History of accidentals in music*

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Abstract

Signs used throughout music scores in order to change a note's pitch slightly are well-known: the sharp (♯) to raise it, the flat (♭) to lower it, and the natural (♮) to restore it to its normal pitch. First we give the etymology of these names, then we show that the conventions used in the past are very different from those used nowadays, especially if we consider *double* accidentals. In addition, accidentals present interesting typographic problems because there are several conventions with precise meanings: accidentals left to the note (with or without parentheses) or upwards.

Accidental signs used in classical or popular music are included in Unicode, as have some signs used for micro-intervals, such as quarter tones. From our point of view, the selection made by Unicode is debatable. In order to clarify the situation, we show the accidentals mainly used for micro-intervals in *musique orientale* and contemporary music. This article requires only basic knowledge in reading music scores.

Keywords History, accidentals' origin, putting accidentals, music typography, micro-intervals, Unicode.

Streszczenie

Znaki używane w zapisie nutowym w celu niewielkiej zmiany wysokości dźwięku są powszechnie znane: krzyżyk (♯) do podniesienia, bemol (♭) do obniżenia i kasownik (♮) do anulowania innych znaków. Najpierw zostanie omówiona etymologia tych nazw, następnie zaś to, że konwencje używane w przeszłości bardzo się różniły od obecnych, zwłaszcza jeśli weźmie się pod uwagę *podwójne* znaki chromatyczne. Na dodatek znaki chromatyczne sprawiają ciekawe problemy typograficzne, gdyż istnieje kilka konwencji przypisywania im precyzyjnego znaczenia: znaki chromatyczne na lewo od nuty (w nawiasach bądź bez nich) albo podniesione.

Do unikodu włączono znaki chromatyczne używane w muzyce klasycznej i popularnej, jak też niektóre znaki używane do oznaczania mikrointerwałów, takich jak ćwiartki dźwięków. Z naszego punktu widzenia można dyskutować z tym doborem znaków. W celu wyjaśnienia sytuacji zostaną pokazane znaki chromatyczne używane do oznaczania mikrointerwałów w muzyce orientalnej i współczesnej. Do zrozumienia tej prezentacji wystarczy jedynie podstawowa znajomość zapisu nutowego.

Słowa kluczowe Historia, pochodzenie znaków chromatycznych, umieszczanie znaków chromatycznych, typografia muzyczna, mikrointerwały, Unicode.

* Polish title: *Historia znaków chromatycznych w muzyce.*

Introduction

Within music scores, an **accidental** is a sign usually put before a note figure, signalling a slight change of its pitch. Let us consider the keys of a piano, *white* keys are denoted by letters from 'A' to 'G',[1] whereas *black* keys are reached by means of accidentals. These signs are well-known: the **sharp** (♯) raises a note's pitch by a semitone,[2] the **flat** (♭) lowers it by a semitone, and the **natural** (♮) restores it to its normal pitch. In LaTeX, these signs are respectively produced by the commands `\sharp`, `\flat`, and `\natural` in math mode.

From a typographic point of view, writing accidentals in music scores obeys rules that are not always precisely known. Besides, these rules have evolved over time. In addition, there are many other signs related to accidentals, some of which are included in Unicode [32]. We personally think that the selection made by Unicode is quite debatable. So the purpose of this article is to give an overview of the conventions related to accidentals. We discuss the etymology of these signs in the first section, then the rules are given in Section 2. Section 3 is devoted to some remarks about characters, software and encodings' organisation. In Section 4, we study accidentals for *micro-intervals* — smaller than semitones — used in *musique orientale*[3] and also in contemporary music. Reading this article requires only basic knowledge of music scores. Readers interested in precise definitions of music terminology can consult [16]. More information about historical points can be found in [1], and also in [22], but in French. To help readers situate musicians cited throughout the article, we give their dates, either in the text or in the bibliography.

1 Origins

In the early Middle Ages, three *modes* were known. These modes cannot be viewed as 'modern' scales

[1] In the English-speaking world. Some other countries — including France, Spain, Italy and Russia — use names coined by Guido d'Arezzo (991 or 992–after 1033) after the verses of a Latin hymn in honour of John the Baptist: *ut ré*, *mi*, *fa*, *sol*, *la*, for C, D, E, F, G, A. Later, the *si* name was added for B in the XVIth century, and *ut* was renamed to *do* in the XVIIth century; the origins of these last two names are controversial.

[2] The interval between two notes played by adjacent notes on a piano, regardless of colour.

[3] This French term encompasses Andalusian classical music, beginning in the Emirate of Cordoba in the IXth century, and including music of countries of North Africa, Near and Middle East. In English, the word 'oriental' is most commonly used to refer to the Far East, whereas 'orientale' in French is often applied to the Near or Middle East. That is why we use the French expression.

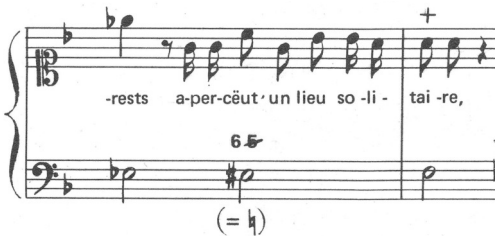

Figure 1: Nicolas Bernier (1664–1734), *Diane*, excerpt [6, p. 3].

including 7 *degrees*, since they were based on *hexachords*, that is, 6-note groups. They were:

- the *natural hexachord*[4] (*hexachordum naturale*): C, D, E, F, G, A;
- the *soft* hexachord (*hexachordum molle*): F, G, A, B♭, C, D;
- the *hard* hexachord (*hexachordum durum*): G, A, B, C, D, E.

Thus, only the B note could be flattened.[5] The '♭' sign derives from a *round b* (*b rotundum*) — originally written '♮' — in connection with the soft hexachord; the French name *bémol* comes from medieval French *bé mol*[6] for *soft b*. The signs '♮' and '♯' derive from a *square b* (*b quadratum*) — originally written '♮' — in connection with the hard hexachord; the French name *bécarre* (♮) comes from medieval French *bé quarré*.[7] The natural and sharp signs are both derived from this 'square b' using two different ways to extend sides of this square. The French name *dièse* (for 'sharp') comes from the Latin word *diesis*: initially, this word denoted a quarter tone interval in ancient music; at the Roman Empire's end, it was used for a semitone interval. To conclude the etymology questions, it seems that the English name 'sharp' (resp. 'flat') comes from 'so high (resp. low) as to be out of tune'.

Let us go back to the natural and sharp signs. The difference between them was vague for a long period of time. Often, ancient scores used sharps in order to raise a note lowered previously. For such a sharp sign, as shown in Fig. 1, a natural sign would

[4] As an example, the Hymn to John the Baptist (cf. *supra*) is written using this mode. Guido d'Arezzo was unable to use this piece to give a name to the B note, since it does not appear within this natural hexachord.

[5] In addition, let us mention that at this time, scribes were hesitating over whether 'B' denotes B♮ or B♭. This ambiguity is removed by the German notation system, still in use today: 'B' stands for B♭, 'H' for B♮. This system is also in use in Central and Eastern Europe, and in Scandinavia. Also, hexachords' names have survived in the German words for the modes of 'classical' tonal scales: *moll* for *minor*, *Dur* for *Major*.

[6] In modern French: *bé mou*.

[7] In modern French: *bé carré*.

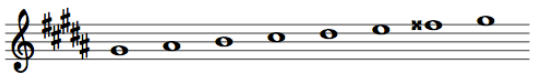

Figure 2: G♯ minor scale.

be substituted in modern notation. In fact, these two signs were clearly separated only at the beginning of the classical era. During the pre-classical period, modern scales — C Major, F Major, G Major, etc. — were progressively emerging, from the XVth to the XVIIth century. The first 'actual' sharp in use was F♯, then the second flat — E♭ — came, and so on: C♯, A♭, G♯, D♭, D♯, G♭, A♯, C♭, E♯, F♭, B♯. The notion of *enharmonic intervals* appeared, e.g., A♭ and G♯ are the same note, although they have different names.[8]

Double accidentals, such as *double sharp* (𝄪) and *double flat* (𝄫), were introduced in the XVIIth century.[9] They raise or lower a note's pitch by *two* semitones. Initially, the goal was to express *sensible notes*[10] for some minor scales, e.g., F𝄪 is the sensible note of the G♯ minor scale, as shown in Fig. 2. The 𝄪 sign was introduced before the 𝄫 sign,[11] whereas the ♭ sign was coined before the ♯ sign.

2 Rules

Most of the rules we give hereafter are well-known for musicians. We examine them from a typographical point of view.

2.1 Restoring accidentals

Often, accidentals are implicit in scores from the Middle Ages. In other words, an accidental may be omitted whenever it was obvious for the musicians of the time, who were used to restoring them.[12] When modern music gravers restore such implicit accidentals,

[8] In fact, that is true only for instruments based on twelve-tone *equal temperament*, e.g., a piano in today's standard tuning. Dealing with other temperaments is outside this article's scope. In addition, let us remark that such enharmonic notes are not limited to those which are played using black keys of a piano: as a counter-example, E♯ and F♮ are enharmonic, too.

[9] [9, §45] gives another — old — notation for the double sharp: ♯, surrounded by four dots. We personally have never seen this sign in any score, even very old ones.

[10] A *sensible note* is located just below a scale's basic note and is *attracted* by it, so a sensible note must be at a distance of a semitone. Only modes — major and minor — with sensible notes are used in classical harmony.

[11] The 𝄫 sign does not belong to any 'classical' scale; it has been introduced 'symmetrically' to the 𝄪 sign.

[12] This may seem surprising, but analogously, many jazz scores today let some details remain implicit: for example, rhythms in jazz scores are often simplified forms in comparison to what jazz musicians actually play. Chords in jazz scores are often simplified, too.

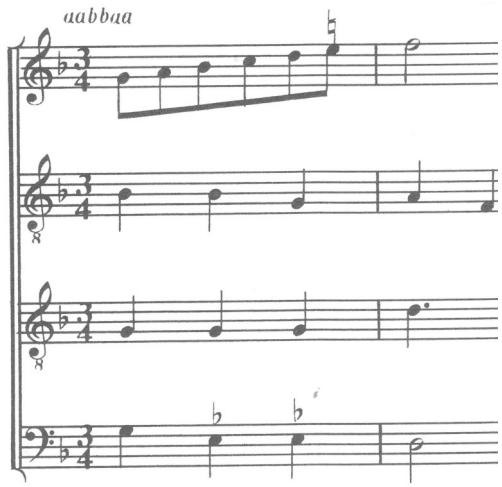

Figure 3: P. Attaingnant [2, no. 19]: *Basse dance*, start.

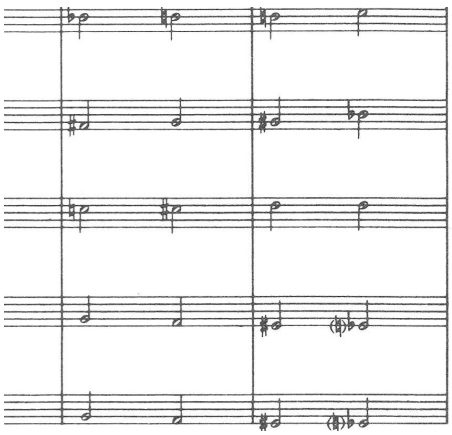

Figure 4: G. Gershwin [12, p. 5]: 1st movement, 7 bars after §2.

they have to put them *above* or *below* the corresponding note head — not at the left — as shown in Fig. 3. Such an accidental only applies to the corresponding note, not to the following ones.[13]

2.2 More double accidentals

As mentioned in §1, a sharp sign sometimes had a relative effect in ancient scores, since it could be used to raise a note already lowered. This view — which appears strange nowadays — has survived through the ages in the use of the double signs 𝄫, 𝄪, and 𝄮 [7, §82]. For example, if a double flattened note is followed by the same note with a 'single' flat sign, it

[13] Thus the repetition of the ♭ sign for two adjacent notes within the bass voice of Fig. 3. Let us also notice a kind of *polytonality*, usual in the music of this time. Contrary to what many people think, polytonality and polymodality were not introduced in the XXth century.

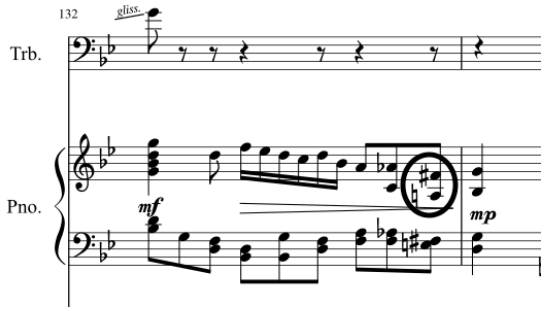

Figure 5: J.-M. Hufflen [15], bar 132.

was incorrect to insert the ♭ sign. Using 𝄫 means that the first ♮ sign cancels one of the two semitones of 𝄫, so the note can now be flattened. As shown in Fig. 4, the same sign is sometimes used after a sharpened note, before flattening it. Symmetrically, the use of 𝄪 is analogous to that of 𝄫. The 𝄮 sign means that a note is restored at its normal pitch after the use of 𝄪 or 𝄫. Nowadays this complicated rule — it introduces 'compound' signs that are actually useless — becomes more and more obsolete, and a 'simple' accidental sign always denotes its original effect, regardless of accidentals used before.

2.3 Accidentals and bars

In most music scores [7, §79], an accidental sign takes effect for the following note and any repetition of that note at the same octave and in the same bar, unless cancelled by another accidental. If a note is tied into the following bar, the accidental takes effect just until this tie's end. If a system of multiple staves is used, an accidental used on one staff never affects others. This convention gradually emerged over the XVIIIth century. Before, accidentals only applied to immediately repeated notes or short groups for which it was obvious that the accidental should go on.[14] In some scores from the XIXth century, accidentals apply to the same notes in the same bar, regardless of octaves. The standard rules can be observed in the example given in Fig. 5. The ♮ sign used with the circled A note at the staff for the piano's right hand avoids any ambiguity but is formally useless: first, this note is not at the same octave as the A♭ at the immediate left, and second the A♭ at the same octave and inside the same bar does not belong to the same staff.

Some contemporary composers use accidentals regardless of bars, that is, accidentals are not continued until a bar's end. The last scores of Hans-Werner Henze (1926–2012) are examples where accidentals apply only to one note or immediately re-

[14] Let us recall that at this time, some accidentals were implicit, supplied by interpreters.

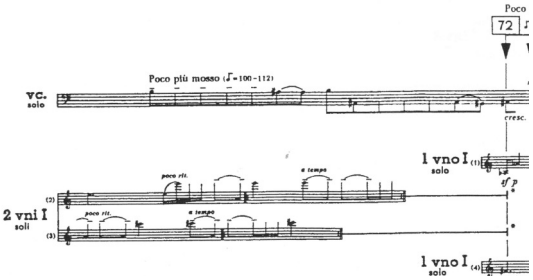

Figure 6: W. Lutosławski [21, p. 30], before Section 72.

peated notes. As other — non-limitative — examples, accidentals apply to only one note in the last scores of Witold Lutosławski and Henryk Mikołaj Górecki (1933–2010). W. Lutosławski uses repeated notes without heads when an accidental applies to some adjacent notes — as shown in Fig. 6 — whereas H. M. Górecki explicitly repeats the same accidental before each repeated note.[15]

When in doubt, music composers and publishers sometimes put extra accidentals down, even if they are 'formally' useless. Such accidentals are called *courtesy* or *cautionary*. For example, if a note has an accidental within a bar, such a courtesy accidental within the next bar allows an interpreter not to be confused about this note's pitch. In particular, courtesy accidentals should be used for notes with lengthy ties at a new system's beginning. Courtesy accidentals should be surrounded by parentheses, but in practice, this convention is often not followed and courtesy accidentals are written as 'actual' accidentals.[16]

2.4 Key signatures

A *key signature* is a set of sharps or flats associated with a scale. The placement of accidentals on key signatures obeys precise rules about the succession of sharps or flats and their placement, depending on the clef used,[17] but now music software programs generating scores do that correctly. So we just give some examples in Fig. 7:

- *(a)*, *(c)*, *(f)* use the well-known *treble* clef,
- *(b)* uses the *tenor* clef, devoted to the high range of instruments such as the bassoon, cello, or trombone,

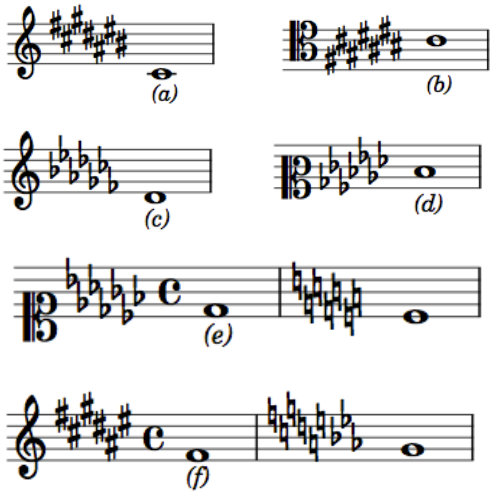

Figure 7: Key signatures.

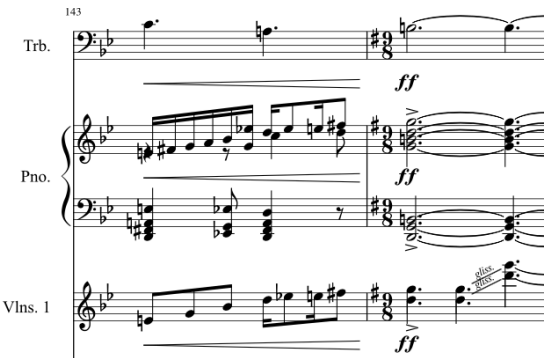

Figure 8: J.-M. Hufflen [15], bars 143–144.

- *(d)* uses the *mezzo-soprano* clef and *(e)* the *soprano* clef.[18]

In *(e)* and *(f)*, we can remark that if a key signature changes throughout a piece, the accidentals absent in the new key signature should be cancelled by ♮ signs, as shown in Fig. 7-*(e,f)*. We can observe that this rule is less used nowadays, so ♮ signs in a key signature change are only used when the new signature is empty, as shown in Fig. 8.

Let us mention that in pre-classical music, some key signatures seem to be incorrect, especially for minor scales. For example, a piece that appears to be in G minor uses the D minor key signature, as shown in Fig. 3. More generally, minor scales sometimes use a key signature with one flat fewer, or one

[15] Let us remark that ♮ signs become useless if such conventions — that accidentals apply to one note only — are used with empty key signature scores (cf. §2.4).

[16] . . . as we did for the circled note in Fig. 5. The score [15] has been typeset with MuseScore [24].

[17] Different key signatures may be used in *musique orientale* and popular music, but this is outside this article's scope.

[18] Nowadays, these two keys are no longer in frequent use. The *soprano* key is still used scholastically (in harmony exercises), while the *mezzo-soprano* key is only used for transposition purposes. To give an idea about relationships among these keys, let us mention that examples *(a–e)* begin with notes at the same pitch.

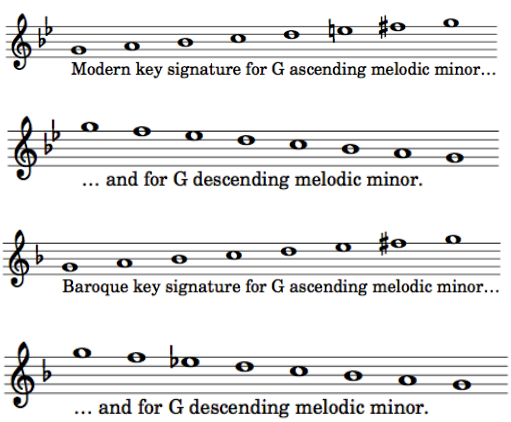

Figure 9: Modern and baroque key signatures for melodic minor scales.

more sharp, or an empty signature for D minor. More examples — including 'incomplete' key signatures for major scales — can be found in [8]. A complete explanation is given in [11]. We can demystify this *modus operandi* about minor scales:[19] it allows *ascending melodic* minor scales[20] to be specified with as few accidentals as possible, with respect to the key signature's signs, as shown in Fig. 9 for the ascending melodic scale of G minor.

3 Intermezzi

The previous sections are based on 'purely' musical material; now, we give some details related to computer science and music software.

3.1 '♯' vs '#'

Often the characters '♯' (`U+266F`) and '#' (`U+0023`) are confused. They are graphically different since the latter is a combination of level horizontal strokes and right-tilting vertical ones, whereas the former is based on vertical strokes and slanted horizontal ones. The '#' character is the *number sign* and is present on standard keyboards, so it often replaces '♯' in practice. A good example is the name of the C# programming language [23], written with a number sign but pronounced 'C sharp'.

[19] The explanation of this *modus operandi* about major scales would need the introduction of *ancient modes*, out of this article's scope.

[20] In this scale, the third is minor, the sixth and seventh are major [7, §151.II]. As pictured in Fig. 9, the sixth and seventh are minor within a *descending melodic* minor scale. In classical harmony, such melodic minor scales should be used only for a *melody*, the successive chords harmonising a melody are based on the *harmonic* minor scale, as defined in Fig. 2 for the G♯ minor scale.

```
\version "2.18.0"
\score {
 \new Staff {
  \clef "treble" \time 3/4
  \accidentalStyle Score.default
  r8 bes'8 fes'4. ges'8 | ees'2 f'4 |
  r8 a'8[ d'8. cis'16] g'4 |
 }
 \layout {}
}
```

Figure 10: Example using LilyPond.

3.2 Accidentals in Unicode

In Unicode [32], the 'basic' accidentals — ♭, ♮, ♯ — are encoded in the *Miscellaneous Symbol Block* (`U+266D`, `U+266E`, `U+266F`). The other accidentals are encoded in the *Musical Symbol Block*, from the code-point `U+1D12A` to `U+1D133`. The first two code-points of this range are for 𝄪 and 𝄫.

3.3 Coding more musical signs

Presently, Unicode has retained only a few musical signs from the multitude of signs used through the ages. Let us mention the SMuFL[21] project. This is a specification providing a standard way of mapping musical symbols required by conventional music notation into the Private Use Area in Unicode's Basic Multilingual Plane (`U+E000`–`U+F8FF`). In particular, all the symbols introduced in the following have been mapped. In addition, several music software packages — e.g., MuseScore [24] — use this encoding.

3.4 Accidentals and LilyPond

The GNU[22] LilyPond music engraver [29] provides a character-based language to specify the rhythm and pitch of a note — a short introduction and example are given in [14]. When LilyPond compiles a piece's specification into a music score, it uses *accidental styles* to decide whether or how accidentals actually appear. These accidental styles — w.r.t. LilyPond's terminology, they may be viewed as *strategies* — include [20]:

`default` accidentals are inserted or are implicit, according to common practice,

`modern` some courtesy accidentals, without parentheses, are added to avoid ambiguity,

`neo-modern` accidentals are repeated if the same note appears again in the same bar, unless this note is immediately repeated,

[21] **S**tandard **Mu**sic **F**ont **L**ayout. See `http://smufl.org` for more technical details.

[22] Recursive acronym: **G**nu's **N**ot **U**nix.

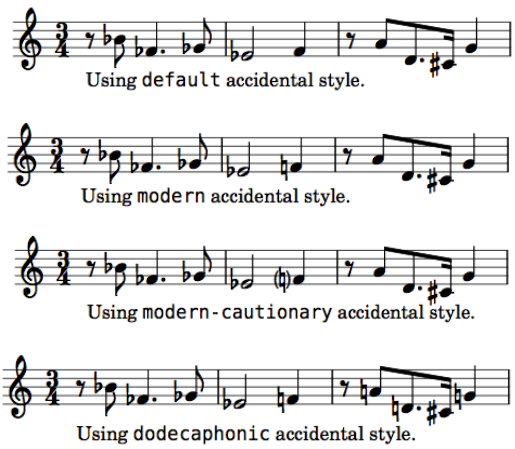

Figure 11: Examples of accidental styles for Fig. 10.

`dodecaphonic` every note gets an accidental sign, including natural signs,

`forget` accidentals are not remembered at all.

The styles:

`modern-cautionary`, `neo-modern-cautionary`, `teaching`

are respectively similar to:

`modern`, `neo-modern`, `dodecaphonic`,

except extra accidentals are surrounded by parentheses, as cautionary accidentals. As a very short example, Fig. 10 gives a LilyPond specification of the *Tema*'s beginning of Arnold Schoenberg's *Variations for Orchestra* [28, p. 7, bars 34–36]. For each note, its accidental is given as '`...is`' for ♯, '`...es`' for ♭, and no suffix for ♮. Results according to some of LilyPond's accidental styles are given in Fig. 11. Other customisation features are available: for example, allowing the use of double accidentals such as 𝄫, 𝄪, and 𝄲; inserting or removing the accidental of a tied note at the start of a new system, and more.

In addition, let us mention that the lilyglyphs package[23] allows music glyphs pictured by LilyPond to be handled by means of TEX-like commands, provided that XELATEX [18] or LUALATEX [13] are used.[24] We have personally added some new commands, but all the glyphs for 'basic' accidentals used throughout this article come from this package.

4 Accidentals for micro-intervals

4.1 What are micro-intervals?

Micro-intervals are *smaller* than semitones. In the early XXth century, composers started to use such intervals, in particular, *quarter* tones.[25] At this time, these intervals were specified by means of *ad hoc* notations: for example, Alban Berg in his *Chamber Concerto* (premiered in 1927, cf. Fig. 12). A later example is given by the last movement of Béla Bartók's *Sonata for Solo Violin*[26] [3], written in 1944. Some composers built totally new organisations of sounds and intervals. Two historical and representative examples are Alois Hába (1893–1973) and Ivan Wyschnegradsky (cf. [36]); both went in this direction after the First World War. In addition, quarter tones are used in some popular music, especially *musique orientale*, but this music is not really based on quarter tones, in the sense that classical music may be viewed as based on semitones (for example, in classical scales, the interval between B and C). In fact, *musique orientale* does not deal with quarter tones between adjacent notes: in addition to tones and semitones, it uses *great tones* (5/4 tone), and *small tones* (3/4 tone). Expressing this organisation by means of our occidental notation causes quarter tone notations to appear, but this interval does not exist in *musique orientale*.

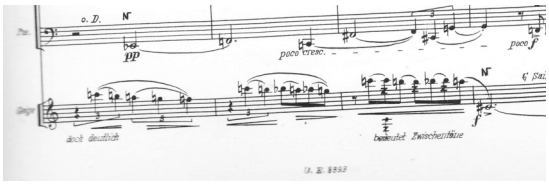

Figure 12: A. Berg [4, p. 53]: bars 274–277.

Other divisions of tones have existed, too. For example, Maurice Ohana (1913–1992) utilised a division of tones by three,[27] and I. Wyschnegradsky divided a tone into 12 parts, and more (!) [34]. As mentioned in §3.2, some accidentals for micro-intervals

[23] Included in the TEX Live distribution.

[24] All these commands — including redefinitions of the commands `\flat`, `\natural`, and `\sharp` — are to be used in text mode.

[25] [6] explains that the evolution of music, throughout the ages, has developed chords incorporating more and more sounds, according to the successive harmonic notes within harmonic series (first the octave, then the fifth, before the third, and so on). In particular, the introduction of micro-intervals at this time can be explained by this theory [6, p. 77–79].

[26] This sonata was composed for violinist Yehudi Menuhin (1916–1999). In a letter dated April 21, 1944, B. Bartók wrote that 'quarter tone steps may be eliminated and replaced by alternative versions.' He would have liked 'to hear both played versions, and then decide if it is worth while to use these 1/4 tones.' Unfortunately, he never heard this work before his death, and the alternatives, only retained within the Menuhin edition, are often played instead.

[27] According to his notation, raising a note by a third tone (resp. 2/3 tone) is signalled by '/' (resp. '//') to the left of the note head. Third tones were also used in the last movement of B. Bartók's *Sonata for Solo Violin* [3, bars 58–62], although an alternative version, retained by Y. Menuhin, avoids them (cf. footnote 26).

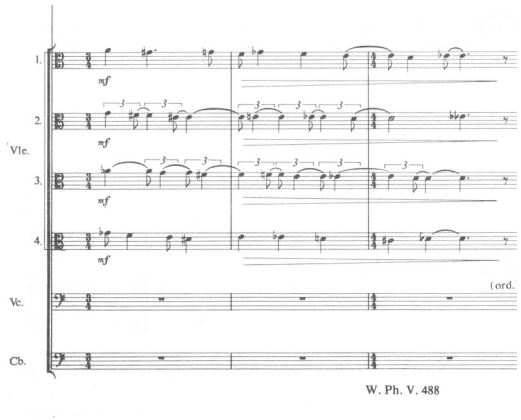

Figure 13: A. Schnittke [27, p. 2]: 1st movement, Section 3.

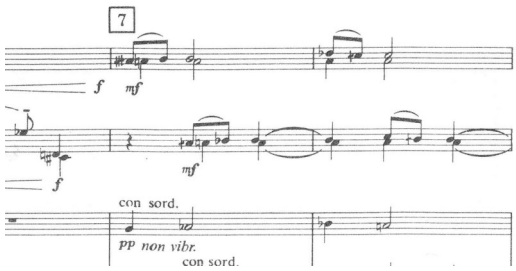

Figure 14: A. Schnittke [27, p. 42]: 3rd movement, Section 7.

belong to the Unicode encoding, but they do not specify the more frequent and more precise intervals.

4.2 Exact micro-intervals

As a semitone is the *exact* division of tones by two, a quarter tone is the exact division of semitones by two, that is, this division yields something *precise*.[28] If quarter tones are used throughout a score, some explanations make the signs' meaning precise. Even if there is no 'official' standardisation, the more frequently used signs are 𝄲 for a *half sharp*, raising a note by a quarter tone,[29] and 𝄳 for a *sharp and half*, raising a note by three quarter tones. In particular, these notations are used by Iannis Xenakis [37]. Alternative notations exist: 𝄰 and 𝄯.

A *half flat*, lowering a note by a quarter tone is often denoted by 𝄭, with a *flat and half*, lowering a note by three quarter tones, by 𝄫, alternative notations being 𝄬 and 𝄪.

As examples, we can see the notations used by Alfred Schnittke in Figs. 13 and 14. Those used by Krzysztof Penderecki, Ivan Wyschnegradsky, and Witold Lutosławski are shown in Figs. 15–17. In these scores, the glyphs for half sharps and sharps and a flat are quite similar. Concerning half flats and flats and a half, A. Schnittke and W. Lutosławski use 'open' glyphs for half flats. K. Penderecki uses black-filled flats for half flats and 𝄭 for flats and a half. More details about these notations and variants can be found in [17]. Let us observe that none of them have been included into Unicode. The glyphs defined by Unicode at present are 𝄲 (U+1D132) and 𝄬 (U+1D133): we have *never* seen them in *any* score.

We end this short study of quarter tones with giving two examples of modes within *musique orientale* in Fig. 18: *rast* and *soznak* (cf. [5, p. 2] & [10, p. 38]). In considering the *rast* mode, we can notice a small tone between the 2nd and 3rd degrees and a great tone between the 3rd and 4th degree. If you are interested in such modes, you can find more details in [5, 10].

4.3 Approximate micro-intervals

Table 1 lists signs derived from the classical accidentals and expressing *indeterminate* pitch [33, p. 138–139]. We include the corresponding code-point for those included in Unicode, preceded by '⋆' if the Unicode's glyph is slightly different.[30] An up (resp. down) arrow means that the note is to be slightly raised (resp. lowered). For example, if an interpreter plays C𝄲 (half sharp) for C𝄯, that is correct but not required; the notation merely expresses that this note must be located between C𝄮 and than C𝄯. In addition, it *should be* closer to C𝄯 than C𝄮. An up-down arrow means 'around' the corresponding note, e.g., C𝄮 may be slightly higher or lower than C𝄮. We can imagine only with difficulty such a notation when several instrumentalists play the same part, e.g., all the violins of a symphonic orchestra, but it has been used in chamber music, an example being given in Fig. 19.

Other notations expressing the same behaviour come from the *breaks in the voice* in Byzantine chant: 𝄬, 𝄮, 𝄯, as shown in Fig. 20.

5 Conclusion

Handling accidentals in music scores is error-prone,

[28] We assume an equal temperament (cf. footnote 8, on p. 148). In any case, unequal temperaments complicate the definition of quarter tones, but still lead to precise results.

[29] As mentioned in §3.3, all the signs introduced in the present section have been included in the mapping done as part of the SMuFL project. For example, the code point of the 𝄲 sign is U+E282.

[30] The arrow of the Unicode character U+1D131 is at the bottom right corner, whereas the 'actual' sign's arrow is at the bottom left corner, as shown in Table 1.

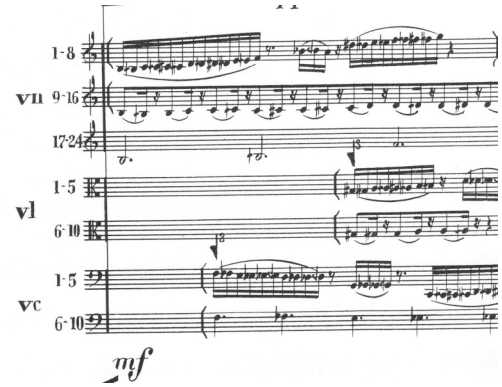

Figure 15: K. Penderecki [26, p. 10]: Section 9.

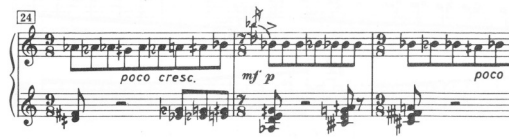

Figure 16: I. Wyschnegradsky [35, p. 34]: Prelude X, bars 24–27.

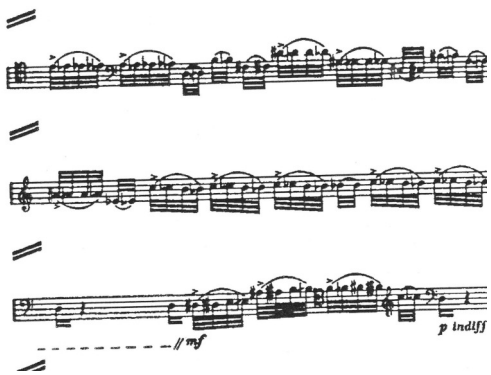

Figure 17: W. Lutosławski [21, p. 4]: *cadenza*.

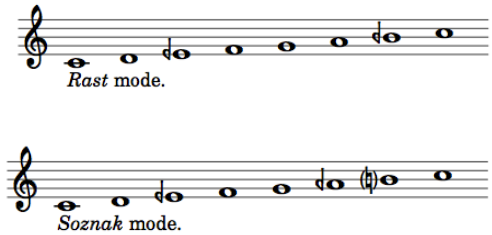

Figure 18: Two examples of modes within *musique orientale*.

𝄲	(U+1D12C)	𝄳	-
𝄳	(U+1D12D)	𝄯	(U+1D130)
𝄲	-	𝄯	⋆(U+1D131)
𝄮	(U+1D12E)	𝄯	-
𝄮	(U+1D12F)		

Table 1: Signs for approximate micro-intervals.

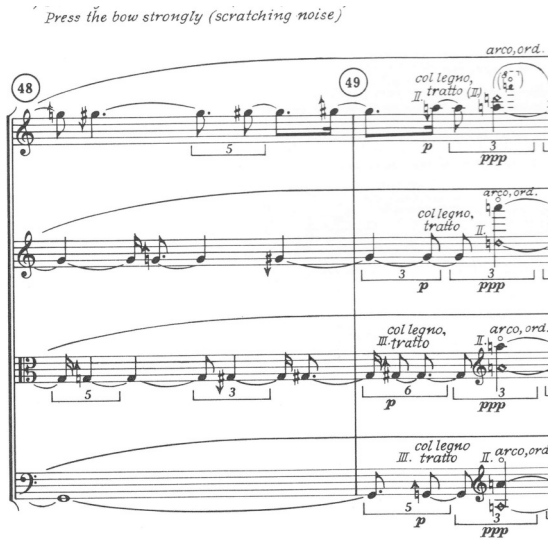

Figure 19: G. Ligeti [19, p. 16]: 2nd movement, bars 48–49.

especially for older scores. Often musicologists doubt their interpretation. However this system has been in use for several centuries, and some attempts to replace them — e.g., [25] — have failed. From a point of view of software generating music scores, LilyPond's *modus operandi* seems to us to be good, in the sense that we can precisely customise a score's final look. Such advanced functions do not exist in MusiXTEX [30] or MuseScore [24]. With respect to Unicode, we speak in favour of adding accidental signs for exact quarter tones. Of course, Unicode does not aim to incorporate all new notations in contemporary music, but including these signs may be interesting for typesetting studies about *musique orientale*. As far as we know, most of the references about this topic use signs for exact quarter tones, not signs for approximate ones, as defined in Unicode.

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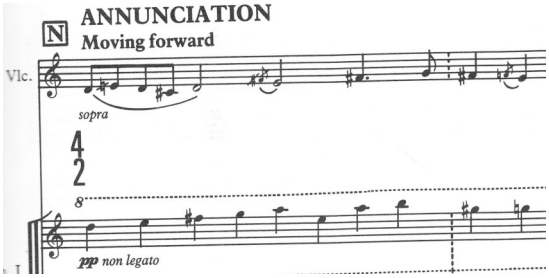

Figure 20: J. Tavener [31, p. 29]: Section N, 2nd movement, beginning.

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