval flattened twice). Although this interval is tonally equivalent to a major sixth, it has a different musical function.
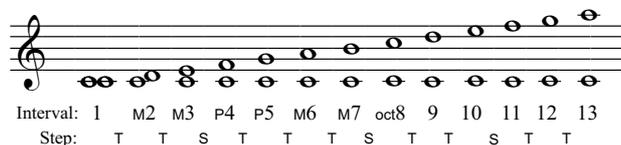

Figure 3: The Major diatonic intervals upon middle C. 'T' denotes a step of a tone between adjacent intervals and 'S' a semitone.

4 REPRESENTION OF CHORDS IN FLAT TEXT

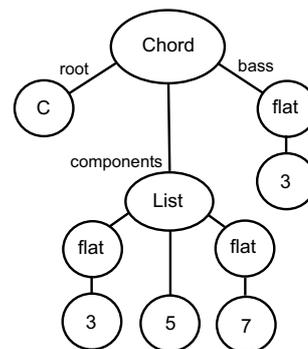In this section we develop a general system for notating chords in flat text that is both musically intuitive and flexible but at the same time rigidly structured. The basic syntax of the notation is outlined in Section 4.1. A shorthand system using a vocabulary of predefined labels for common chords is introduced in Section 4.2. Finally, a formalised description of the syntax for the system is given in Backus-Naur Form Ledgard and Marcotty (1981) in Table 1.

4.1 Developing a Syntax for Chord Notation

It is important for use in text annotation that chord symbols be context independent. Using the chord model described in Section 3 and a context independent approach to notation, similar to the Jazz style described in Section 2, we define the following syntax for representing a chord in flat text:

```
root : (degree1, degree2...) / bass
```

The root note is written first followed by a colon (`:`) separator. A comma delimited list of the chord degrees is then written, contained by parentheses. Finally, an optional bass note may be added at the end after a forward slash character (`/`) if it is different to the root. The naturals, intervals and modifiers are defined in Table 1 following equations 1 to 3. The sharp and flat are signified by the hash symbol # and the lowercase `b` respectively.

To keep the notation musically intuitive, note modifiers come after naturals so A$\flat$ becomes `Ab`. Degree modifiers come before intervals so a flattened seventh becomes `b7`. An extra chord state denoted by a single uppercase `N` is also added to signify 'no chord' to mark silence or untuned, possibly percussive musical material. To resolve the possible ambiguity between a note `B` and a flat modifier `b` the notation is necessarily case sensitive.

Following these rules, all chords may now be described in flat text in an unambiguous manner. For example, using our system a C major chord becomes:

```
C:(3,5)
```

Likewise, a C minor chord becomes:

```
C:(b3,5)
```

A more complex chord such as a D$\sharp$ minor seventh chord in second inversion with an added ninth would become:

```
D#:(b3,5,b7,9)/5
```

Table 1: Syntax of Chord Notation in Backus-Naur Form

```
<chord>        ::=   <note> ":" <shorthand> ["("<degree-list>")"]["/"<degree>]
                   | <note> ":" "("<degree-list>")" ["/"<degree>]
                   | <note> ["/"<degree>]  | "N"

<note>         ::=  <natural>|<note> <modifier>

<natural>      ::=  A|B|C|D|E|F|G

<modifier>     ::=  b|#

<degree-list>  ::=  ["*"] <degree> ["," <degree-list>]

<degree>       ::=  <interval>|<modifier> <degree>

<interval>     ::=  1|2|3|4|5|6|7|8|9|10|11|12|13

<shorthand>    ::=  maj|min|dim|aug|maj7|min7|7|dim7|hdim7
                   |minmaj7|maj6|min6|9|maj9|min9|sus4
```

Table 2: Shorthand definitions for common chords

| Chord Type		Shorthand Notation	Components List
Triad Chords:			
	Major	maj	(3,5)
	Minor	min	(b3,5)
	Diminished	dim	(b3,b5)
	Augmented	aug	(3,#5)
Seventh Chords:			
	Major Seventh	maj7	(3,5,7)
	Minor Seventh	min7	(b3,5,b7)
	Seventh	7	(3,5,b7)
	Diminished Seventh	dim7	(b3,b5,bb7)
	Half Diminished Seventh	hdim7	(b3,b5,b7)
	Minor (Major Seventh)	minmaj7	(b3,5,7)
Sixth Chords:			
	Major Sixth	maj6	(3,5,6)
	Minor Sixth	min6	(b3,5,6)
Extended Chords:			
	Ninth	9	(3,5,b7,9)
	Major Ninth	maj9	(3,5,7,9)
	Minor Ninth	min9	(b3,5,b7,9)
Suspended Chords:			
	Suspended 4th	sus4	(4,5)
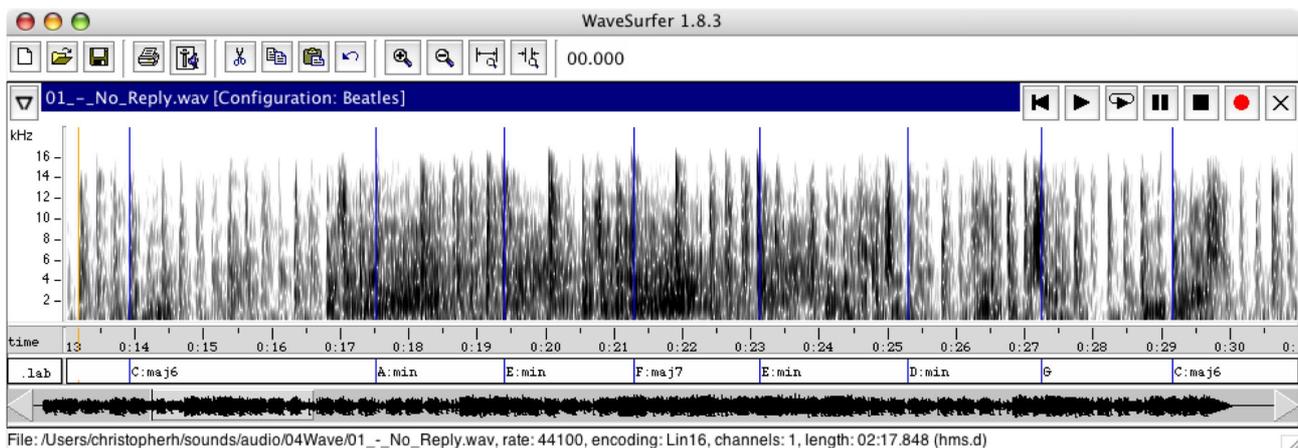
Figure 5: Part of the transcription file for *No Reply* by The Beatles displayed in Wavesurfer

4.2 Shorthand Notation

Our chord representation is straightforward and capable of fully describing any chord within Western tonal music. However, for manual annotation purposes, the inclusion of more musically intuitive shorthand labels for common chords is a useful extension. A proposed vocabulary of shorthand labels is given in Table 2 where each label is understood as a pre-set list of degrees. In this way, a chord may now also be defined by:

```
root : shorthand(extra-degrees) / bass
```

A common convention for labelling the quality of chords is: major 'M', minor 'm', augmented '+' and diminished 'o'. We choose more verbose labels, however, because it makes typographic errors in annotations easier to detect. Provision for extra degrees in parentheses is left so that additional intervals may be added to common chords. To make the shorthand system more flexible a special 'omit degree' symbol, an asterisk *, is also added to denote a missing interval from a shorthand notated chord. Hence a C minor seventh chord could become:

$$C:min7 \quad \equiv \quad C:(b3,5,b7)$$

and a C minor seventh with an added 11th degree but no 5th degree could be written:

$$C:min7(*5,11) \quad \equiv \quad C:(b3,b7,11)$$

To stay consistent with most chord notation styles, a root note on its own (i.e. with no shorthand label or defined degrees) is assumed to denote a major chord. Therefore a C major chord may be written simply as:

$$C \quad \equiv \quad C:maj \quad \equiv \quad C:(3,5)$$

Likewise, a root note followed directly by a forward slash and a bass note is assumed to be a major chord in an inverted form. For example a first inversion A major chord could be written:

$$A/3 \quad \equiv \quad A:maj/3 \quad \equiv \quad A:(3,5)/3$$

Added note chords should be explicitly labelled as major or minor to avoid confusion. Therefore a C major with an added fourth becomes:

$$C:maj(4) \quad \equiv \quad C:(3,4,5)$$

5 ANNOTATED COLLECTION

A database of annotations of songs from The Beatles back catalogue is available at the Centre for Digital Music website[1]. The annotations are in the form of `.lab` transcription files compatible with the Wavesurfer audio editor(see Figure 5). The transcription files contain a list of chord symbols, each with an associated start time and end time.

A set of Matlab tools is also available at the same web address for manipulating chord symbols and transcription files to aid annotation.

6 CONCLUSIONS

In this paper we have presented a general chord representation syntax for use in text annotations. The representation is an extendible format that will afford much easier sharing of annotations between researchers. To this end we have made a database of annotations using this syntax available on the internet and a dedicated wavesurfer plug-in for chord annotation is planned for the future.

One area where annotations in this style may prove particularly useful is in providing benchmark test sets for events such as the ISMIR contest. It is also possible that this style of representation could find uses elsewhere in music meta-data standards such as MPEG-7 and MusicXML.

Our representation is extensible. Additions to the list of shorthand labels can be made easily because each label is simply a macro definition of a set of intervals. Extensions to the notation such as the inclusion of microtonal intervals is a possibility for the future. This kind of enhancement could easily be achieved using additional switch characters to denote the presence of such information.

ACKNOWLEDGEMENTS

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[1] www.elec.qmul.ac.uk/digitalmusic/

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Audio Contents). More information can be found at the project website http://www.semanticaudio.org.

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