LilyPond

The music typesetter

Essay on automated music engraving

The LilyPond development team

This essay discusses automatic music engraving functions within LilyPond version 2.23.82.

For more information about how this manual fits with the other documentation, or to read this manual in other formats, see Section "Manuals" in *General Information*.

If you are missing any manuals, the complete documentation can be found at `https://lilypond.org/`.

For LilyPond version 2.23.82

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1 Music engraving

This essay describes why LilyPond was created and how it can produce such beautiful sheet music.

1.1 The LilyPond story

Long before LilyPond had been used to engrave beautiful performance scores, before it could create university course notes or even simple melodies, before there was a community of users around the world or even an essay on music engraving, LilyPond began with a question:

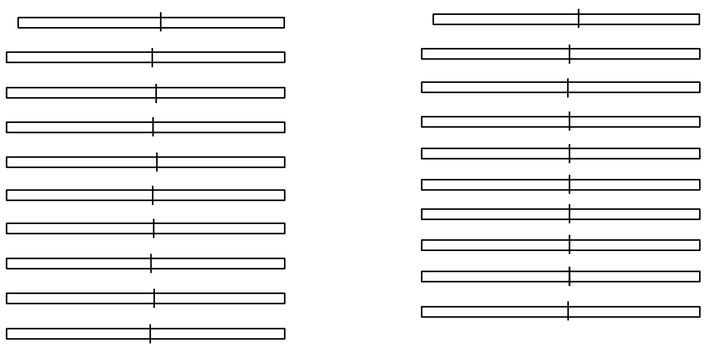
> Why does most computer output fail to achieve the beauty and balance of a hand-engraved score?

Some of the answers can be found by examining the two scores on the following pages. The first score is a beautiful hand-engraved score from 1950 and the second is a modern, computer-engraved edition.

The notes here are identical, taken from Bach's first Suite for solo cello, but the appearance is different, especially if you print them out and view them from a distance. Try reading or playing from each of the scores and you will find that the hand-engraved score is more enjoyable to use. It has flowing lines and movement, and it feels like a living, breathing piece of music, while the newer edition seems cold and mechanical.

It is hard to immediately see what makes the difference with the newer edition. Everything looks neat and tidy, possibly even "better" because it looks more computerized and uniform. This really puzzled us for quite a while. We wanted to improve computer notation, but we first had to figure out what was wrong with it.

The answer lies in the precise, mathematical uniformity of the newer edition. Find the bar line in the middle of each line: in the hand-engraved score the position of these bar lines has some natural variation, while in the newer version they line up almost perfectly. This is shown in these simplified page layout diagrams, traced from the hand-engraved (left) and computer-generated music (right):



In the computer-generated output, even the individual note heads are aligned in vertical columns, making the contour of the melody disappear into a rigid grid of musical markings.

There are other differences as well: in the hand-engraved edition the vertical lines are all stronger, the slurs lie closer to the note heads, and there is more variety in the slopes of the beams. Although such details may seem like nitpicking, the result is a score that is easier to read. In the computer-generated output, each line is nearly identical and if the musician looks away for a moment she will be lost on the page.

LilyPond was designed to solve the problems we found in existing software and to create beautiful music that mimics the finest hand-engraved scores.

Bärenreiter BA 320, ©1950:

Henle no. 666, ©2000:

1.2 Engraving details

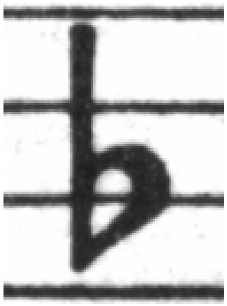
The art of music typography is called *(plate) engraving*, a term that derives from the manual process of music printing[1]. Just a few decades ago, sheet music was made by cutting and stamping the music into a zinc or pewter plate in mirror image. The plate would be inked, and the depressions caused by the cutting and stamping would hold ink. An image was formed by pressing paper to the plate. The stamping and cutting was done completely by hand and making a correction was cumbersome, so the engraving had to be nearly perfect in one go. Engraving was a highly specialized skill; a craftsman had to complete around five years of training before earning the title of master engraver, and another five years of experience were necessary to become truly skilled.

LilyPond is inspired by traditional manual engravings published by European music publishers in and towards the end of the first half of the twentieth century, including Bärenreiter, Duhem, Durand, Hofmeister, Peters, and Schott. This is sometimes regarded as the peak of traditional musical engraving practice. As we have studied these editions we have learned a great deal about what goes into a well-engraved score, and the aspects that we wanted to imitate in LilyPond.

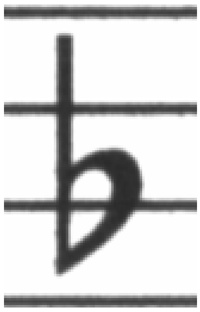
Music fonts

The images below illustrate some differences between traditional engraving and typical computer output. The left picture shows a scan of a flat symbol from a hand-engraved Bärenreiter edition, while the right picture depicts a symbol from an edition of the same music published in 2000. Although both images are printed in the same shade of ink, the earlier version looks darker: the staff lines are heavier, and the Bärenreiter flat has a bold, almost voluptuous rounded look. The right scan, on the other hand, has thinner lines and a straight layout with sharp corners.

[1] Early European printers explored several processes, including hand-carved wooden blocks, movable type, and engraved sheets of thin metal. Typesetting had the advantage of being more easily corrected and facilitating the inclusion of text and lyrics, but only engraving offered the ability to do unimpeded layout and unanticipated notation. In the end, hand-engraved scores became the standard for all printed music, with the exception of some hymnals and songbooks where typesetting was justified by its ease and economy, even into the twentieth century.



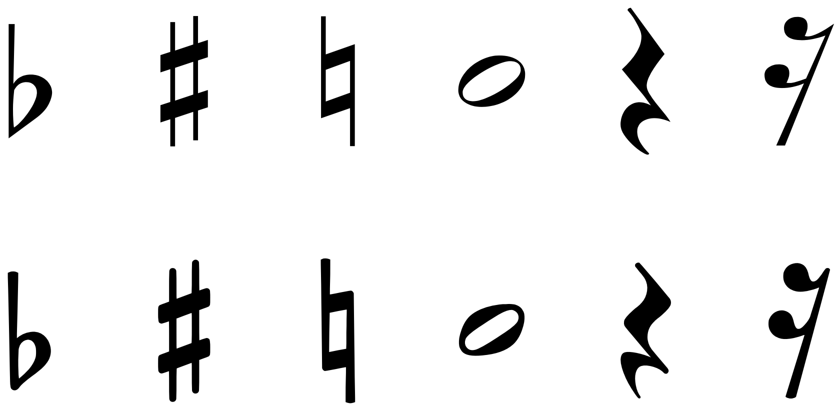
Bärenreiter (1950)



Henle (2000)

When we wanted to write a computer program to create music typography, there were no musical fonts freely available that could match the elegance of our favorite scores. Undeterred, we created a font of musical symbols, relying on nice printouts of hand-engraved music. The experience helped develop a typographical taste, and it made us appreciate subtle design details. Without that experience, we would not have realized how ugly the fonts were that we admired at first.

Below is a sample of two music fonts: the upper set is the default font in the Sibelius software (the *Opus* font), and the lower set is our own LilyPond font.

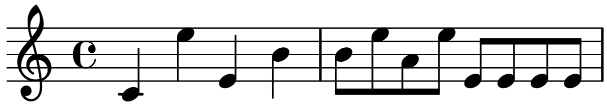


The LilyPond symbols are heavier and their weight is more consistent, which makes them easier to read. Fine endings, such as the ones on the sides of the quarter rest, should not end in sharp points, but rather in rounded shapes. This is because sharp corners of the punching dies are fragile and quickly wear out when stamping in metal. Taken together, the blackness of the font must be carefully tuned together with the thickness of lines, beams and slurs to give a strong yet balanced overall impression.

Also, notice that our half-note head is not elliptic but slightly diamond shaped. The vertical stem of a flat symbol is slightly brushed, becoming wider at the top. The sharp and the natural are easier to distinguish from a distance because their angled lines have different slopes and the vertical strokes are heavier.

Optical spacing

In spacing, the distribution of space should reflect the durations between notes. However, as we saw in the Bach Suite above, many modern scores adhere to the durations with mathematical precision, which leads to poor results. In the next example a motif is printed twice: the first time using exact mathematical spacing, and the second with corrections. Which do you prefer?

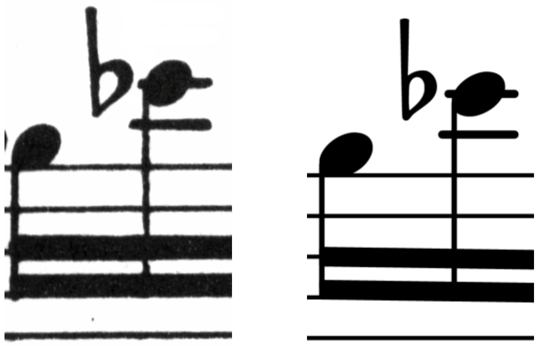


Each bar in the fragment only uses notes that are played in a constant rhythm. The spacing should reflect that. Unfortunately, the eye deceives us a little; not only does it notice the distance between note heads, it also takes into account the distance between consecutive stems. As a result, the notes of an up-stem/down-stem combination should be put farther apart, and the notes of a down-stem/up-stem combination should be put closer together, all depending on the combined vertical positions of the notes. The lower two measures are printed with this correction, the upper two measures, however, form down-stem/up-stem clumps of notes. A master engraver would adjust the spacing as needed to please the eye.

The spacing algorithms in LilyPond even take the bar lines into account, which is why the final up-stem in the properly spaced example has been given a little more space before the bar line to keep it from looking crowded. A down-stem would not need this adjustment.

Ledger lines

Ledger lines present a typographical challenge: they make it more difficult to space musical symbols close together and they must be clear enough to identify the pitch at a glance. In the example below, we see that ledger lines should be thicker than normal staff lines and that an expert engraver will shorten a ledger line to allow closer spacing with accidentals. We have included this feature in LilyPond's engraving.

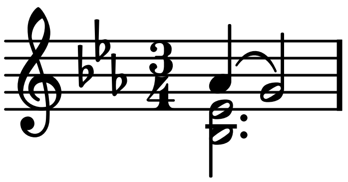


Optical sizing

Music may need to be printed in a range of sizes. Originally, this was accomplished by creating punching dies in each of the required sizes, which meant that each die was designed to look its best at that size. With the advent of digital fonts, a single outline can be mathematically scaled to any size, which is very convenient, but at the smaller sizes the glyphs will appear very light.

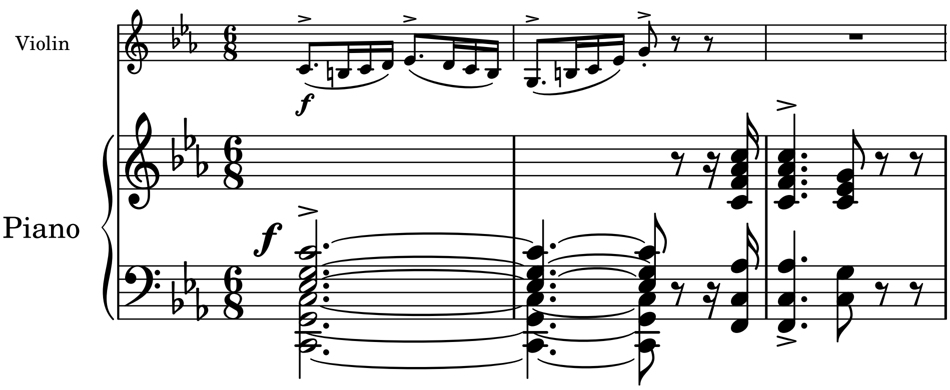
In LilyPond, we have created fonts in a range of weights, corresponding to a range of music sizes. This is a LilyPond engraving at staff size 26:

and this is the same engraving set at staff size 11, then magnified by 236% to print at the same size as the previous example:



At smaller sizes, LilyPond uses proportionally heavier lines so the music will still read well.

This also allows staves of different sizes to coexist peacefully when used together on the same page:



Why work so hard?

Musicians are usually more absorbed with performing than with studying the looks of a piece of music, so nitpicking typographical details may seem academic. But it is not. Sheet music is performance material: everything is done to aid the musician in letting her perform better, and anything that is unclear or unpleasant to read is a hindrance.

Traditionally engraved music uses bold symbols on heavy staff to create a strong, well-balanced look that stands out well when the music is far away from the reader: for example, if it is on a music stand. A careful distribution of white space allows music to be set very tightly without crowding symbols together. The result minimizes the number of page turns, which is a great advantage.

This is a common characteristic of typography. Layout should be pretty, not only for its own sake, but especially because it helps the reader in his task. For sheet music this is of double importance because musicians have a limited amount of attention. The less attention they need for reading, the more they can focus on playing the music. In other words, better typography translates to better performances.

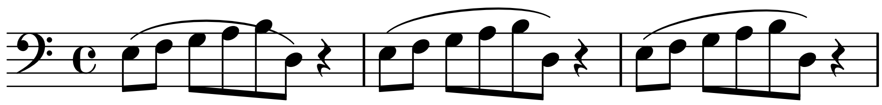
These examples demonstrate that music typography is an art that is subtle and complex, and that producing it requires considerable expertise, which musicians usually do not have. LilyPond is our effort to bring the graphical excellence of hand-engraved music to the computer age, and make it available to normal musicians. We have tuned our algorithms, font-designs, and program settings to produce prints that match the quality of the old editions we love to see and love to play from.

1.3 Automated engraving

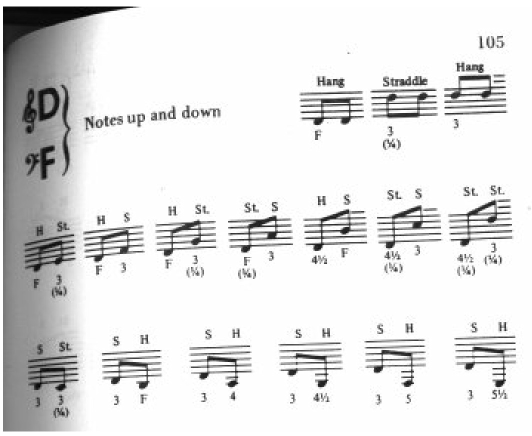
Here we describe what is required to create software that can mimic the layout of engraved scores: a method of describing good layouts to the computer and a lot of detailed comparisons with real engravings.

Beauty contests

How do we actually make formatting decisions? In other words, which of the three configurations should we choose for the following slur?



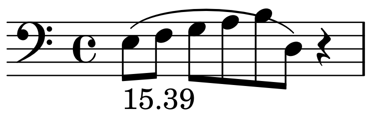
There are a few books on the art of music engraving available. Unfortunately, they contain simple rules of thumb and some examples. Such rules can be instructive, but they are a far cry from an algorithm that we could readily implement in a computer. Following the instructions from literature leads to algorithms with lots of hand-coded exceptions. Doing all this case analysis is a lot of work, and often not all cases are covered completely:



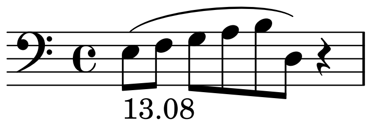
(Image source: Ted Ross, *The Art of Music Engraving*)

Rather than trying to write detailed layout rules for every possible scenario, we only have to describe the objectives well enough that LilyPond can judge the attractiveness of several alternatives. Then, for each possible configuration we compute an ugliness score and we choose the least ugly configuration.

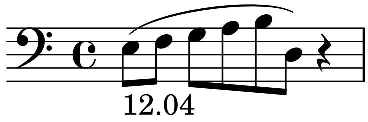
For example, here are three possible slur configurations, and LilyPond has given each one a score in 'ugly points'. The first example gets 15.39 points for grazing one of the noteheads:



The second one is nicer, but the slur doesn't start or end on the note heads. It gets 1.71 points for the left side and 9.37 points for the right side, plus another 2 points because the slur ascends while the melody descends for a total of 13.08 ugly points:



The final slur gets 10.04 points for the gap on the right and 2 points for the upward slope, but it is the most attractive of the three configurations, so LilyPond selects this one:



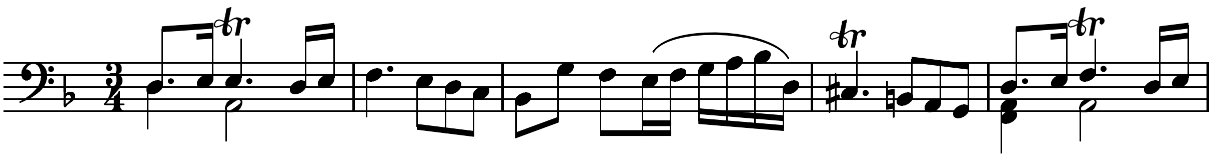
This technique is quite general, and is used to make optimal decisions for beam configurations, ties and dots in chords, line breaks, and page breaks. The results of these decisions can be judged by comparison to real engravings.

Improvement by benchmarking

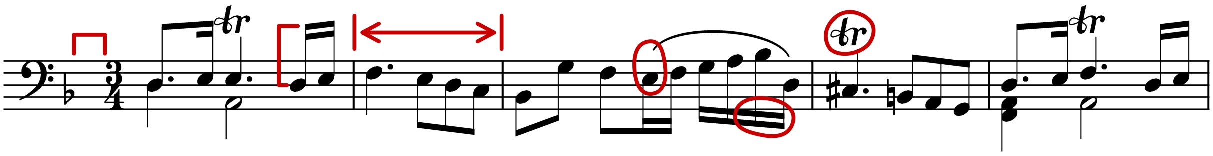
LilyPond's output has improved gradually over time, and it continues to improve by comparing its output to hand-engraved scores.

For example, here is one line of a benchmark piece from a hand-engraved edition (Bärenreiter BA320):

and the same quotation as engraved by a very old version of LilyPond (version 1.4, May 2001):



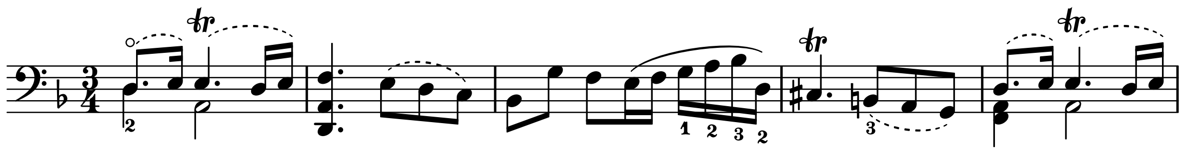
The LilyPond 1.4 output is certainly readable, but close comparison with the hand-engraved score showed a lot of errors in the formatting details:



- there is too much space before the time signature
- the stems of the beamed notes are too long
- the second and fourth measures are too narrow
- the slur is awkward-looking
- the trill marks are too big
- the stems are too thin

(There were also two missing note heads, several missing editorial annotations, and an incorrect pitch!)

By adjusting the layout rules and font design, the output has improved considerably. Compare the same reference score and the output from the current version of LilyPond (2.23.82):

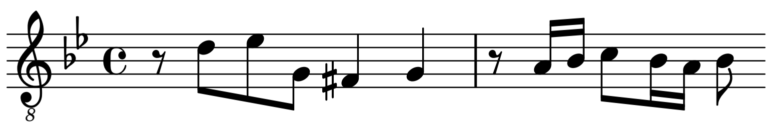


The current output is not a clone of the reference edition, but it is much closer to publication quality that the earlier output.

Getting things right

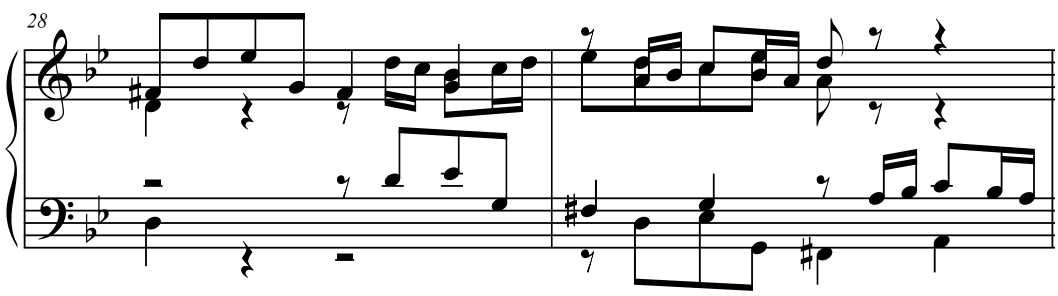
We can also measure LilyPond's ability to make music engraving decisions automatically by comparing LilyPond's output to the output of a commercial software product. In this case we have chosen Finale 2008, which is one of the most popular commercial score writers, particularly in North America. Sibelius is its major rival and appears to be especially strong in the European market.

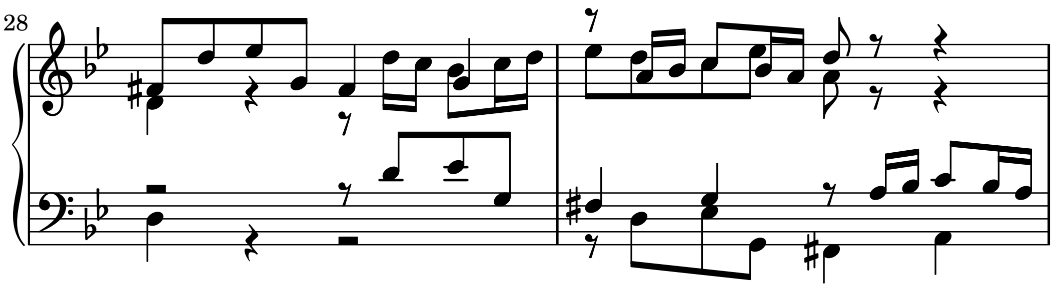
For our comparison we selected Bach's Fugue in G minor from the Well-Tempered Clavier, Book I, BWV 861, whose opening subject is



We made our comparison by engraving the last seven measures of the piece (28–34) in Finale and LilyPond. This is the point in the piece where the subject returns in a three-part stretto and leads into the closing section. In the Finale version, we have resisted the temptation to make any adjustments to the default output because we are trying to show the things that each software package gets right without assistance. The only major edits that we made were adjusting the page size to match this essay and forcing the music onto two systems to make the comparison easier. By default Finale would have engraved two systems of three measures each and a final, full-width system containing a single measure.

Many of the differences between the two engravings are visible in measures 28–29, as shown here with Finale first and LilyPond second:





Some shortcomings in the unedited Finale output include:

- Most of the beams extend too far off the staff. A beam that points towards the center of the staff should have a length of about one octave, but engravers shorten this when the beam points away from the staff in multi-voice music. The Finale beaming can easily be improved with their Patterson Beams plug-in, but we elected to skip that step for this example.
- Finale doesn't adjust the positions of interlocking note heads, which makes the music extremely difficult to read when the upper and lower voices exchange positions temporarily:

- Finale has placed all of the rests at fixed heights on the staff. The user is free to adjust them as needed, but the software makes no attempt to consider the content of the other voice. As luck would have it, there are no true collisions between notes and rests in this example, but that has more to do with the positions of the notes than the rest. In other words, Bach deserves more credit for avoiding a complete collision than Finale does.

This example is not intended to suggest that Finale cannot be used to produce publication-quality output. On the contrary, in the hands of a skilled user it can and does, but it requires skill and time. One of the fundamental differences between LilyPond and commercial scorewriters is that LilyPond hopes to reduce the amount of human intervention to an absolute minimum, while other packages try to provide an attractive interface in which to make these types of edits.

One particularly glaring omission we found from Finale is a missing flat in measure 33:

The flat symbol is required to cancel out the natural in the same measure, but Finale misses it because it occurred in a different voice. So in addition to running a beaming plug-in and checking the spacing on the noteheads and rests, the user must also check each measure for cross-voice accidentals to avoid interrupting a rehearsal over an engraving error.

If you are interested in examining these examples in more detail, the full seven-measure excerpt can be found at the end of this essay along with four different published engravings. Close examination reveals that there is some acceptable variation among the hand-engravings, but that LilyPond compares reasonably well to that acceptable range. There are still some shortcomings in the LilyPond output, for example, it appears a bit too aggressive in shortening some of the stems, so there is room for further development and fine-tuning.

Of course, typography relies on human judgment of appearance, so people cannot be replaced completely. However, much of the dull work can be automated. If LilyPond solves most of the common situations correctly, this will be a huge improvement over existing software. Over the course of years, the software can be refined to do more and more things automatically, so manual overrides are less and less necessary. Where manual adjustments are needed, LilyPond's structure has been designed with that flexibility in mind.

1.4 Building software

This section describes some of the programming decisions that we made when designing LilyPond.

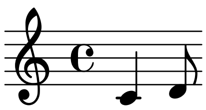
Music representation

Ideally, the input format for any high-level formatting system is an abstract description of the content. In this case, that would be the music itself. This poses a formidable problem: how can we define what music really is? Instead of trying to find an answer, we have reversed the question. We write a program capable of producing sheet music, and adjust the format to be as lean as possible. When the format can no longer be trimmed down, by definition we are left with content itself. Our program serves as a formal definition of a music document.

The syntax is also the user-interface for LilyPond, hence it is easy to type:

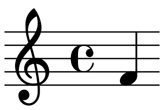
```
{
  c'4 d'8
}
```

to create a quarter note on middle C (C1) and an eighth note on the D above middle C (D1).



On a microscopic scale, such syntax is easy to use. On a larger scale, syntax also needs structure. How else can you enter complex pieces like symphonies and operas? The structure is formed by the concept of music expressions: by combining small fragments of music into larger ones, more complex music can be expressed. For example

```
f'4
```

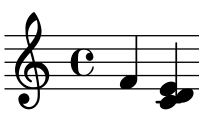


Simultaneous notes can be constructed by enclosing them with << and >>:

```
<<c4 d4 e4>>
```

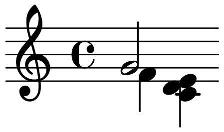
This expression is put in sequence by enclosing it in curly braces `{ ... }`:

```
{ f4 <<c4 d4 e4>> }
```



The above is also an expression, and so it may be combined again with another simultaneous expression (a half note) using <<, \\, and >>:

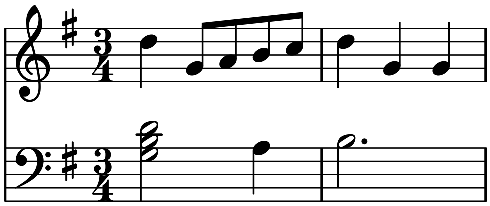
```
<< g2 \\ { f4 <<c4 d4 e4>> } >>
```



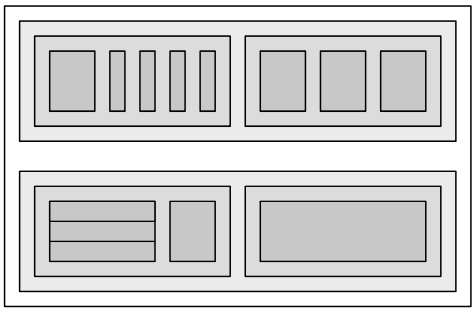
Such recursive structures can be specified neatly and formally in a context-free grammar. The parsing code is also generated from this grammar. In other words, the syntax of LilyPond is clearly and unambiguously defined.

User-interfaces and syntax are what people see and deal with most. They are partly a matter of taste, and also the subject of much discussion. Although discussions on taste do have their merit, they are not very productive. In the larger picture of LilyPond, the importance of input syntax is small: inventing neat syntax is easy, while writing decent formatting code is much harder. This is also illustrated by the line-counts for the respective components: parsing and representation take up less than 10% of the source code.

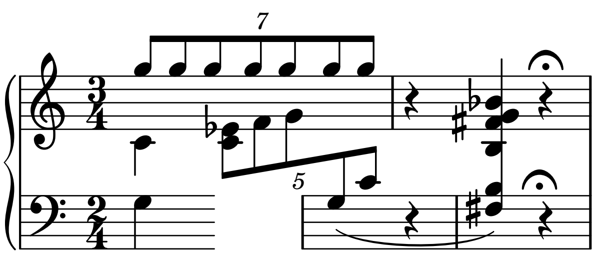
When designing the structures used in LilyPond, we made some different decisions than are apparent in other software. Consider the hierarchical nature of music notation:



In this case, there are pitches grouped into chords that belong to measures, which belong to staves. This resembles a tidy structure of nested boxes:



Unfortunately, the structure is tidy because it is based on some excessively restrictive assumptions. This becomes apparent if we consider a more complicated musical example:



In this example, staves start and stop at will, voices jump around between staves, and the staves have different time signatures. Many software packages would struggle with reproducing this example because they are built on the nested box structure. With LilyPond, on the other hand, we have tried to keep the input format and the structure as flexible as possible.

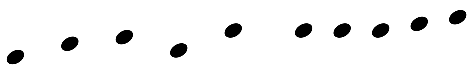
What symbols to engrave?

The formatting process decides where to place symbols. However, this can only be done once it is decided *what* symbols should be printed – in other words, what notation to use.

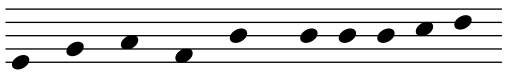
Common music notation is a system of recording music that has evolved over the past 1000 years. The form that is now in common use dates from the early Renaissance. Although the basic form (i.e., note heads on a 5-line staff) has not changed, the details still evolve to express the innovations of contemporary notation. Hence, common music notation encompasses some 500 years of music. Its applications range from monophonic melodies to monstrous counterpoints for a large orchestra.

How can we get a grip on such a seven-headed beast, and force it into the confines of a computer program? Our solution is to break up the problem of notation (as opposed to engraving, i.e., typography) into digestible and programmable chunks: every type of symbol is handled by a separate module, a so-called plug-in. Each plug-in is completely modular and independent, so each can be developed and improved separately. Such plug-ins are called `engravers`, by analogy with craftsmen who translate musical ideas to graphic symbols.

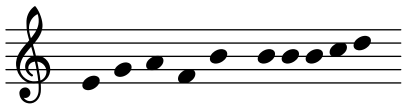
In the following example, we start out with a plug-in for note heads, the `Note_heads_engraver`.



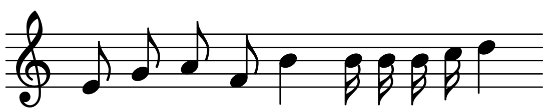
Then a `Staff_symbol_engraver` adds the staff,



the `Clef_engraver` defines a reference point for the staff,

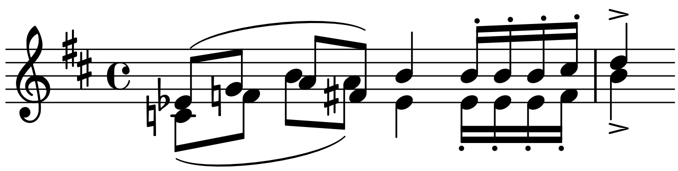


and the `Stem_engraver` adds stems.

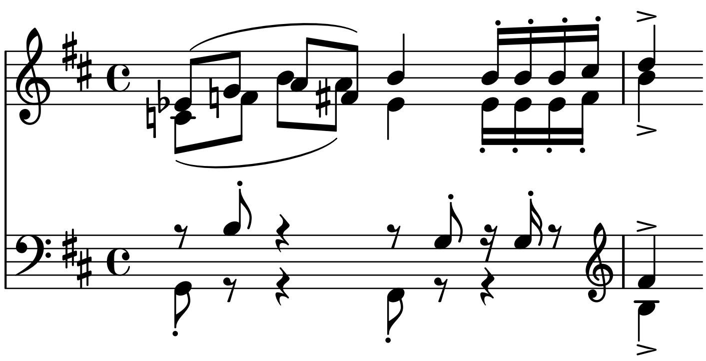


The `Stem_engraver` is notified of any note head coming along. Every time one (or more, for a chord) note head is seen, a stem object is created and connected to the note head. By adding engravers for beams, slurs, accents, accidentals, bar lines, time signature, and key signature, we get a complete piece of notation.

This system works well for monophonic music, but what about polyphony? In polyphonic notation, many voices can share a staff.



In this situation, the accidentals and staff are shared, but the stems, slurs, beams, etc., are private to each voice. Hence, engravers should be grouped. The engravers for note heads, stems, slurs, etc., go into a group called 'Voice context', while the engravers for key, accidental, bar, etc., go into a group called 'Staff context'. In the case of polyphony, a single Staff context contains more than one Voice context. Similarly, multiple Staff contexts can be put into a single Score context. The Score context is the top level notation context.



See also

Internals Reference: Section "Contexts" in *Internals Reference*.

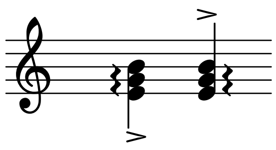
Flexible architecture

When we started, we wrote the LilyPond program entirely in the C++ programming language; the program's functionality was set in stone by the developers. That proved to be unsatisfactory for a number of reasons:

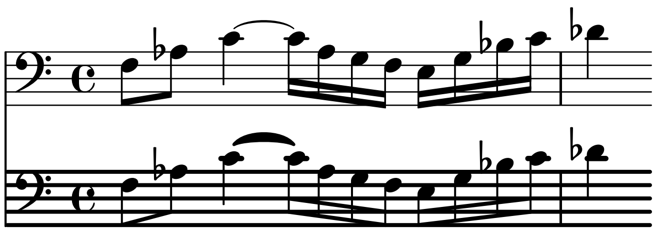
- When LilyPond makes mistakes, users need to override formatting decisions. Therefore, the user must have access to the formatting engine. Hence, rules and settings cannot be fixed by us at compile-time but must be accessible for users at run-time.
- Engraving is a matter of visual judgment, and therefore a matter of taste. As knowledgeable as we are, users can disagree with our personal decisions. Therefore, the definitions of typographical style must also be accessible to the user.
- Finally, we continually refine the formatting algorithms, so we need a flexible approach to rules. The C++ language forces a certain method of grouping rules that cannot readily be applied to formatting music notation.

These problems have been addressed by integrating an interpreter for the Scheme programming language and rewriting parts of LilyPond in Scheme. The current formatting architecture is built around the notion of graphical objects, described by Scheme variables and functions. This architecture encompasses formatting rules, typographical style and individual formatting decisions. The user has direct access to most of these controls.

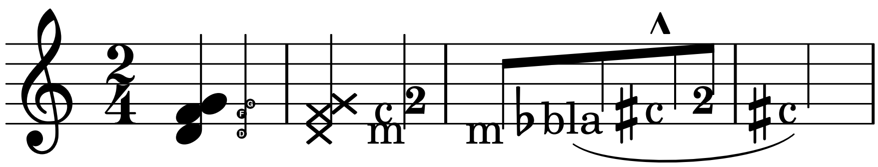
Scheme variables control layout decisions. For example, many graphical objects have a direction variable that encodes the choice between up and down (or left and right). Here you see two chords, with accents and arpeggios. In the first chord, the graphical objects have all directions down (or left). The second chord has all directions up (right).



The process of formatting a score consists of reading and writing the variables of graphical objects. Some variables have a preset value. For example, the thickness of many lines – a characteristic of typographical style – is a variable with a preset value. You are free to alter this value, giving your score a different typographical impression.

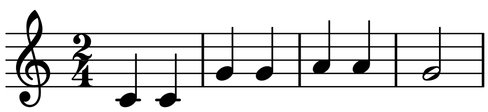


Formatting rules are also preset variables: each object has variables containing procedures. These procedures perform the actual formatting, and by substituting different ones, we can change the appearance of objects. In the following example, the rule governing which note head objects are used to produce the note head symbol is changed during the music fragment.

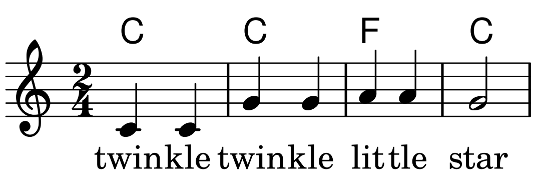


1.5 Putting LilyPond to work

We have written LilyPond as an experiment of how to condense the art of music engraving into a computer program. Thanks to all that hard work, the program can now be used to perform useful tasks. The simplest application is printing notes.



By adding chord names and lyrics we obtain a lead sheet.

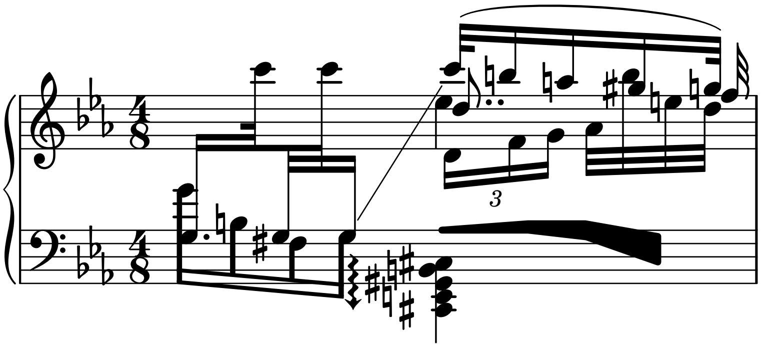


Polyphonic notation and piano music can also be printed. The following example combines some more exotic constructs.

Screech and boink

Random complex notation

Han-Wen Nienhuys



The fragments shown above have all been written by hand, but that is not a requirement. Since the formatting engine is mostly automatic, it can serve as an output means for other programs that manipulate music. For example, it can also be used to convert databases of musical fragments to images for use on websites and multimedia presentations.

This manual also shows an application: the input format is text, and can therefore be easily embedded in other text-based formats such as LaTeX, HTML, or in the case of this manual, Texinfo. Using the `lilypond-book` program, included with LilyPond, the input fragments can be replaced by music images in the resulting PDF or HTML output files. Another example is the third-party OOoLilyPond extension for OpenOffice.org or LibreOffice, which makes it extremely easy to embed musical examples in documents.

For more examples of LilyPond in action, full documentation, and the software itself, see our main website: www.lilypond.org.

1.6 Engraved examples (BWV 861)

This section contains four reference engravings and two software-engraved versions of Bach's Fugue in G minor from the Well-Tempered Clavier, Book I, BWV 861 (the last seven measures).

Bärenreiter BA5070 (Neue Ausgabe Sämtlicher Werke, Serie V, Band 6.1, 1989):

Bärenreiter BA5070 (Neue Ausgabe Sämtlicher Werke, Serie V, Band 6.1, 1989), an alternate musical source. Aside from the textual differences, this demonstrates slight variations in the engraving decisions, even from the same publisher and edition:

Breitkopf & Härtel, edited by Ferruccio Busoni (Wiesbaden, 1894), also available from the Petrucci Music Library (IMSLP #22081). The editorial markings (fingerings, articulations, etc.) have been removed for clearer comparison with the other editions here:

Bach-Gesellschaft edition (Leipzig, 1866), available from the Petrucci Music Library (IMSPL #02221):

Finale 2008:

LilyPond, version 2.23.82:

2 Literature list

Here are lists of references used in LilyPond.

2.1 Short literature list

If you need to know more about music notation, here are some interesting titles to read.

Ignatzek 1995

Klaus Ignatzek, Die Jazzmethode für Klavier. Schott's Söhne 1995. Mainz, Germany ISBN 3-7957-5140-3.

A tutorial introduction to playing Jazz on the piano. One of the first chapters contains an overview of chords in common use for Jazz music.

Gerou 1996

Tom Gerou and Linda Lusk, Essential Dictionary of Music Notation. Alfred Publishing, Van Nuys CA ISBN 0-88284-768-6.

A concise, alphabetically ordered list of typesetting and music (notation) issues, covering most of the normal cases.

Gould 2011

Elaine Gould, Behind Bars: the Definitive Guide to Music Notation. Faber Music Ltd. ISBN 0-571-51456-1.

Hals über Kopf: Das Handbuch des Notensatzes. Edition Peters. ISBN 1843670488.

A comprehensive guide to the rules and conventions of music notation. Covering everything from basic themes to complex techniques and providing a comprehensive grounding in notational principles.

Read 1968

Gardner Read, Music Notation: A Manual of Modern Practice. Taplinger Publishing, New York (2nd edition).

A standard work on music notation.

Ross 1987

Ted Ross, Teach yourself the art of music engraving and processing. Hansen House, Miami, Florida 1987.

This book is about music engraving, i.e., professional typesetting. It contains directions on stamping, use of pens and notational conventions. The sections on reproduction technicalities and history are also interesting.

Schirmer 2001

The G.Schirmer/AMP Manual of Style and Usage. G.Schirmer/AMP, NY, 2001. (This book can be ordered from the rental department.)

This manual specifically focuses on preparing print for publication by Schirmer. It discusses many details that are not in other, normal notation books. It also gives a good idea of what is necessary to bring printouts to publication quality.

Stone 1980

Kurt Stone, Music Notation in the Twentieth Century. Norton, New York 1980.

This book describes music notation for modern serious music, but starts out with a thorough overview of existing traditional notation practices.

2.2 Long literature list

University of Colorado Engraving music bibliography

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- Anna Maria Busse Berger. **Mensuration and proportion signs : origins and evolution**. Clarendon Press, Oxford, England, 1993. subject: early notation.
- Roger Bowers. **Music & Letters**, volume 73. August 1992. Some reflection upon notation and proportion in Monteverdi's mass and vespers.
- Paul Brainard. **Current Musicology**. Number 50. July-Dec 1992. Proportional notation in the music of Schutz and his contemporaries in the 17th Century.
- Carl Brandt and Clinton Roemer. **Standardized Chord Symbol Notation**. Roerick Music Co., Sherman Oaks, CA. subject: musical notation.
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- John Cage. **Notations**. Something Else Press, New York, 1969. Music, Manuscripts, Facsimiles. Facsimiles of holographs from the Foundation for Contemporary Performance Arts, with text by 269 composers, but rearranged using chance operations.,V).
- J Carter. **New Paths in Book Collecting**. London, 1934. subject: history of music printing and engraving.
- F. Chrsander. **A Sketch of the HIstory of Music printing, from the 15th to the 16th century**. 18??. subject: history of music printing and engraving.
- Henry Cowell. **Our Inadequate Notation**. *Modern Music*, 4(3), 1927. subject: 20th century notation.
- Henry Cowell. **New Musical Resources**. Alfred A. Knopf, Inc., New York, 1930. subject: 20th century notation.
- O.F. Deutsch. **Music Publishers' Numbers**. London, 1946. subject: history of music printing and engraving.
- Suzanne Eggleston. **Notes**. *New periodicals*, 51(2):657(7), Dec 1994. A list of new music periodicals covering the period Jun.-Dec. 1994. Includes aims, formats and a description of the contents of each listed periodical. Includes Music Notation News.
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