LilyPond

The music typesetter

Contributor's Guide

The LilyPond development team

This manual documents contributing to LilyPond version 2.21.81. It discusses technical issues and policies that contributors should follow.

This manual is not intended to be read sequentially; new contributors should only read the sections which are relevant to them. For more information about different jobs, see Section "Help us" in *Contributor's Guide*.

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 `http://lilypond.org/`.

Copyright © 2007–2020 by the authors.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.1 or any later version published by the Free Software Foundation; with no Invariant Sections. A copy of the license is included in the section entitled "GNU Free Documentation License".

For LilyPond version 2.21.81

Table of Contents

1 Introduction to contributing 1
1.1 Help us 1
1.2 Overview of work flow 2
1.3 Summary for experienced developers 2
1.4 Mentors 3

2 Quick start 5
2.1 LilyDev 5
Installing LilyDev in VirtualBox 5
Configuring LilyDev in VirtualBox 7
2.2 Compiling with LilyDev 8
2.3 Now start work! 9

3 Working with source code 10
3.1 Setting up 10
3.1.1 Installing Git 10
3.1.2 Cloning and forking the repository 10
3.1.3 Configuring Git 10
3.2 Git cheat sheet 11
Pulling recent changes 11
Viewing the history 11
Switching branches 11
Listing branches 12
Staging and committing files 12
Amending and reverting changes 12
Uploading your branch for review 12
Deleting branches 12
3.3 Lifecycle of a merge request 13
3.3.1 Uploading a patch for review 13
3.3.2 Automated and manual testing 13
3.3.3 Patch countdown 13
3.3.4 Merging to master 14
3.3.5 Abandoned patches 14
3.4 Writing good commit messages 14
3.5 Commit access 15
3.6 Further Git documentation resources 16
3.7 Repository directory structure 16
3.8 Other repositories 18

4 Compiling 20
4.1 Overview of compiling 20
4.2 Requirements 20
4.2.1 Requirements for running LilyPond 20
4.2.2 Requirements for compiling LilyPond 21
Fedora 21
Linux Mint 22
OpenSUSE 22

Ubuntu ... 23
Other ... 23
4.2.3 Requirements for building documentation ... 24
4.3 Getting the source code ... 25
4.4 Configuring `make` ... 26
4.4.1 Running `./autogen.sh` ... 26
4.4.2 Running `../configure` ... 26
Configuration options ... 26
Checking build dependencies ... 26
Configuring target directories ... 27
4.5 Compiling LilyPond ... 27
4.5.1 Using `make` ... 27
4.5.2 Saving time with the `-j` option ... 28
4.5.3 Useful `make` variables ... 28
4.6 Post-compilation options ... 28
4.6.1 Installing LilyPond from a local build ... 28
4.6.2 Generating documentation ... 28
Documentation editor's edit/compile cycle ... 28
Building documentation ... 29
Building a single document ... 29
Saving time with `CPU_COUNT` ... 30
Installing documentation ... 30
Building documentation without compiling ... 30
4.6.3 Testing LilyPond binary ... 31
4.7 Problems ... 31
Compiling on MacOS X ... 31
FreeBSD ... 32
International fonts ... 32
Using lilypond python libraries ... 32
4.8 Concurrent stable and development versions ... 32
4.9 Build system ... 33

5 Documentation work ... 34

5.1 Introduction to documentation work ... 34
5.2 `\version` in documentation files ... 34
5.3 Documentation suggestions ... 35
5.4 Texinfo introduction and usage policy ... 36
5.4.1 Texinfo introduction ... 36
5.4.2 Documentation files ... 36
5.4.3 Sectioning commands ... 37
5.4.4 LilyPond formatting ... 38
5.4.5 Text formatting ... 40
5.4.6 Syntax survey ... 40
Comments ... 40
Cross references ... 41
External links ... 41
Fixed-width font ... 41
Indexing ... 42
Lists ... 43
Special characters ... 43
Miscellany ... 43
5.4.7 Other text concerns ... 44
5.5 Documentation policy ... 44
5.5.1 Books ... 44

5.5.2 Section organization ... 45
5.5.3 Checking cross-references ... 46
5.5.4 General writing ... 47
5.5.5 Technical writing style ... 47
5.6 Tips for writing docs ... 48
5.7 Scripts to ease doc work ... 48
5.7.1 Scripts to test the documentation ... 48
Building only one section of the documentation ... 49
5.7.2 Scripts to create documentation ... 49
Stripping whitespace and generating menus ... 49
Updating doc with `convert-ly` ... 49
5.8 Docstrings in scheme ... 50
5.9 Translating the documentation ... 50
5.9.1 Getting started with documentation translation ... 50
Translation requirements ... 50
Which documentation can be translated ... 50
Starting translation in a new language ... 51
5.9.2 Documentation translation details ... 51
Files to be translated ... 51
Translating the Web site and other Texinfo documentation ... 53
Adding a Texinfo manual ... 55
5.9.3 Documentation translation maintenance ... 55
Check state of translation ... 55
Updating documentation translation ... 56
Updating translation committishes ... 56
5.9.4 Translations management policies ... 57
Maintaining without updating translations ... 57
Managing documentation translation with Git ... 59
5.9.5 Technical background ... 59

6 Website work ... 61
6.1 Introduction to website work ... 61
6.2 Uploading website ... 61
6.3 Debugging website and docs locally ... 62
6.4 Translating the website ... 62

7 LSR work ... 63
7.1 Introduction to LSR ... 63
7.2 Adding and editing snippets ... 63
7.3 Approving snippets ... 64
7.4 LSR to Git ... 64
7.5 Fixing snippets in LilyPond sources ... 65
7.6 Renaming a snippet ... 66
7.7 Updating the LSR to a new version ... 66

8 Issues ... 69
8.1 Introduction to issues ... 69
8.2 The Bug Squad ... 69
8.2.1 Bug Squad setup ... 69
8.2.2 Bug Squad checklists ... 70
8.3 Issue classification ... 71
8.4 Adding issues to the tracker ... 72
8.5 Patch handling ... 73

8.6 Summary of project status ... 73

9 Regression tests ... 75

9.1 Introduction to regression tests ... 75
9.2 Precompiled regression tests ... 75
9.3 Compiling regression tests ... 76
9.4 Regtest comparison ... 77
9.5 Pixel-based regtest comparison ... 77
9.6 Finding the cause of a regression ... 78
9.7 MusicXML tests ... 79

10 Programming work ... 80

10.1 Overview of LilyPond architecture ... 80
10.2 LilyPond programming languages ... 82
10.2.1 C++ ... 82
10.2.2 Flex ... 82
10.2.3 GNU Bison ... 82
10.2.4 GNU Make ... 82
10.2.5 GUILE or Scheme ... 82
10.2.6 MetaFont ... 82
10.2.7 PostScript ... 82
10.2.8 Python ... 83
10.2.9 Scalable Vector Graphics (SVG) ... 83
10.3 Programming without compiling ... 83
10.3.1 Modifying distribution files ... 83
10.3.2 Desired file formatting ... 83
10.4 Finding functions ... 83
10.4.1 Using the ROADMAP ... 84
10.4.2 Using grep to search ... 84
10.4.3 Using git grep to search ... 84
10.4.4 Searching on the git repository at GitLab and Savannah ... 84
10.5 Code style ... 84
10.5.1 Languages ... 84
10.5.2 Filenames ... 84
10.5.3 Indentation ... 85
10.5.4 Naming Conventions ... 87
10.5.5 Broken code ... 87
10.5.6 Code comments ... 87
10.5.7 Handling errors ... 88
10.5.8 Localization ... 88
10.6 Warnings, Errors, Progress and Debug Output ... 89
Available log levels ... 90
Functions for debug and log output ... 90
All logging functions at a glance ... 90
10.7 Debugging LilyPond ... 91
10.7.1 Debugging overview ... 92
10.7.2 Debugging C++ code ... 92
10.7.3 Debugging Scheme code ... 93
10.8 Tracing object relationships ... 95
10.9 Adding or modifying features ... 96
10.9.1 Write the code ... 96
10.9.2 Write regression tests ... 96
10.9.3 Write convert-ly rule ... 96

10.9.4 Automatically update documentation ... 96
10.9.5 Manually update documentation ... 97
10.9.6 Edit changes.tely ... 97
10.9.7 Verify successful build ... 97
10.9.8 Verify regression tests ... 98
10.9.9 Post patch for comments ... 98
10.9.10 Push patch ... 98
10.9.11 Closing the issues ... 98
10.10 Iterator tutorial ... 99
10.11 Engraver tutorial ... 99
10.11.1 Useful methods for information processing ... 99
10.11.2 Translation process ... 99
10.11.3 Preventing garbage collection for SCM member variables ... 99
10.11.4 Listening to music events ... 100
10.11.5 Acknowledging grobs ... 100
10.11.6 Engraver declaration/documentation ... 101
10.12 Callback tutorial ... 101
10.13 Understanding pure properties ... 101
10.13.1 Purity in LilyPond ... 101
10.13.2 Writing a pure function ... 102
10.13.3 How purity is defined and stored ... 102
10.13.4 Where purity is used ... 103
10.13.5 Case studies ... 103
10.13.6 Debugging tips ... 104
10.14 LilyPond scoping ... 104
10.15 Scheme->C interface ... 104
10.15.1 Comparison ... 105
10.15.2 Conversion ... 106
10.16 LilyPond miscellany ... 106
10.16.1 Spacing algorithms ... 106
10.16.2 Info from Han-Wen email ... 106
10.16.3 Music functions and GUILE debugging ... 110
10.16.4 Articulations on EventChord ... 111

11 Release work ... 112
11.1 Development phases ... 112
11.2 Minor release checklist ... 112
11.3 Major release checklist ... 114
11.4 Release extra notes ... 116
11.5 Notes on builds with GUB ... 117

12 Modifying the Emmentaler font ... 120
12.1 Overview of the Emmentaler font ... 120
12.2 Font creation tools ... 120
12.3 Adding a new font section ... 120
12.4 Adding a new glyph ... 120
12.5 Building the changed font ... 121
12.6 METAFONT formatting rules ... 121

13 Administrative policies 122
13.1 Meta-policy for this document 122
13.2 Environment variables 122
13.3 Meisters 122
The Bug Meister 123
The Doc Meister 123
The Patch Meister 123
The Translation Meister 123
13.4 Administrative mailing list 124
13.5 Grand Organization Project (GOP) 124
13.5.1 Motivation 124
13.5.2 Ongoing jobs 125
13.5.3 Policy decisions 125
13.5.4 Policy decisions (finished) 127
13.5.4.1 GOP-PROP 1 - python formatting 127
13.5.4.2 GOP-PROP 2 - mentors and frogs 127
13.5.4.3 GOP-PROP 3 - C++ formatting 128
13.5.4.4 GOP-PROP 4 - lessons from 2.14 128
13.5.4.5 GOP-PROP 5 - build system output (not accepted) 130
13.5.4.6 GOP-PROP 6 - private mailing list 130
13.5.4.7 GOP-PROP 7 - developers as resources 131
13.5.4.8 GOP-PROP 8 - issue priorities 132
13.5.4.9 GOP-PROP 9 - behavior of make doc 133
13.6 Unsorted policies 134

Appendix A GNU Free Documentation License 135

1 Introduction to contributing

This chapter presents a quick overview of ways that people can help LilyPond.

1.1 Help us

We need you!

Thank you for your interest in helping us — we would love to see you get involved! Your contribution will help a large group of users make beautifully typeset music.

Even working on small tasks can have a big impact: taking care of them allows experienced developers work on advanced tasks, instead of spending time on those simple tasks.

For a multi-faceted project like LilyPond, sometimes it's tough to know where to begin. In addition to the avenues proposed below, you can send an e-mail to the lilypond-devel@gnu.org (`https://lists.gnu.org/mailman/listinfo/lilypond-devel`) mailing list, and we'll help you to get started.

Simple tasks

No programming skills required!

- Mailing list support: answer questions from fellow users. (This may entail helping them navigate the online documentation; in such cases it may sometimes be appropriate to point them to version-agnostic URL paths such as `/latest/` (`https://lilypond.org/doc/latest/Documentation/notation/`) or `/stable/` (`https://lilypond.org/doc/stable/Documentation/notation/`), which are automatically redirected.)
- Bug reporting: help users create proper Section "Bug reports" in *General Information*, and/or join the Bug Squad to organize Section "Issues" in *Contributor's Guide*.
- Documentation: small changes can be proposed by following the guidelines for Section "Documentation suggestions" in *Contributor's Guide*.
- LilyPond Snippet Repository (LSR): create and fix snippets following the guidelines in Section "Adding and editing snippets" in *Contributor's Guide*.
- Discussions, reviews, and testing: the developers often ask for feedback about new documentation, potential syntax changes, and testing new features. Please contribute to these discussions!

Advanced tasks

These jobs generally require that you have the source code and can compile LilyPond.

> **Note:** We suggest that contributors using Windows or MacOS X do **not** attempt to set up their own development environment; instead, use Lilydev as discussed in Section "Quick start" in *Contributor's Guide*.

Contributors using Linux or FreeBSD may also use Lilydev, but if they prefer their own development environment, they should read Section "Working with source code" in *Contributor's Guide*, and Section "Compiling" in *Contributor's Guide*.

Begin by reading Section "Summary for experienced developers" in *Contributor's Guide*.

- Documentation: for large changes, see Section "Documentation work" in *Contributor's Guide*.
- Website: the website is built from the normal documentation source. See the info about documentation, and also Section "Website work" in *Contributor's Guide*.

- Translations: see Section "Translating the documentation" in *Contributor's Guide*, and Section "Translating the website" in *Contributor's Guide*.
- Bugfixes or new features: read Section "Programming work" in *Contributor's Guide*.

1.2 Overview of work flow

> **Advanced note:** Experienced developers should skip to Section 1.3 [Summary for experienced developers], page 2.

Git is a *version control system* that tracks the history of a program's source code. The LilyPond source code is maintained as a Git repository, which contains:

- all of the source files needed to build LilyPond, and
- a record of the entire history of every change made to every file since the program was born.

The 'official' LilyPond Git repository is hosted by the GNU Savannah software forge at `https://git.sv.gnu.org`. The server provides two separate interfaces for viewing the LilyPond Git repository online: cgit (`http://git.sv.gnu.org/cgit/lilypond.git/`) and gitweb (`http://git.sv.gnu.org/gitweb/?p=lilypond.git`).

However, the main development takes place at `https://gitlab.com/lilypond/lilypond/`, which also hosts the project's issues. Automatic mirroring ensures that 'important' branches (such as `master` and `stable/*`) are up-to-date on the 'official' repository at GNU Savannah, so you can also base your development on a clone from there.

Compiling ('building') LilyPond allows developers to see how changes to the source code affect the program itself. Compiling is also needed to package the program for specific operating systems or distributions. LilyPond can be compiled from a local Git repository (for developers), or from a downloaded tarball (for packagers). Compiling LilyPond is a rather involved process, and most contributor tasks do not require it.

Contributors can contact the developers through the 'lilypond-devel' mailing list. The mailing list archive is located at `http://lists.gnu.org/archive/html/lilypond-devel/`. If you have a question for the developers, search the archives first to see if the issue has already been discussed. Otherwise, send an email to `lilypond-devel@gnu.org`. You can subscribe to the developers' mailing list here: `http://lists.gnu.org/mailman/listinfo/lilypond-devel`.

> **Note:** Contributors on Windows or MacOS X wishing to compile code or documentation are strongly advised to use our Debian LilyPond Developer Remix, as discussed in Chapter 2 [Quick start], page 5.

1.3 Summary for experienced developers

If you are already familiar with typical open-source tools, here's what you need to know:

- **'official' source repository**: hosted by GNU Savannah

  `https://git.savannah.gnu.org/gitweb/?p=lilypond.git`
- **development platform**: hosted by GitLab; also includes the issue tracker (see Chapter 8 [Issues], page 69)

  `https://gitlab.com/lilypond/lilypond/`
- **environment variables**: many maintenance scripts, and many instructions in this guide rely on predefined Section 13.2 [Environment variables], page 122.
- **mailing lists**: given on Section "Contact" in *General Information*.
- **Git branches**:
  - `master`: always base your work from this branch, but **never push** directly to it. Instead, use GitLab to merge changes after they have passed automatic testing (see below).

  - `translation`: Translators should base their work on this branch only and push any translation patches directly to it as well.
  - `dev/foo`: feel free to push any new branch name under `dev/`.
- **regression tests**: also known as "regtests". A collection of more than a thousand `.ly` files that are used to track LilyPond's engraving output between released stable and unstable versions as well as checked for all patches submitted for testing.

  If a patch introduces any unintentional changes to any of the regtests it is very likely it will be rejected (to be fixed) – always make sure that, if you expect any regression test changes, that they are explained clearly as part of the patch description when submitting for testing. For more information see Chapter 9 [Regression tests], page 75.
- **reviews**: after finishing work on a patch or branch:
  1. Commit the changes and create a merge request. More information on this can be found in the section Section 3.3.1 [Uploading a patch for review], page 13.
  2. Patches are generally tested within 24 hours of submission. Once it has passed the basic tests – `make check`, `make`, `make doc` – the tracker will be updated and the patch's status will change to `Patch::review` for other developers to examine.
  3. Every third day, the "Patch Meister" will examine all merge requests currently under review, looking for any comments by other developers. Depending on what has been posted, the patch will be either; "moved on" to the next patch status (`Patch::countdown`); set back to `Patch::needs_work`; or if more discussion is needed, left at `Patch::review`. In all cases the merge request will be updated by the Patch Meister accordingly.
  4. Once another three days have passed, any patch that has been given `Patch::countdown` status will be changed to `Patch::push`, the merge request is updated, and the developer can now rebase and merge to the `master` branch (or ask one of the other developers to merge it for you).

     Advanced note: This process does means that most patches will take about a week before finally being merged into `master`. With the limited resources for reviewing patches available and a history of unintended breakages in the `master` branch (from patches that have not had time to be reviewed properly), this is the best compromise we have found.

1.4 Mentors

We have a semi-formal system of mentorship, similar to the medieval "journeyman/master" training system. New contributors will have a dedicated mentor to help them "learn the ropes".

> **Note:** This is subject to the availability of mentors; certain jobs have more potential mentors than others.

Contributor responsibilities

1. Ask your mentor which sections of the CG you should read.
2. If you get stuck for longer than 10 minutes, ask your mentor. They might not be able to help you with all problems, but we find that new contributors often get stuck with something that could be solved/explained with 2 or 3 sentences from a mentor.
3. If you have been working on a task much longer than was originally estimated, stop and ask your mentor. There may have been a miscommunication, or there may be some time-saving tips that could vastly simply your task.
4. Send patches to your mentor for initial comments.

5. Inform your mentor if you're going to be away for a month, or if you leave entirely. Contributing to lilypond isn't for everybody; just let your mentor know so that we can reassign that work to somebody else.
6. Inform your mentor if you're willing to do more work – we always have way more work than we have helpers available. We try to avoid overwhelming new contributors, so you'll be given less work than we think you can handle.

Mentor responsibilities

1. Respond to questions from your contributor(s) promptly, even if the response is just "sorry, I don't know" or "sorry, I'm very busy for the next 3 days; I'll get back to you then". Make sure they feel valued.
2. Inform your contributor(s) about the expected turnaround for your emails – do you work on lilypond every day, or every weekend, or what? Also, if you'll be unavailable for longer than usual (say, if you normally reply within 24 hours, but you'll be at a conference for a week), let your contributors know. Again, make sure they feel valued, and that your silence (if they ask a question during that period) isn't their fault.
3. Inform your contributor(s) if they need to do anything unusual for the builds, such as doing a "make clean / doc-clean" or switching git branches (not expected, but just in case...)
4. You don't need to be able to completely approve patches. Make sure the patch meets whatever you know of the guidelines (for doc style, code indentation, whatever), and then send it on to -devel for more comments. If you feel confident about the patch, you can push it directly (this is mainly intended for docs and translations; code patches should almost always go to -devel before being pushed).
5. Keep track of patches from your contributor. Either open merge requests yourself, or help and encourage them to upload the patches themselves.
6. Encourage your contributor to review patches, particularly your own! It doesn't matter if they're not familiar with C++ / scheme / build system / doc stuff – simply going through the process is valuable. Besides, anybody can find a typo!
7. Contact your contributor at least once a week. The goal is just to get a conversation started – there's nothing wrong with simply copy&pasting this into an email:

```
Hey there,

How are things going?  If you sent a patch and got a review, do
you know what you need to fix?  If you sent a patch but have no
reviews yet, do you know when you will get reviews?  If you are
working on a patch, what step(s) are you working on?
```

2 Quick start

Want to submit a patch for LilyPond? Great! Never created a patch before? Never compiled software before? No problem! This chapter is for you and will help you do this as quickly and easily as possible.

2.1 LilyDev

> **Note:** The following sections are based on LilyDev v2 and are not necessarily correct for different releases.

"LilyDev" is a custom GNU/Linux operating system which includes all the necessary software and tools to compile LilyPond, the documentation and the website (also see Chapter 6 [Website work], page 61). It is also prepared for building the [Grand Unified Builder (GUB)], page 19, though this is an involved process and may require further tweaking.

While compiling LilyPond on Mac OS and Windows is possible, both environments are complex to set up. LilyDev can be easily run inside a 'virtual machine' on either of these operating systems relatively easily using readily available virtualization software. We recommend using VirtualBox as it is available for all major operating systems and is very easy to install & configure.

LilyDev comes in two 'flavours': containers and a standard disk image. Windows or Mac OS users should choose the Debian disk image (to be run in a virtual machine), that is the file named `LilyDev-VERSION-debian-vm.zip`. GNU/Linux users are recommended to choose one of the containers (currently Debian or Fedora), which are smaller in size, lightweight and easier to manage. The Fedora disk image has currently not been released, you can create it from the sources located in the `/mkosi` subdirectory of the LilyDev repository, however.

Download the appropriate file from here:

`https://github.com/fedelibre/LilyDev/releases/latest`

> **Note:** Apart from installing and configuring LilyDev in VirtualBox, the rest of the chapter assumes that you are comfortable using the command-line and is intended for users who may have never created a patch or compiled software before. More experienced developers (who prefer to use their own development environment) may still find it instructive to skim over the following information.

If you are not familiar with GNU/Linux, it may be beneficial to read a few "introduction to Linux" type web pages.

Installing LilyDev in VirtualBox

This section discusses how to install and use LilyDev with VirtualBox.

> **Note:** If you already know how to install a virtual machine using a disc image inside VirtualBox (or your own virtualization software) then you can skip this section.

1. Download VirtualBox from here:

   `http://www.virtualbox.org/wiki/Downloads`

> **Note:** In virtualization terminology, the operating system where VirtualBox is installed is known as the **host**. LilyDev will be installed 'inside' VirtualBox as a **guest**.

2. The zip archive you downloaded contains the raw disk image and its SHA256 checksum. You can verify the integrity of the downloaded archive with any hashing tool your OS does support. On Linux, run the following command in the directory where you have extracted the files (this may take some time):

   ```
   sha256sum -c SHA256SUMS
   ```

   For Windows, look for the tools `FCIV` or `certutil` to compute the archive's hash.

3. As VirtualBox does not support the raw format, you have to extract it and then convert it to VDI format. Make sure that 'VBoxManage' is in your `PATH` or call it from your VirtualBox installation directory:

   ```
   VBoxManage convertfromraw LilyDev-VERSION-debian-vm.img \
     LilyDev-VERSION-debian-vm.vdi
   ```

   > **Note:** You need a fair amount of disk space (around 30 GB) to extract the raw image. After converting to a dynamic VirtualBox image it will take up much less space (only the amount of space that is actually allocated by the guest filesystem)

4. Start the VirtualBox software and click 'New' to create a new "virtual machine".

   The 'New Virtual Machine Wizard' walks you through setting up your guest virtual machine. Choose an appropriate name for your LilyDev installation and select the 'Linux' operating system. When selecting the 'version' choose 'Debian (64-bit)'. If you do not have that specific option choose 'Linux 2.6/3.x/4.x (64-bit)'.

5. Select the amount of RAM you allow the LilyDev guest to use from your host operating system when it is running. If possible, use at least 1 GB of RAM; the more RAM you can spare from your host the better

6. In the 'Hard Disk' step, you use the VDI file you have previously created. You may move it within the virtual machine's folder already created by the wizard (in GNU/Linux the default should be `~/VirtualBox VMs/NAME`). Click on 'Use an existing virtual hard disk file' and browse to the VDI file.

7. Verify the summary details and click 'Create' as soon as you are satisfied. Your new guest shall be displayed in the VirtualBox window now.

8. Enable EFI within the virtual machine's settings – click on System → Motherboard and select 'Extended features: Enable EFI'. Otherwise, you won't be able to boot the image.

9. VirtualBox 'guest additions', which are installed by default in the debian image, provide some additional features such as being able to dynamically resize the LilyDev window, allow seamless interaction with your mouse pointer on both the host and guest, and let you copy/paste between your host and guest if needed. It seems that dynamic window resizing works only with the 'VBoxVGA' graphics controller, which you can choose in Display → Graphics Controller. To enable clipboard sharing between guest and host, choose General → Advanced → Shared Clipboard → Bidirectional.

10. Click the 'Start' button and wait until the login screen appears. Log in as `dev` user then; type the password `lilypond`. Before starting any work, be sure to complete the next steps.

    > **Note:** Since the default keyboard layout is US (American), you may have to type the password differently if you are using another layout, like 'lilzpond' on a German keyboard, for example.

11. Open a terminal by clicking Applications → Terminal at the upper left of the screen. You may want to change the password of user 'dev' before doing further work with the command `passwd`.

12. You might need to change the keyboard layout from default US (American) to your national layout. Therefore open a terminal and run

    ```
    sudo dpkg-reconfigure keyboard-configuration
    ```

    > **Note:** You need superuser rights to change certain aspects of the system configuration. The `sudo` tool allows to gain superuser rights temporarily. It does show you a warning message on its first use that reminds you to use your extended rights carefully.

    At first, you are prompted for the model of your keyboard. Press Enter to show further models. In most cases, it is sufficient to choose 'Generic, 105 keys'. After that, choose your keyboard layout. Now, you can customize the function of your `AltGr` key. Normally, the default layout settings fit well, so take number 1. The same holds for the question of whether you want to configure a 'compose' key. At last, you are asked if you want to configure `Ctrl+Alt+Backspace` as a shortcut to terminate the X server. Presumably, you do not need this, so you can safely type 'no'.

13. To set up your system language (charset, localized messages etc.), continue with

    ```
    sudo dpkg-reconfigure locales
    ```

    > **Note:** Restarting is required in order to take the changes into effect.

14. Finally, you should run a setup script. If you are on the command line already, simply type `./setup.sh` to run the interactive script that does set up git and downloads all the repositories needed to build LilyPond.

Configuring LilyDev in VirtualBox

- In the settings for the virtual machine, set the network to Bridged mode to allow you to access shared folders when using Windows hosts.
- Set up any additional features, such as 'Shared Folders' between your main operating system and LilyDev. This is distinct from the networked share folders in Windows. Consult the external documentation for this.

  Some longtime contributors have reported that 'shared folders' are rarely useful and not worth the fuss, particularly since files can be shared over a network instead.
- Pasting into a terminal is done with `Ctrl+Shift+v`.
- Right-click allows you to edit a file with the text editor (default is Leafpad).

Known issues and warnings

Not all hardware is supported in all virtualization tools. In particular, some contributors have reported problems with USB network adapters. If you have problems with network connection (for example Internet connection in the host system is lost when you launch virtual system), try installing and running LilyDev with your computer's built-in network adapter used to connect to the network. Refer to the help documentation that comes with your virtualization software.

2.2 Compiling with LilyDev

LilyDev is our custom GNU/Linux which contains all the necessary dependencies to do LilyPond development; for more information, see Section 2.1 [LilyDev], page 5.

Preparing the build

To prepare the build directory, enter (or copy&paste) the below text. This should take less than a minute.

```
cd $LILYPOND_GIT
sh autogen.sh --noconfigure
mkdir -p build/
cd build/
../configure
```

Building `lilypond`

Compiling LilyPond will take anywhere between 1 and 15 minutes on most 'modern' computers – depending on CPU and available RAM. We also recommend that you minimize the terminal window while it is building; this can help speed up on compilation times.

```
cd $LILYPOND_GIT/build/
make
```

It is possible to run `make` with the `-j` option to help speed up compilation times even more. See Section 4.5 [Compiling LilyPond], page 27,

You may run the compiled `lilypond` with:

```
cd $LILYPOND_GIT/build/
out/bin/lilypond my-file.ly
```

Building the documentation

Compiling the documentation is a much more involved process, and will likely take 2 to 10 hours.

```
cd $LILYPOND_GIT/build/
make
make doc
```

The documentation is put in `out-www/offline-root/`. You may view the html files by entering the below text; we recommend that you bookmark the resulting page:

```
firefox $LILYPOND_GIT/build/out-www/offline-root/index.html
```

Installing

Don't. There is no reason to install LilyPond within LilyDev. All development work can (and should) stay within the `$LILYPOND_GIT` directory, and any personal composition or typesetting work should be done with an official GUB release.

Problems and other options

To select different build options, or isolate certain parts of the build, or to use multiple CPUs while building, read Chapter 4 [Compiling], page 20.

In particular, contributors working on the documentation should be aware of some bugs in the build system, and should read the workarounds in Section 4.6.2 [Generating documentation], page 28.

2.3 Now start work!

LilyDev users may now skip to the chapter which is aimed at their intended contributions:

- Chapter 5 [Documentation work], page 34,
- Section 5.9 [Translating the documentation], page 50,
- Chapter 6 [Website work], page 61,
- Chapter 9 [Regression tests], page 75,
- Chapter 10 [Programming work], page 80,

These chapters are mainly intended for people not using LilyDev, but they contain extra information about the "behind-the-scenes" activities. We recommend that you read these at your leisure, a few weeks after beginning work with LilyDev.

- Chapter 3 [Working with source code], page 10,
- Chapter 4 [Compiling], page 20,

3 Working with source code

The LilyPond project uses Git (`https://git-scm.com/`) as a version control system. This section is intended at getting new contributors started with Git, and helping senior developers with less frequently used procedures.

3.1 Setting up

3.1.1 Installing Git

On UNIX systems (such as GNU/Linux, Mac OS X, FreeBSD), the easiest way to download and install Git is through a package manager. Alternatively, you can visit the Git website (`http://git-scm.com/`) for downloadable installers.

For convenience, you may also install a graphical front-end to Git. Packaged in the installers come `gitk` (for browsing the history) and `git-gui` (for committing). Git's official website provides a list of GUI clients (`https://git-scm.com/downloads/guis/`), including free software for various platforms.

3.1.2 Cloning and forking the repository

Clone the LilyPond repository (`https://gitlab.com/lilypond/lilypond`) to get the source code and its history:

```
git clone git@gitlab.com:lilypond/lilypond.git
```

New contributors need to fork it in order to push branches. Using a fork is no longer necessary (but may be convenient) when you are given developer access. You need to create an account on GitLab (`https://gitlab.com/`). Visit `https://gitlab.com/lilypond/lilypond` and press "Fork" on the top right. After the fork is created, set up a new remote:

```
cd lilypond
git remote add fork git@gitlab.com:your-username/lilypond.git
```

To list remote repositories that are configured, along with their URLs:

```
git remote -v
```

You should have `origin` pointing to the official LilyPond repository, and `fork` pointing to your your private fork.

3.1.3 Configuring Git

Settings apply to any repository on your computer, unless you leave out the `--global` option.

You first need configure some basic settings required for keeping track of commit authors:

```
git config --global user.name "John Smith"
git config --global user.email john@example.com
```

It is also recommended to enable colored output:

```
git config --global color.ui auto
```

If none of your editor-related environment variables are set, the default text editor used for writing commit messages, etc., is usually `vim`. If your are not familiar with it, change it to an editor that you are comfortable with; for example, Gedit:

```
git config --global core.editor gedit
```

Finally, and in some ways most importantly, let's make sure that we can easily see the state of our working copy. If you are not using LilyDev or Windows, add the following lines to your `~/.bashrc`:

```
export PS1="\u@\h \w\$(__git_ps1)$ "
```

```
export GIT_PS1_SHOWDIRTYSTATE=true
export GIT_PS1_SHOWUNTRACKEDFILES=true
export GIT_PS1_SHOWUPSTREAM=auto
```

After starting a new terminal, your prompt will show the current branch (this term and others are explained below). Additionally, some symbols next to the branch name indicate certain states. A star "*" means that there are unstaged changes. With a plus "+", the changes are staged. If there are untracked files, a percent "%" will appear. Finally, we can also see the state of the local repository compared to upstream: "=" means up to date, "<" is behind, ">" is ahead, "<>" means they have diverged.

You may need to install the additional `bash-completion` package.

3.2 Git cheat sheet

The intent of this section is to get you working on LilyPond quickly. If you want to learn about Git, go read Section 3.6 [Further Git documentation resources], page 16.

Also, these instructions are designed to eliminate the most common problems we have found in using Git. If you already know Git and have a different way of working, great! Feel free to ignore these advice.

Pulling recent changes

As LilyPond's source code is continously improved, it is wise to integrate recent changes into your local copy whenever you start a working session. On the `master` branch (this term is explained below), run:

```
git pull
```

Viewing the history

Each change is contained in a *commit* with an explanatory message. To list commits starting from the latest:

```
git log
```

Press `Enter` to see more or `Q` to exit.

Start work: make a new branch

The Git workflow is based on branches, which can be viewed as different copies of the source code with concurrent changes that are eventually merged. You start a contribution by creating a branch, freezing the initial state of the source code you will base your work onto. Ultimately, your branch will be *merged* in *master*. This latter special branch centralizes all features developed simultaneously and is the source for unstable releases.

> **Note:** Remember, **never** directly commit to `master`.

Let's pretend you want to add a section to the Contributor's Guide about using branches. To create a new branch for this:

```
git branch cg-add-branches
```

Switching branches

Switching branches is somehow like "loading a file", although in this case it is really "loading a directory and subdirectories full of files". The command to use is `git checkout`.

```
git checkout master
git checkout cg-add-branches
git checkout origin/release/unstable
```

Branches that begin with `origin/` are part of the remote repository, rather than your local repository, so when you check them out you get a temporary local branch. Therefore, do not commit to these either. Always work in a local branch.

Listing branches

To list local branches:

```
git branch
```

If you want remote branches too:

```
git branch -a
```

In the output, the current branch is prefixed with a star.

Staging and committing files

Now edit files. To show a summary of your edits:

```
git status
```

For every file that you modified or added, first preview your changes:

```
git diff file
```

If everything looks right:

```
git add file
```

Then commit your changes:

```
git commit
```

A text editor window appears for you to write a commit message. See Section 3.4 [Writing good commit messages], page 14.

Amending and reverting changes

To add some more changes to the latest commit, stage them using `git add`, then run:

```
git commit --amend
```

This also works for rephrasing the commit message.

To revert changes to a file that has not been committed yet:

```
git checkout filename
```

To get back to the last commit, *discarding all changes*:

```
git reset --hard HEAD
```

Uploading your branch for review

To upload the current branch on the remote repository:

```
git push -u fork cg-add-branches
```

This sets the remote branch so subsequent pushes are simpler:

```
git push
```

The next section covers how to create a merge request from your branch.

Deleting branches

After the merge request has passed testing and was merged to `master`, or after a failed experiment, you can delete your local branch.

```
git checkout master
git branch -d cg-add-branches
```

As a safety measure, this will fail if the commits of `cg-add-branches` are not present in `master`. This can be because you used GitLab to rebase your branch, which modifies the commit data and changes the hash. If you are sure that the branch is not needed anymore, replace the `-d` on the final line with a `-D` instead.

3.3 Lifecycle of a merge request

3.3.1 Uploading a patch for review

Any non-trivial change should be reviewed as a merge request:

```
https://gitlab.com/lilypond/lilypond/-/merge_requests
```

Ensure your branch differs from latest `master` by just the changes to be uploaded.

Make sure that `make`, `make test` and `make doc` succeed. Even if the individual commits contain incomplete features, they must **all** pass these tests.

Branches pushed on the main repository should start with `dev/`.

After pushing, create a merge request to start the review cycle. There are multiple options for this as outlined in GitLab's documentation (`https://docs.gitlab.com/ee/user/project/merge_requests/`). This will also ask you for a message that will accompany your patch.

If you are not a member of the team and create the merge request from a fork, consider enabling the box to "Allow commits from members who can merge to the target branch". This makes it possible for somebody with permissions to rebase your changes and merge them for you. Please refer to Section 3.3.4 [Merging to master], page 14, for more details.

3.3.2 Automated and manual testing

When a merge request is opened, a bot automatically adds the `Patch::new` label to it, and it enters the countdown cycle. GitLab triggers automated testing which ensures that the patch completes `make`, `make test`, and `make doc`. Afterwards, the Patch Meister manually runs `make check` to verify regression tests. If both steps pass, the merge request is labelled `Patch::review`. On failure, the status is updated to `Patch::needs_work`.

3.3.3 Patch countdown

The Patch Meister reviews the tracker periodically, to list patches which have been on review for at least 24 hours. For each patch, the Handler reviews any discussion on the merge request, to determine whether the patch can go forward. If there is any indication that a developer thinks the patch is not ready, the Handler marks it `Patch::needs_work` and makes a comment regarding the reason, referring to the comment if needed.

Patches with explicit approval, or at least no negative comment, are updated to `Patch::countdown`. The countdown is a 48-hour waiting period in which any final reviews or complaints should be made.

The Patch Meister sends an email to the developer list. The subject line has a fixed formatting, to enable filtering by email clients, like so:

```
PATCHES: Countdown for February 30th
```

The text of the email sets the deadline for this countdown batch. At present, batches are done on Tuesday, Thursday and Sunday evenings.

At the next countdown, if no problems were found, the patch will be set to `Patch::push`. New contributors should ask for it to be merged. Developers merge their patches themselves, see Section 3.3.4 [Merging to master], page 14, and Section 3.5 [Commit access], page 15.

Alternately, your patch may be set to `Patch::needs_work`, indicating that you should fix something (or at least discuss why the patch needs no modification). It also happens that patches waiting for minor fixes are put on countdown a second time.

Successive revisions are made in response to comments are uploaded by pushing to the same branch. GitLab automatically keeps track of all pushed commits and allows to compare revisions with each other.

As in most organisations of unpaid volunteers, fixed procedures are useful in as much as they get the job done. In our community, there is room for senior developers to bypass normal patch handling flows, particularly now that the testing of patches is largely automated. Similarly, the minimum age of 24 hours can reasonably be waived if the patch is minor and from an experienced developer.

3.3.4 Merging to master

Before allowing a merge request to be merged, GitLab ensures the following:

1. The merge must be fast-forward. In most cases, this can be achieved by 'rebasing' the branch with the most recent commits from `master`. This can be handled via GitLab, if no conflicts arise. Otherwise, or if preferred, the operation can be performed locally.
2. The (possibly rebased) changes must have passed automatic testing. This ensures that the `master` branch is always clean and ready for development and translation.

After rebasing, GitLab will immediately start the automatic testing pipeline. At the moment, all steps may take up to one hour to complete. If you are confident about the rebased result of your changes, you may click "Merge when pipeline succeeds" to avoid waiting for the tests. On failure, the merge will be aborted and no harm is done to the `master` branch.

Because GitLab enforces fast-forward merges, this means only one set of changes can be rebased and merged at once. A second merge request would be rejected later on because it does not contain the commit(s) merged first. To avoid wasting testing resources, please avoid this situation and check first if a pipeline with a scheduled merge is already running. View the list of merge requests (`https://gitlab.com/lilypond/lilypond/-/merge_requests`) and verify that no merge request with `Patch::push` status has a blue "timer" icon.

How to merge a branch without rebasing

It is generally recommended to rebase commits before merging to get a linear history. However, this is not always possible or wanted. This particularly holds for the `translation` branch and `release/unstable` which cannot be force-pushed. For these cases, use the following procedure:

1. Merge the branch manually using the command line. The example assumes no pending changes in the local `master` branch and merges the `translation` branch:

   ```
   git checkout master
   git pull
   git merge translation
   git push origin HEAD:translation
   ```

2. Open a merge request at GitLab. This will immediately trigger automatic testing as described above.
3. Accept the merge request once the testing finishes, or use the button to "Merge when pipeline succeeds".

3.3.5 Abandoned patches

Roughly at six month intervals, the Patch Meister can list the patches which have been set to `Patch::needs_work` and send the results to the developer list for review. In most cases, these patches should be marked `Patch::abandoned` but this should come from the developer if possible.

3.4 Writing good commit messages

Your commit message should begin with a one-line summary describing the change (no more than 50 characters long), and if necessary a blank line followed by more explanatory text (wrapped at 72 characters). Here is how a good commit message looks like:

```
Doc: add Baerenreiter and Henle solo cello suites

Added comparison of solo cello suite engravings to new essay with
high-resolution images.  Fixed cropping on Finale example.

Closes #1234.
```

The "Closes" part is specially recognized by GitLab. See the documentation for closing issues automatically (`https://docs.gitlab.com/ee/user/project/issues/managing_issues.html#closing-issues-automatically`).

Commit messages often start with a short prefix describing the general location of the changes. Commit affecting the documentation in English (or in several languages simultaneously) should be prefixed with "Doc:". When the commit affects only one of the translations, use "Doc-**:", where ** is the two-letter language code. For the website, this is "Web:" or "Web-**". Commits that change CSS files should use "Web: CSS" or "Doc: CSS:". Finally, changes to a single file are often prefixed with the name of the file involved.

The imperative form, e.g. "Include this in that", is strongly preferred over the descriptive form "That is now included in this".

See also this blog post (`https://chris.beams.io/posts/git-commit/`) for details on how to write good commit messages.

3.5 Commit access

New contributors are not able to push branches directly to the main repository – only members of the LilyPond development team have *commit access*. If you are a contributor and are interested in joining the development team, contact the Project Manager through the mailing list (`lilypond-devel@gnu.org`). Generally, only contributors who have already provided a number of patches which have been merged to the main repository will be considered for membership.

If you have been approved by the Project Manager, use the following procedure to obtain commit access.

- Navigate to `https://gitlab.com/lilypond` and 'Request access' to the group. Make sure that your account can be related to your activity on the mailing list. If in doubt, please post the user name after requesting access.

  Note that you will not have commit access until the Project Manager activates your membership. Once your membership is activated, LilyPond should appear under the heading "Groups" on your profile page.
- Generate and register an SSH key pair. Excellent instructions are provided in GitLab's documentation (`https://docs.gitlab.com/ee/ssh/`).
- Configure Git to use the SSH protocol (instead of the GIT or HTTP protocols). From your local Git repository, enter:

  ```
  git remote set-url origin git@gitlab.com:lilypond/lilypond.git
  ```
- After your membership has been activated and you've configured Git to use SSH, test the connection with:

  ```
  git pull --verbose
  ```

  SSH should issue the following warning:

  ```
  The authenticity of host 'gitlab.com' can't be established.
  ECDSA key fingerprint is SHA256:HbW3g8zUjNSksFbqTiUWPWg2Bq1x8xdGUrliXFzSnUw.
  Are you sure you want to continue connecting (yes/no/[fingerprint])?
  ```

  Make sure the key fingerprint displayed matches the one above or one of the others published by GitLab (`https://docs.gitlab.com/ee/user/gitlab_com/index.html#`

`ssh-host-keys-fingerprints`). If it doesn't, respond "no" and check that you configured Git properly in the previous step. If it does match, respond "yes". SSH should then issue another warning:

```
Warning: Permanently added 'gitlab.com' (ECDSA) to the list of known hosts.
```

The list of known hosts is stored in the file `~/.ssh/known_hosts`.

At this point, you are prompted for your passphrase if you have one, then Git will attempt a pull.

If `git pull --verbose` fails, you should see error messages like these:

```
Permission denied (publickey).
fatal: The remote end hung up unexpectedly
```

If you get the above error, you may have made a mistake when registering your SSH key. If the key is properly registered and it still doesn't work after an hour, ask for help on the mailing list.

If `git pull --verbose` succeeds, the output will include a 'From' line that shows 'ssh' as the protocol:

```
From git@gitlab.com:lilypond/lilypond.git
```

- Test your commit access with a dry run:

  ```
  git push --dry-run --verbose
  ```

- Repeat the steps from generating an SSH key through to testing your commit access, for each machine from which you will be making commits, or you may simply copy the files from your local `~/.ssh` folder to the same folder on the other machine.

3.6 Further Git documentation resources

- In-depth tutorials: `http://git-scm.com/documentation`
- Book about Git: Pro Git (`http://progit.org/`)
- GitLab user documentation: `https://docs.gitlab.com/ee/user/index.html`
- Github help: `http://help.github.com/` (very highly recommended by Graham)

Finally, please remember to read the man page of every Git command you will find in this manual in case you want to discover alternate methods or just understand how it works. The man pages can also be read online (`http://www.kernel.org/pub/software/scm/git/docs/`).

3.7 Repository directory structure

```
Prebuilt Documentation and packages are available from:

    http://www.lilypond.org

LilyPond development is hosted at:

    http://savannah.gnu.org/projects/lilypond

Here is a simple explanation of the directory layout for
LilyPond's source files.


.                         Toplevel README's, ChangeLog,
|                           build bootstrapping, patches
|                           for third party programs
```

```
|
|-- Documentation/       Top sources for most of the manuals
|   |
|   |
|   |   INDIVIDUAL CHAPTERS FOR EACH MANUAL:
|   |     Note: "Snippets" and "Internals Reference" are
|   |     auto-generated during the Documentation Build process.
|   |
|   |
|   |-- contributor/     Contributor's Guide
|   |-- essay/           Essay on automated music engraving
|   |-- extending/       Extending the functionality of LilyPond
|   |-- learning/        Learning Manual
|   |-- notation/        Notation Reference
|   |-- usage/           Runnning the programs that come with LilyPond
|   |-- web/             The website
|   |
|   |
|   |   TRANSLATED MANUALS:
|   |     Each language's directory can contain...
|   |       1) translated versions of:
|   |          * top sources for manuals
|   |          * individual chapters for each manual
|   |       2) a texidocs/ directory for snippet translations
|   |
|   |-- ca/              Catalan
|   |-- cs/              Czech
|   |-- de/              German
|   |-- es/              Spanish
|   |-- fr/              French
|   |-- hu/              Hungarian
|   |-- it/              Italian
|   |-- ja/              Japanese
|   |-- nl/              Dutch
|   |-- pt/              Portuguese
|   |-- zh/              Chinese
|   |
|   |
|   |   MISCELLANEOUS DOC STUFF:
|   |
|   |-- css/             CSS files for HTML docs
|   |-- included/        .ly files used in the manuals
|   |-- logo/            Web logo and "note" icon
|   |-- ly-examples/     .ly files for the "Examples" webpage
|   |-- misc/            Old announcements, ChangeLogs and NEWS
|   |-- pictures/        Images used (eps/jpg/png/svg)
|   |   `-- pdf/         (pdf)
|   |-- po/              Translated build/maintenance scripts
|   |-- snippets/        Auto-generated from the LSR and from ./new/
|   |   `-- new/         Snippets too new for the LSR
|   `-- topdocs/         AUTHORS, INSTALL, README
|
```

```
|
|   C++ SOURCES:
|
|-- flower/              A simple C++ library
|-- lily/                C++ sources for the LilyPond binary
|
|
|   LIBRARIES:
|
|-- ly/                  .ly \include files
|-- mf/                  MetaFont sources for Emmentaler fonts
|-- ps/                  PostScript library files
|-- scm/                 Scheme sources for LilyPond and subroutine files
|-- tex/                 TeX and texinfo library files
|
|
|   SCRIPTS:
|
|-- config/              Autoconf helpers for configure script
|-- python/              Python modules, MIDI module
|   `-- auxiliar/        Python modules for build/maintenance
|-- scripts/             End-user scripts (--> lilypond/usr/bin/)
|   |-- auxiliar/        Maintenance and non-essential build scripts
|   `-- build/           Essential build scripts
|
|
|   BUILD PROCESS:
|   (also see SCRIPTS section above)
|
|-- make/                Specific make subroutine files
|-- stepmake/            Generic make subroutine files
|
|
|   REGRESSION TESTS:
|
|-- input/
|   `-- regression/      .ly regression tests
|       |-- abc2ly/      .abc regression tests
|       |-- lilypond-book/  lilypond-book regression tests
|       |-- midi/        midi2ly regression tests
|       `-- musicxml/    .xml and .itexi regression tests
|
|
|   MISCELLANEOUS:
|
|-- elisp/               Emacs LilyPond mode and syntax coloring
|-- vim/                 Vi(M) LilyPond mode and syntax coloring
`-- po/                  Translations for binaries and end-user scripts
```

3.8 Other repositories

TODO: to be updated (infrastructure, static-files, lilypond-extra is no more).

We have a few other code repositories.

lilypond-extra

There is a separate repository for general administrative scripts, as well as pictures and media files for the website. People interested in working on the website should download this repository, and set their `$LILYPOND_WEB_MEDIA_GIT` environment variable to point to that repository.

```
https://github.com/gperciva/lilypond-extra
```

To configure an environment variable in Bash (the default for most GNU/Linux distributions),

```
export LILYPOND_WEB_MEDIA_GIT=$HOME/dir/of/lilypond-extra/
```

Be aware that `lilypond-extra` is the definitive source for some binary files – in particular PDF versions of papers concerning LilyPond. To add further PDFs of this sort, all that is necessary is to add the PDF to `lilypond-extra` and then add a reference to it in the documentation. The file will then be copied to the website when `make website` is run.

However, pictures that are also used in the documentation build are mastered in the main Git repository. If any of these is changed, it should be updated in Git, and then the updates copied to `lilypond-extra`.

Grand Unified Builder (GUB)

Another item of interest might be the Grand Unified Builder, our cross-platform building tool. Since it is used by other projects as well, it is not stored in our main repository. For more info, see GUB's home page (`https://lilypond.org/gub`).

The location for the repository is:

```
http://github.com/gperciva/gub
```

LilyPad

Our binary releases on MacOS X and Windows contain a lightweight text editor.

To make any modifications the Windows editor, you will need to do the following:

1. Clone the git repository from `https://github.com/gperciva/lilypad`
2. Make changes to the source, and check it compiles. In a Windows environment `MinGW` provides both a `Git` installation and a `gcc` compiler. This can be obtained from `http://www.mingw.org/`
3. Update the version which is contained in the `rsrc.rc`. Check this compiles, too.
4. Commit the changes with an informative commit message.
5. Push the changes to github. You will need to use syntax similiar to this:

   ```
   git push https://UserName@github.com/gperciva/lilypad.git
   ```

   You will need to have push access to the git repository for this to be successful.
6. Make a tarball of the source code to be used by GUB by pulling the updated repository from GitHub. Ensure that the tarball has the correct Version number.
7. Copy the tarball to `https://lilypond.org/downloads/gub-sources/lilypad/`. You will need to have SSH access to `lilypond.org`. If you do not, contact the Release Manager via the lilypond-devel mailing list.
8. Update GUB to make it use the new tarball by editing `gub/specs/lilypad.py` and changing the `source =` line to point to the new source.
9. Push this updated `lilypad.py` version to the GUB repository on GitHub.
10. Test the changes with a new GUB compile.

4 Compiling

This chapter describes the process of compiling the LilyPond program from source files.

4.1 Overview of compiling

Compiling LilyPond from source is an involved process, and is only recommended for developers and packagers. Typical program users are instead encouraged to obtain the program from a package manager (on Unix) or by downloading a precompiled binary configured for a specific operating system. Pre-compiled binaries are available on the Section "Download" in *General Information* page.

Compiling LilyPond from source is necessary if you want to build, install, or test your own version of the program.

A successful compile can also be used to generate and install the documentation, incorporating any changes you may have made. However, a successful compile is not a requirement for generating the documentation. The documentation can be built using a Git repository in conjunction with a locally installed copy of the program. For more information, see [Building documentation without compiling], page 30.

Attempts to compile LilyPond natively on Windows have been unsuccessful, though a workaround is available (see Section "LilyDev" in *Contributor's Guide*).

4.2 Requirements

4.2.1 Requirements for running LilyPond

This section contains the list of separate software packages that are required to run LilyPond.

- DejaVu fonts (`http://www.dejavu-fonts.org/`) These are normally installed by default.
- FontConfig (`http://www.fontconfig.org/`) Use version 2.4.0 or newer.
- Freetype (`http://www.freetype.org/`) Use version 2.3.9 or newer.
- Ghostscript (`http://www.ghostscript.com`) Use version 9.03 or newer.
- Guile (`http://www.gnu.org/software/guile/guile.html`) Use version 1.8.8. It is possible to build LilyPond with version 2.*x* of Guile and most features will work, but this is not officially supported (yet). In particular, performance and especially the startup time will be worse.
- Pango (`http://www.pango.org/`) Use version 1.36 or newer.
- Python (`http://www.python.org`) Use version 3.5 or newer.
- International fonts. For example:

  Fedora:

  ```
  fonts-arabic
  fonts-hebrew
  fonts-ja
  fonts-xorg-truetype
  taipeifonts
  ttfonts-ja
  ttfonts-zh_CN
  ```

  Debian based distributions:

  ```
  emacs-intl-fonts
  fonts-ipafont-gothic
  fonts-ipafont-mincho
  ```

```
xfonts-bolkhov-75dpi
xfonts-cronyx-75dpi
xfonts-cronyx-100dpi
xfonts-intl-.*
```

These are normally installed by default and are required only to create music with international text or lyrics.

4.2.2 Requirements for compiling LilyPond

This section contains instructions on how to quickly and easily get all the software packages required to build LilyPond.

Most of the more popular Linux distributions only require a few simple commands to download all the software needed. For others, there is an explicit list of all the individual packages (as well as where to get them from) for those that are not already included in your distributions' own repositories.

Fedora

The following instructions were tested on 'Fedora' versions 22 & 23 and will download all the software required to both compile LilyPond and build the documentation.

- Download and install all the LilyPond build-dependencies (approximately 700MB);

  ```
  sudo dnf builddep lilypond --nogpgcheck
  ```

- Download and install additional 'build' tools required for compiling;

  ```
  sudo dnf install autoconf gcc-c++
  ```

- Download `texi2html 1.82` directly from: `http://download.savannah.gnu.org/releases/texi2html/texi2html-1.82.tar.gz`;

  `texi2html` is only required if you intend to compile LilyPond's own documentation (e.g. to help with any document writing). The version available in the Fedora repositories is too new and will not work. Extract the files into an appropriate location and then run the commands;

  ```
  ./configure
  make
  sudo make install
  ```

  This should install `texi2html 1.82` into `/usr/local/bin`, which will normally take priority over `/usr/bin` where the later, pre-installed versions gets put. Now verify that your operating system is able to see the correct version of `texi2html`.

  ```
  texi2html --version
  ```

- Although not 'required' to compile LilyPond, if you intend to contribute to LilyPond (codebase or help improve the documentation) then it is recommended that you also need to install `git`.

  ```
  sudo dnf install git
  ```

  Also see Section "Working with source code" in *Contributor's Guide*.

Note: By default, when building LilyPond's documentation, `pdfTeX` is be used. However ligatures (fi, fl, ff etc.) may not be printed in the PDF output. In this case XeTeX can be used instead. Download and install the `texlive-xetex` package.

```
sudo dnf install texlive-xetex
```

The scripts used to build the LilyPond documentation will use `XeTeX` instead of `pdfTeX` to generate the PDF documents if it is available. No additional configuration is required.

Linux Mint

The following instructions were tested on 'Linux Mint 17.1' and 'LMDE - Betsy' and will download all the software required to both compile LilyPond and build the documentation..

- Enable the *sources* repository;
  1. Using the *Software Sources* GUI (located under *Administration*).
  2. Select *Official Repositories*.
  3. Check the *Enable source code repositories* box under the *Source Code* section.
  4. Click the *Update the cache* button and when it has completed, close the *Software Sources* GUI.
- Download and install all the LilyPond build-dependencies (approximately 200MB);

  ```
  sudo apt-get build-dep lilypond
  ```
- Download and install additional 'build' tools required for compiling;

  ```
  sudo apt-get install autoconf fonts-texgyre texlive-lang-cyrillic
  ```
- Although not 'required' to compile LilyPond, if you intend to contribute to LilyPond (codebase or help improve the documentation) then it is recommended that you also need to install `git`.

  ```
  sudo apt-get install git
  ```

  Also see Section "Working with source code" in *Contributor's Guide*.

Note: By default, when building LilyPond's documentation, `pdfTeX` is be used. However ligatures (fi, fl, ff etc.) may not be printed in the PDF output. In this case XeTeX can be used instead. Download and install the `texlive-xetex` package.

```
sudo apt-get install texlive-xetex
```

The scripts used to build the LilyPond documentation will use `XeTex` instead of `pdfTex` to generate the PDF documents if it is available. No additional configuration is required.

OpenSUSE

The following instructions were tested on 'OpenSUSE 13.2' and will download all the software required to both compile LilyPond and build the documentation.

- Add the *sources* repository;

  ```
  sudo zypper addrepo -f \
  "http://download.opensuse.org/source/distribution/13.2/repo/oss/" sources
  ```
- Download and install all the LilyPond build-dependencies (approximately 680MB);

  ```
  sudo zypper source-install lilypond
  ```
- Download and install additional 'build' tools required for compiling;

  ```
  sudo zypper install make
  ```

- Although not 'required' to compile LilyPond, if you intend to contribute to LilyPond (codebase or help improve the documentation) then it is recommended that you also need to install `git`.

  ```
  sudo zypper install git
  ```

  Also see Section "Working with source code" in *Contributor's Guide*.

> **Note:** By default, when building LilyPond's documentation, `pdfTeX` is be used. However ligatures (fi, fl, ff etc.) may not be printed in the PDF output. In this case XeTeX can be used instead. Download and install the `texlive-xetex` package.
>
> ```
> sudo zypper install texlive-xetex
> ```
>
> The scripts used to build the LilyPond documentation will use `XeTex` instead of `pdfTex` to generate the PDF documents if it is available. No additional configuration is required.

Ubuntu

The following commands were tested on Ubuntu versions `14.04 LTS`, `14.10` and `15.04` and will download all the software required to both compile LilyPond and build the documentation.

- Download and install all the LilyPond build-dependencies (approximately 200MB);

  ```
  sudo apt-get build-dep lilypond
  ```

- Download and install additional 'build' tools required for compiling;

  ```
  sudo apt-get install autoconf fonts-texgyre texlive-lang-cyrillic
  ```

- Although not 'required' to compile LilyPond, if you intend to contribute to LilyPond (codebase or help improve the documentation) then it is recommended that you also need to install `git`.

  ```
  sudo apt-get install git
  ```

  Also see Section "Working with source code" in *Contributor's Guide*.

> **Note:** By default, when building LilyPond's documentation, `pdfTeX` is be used. However ligatures (fi, fl, ff etc.) may not be printed in the PDF output. In this case XeTeX can be used instead. Download and install the `texlive-xetex` package.
>
> ```
> sudo apt-get install texlive-xetex
> ```
>
> The scripts used to build the LilyPond documentation will use `XeTex` instead of `pdfTex` to generate the PDF documents if it is available. No additional configuration is required.

Other

The following individual software packages are required just to compile LilyPond.

- GNU Autoconf (`http://www.gnu.org/software/autoconf`)
- GNU Bison (`http://www.gnu.org/software/bison/`)

  Use version 2.4.1 or newer.

- Compiler with support for C++11

  Version 4.8.5 or newer of the GNU Compiler Collection (`https://gcc.gnu.org/`) and version 3.5 or newer of Clang (`https://clang.llvm.org/`) should work.

- Flex (`https://github.com/westes/flex`)

  Use version 2.5.29 or newer.
- FontForge (`https://fontforge.org/`)

  Use version 20120731 or newer with enabled scripting using Python 3; it must also be compiled with the `--enable-double` switch, else this can lead to inaccurate intersection calculations which end up with poorly-rendered glyphs in the output.
- GNU gettext (`http://www.gnu.org/software/gettext/gettext.html`)

  Use version 0.17 or newer.
- GNU Make (`http://www.gnu.org/software/make/`)

  Use version 3.78 or newer.
- MetaFont (`http://metafont.tutorial.free.fr/`)

  The `mf-nowin`, `mf`, `mfw` or `mfont` binaries are usually packaged along with TEX (`http://www.latex-project.org/ftp.html`).
- MetaPost (`http://cm.bell-labs.com/who/hobby/MetaPost.html`)

  The `mpost` binary is also usually packaged with TEX (`http://www.latex-project.org/ftp.html`).
- Perl (`http://www.perl.org/`)
- Texinfo (`http://www.gnu.org/software/texinfo/`)

  Use version 6.1 or newer.
- Type 1 utilities (`http://www.lcdf.org/~eddietwo/type/#t1utils`)

  Use version 1.33 or newer.
- Cyrillic fonts (`https://www.ctan.org/pkg/cyrillic?lang=en`)

  Often packaged in repositories as `texlive-lang-cyrillic`.
- TeX Gyre 'OTF' font packages. As of LilyPond version 2.19.26, the previous default serif, san serif and monospace fonts now use Tex Gyre's *Schola*, *Heros* and *Cursor* fonts respectively. Also See Section "Fonts" in *Notation Reference*.

  Some distributions do not always provide 'OTF' font files in the Tex Gyre packages from their repositories. Use the command `fc-list | grep texgyre` to list the fonts available to your system and check that the appropriate `*.otf` files are reported. If they are not then download and manually extract the 'OTF' files to either your local `~/.fonts/` directory or use the `configure` command and the `--with-texgyre-dir=/path_to_otf_files/` option.

  The following font families are required:

  Schola (`http://www.gust.org.pl/projects/e-foundry/tex-gyre/schola`), Heros (`http://www.gust.org.pl/projects/e-foundry/tex-gyre/heros`) and Cursor (`http://www.gust.org.pl/projects/e-foundry/tex-gyre/cursor`).

4.2.3 Requirements for building documentation

The entire set of documentation for the most current build of LilyPond is available online at `https://lilypond.org/doc/v2.19/Documentation/web/development`, but you can also build them locally from the source code. This process requires some additional tools and packages.

> **Note:** If the instructions for one of the previously listed Linux in the previous section (Section "Requirements for compiling LilyPond" in *Contributor's Guide*) have been used, then the following can be ignored as the software should already be installed.

- Everything listed in Section 4.2.2 [Requirements for compiling LilyPond], page 21,

- ImageMagick (`http://www.imagemagick.org/`)
- gzip (`http://gzip.org/`)
- rsync (`http://rsync.samba.org/`)
- Texi2HTML (`http://www.nongnu.org/texi2html/`)

  Use version 1.82. Later versions might work, but produce suboptimal results.

  Download `texi2html 1.82` directly from: `http://download.savannah.gnu.org/releases/texi2html/texi2html-1.82.tar.gz`;

  Extract the files into an appropriate location and then run the commands;

  ```
  ./configure
  make
  sudo make install
  ```

  Now verify that your operating system is able to see the correct version of `texi2html`.

  ```
  texi2html --version
  ```

- Fonts required to build the documentation in addition to those required to run LilyPond:

  ```
  gsfonts
  fonts-linuxlibertine
  fonts-liberation
  fonts-dejavu
  fonts-freefont-otf
  ttf-bitstream-vera
  texlive-fonts-recommended
  ttf-xfree86-nonfree
  ```

  Note: By default, when building LilyPond's documentation, `pdfTeX` is be used. However ligatures (fi, fl, ff etc.) may not be printed in the PDF output. In this case XeTeX can be used instead. Download and install the `texlive-xetex` package. The scripts used to build the LilyPond documentation will use `XeTex` instead of `pdfTex` to generate the PDF documents if it is available. No additional configuration is required.

4.3 Getting the source code

Downloading the Git repository

In general, developers compile LilyPond from within a local Git repository. Setting up a local Git repository is explained in Section "Starting with Git" in *Contributor's Guide*.

Downloading a source tarball

Packagers are encouraged to use source tarballs for compiling.

The tarball for the latest stable release is available on the Section "Source" in *General Information* page.

The latest source code snapshot (`http://git.savannah.gnu.org/gitweb/?p=lilypond.git;a=snapshot`) is also available as a tarball from the GNU Savannah Git server.

All tagged releases (including legacy stable versions and the most recent development release) are available here:

```
https://lilypond.org/download/source/
```

Download the tarball to your `~/src/` directory, or some other appropriate place.

> **Note:** Be careful where you unpack the tarball! Any subdirectories of the current folder named `lilypond/` or `lilypond-x.y.z/` (where *x.y.z* is the release number) will be overwritten if there is a name clash with the tarball.

Unpack the tarball with this command:

```
tar -xzf lilypond-x.y.z.tar.gz
```

This creates a subdirectory within the current directory called `lilypond-x.y.z/`. Once unpacked, the source files occupy about 40 MB of disk space.

Windows users wanting to look at the source code may have to download and install the free-software 7zip archiver (`http://www.7-zip.org`) to extract the tarball.

4.4 Configuring `make`

4.4.1 Running `./autogen.sh`

After you unpack the tarball (or download the Git repository), the contents of your top source directory should be similar to the current source tree listed at `http://git.sv.gnu.org/gitweb/?p=lilypond.git;a=tree`.

Next, you need to create the generated files; enter the following command from your top source directory:

```
./autogen.sh --noconfigure
```

This will generate a number of files and directories to aid configuration, such as `configure`, `README.txt`, etc.

Next, create the build directory with:

```
mkdir build/
cd build/
```

We heavily recommend building lilypond inside a separate directory with this method.

4.4.2 Running `../configure`

Configuration options

> **Note:** make sure that you are in the `build/` subdirectory of your source tree.

The `../configure` command (generated by `./autogen.sh`) provides many options for configuring `make`. To see them all, run:

```
../configure --help
```

Checking build dependencies

> **Note:** make sure that you are in the `build/` subdirectory of your source tree.

When `../configure` is run without any arguments, it will check to make sure your system has everything required for compilation:

```
../configure
```

If any build dependency is missing, `../configure` will return with:

```
ERROR: Please install required programs:  foo
```

The following message is issued if you are missing programs that are only needed for building the documentation:

```
WARNING: Please consider installing optional programs:  bar
```

If you intend to build the documentation locally, you will need to install or update these programs accordingly.

> **Note:** `../configure` may fail to issue warnings for certain documentation build requirements that are not met. If you experience problems when building the documentation, you may need to do a manual check of Section 4.2.3 [Requirements for building documentation], page 24.

Configuring target directories

> **Note:** make sure that you are in the `build/` subdirectory of your source tree.

If you intend to use your local build to install a local copy of the program, you will probably want to configure the installation directory. Here are the relevant lines taken from the output of `../configure --help`:

> By default, '`make install`' will install all the files in `/usr/local/bin`, `/usr/local/lib` etc. You can specify an installation prefix other than `/usr/local` using '`--prefix`', for instance '`--prefix=$HOME`'.

A typical installation prefix is `$HOME/usr`:

```
../configure --prefix=$HOME/usr
```

Note that if you plan to install a local build on a system where you do not have root privileges, you will need to do something like this anyway—`make install` will only succeed if the installation prefix points to a directory where you have write permission (such as your home directory). The installation directory will be automatically created if necessary.

The location of the `lilypond` command installed by this process will be *prefix*`/bin/lilypond`; you may want to add *prefix*`/bin/` to your `$PATH` if it is not already included.

It is also possible to specify separate installation directories for different types of program files. See the full output of `../configure --help` for more information.

If you encounter any problems, please see Section 4.7 [Problems], page 31.

4.5 Compiling LilyPond

4.5.1 Using `make`

> **Note:** make sure that you are in the `build/` subdirectory of your source tree.

LilyPond is compiled with the `make` command. Assuming `make` is configured properly, you can simply run:

```
make
```

'`make`' is short for '`make all`'. To view a list of `make` targets, run:

```
make help
```

TODO: Describe what `make` actually does.

See also

Section 4.6.2 [Generating documentation], page 28, provides more info on the `make` targets used to build the LilyPond documentation.

4.5.2 Saving time with the `-j` option

If your system has multiple CPUs, you can speed up compilation by adding '`-jX`' to the `make` command, where '`X`' is one more than the number of cores you have. For example, a typical Core2Duo machine would use:

```
make -j3
```

If you get errors using the `-j` option, and '`make`' succeeds without it, try lowering the `X` value.

Because multiple jobs run in parallel when `-j` is used, it can be difficult to determine the source of an error when one occurs. In that case, running '`make`' without the `-j` is advised.

4.5.3 Useful `make` variables

`make` normally echoes each command, but LilyPond makefiles suppress this behavior by default. The goal is to show progress without hiding warnings and errors in the noise of long commands.

To enable echoing commands, and to increase the verbosity of some of the commands, set `VERBOSE=1` on the command line or in `local.make` at the top of the build tree.

Similarly, to reduce the verbosity, set `SILENT=1`. Because of the way these options are implemented, `make -s` does not serve this purpose.

4.6 Post-compilation options

4.6.1 Installing LilyPond from a local build

If you configured `make` to install your local build in a directory where you normally have write permission (such as your home directory), and you have compiled LilyPond by running `make`, you can install the program in your target directory by running:

```
make install
```

If instead, your installation directory is not one that you can normally write to (such as the default `/usr/local/`, which typically is only writeable by the superuser), you will need to temporarily become the superuser when running `make install`:

```
sudo make install
```

or...

```
su -c 'make install'
```

If you don't have superuser privileges, then you need to configure the installation directory to one that you can write to, and then re-install. See [Configuring target directories], page 27.

4.6.2 Generating documentation

Documentation editor's edit/compile cycle

To work on a manual, do the following

- Build lilypond itself

  ```
  make [-jX]
  ```

- Then build the specific manual to work on, and inspect:

  ```
  ## edit source files, then...
  make CPU_COUNT=X -C Documentation out=www out-www/LANGUAGE/MYMANUAL.pdf
  ```

```
## if you prefer checking HTML files
make CPU_COUNT=X -C Documentation out=www out-www/LANGUAGE/MYMANUAL/index.html
```

- To remove compiled documentation from your system, use '`make doc-clean`' in the toplevel build directory.

Building documentation

After a successful compile (using `make`), the documentation can be built by issuing:

```
make doc
```

or, to build only the PDF documentation and not the HTML,

```
make -C Documentation out=www pdf
```

> **Note:** The first time you run `make doc`, the process can easily take an hour or more with not much output on the command line.

After this initial build, `make doc` only makes changes to the documentation where needed, so it may only take a minute or two to test changes if the documentation is already built.

If `make doc` succeeds, the HTML documentation tree is available in `out-www/offline-root/`, and can be browsed locally. The documentation can also be inspected in the `Documentation/out-www` subdirectory.

`make doc` sends the output from most of the compilation to logfiles. If the build fails for any reason, it should print the name of a logfile, explaining what failed.

`make doc` compiles the documents for all languages. To save some compile time, the English language documents can be compiled on their own with:

```
make LANGS='en' doc
```

Similarly, it is possible to compile a subset of the translated documentation by specifying their language codes on the command line. For example, the French and German translations are compiled with:

```
make LANGS='de fr' doc
```

Compilation of documentation in Info format with images can be done separately by issuing:

```
make info
```

An issue when switching branches between master and translation is the appearance/disappearance of translated versions of some manuals. If you see such a warning from make:

```
No rule to make target `X', needed by `Y'
```

Your best bet is to delete the file Y.dep and to try again.

Building a single document

It's possible to build a single document. For example, to rebuild only `contributor.pdf`, do the following:

```
cd build/
cd Documentation/
touch ../../Documentation/en/contributor.texi
make out=www out-www/en/contributor.pdf
```

If you are only working on a single document, test-building it in this way can give substantial time savings - recreating `contributor.pdf`, for example, takes a matter of seconds.

Saving time with CPU_COUNT

The most time consuming task for building the documentation is running LilyPond to build images of music, and there cannot be several simultaneously running `lilypond-book` instances, so the `-j make` option does not significantly speed up the build process. To help speed it up, the makefile variable `CPU_COUNT` may be set in `local.make` or on the command line to the number of `.ly` files that LilyPond should process simultaneously, e.g. on a dual core machine:

```
make -j2 CPU_COUNT=2 doc
```

The recommended value of `CPU_COUNT` is the number of cores. If the build runs into out-of-memory problems, use a lower number.

Installing documentation

The HTML, PDF and if available Info files can be installed into the standard documentation path by issuing

```
make install-doc
```

This also installs Info documentation with images. The final installation of Info documentation (integrating it into the documentation directory) is printed on standard output.

To install the Info documentation separately, run:

```
make install-info
```

Note that to get the images in Info documentation, `install-doc` target creates symbolic links to HTML and PDF installed documentation tree in *`prefix`*`/share/info`, in order to save disk space, whereas `install-info` copies images in *`prefix`*`/share/info` subdirectories.

It is possible to build a documentation tree in `out-www/online-root/`, with special processing, so it can be used on a website with content negotiation for automatic language selection; this can be achieved by issuing

```
make WEB_TARGETS=online doc
```

and both 'offline' and 'online' targets can be generated by issuing

```
make WEB_TARGETS="offline online" doc
```

Several targets are available to clean the documentation build and help with maintaining documentation; an overview of these targets is available with

```
make help
```

from every directory in the build tree. Most targets for documentation maintenance are available from `Documentation/`; for more information, see Section "Documentation work" in *Contributor's Guide*.

The makefile variable `QUIET_BUILD` may be set to `1` for a less verbose build output, just like for building the programs.

Building documentation without compiling

The documentation can be built locally without compiling LilyPond binary, if LilyPond is already installed on your system.

From a fresh Git checkout, do

```
./autogen.sh   # ignore any warning messages
cp GNUmakefile.in GNUmakefile
make -C scripts && make -C python
nice make LILYPOND_EXTERNAL_BINARY=/path/to/bin/lilypond doc
```

This may break: if a new feature is added with a test file in input/regression, even the latest development release of LilyPond will fail to build the docs.

You may build the manual without building all the `input/*` stuff (i.e. mostly regression tests): change directory, for example to `Documentation/`, issue `make doc`, which will build documentation in a subdirectory `out-www` from the source files in current directory. In this case, if you also want to browse the documentation in its post-processed form, change back to top directory and issue

```
make out=www WWW-post
```

4.6.3 Testing LilyPond binary

LilyPond comes with an extensive suite that exercises the entire program. This suite can be used to test that the binary has been built correctly.

The test suite can be executed with:

```
make test
```

If the test suite completes successfully, the LilyPond binary has been verified.

More information on the regression test suite is found at Section "Regression tests" in *Contributor's Guide*.

4.7 Problems

For help and questions use `lilypond-user@gnu.org`. Send bug reports to `bug-lilypond@gnu.org`.

Bugs that are not fault of LilyPond are documented here.

Compiling on MacOS X

Here are special instructions for compiling under MacOS X. These instructions assume that dependencies are installed using MacPorts. (`http://www.macports.org/`) The instructions have been tested using OS X 10.5 (Leopard).

First, install the relevant dependencies using MacPorts.

Next, add the following to your relevant shell initialization files. This is `~/.profile` by default. You should create this file if it does not exist.

```
export PATH=/opt/local/bin:/opt/local/sbin:$PATH
export DYLD_FALLBACK_LIBRARY_PATH=/opt/local/lib:$DYLD_FALLBACK_LIBRARY_PATH
```

Now you must edit the generated `config.make` file. Change

```
FLEXLEXER_FILE = /usr/include/FlexLexer.h
```

to:

```
FLEXLEXER_FILE = /opt/local/include/FlexLexer.h
```

At this point, you should verify that you have the appropriate fonts installed with your ghostscript installation. Check `ls /opt/local/share/ghostscript/fonts` for: 'c0590*' files (.pfb, .pfb and .afm). If you don't have them, run the following commands to grab them from the ghostscript SVN server and install them in the appropriate location:

```
svn export http://svn.ghostscript.com/ghostscript/tags/urw-fonts-1.0.7pre44/
sudo mv urw-fonts-1.0.7pre44/* /opt/local/share/ghostscript/fonts/
rm -rf urw-fonts-1.07pre44
```

Now run the `./configure` script. To avoid complications with automatic font detection, add

```
--with-fonts-dir=/opt/local/share/ghostscript/fonts
```

FreeBSD

To use system fonts, dejaview must be installed. With the default port, the fonts are installed in `usr/X11R6/lib/X11/fonts/dejavu`.

Open the file `$LILYPONDBASE/usr/etc/fonts/local.conf` and add the following line just after the `<fontconfig>` line. (Adjust as necessary for your hierarchy.)

```
<dir>/usr/X11R6/lib/X11/fonts</dir>
```

International fonts

On Mac OS X, all fonts are installed by default. However, finding all system fonts requires a bit of configuration; see this post (`http://lists.gnu.org/archive/html/lilypond-user/2007-03/msg00472.html`) on the `lilypond-user` mailing list.

On Linux, international fonts are installed by different means on every distribution. We cannot list the exact commands or packages that are necessary, as each distribution is different, and the exact package names within each distribution changes. Here are some hints, though:

```
Red Hat Fedora

    taipeifonts fonts-xorg-truetype ttfonts-ja fonts-arabic \
         ttfonts-zh_CN fonts-ja fonts-hebrew

Debian GNU/Linux

   apt-get install emacs-intl-fonts xfonts-intl-.* \
        fonts-ipafont-gothic  fonts-ipafont-mincho \
        xfonts-bolkhov-75dpi xfonts-cronyx-100dpi xfonts-cronyx-75dpi
```

Using lilypond python libraries

If you want to use lilypond's python libraries (either running certain build scripts manually, or using them in other programs), set `PYTHONPATH` to `python/out` in your build directory, or `.../usr/lib/lilypond/current/python` in the installation directory structure.

4.8 Concurrent stable and development versions

It can be useful to have both the stable and the development versions of LilyPond available at once. One way to do this on GNU/Linux is to install the stable version using the precompiled binary, and run the development version from the source tree. After running `make all` from the top directory of the LilyPond source files, there will be a binary called `lilypond` in the `out` directory:

```
<path to>/lilypond/out/bin/lilypond
```

This binary can be run without actually doing the `make install` command. The advantage to this is that you can have all of the latest changes available after pulling from git and running `make all`, without having to uninstall the old version and reinstall the new.

So, to use the stable version, install it as usual and use the normal commands:

```
lilypond foobar.ly
```

To use the development version, create a link to the binary in the source tree by saving the following line in a file somewhere in your `$PATH`:

```
exec <path to>/lilypond/out/bin/lilypond "$@"
```

Save it as `Lilypond` (with a capital L to distinguish it from the stable `lilypond`), and make it executable:

```
chmod +x Lilypond
```

Then you can invoke the development version this way:

```
Lilypond foobar.ly
```

TODO: ADD

- other compilation tricks for developers

4.9 Build system

We currently use make and stepmake, which is complicated and only used by us. Hopefully this will change in the future.

Version-specific texinfo macros

- made with `scripts/build/create-version-itexi.py` and `scripts/build/create-weblinks-itexi.py`
- used extensively in the `WEBSITE_ONLY_BUILD` version of the website (made with `website.make`, used on lilypond.org)
- not (?) used in the main docs?
- the numbers in VERSION file: MINOR_VERSION should be 1 more than the last release, VERSION_DEVEL should be the last **online** release. Yes, VERSION_DEVEL is less than VERSION.

5 Documentation work

There are currently 11 manuals for LilyPond, not including the translations. Each book is available in HTML, PDF, and info. The documentation is written in a language called `texinfo` – this allows us to generate different output formats from a single set of source files.

To organize multiple authors working on the documentation, we use a Version Control System (VCS) called Git, previously discussed in Chapter 3 [Working with source code], page 10.

5.1 Introduction to documentation work

Our documentation tries to adhere to our Section 5.5 [Documentation policy], page 44. This policy contains a few items which may seem odd. One policy in particular is often questioned by potential contributors: we do not repeat material in the Notation Reference, and instead provide links to the "definitive" presentation of that information. Some people point out, with good reason, that this makes the documentation harder to read. If we repeated certain information in relevant places, readers would be less likely to miss that information.

That reasoning is sound, but we have two counter-arguments. First, the Notation Reference – one of *five* manuals for users to read – is already over 500 pages long. If we repeated material, we could easily exceed 1000 pages! Second, and much more importantly, LilyPond is an evolving project. New features are added, bugs are fixed, and bugs are discovered and documented. If features are discussed in multiple places, the documentation team must find every instance. Since the manual is so large, it is impossible for one person to have the location of every piece of information memorized, so any attempt to update the documentation will invariably omit a few places. This second concern is not at all theoretical; the documentation used to be plagued with inconsistent information.

If the documentation were targeted for a specific version – say, LilyPond 2.10.5 – and we had unlimited resources to spend on documentation, then we could avoid this second problem. But since LilyPond evolves (and that is a very good thing!), and since we have quite limited resources, this policy remains in place.

A few other policies (such as not permitting the use of tweaks in the main portion of NR 1+2) may also seem counter-intuitive, but they also stem from attempting to find the most effective use of limited documentation help.

Before undertaking any large documentation work, contributors are encouraged to contact the Section 13.3 [Meisters], page 122.

5.2 `\version` in documentation files

Every documentation file which includes LilyPond code must begin with a `\version` statement, since the build procedure explicitly tests for its presence and will not continue otherwise. The `\version` statement should reference a version of LilyPond consistent with the syntax of the contained code.

Since the `\version` statement is not valid Texinfo input it must be commented out like this:

```
@c \version "2.19.1"
```

So, if you are adding LilyPond code which is not consistent with the current version header, you should

1. run convert-ly on the file using the latest version of LilyPond (which should, if everybody has done proper maintenance, not change anything);
2. add the new code;
3. modify the version number to match the new code.

5.3 Documentation suggestions

Small additions

For additions to the documentation,

1. Tell us where the addition should be placed. Please include both the section number and title (i.e. "LM 2.13 Printing lyrics").
2. Please write exact changes to the text.
3. A formal patch to the source code is *not* required; we can take care of the technical details.
4. Send the suggestions to the `bug-lilypond` mailing list as discussed in Section "Contact" in *General Information*.
5. Here is an example of a perfect documentation report:

```
To: bug-lilypond@gnu.org
From: helpful-user@example.net
Subject: doc addition

In LM 2.13 (printing lyrics), above the last line ("More options,
like..."), please add:

----
To add lyrics to a divided part, use blah blah blah.  For example,

\score {
  \notes {blah <<blah>> }
  \lyrics {blah <<blah>> }
  blah blah blah
}
----

In addition, the second sentence of the first paragraph is
confusing.  Please delete that sentence (it begins "Users
often...") and replace it with this:
----
To align lyrics with something, do this thing.
----

Have a nice day,
Helpful User
```

Larger contributions

To replace large sections of the documentation, the guidelines are stricter. We cannot remove parts of the current documentation unless we are certain that the new version is an improvement.

1. Ask on the lilypond-devel mailing list if such a rewrite is necessary; somebody else might already be working on this issue!
2. Split your work into small sections; this makes it much easier to compare the new and old documentation.
3. Please prepare a formal git patch.

Contributions that contain examples using overrides

Examples that use overrides, tweaks, customer Scheme functions etc. are (with very few exceptions) not included in the main text of the manuals; as there would be far too many, equally useful, candidates.

The correct way is to submit your example, with appropriate explanatory text and tags, to the LilyPond Snippet Repository (LSR). Snippets that have the "docs" tag can then be easily added as a *selected snippet* in the documentation. It will also appear automatically in the Snippets lists. See Section 7.1 [Introduction to LSR], page 63.

Snippets that *don't* have the "docs" tag will still be searchable and viewable within the LSR, but will be not be included in the Snippets list or be able to be included as part of the main documentation.

Generally, any new snippets that have the "docs" tag are more carefully checked for syntax and formatting.

Announcing your snippet

Once you have followed these guidelines, please send a message to lilypond-devel with your documentation submissions. Unfortunately there is a strict 'no top-posting' check on the mailing list; to avoid this, add:

```
> I'm not top posting
```

(you must include the `>`) to the top of your documentation addition.

We may edit your suggestion for spelling, grammar, or style, and we may not place the material exactly where you suggested, but if you give us some material to work with, we can improve the manual much faster.

Thanks for your interest!

5.4 Texinfo introduction and usage policy

5.4.1 Texinfo introduction

The language is called Texinfo; you can see its manual here:

`http://www.gnu.org/software/texinfo/manual/texinfo/`

However, you don't need to read those docs. The most important thing to notice is that text is text. If you see a mistake in the text, you can fix it. If you want to change the order of something, you can cut-and-paste that stuff into a new location.

> **Note:** Rule of thumb: follow the examples in the existing docs. You can learn most of what you need to know from this; if you want to do anything fancy, discuss it on `lilypond-devel` first.

5.4.2 Documentation files

All manuals live in `Documentation/`.

In particular, there are four user manuals, their respective master source files are `learning.tely` (LM, Learning Manual), `notation.tely` (NR, Notation Reference), `music-glossary.tely` (MG, Music Glossary), and `lilypond-program` (AU). Each chapter is written in a separate file, ending in `.itely` for files containing lilypond code, and `.itexi` for files without lilypond code, located in a subdirectory associated to the manual (`learning/` for `learning.tely`, and so on); list the subdirectory of each manual to determine the filename of the specific chapter you wish to modify.

Developer manuals live in `Documentation/` too. Currently there is only one: the Contributor's Guide `contrib-guide.texi` you are reading.

Snippet files are part of documentation, and the Snippet List (SL) lives in `Documentation/` just like the manuals. For information about how to modify the snippet files and SL, see Chapter 7 [LSR work], page 63.

5.4.3 Sectioning commands

The Notation Reference uses section headings at four, occasionally five, levels.

- Level 1: @chapter
- Level 2: @section
- Level 3: @subsection
- Level 4: @unnumberedsubsubsec
- Level 5: @subsubsubheading

The first three levels are numbered in HTML, the last two are not. Numbered sections correspond to a single HTML page in the split HTML documents.

The first four levels always have accompanying nodes so they can be referenced and are also included in the ToC in HTML.

Most of the manual is written at level 4 under headings created with

```
@node Foo
@unnumberedsubsubsec Foo
```

Level 3 subsections are created with

```
@node Foo
@subsection Foo
```

Level 4 headings and menus must be preceded by level 3 headings and menus, and so on for level 3 and level 2. If this is not what is wanted, please use:

```
@subsubsubheading Foo
```

Please leave two blank lines above a `@node`; this makes it easier to find sections in texinfo.

Do not use any `@` commands for a `@node`. They may be used for any `@sub...` sections or headings however.

```
not:
@node @code{Foo} Bar
@subsection @code{Foo} Bar

but instead:
@node Foo Bar
@subsection @code{Foo} Bar
```

No punctuation may be used in the node names. If the heading text uses punctuation (in particular, colons and commas) simply leave this out of the node name and menu.

```
@menu
* Foo Bar::
@end menu

@node Foo Bar
@subsection Foo: Bar
```

Backslashes must not be used in node names or section headings. If the heading text should include a backslash simply leave this out of the node name and menu and replace it with `@bs{}` in the heading text.

```
@menu
```

```
* The set command
@end menu

@node The set command
@subsection The @code{@bs{}set} command
```

References to such a node may use the third argument of the `@ref` command to display the texually correct heading.

```
@ref{The set command,,The @code{@bs{}set command}
```

With the exception of `@` commands, `\` commands and punctuation, the section name should match the node name exactly.

Sectioning commands (`@node` and `@section`) must not appear inside an `@ignore`. Separate those commands with a space, ie `@n ode`.

Nodes must be included inside a

```
@menu
* foo::
* bar::
@end menu
```

construct. These can be constructed with scripts: see [Stripping whitespace and generating menus], page 49.

5.4.4 LilyPond formatting

- Most LilyPond examples throughout the documentation can be produced with:

  ```
  @lilypond[verbatim,quote]
  ```

  If using `\book{}` in your example then you must also include the `papersize=X` variable, where `X` is a defined paper size from within `scm/paper.scm`. This is to avoid the default `a4` paper size being used and leaving too much unnecessary whitespace and potentially awkward page breaks in the PDFs.

  The preferred `papersize`s are `a5`, `a6` or `a8landscape`.

  `a8landscape` works best for a single measure with a single title and/or single `tagline`:

  ```
  @lilypond[papersize=a8landscape,verbatim]
  \book {
    \header {
      title = "A scale in LilyPond"
    }
    \relative {
      c d e f
    }
  }
  @end lilypond
  ```

  and can also be used to easily show features that require page breaks (i.e. page numbers) without taking large amounts of space within the documentation. Do not use the `quote` option with this paper size.

  `a5` or `a6` paper sizes are best used for examples that have more than two measures of music or require multiple staves (i.e. to illustrate cross-staff features, RH and LH parts etc.) and where `\book{}` constructions are required or where `a8landscape` produces an example that is too cramped. Depending on the example the `quote` option may need to be omitted.

  In rare cases, other options may be used (or omitted), but ask first.

- Please avoid using extra spacing either after or within the `@lilypond` parameters.

```
not:          @lilypond [verbatim, quote, fragment]
but instead:  @lilypond[verbatim,quote,fragment]
```

- Inspirational headwords are produced with:

```
@lilypondfile[quote,ragged-right,line-width=16\cm,staffsize=16]
{pitches-headword.ly}
```

- LSR snippets are linked with:

```
@lilypondfile[verbatim,quote,ragged-right,texidoc,doctitle]
{filename.ly}
```

- Use two spaces for indentation in lilypond examples (no tabs).
- All engravers should have double-quotes around them:

```
\consists "Spans_arpeggio_engraver"
```

  LilyPond does not strictly require this, but it is a useful convention to follow.

- Try to avoid using `#'` or `#`` when describing context or layout properties outside of an `@example` or `@lilypond`, unless the description explicitly requires it.

  i.e. "...setting the `transparent` property leaves the object where it is, but makes it invisible."

- If possible, only write one bar per line.
- If you only have one bar per line, omit bar checks. If you must put more than one bar per line (not recommended), then include bar checks.
- Tweaks should, if possible, also occur on their own line.

```
not:          \override TextScript.padding = #3 c1^"hi"
but instead:  \override TextScript.padding = #3
              c1^"hi"
```

  excepted in Templates, where 'doctitle' may be omitted.

- Avoid long stretches of input code. Nobody is going to read them in print. Create small examples. However, this does not mean it has be minimal.
- Specify durations for at least the first note of every bar.
- If possible, end with a complete bar.
- Comments should go on their own line, and be placed before the line(s) to which they refer.
- For clarity, always use { } marks even if they are not technically required; i.e.

```
not:

\context Voice \repeat unfold 2 \relative c' {
  c2 d
}

but instead:

\context Voice {
  \repeat unfold 2 {
    \relative c' {
      c2 d
    }
  }
}
```

- Add a space around { } marks; i.e.

```
not:          \chordmode{c e g}
but instead:  \chordmode { c e g }
```

- Use { } marks for additional `\markup` format commands; i.e.

```
not:          c^\markup \tiny\sharp
but instead:  c^\markup { \tiny \sharp }
```

- Remove any space around `< >` marks; i.e.

```
not:           < c e g > 4
but instead:   <c e g>4
```

- Beam, slur and tie marks should begin immediately after the first note with beam and phrase marks ending immediately after the last.

```
a8\( ais16[ b cis( d] b) cis4~ b' cis,\)
```

- If you want to work on an example outside of the manual (for easier/faster processing), use this header:

```
\paper {
  indent = 0\mm
  line-width = 160\mm - 2.0 * 0.4\in
  line-width = #(- line-width (* mm  3.000000))
}

\layout {
}
```

  You may not change any of these values. If you are making an example demonstrating special `\paper{}` values, contact the Documentation Editor.

5.4.5 Text formatting

- Lines should be less than 72 characters long. (We personally recommend writing with 66-char lines, but do not bother modifying existing material). Also see the recommendations for fixed-width fonts in the Section 5.4.6 [Syntax survey], page 40.
- Do not use tabs.
- Do not use spaces at the beginning of a line (except in `@example` or `@verbatim` environments), and do not use more than a single space between words. 'makeinfo' copies the input lines verbatim without removing those spaces.
- Use two spaces after a period.
- In examples of syntax, use `@var{`*`musicexpr`*`}` for a music expression.
- Don't use `@rinternals{}` in the main text. If you're tempted to do so, you're probably getting too close to "talking through the code". If you really want to refer to a context, use `@code{}` in the main text and `@rinternals{}` in the `@morerefs`.

5.4.6 Syntax survey

Comments

- `@c ...` — single line comment. '`@c NOTE:`' is a comment which should remain in the final version. (gp only command ;)
- `@ignore` — multi-line comment:

```
@ignore
...
@end ignore
```

Cross references

Enter the exact `@node` name of the target reference between the brackets (eg. '`@ref{Syntax survey}`'). Do not split a cross-reference across two lines – this causes the cross-reference to be rendered incorrectly in HTML documents.

- `@ref{...}` — link within current manual.
- `@rchanges{...}` — link to Changes.
- `@rcontrib{...}` — link to Contributor's Guide.
- `@ressay{...}` — link to Engraving Essay.
- `@rextend{...}` — link to Extending LilyPond.
- `@rglos{...}` — link to the Music Glossary.
- `@rinternals{...}` — link to the Internals Reference.
- `@rlearning{...}` — link to Learning Manual.
- `@rlsr{...}` — link to a Snippet section.
- `@rprogram{...}` — link to Application Usage.
- `@ruser{...}` — link to Notation Reference.
- `@rweb{...}` — link to General Information.

External links

- `@email{...}` — create a `mailto:` E-mail link.
- `@uref{`*`URL`*`[, `*`link text`*`]}` — link to an external url. Use within an `@example ... @end example`.

```
@example
@uref{URL [, link text ]}
@end example
```

Fixed-width font

- `@code{...}`, `@samp{...}` —

  Use the `@code{...}` command when referring to individual language-specific tokens (keywords, commands, engravers, scheme symbols, etc.) in the text. Ideally, a single `@code{...}` block should fit within one line in the PDF output.

  Use the `@samp{...}` command when you have a short example of user input, unless it constitutes an entire `@item` by itself, in which case `@code{...}` is preferable. Otherwise, both should only be used when part of a larger sentence within a paragraph or `@item`. Do not use `@code{...}` or `@samp{...}` inside an `@example` block, and do not use either as a free-standing paragraph; use `@example` instead.

  A single unindented line in the PDF has space for about 79 fixed-width characters (76 if indented). Within an `@item` there is space for about 75 fixed-width characters. Each additional level of `@itemize` or `@enumerate` shortens the line by about 4 columns.

  However, even short blocks of `@code{...}` and `@samp{...}` can run into the margin if the Texinfo line-breaking algorithm gets confused. Additionally, blocks that are longer than this may in fact print nicely; it all depends where the line breaks end up. If you compile the docs yourself, check the PDF output to make sure the line breaks are satisfactory.

  The Texinfo setting `@allowcodebreaks` is set to `false` in the manuals, so lines within `@code{...}` or `@samp{...}` blocks will only break at spaces, not at hyphens or underscores. If the block contains spaces, use `@w{@code{...}}` or `@w{@samp{...}}` to prevent unexpected line breaks.

The Texinfo settings `txicodequoteundirected` and `txicodequotebacktick` are both set in the manuals, so backticks (`) and apostrophes (') placed within blocks of `@code`, `@example`, or `@verbatim` are not converted to left- and right-angled quotes (‘ ’) as they normally are within the text, so the apostrophes in ‘`@w{@code{\relative c''}}`’ will display correctly. However, these settings do not affect the PDF output for anything within a `@samp` block (even if it includes a nested `@code` block), so entering ‘`@w{@samp{\relative c''}}`’ wrongly produces ‘`\relative c’’`’ in PDF. Consequently, if you want to use a `@samp{...}` block which contains backticks or apostrophes, you should instead use ‘`@q{@code{...}}`’ (or ‘`@q{@w{@code{...}}}`’ if the block also contains spaces). Note that backslashes within `@q{...}` blocks must be entered as ‘`@bs{}`’, so the example above would be coded as ‘`@q{@w{@code{@bs{}relative c''}}}`’.

- `@command{...}` — Use when referring to command-line commands within the text (eg. ‘`@command{convert-ly}`’). Do not use inside an `@example` block.
- `@example` — Use for examples of program code. Do not add extraneous indentation (i.e. don’t start every line with whitespace). Use the following layout (notice the use of blank lines). Omit the `@noindent` if the text following the example starts a new paragraph:

```
...text leading into the example...

@example
...
@end example

@noindent
continuation of the text...
```

  Individual lines within an `@example` block should not exceed 74 characters; otherwise they will run into the margin in the PDF output, and may get clipped. If an `@example` block is part of an `@item`, individual lines in the `@example` block should not exceed 70 columns. Each additional level of `@itemize` or `@enumerate` shortens the line by about 4 columns.

  For long command line examples, if possible, use a trailing backslash to break up a single line, indenting the next line with 2 spaces. If this isn’t feasible, use ‘`@smallexample ... @end smallexample`’ instead, which uses a smaller fontsize. Use `@example` whenever possible, but if needed, `@smallexample` can fit up to 90 characters per line before running into the PDF margin. Each additional level of `@itemize` or `@enumerate` shortens a `@smallexample` line by about 5 columns.
- `@file{...}` — Use when referring to filenames and directories in the text. Do not use inside an `@example` block.
- `@option{...}` — Use when referring to command-line options in the text (eg. ‘`@option{--format}`’). Do not use inside an `@example` block.
- `@verbatim` — Prints the block exactly as it appears in the source file (including whitespace, etc.). For program code examples, use `@example` instead. `@verbatim` uses the same format as `@example`.

  Individual lines within an `@verbatim` block should not exceed 74 characters; otherwise they will run into the margin in the PDF output, and may get clipped. If an `@verbatim` block is part of an `@item`, individual lines in the `@verbatim` block should not exceed 70 columns. Each additional level of `@itemize` or `@enumerate` shortens the line by about 4 columns.

Indexing

- `@cindex ...` — General index. Please add as many as you can. Don’t capitalize the first word.
- `@funindex ...` — is for a \lilycommand.

Lists

- `@enumerate` — Create an ordered list (with numbers). Always put '`@item`' on its own line. As an exception, if all the items in the list are short enough to fit on single lines, placing them on the '`@item`' lines is also permissible. '`@item`' and '`@end enumerate`' should always be preceded by a blank line.

```
@enumerate

@item
A long multi-line item like this one must begin
on a line of its own and all the other items in
the list must do so too.

@item
Even short ones

@end enumerate
```

```
@enumerate

@item Short item

@item Short item

@end enumerate
```

- `@itemize` — Create an unordered list (with bullets). Use the same format as `@enumerate`. Do not use '`@itemize @bullet`'.

Special characters

> **Note:** In Texinfo, the backslash is an ordinary character, and is entered without escaping (e.g. '`The @code{\foo} command`'). However, within double-quoted Scheme and/or LilyPond strings, backslashes (including those ending up in Texinfo markup) need to be escaped by doubling them:
>
> ```
> (define (foo x)
>   "The @code{\\foo} command..."
>   ...)
> ```

- `--`, `---` — Create an en dash (–) or an em dash (—) in the text. To print two or three literal hyphens in a row, wrap one of them in a `@w{...}` (eg. '`-@w{-}-`').
- `@@`, `@{`, `@}` — Create an at-sign (@), a left curly bracket ({), or a right curly bracket (}).
- `@bs{}` — Create a backslash within a `@q{...}`, `@qq{...}`, or `@warning{...}` block. This is a custom LilyPond macro, not a builtin @-command in Texinfo. Texinfo would also allow '`\\`', but this breaks the PDF output.
- `@tie{}` — Create a *variable-width* non-breaking space in the text (use '`@w{ }`' for a single *fixed-width* non-breaking space). Variables or numbers which consist of a single character (probably followed by a punctuation mark) should be tied properly, either to the previous or the next word. Example: '`The letter@tie{}@q{I} is skipped`'

Miscellany

- `@notation{...}` — refers to pieces of notation, e.g. '`@notation{clef}`'. Also use for

specific lyrics (‘`the @notation{A - men} is centered`’). Only use once per subsection per term.

- `@q{...}` — Single quotes. Used for ‘vague’ terms. To get a backslash (\), you must use ‘`@bs{}`’.
- `@qq{...}` — Double quotes. Used for actual quotes (“he said”) or for introducing special input modes. To get a backslash (\), you must use ‘`@bs{}`’.
- `@var{...}` — Use for metasyntactic variables (such as *foo*, *bar*, *arg1*, etc.). In most cases, when the `@var{...}` command appears in the text (and not in an `@example` block) it should be wrapped with an appropriate texinfo code-highlighting command (such as `@code`, `@samp`, `@file`, `@command`, etc.). For example: ‘`@code{@var{foo}}`’, ‘`@file{@var{myfile.ly}}`’, ‘`@samp{git checkout @var{branch}}`’, etc. This improves readability in the PDF and HTML output.
- `@version{}` — Return the current LilyPond version string. Use ‘`@w{@version{}}`’ if it’s at the end of a line (to prevent an ugly line break in PDF); use ‘`@w{"@version{}"}`’ if you need it in quotes.
- `@w{...}` — Do not allow any line breaks.
- `@warning{...}` — produces a “Note: ” box. Use for important messages. To get a backslash (\), you must use ‘`@bs{}`’.

5.4.7 Other text concerns

- References must occur at the end of a sentence, for more information see the texinfo manual (`http://www.gnu.org/software/texinfo/manual/texinfo/`). Ideally this should also be the final sentence of a paragraph, but this is not required. Any link in a doc section must be duplicated in the `@morerefs` section at the bottom.
- Introducing examples must be done with

```
. (i.e. finish the previous sentence/paragraph)
: (i.e. `in this example:')
, (i.e. `may add foo with the blah construct,')
```

  The old “sentence runs directly into the example” method is not allowed any more.
- Abbrevs in caps, e.g., HTML, DVI, MIDI, etc.
- Colon usage
  1. To introduce lists
  2. When beginning a quote: “So, he said,...”.

     This usage is rarer. Americans often just use a comma.
  3. When adding a defining example at the end of a sentence.
- Non-ASCII characters which are in utf-8 should be directly used; this is, don’t say ‘`Ba@ss{}tuba`’ but ‘`Baßtuba`’. This ensures that all such characters appear in all output formats.

5.5 Documentation policy

5.5.1 Books

There are four parts to the documentation: the Learning Manual, the Notation Reference, the Program Reference, and the Music Glossary.

- Learning Manual:

  The LM is written in a tutorial style which introduces the most important concepts, structure and syntax of the elements of a LilyPond score in a carefully graded sequence of steps.

Explanations of all musical concepts used in the Manual can be found in the Music Glossary, and readers are assumed to have no prior knowledge of LilyPond. The objective is to take readers to a level where the Notation Reference can be understood and employed to both adapt the templates in the Appendix to their needs and to begin to construct their own scores. Commonly used tweaks are introduced and explained. Examples are provided throughout which, while being focussed on the topic being introduced, are long enough to seem real in order to retain the readers' interest. Each example builds on the previous material, and comments are used liberally. Every new aspect is thoroughly explained before it is used.

Users are encouraged to read the complete Learning Manual from start-to-finish.

- Notation Reference: a (hopefully complete) description of LilyPond input notation. Some material from here may be duplicated in the Learning Manual (for teaching), but consider the NR to be the "definitive" description of each notation element, with the LM being an "extra". The goal is _not_ to provide a step-by-step learning environment – do not avoid using notation that has not be introduced previously in the NR (for example, use \break if appropriate). This section is written in formal technical writing style.

  Avoid duplication. Although users are not expected to read this manual from start to finish, they should be familiar with the material in the Learning Manual (particularly "Fundamental Concepts"), so do not repeat that material in each section of this book. Also watch out for common constructs, like ^ - _ for directions – those are explained in NR 3. In NR 1, you can write: DYNAMICS may be manually placed above or below the staff, see @ref{Controlling direction and placement}.

  Most tweaks should be added to LSR and not placed directly in the `.itely` file. In some cases, tweaks may be placed in the main text, but ask about this first.

  Finally, you should assume that users know what the notation means; explaining musical concepts happens in the Music Glossary.

- Application Usage: information about using the program lilypond with other programs (lilypond-book, operating systems, GUIs, convert-ly, etc). This section is written in formal technical writing style.

  Users are not expected to read this manual from start to finish.

- Music Glossary: information about the music notation itself. Explanations and translations about notation terms go here.

  Users are not expected to read this manual from start to finish.

- Internals Reference: not really a documentation book, since it is automagically generated from the source, but this is its name.

5.5.2 Section organization

- The order of headings inside documentation sections should be:

```
main docs
@predefined
@endpredefined
@snippets
@morerefs
@knownissues
```

- You *must* include a @morerefs.
  - The order of items inside the @morerefs section is

```
Music Glossary:
@rglos{foo},
@rglos{bar}.
```

```
Learning Manual:
@rlearning{baz},
@rlearning{foozle}.

Notation Reference:
@ruser{faazle},
@ruser{boo}.

Application Usage:
@rprogram{blah}.

Essay on automated music engraving:
@ressay{yadda}.

Extending LilyPond:
@rextend{frob}.

Installed Files:
@file{path/to/dir/blahz}.

Snippets: @rlsr{section}.

Internals Reference:
@rinternals{fazzle},
@rinternals{booar}.
```

  - If there are multiple entries, separate them by commas but do not include an 'and'.
  - Always end with a period.
  - Place each link on a new line as above; this makes it much easier to add or remove links. In the output, they appear on a single line.

    ("Snippets" is REQUIRED; the others are optional)
  - Any new concepts or links which require an explanation should go as a full sentence(s) in the main text.
  - Don't insert an empty line between @morerefs and the first entry! Otherwise there is excessive vertical space in the PDF output.
- To create links, use @ref{} if the link is within the same manual.
- @predefined ... @endpredefined is for commands in `ly/*-init.ly`
- Do not include any real info in second-level sections (i.e. 1.1 Pitches). A first-level section may have introductory material, but other than that all material goes into third-level sections (i.e. 1.1.1 Writing Pitches).
- The @knownissues should not discuss any issues that are in the tracker, unless the issue is Priority-Postponed. The goal is to discuss any overall architecture or syntax decisions which may be interpreted as bugs. Normal bugs should not be discussed here, because we have so many bugs that it would be a huge task to keep the @knownissues current and accurate all the time.

5.5.3 Checking cross-references

Cross-references between different manuals are heavily used in the documentation, but they are not checked during compilation. However, if you compile the documentation, a script called check_texi_refs can help you with checking and fixing these cross-references; for information on

usage, cd into a source tree where documentation has been built, cd into Documentation and run:

```
make check-xrefs
make fix-xrefs
```

Note that you have to find yourself the source files to fix cross-references in the generated documentation such as the Internals Reference; e.g. you can grep scm/ and lily/.

5.5.4 General writing

- Do not forget to create @cindex entries for new sections of text. Enter commands with @funindex, i.e.

  ```
  @cindex pitches, writing in different octaves
  @funindex \relative
  ```

  Do not bother with the @code{} (they are added automatically). These items are added to both the command index and the unified index. Both index commands should go in front of the actual material.
- @cindex entries should not be capitalized, i.e.

  ```
  @cindex time signature
  ```

  is preferred instead of "Time signature". Only use capital letters for musical terms which demand them, e.g. "D.S. al Fine".
- For scheme function index entries, only include the final part, i.e.

  ```
  @funindex modern-voice-cautionary
       and NOT
  @funindex #(set-accidental-style modern-voice-cautionary)
  ```
- Use American spelling. LilyPond's internal property names use this convention.
- Here is a list of preferred terms to be used:
  - *Simultaneous* NOT concurrent.
  - *Measure*: the unit of music.
  - *Bar line*: the symbol delimiting a measure NOT barline.
  - *Note head* NOT notehead.
  - *Chord construct* NOT just chord (when referring to < ... >)
  - *Staff* NOT stave.
  - *Staves* NOT Staffs: Phrases such as 'multiple @internalsref{Staff}s' should be rephrased to 'multiple @internalsref{Staff} contexts'.

5.5.5 Technical writing style

These refer to the NR. The LM uses a more gentle, colloquial style.

- Do not refer to LilyPond in the text. The reader knows what the manual is about. If you do, capitalization is LilyPond.
- If you explicitly refer to 'lilypond' the program (or any other command to be executed), write `@command{lilypond}`.
- Do not explicitly refer to the reader/user. There is no one else besides the reader and the writer.
- Avoid contractions (don't, won't, etc.). Spell the words out completely.
- Avoid abbreviations, except for commonly used abbreviations of foreign language terms such as etc. and i.e.
- Avoid fluff ("Notice that," "as you can see," "Currently,").
- The use of the word 'illegal' is inappropriate in most cases. Say 'invalid' instead.

5.6 Tips for writing docs

In the NR, I highly recommend focusing on one subsection at a time. For each subsection,

- check the mundane formatting. Are the headings (@predefined, @morerefs, etc.) in the right order?
- add any appropriate index entries.
- check the links in the @morerefs section – links to music glossary, internal references, and other NR sections are the main concern. Check for potential additions.
- move LSR-worthy material into LSR. Add the snippet, delete the material from the `.itely` file, and add a @lilypondfile command.
- check the examples and descriptions. Do they still work? **Do not** assume that the existing text is accurate/complete; some of the manual is highly out of date.
- is the material in the @knownissues still accurate?
- can the examples be improved (made more explanatory), or is there any missing info? (feel free to ask specific questions on -user; a couple of people claimed to be interesting in being "consultants" who would help with such questions)

In general, I favor short text explanations with good examples – "an example is worth a thousand words". When I worked on the docs, I spent about half my time just working on those tiny lilypond examples. Making easily-understandable examples is much harder than it looks.

Tweaks

In general, any \set or \override commands should go in the "select snippets" section, which means that they should go in LSR and not the `.itely` file. For some cases, the command obviously belongs in the "main text" (i.e. not inside @predefined or @morerefs or whatever) – instrument names are a good example of this.

```
\set Staff.instrumentName = "foo"
```

On the other side of this,

```
\override Score.Hairpin.after-line-breaking = ##t
```

clearly belongs in LSR.

I'm quite willing to discuss specific cases if you think that a tweaks needs to be in the main text. But items that can go into LSR are easier to maintain, so I'd like to move as much as possible into there.

It would be "nice" if you spent a lot of time crafting nice tweaks for users... but my recommendation is **not** to do this. There's a lot of doc work to do without adding examples of tweaks. Tweak examples can easily be added by normal users by adding them to the LSR.

One place where a documentation writer can profitably spend time writing or upgrading tweaks is creating tweaks to deal with known issues. It would be ideal if every significant known issue had a workaround to avoid the difficulty.

See also

Section 7.2 [Adding and editing snippets], page 63.

5.7 Scripts to ease doc work

5.7.1 Scripts to test the documentation

Building only one section of the documentation

In order to save build time, a script is available to build only one section of the documentation in English with a default HTML appearance.

If you do not yet have a `build/` subdirectory within the LilyPond Git tree, you should create this first. You can then build a section of the documentation with the following command:

```
scripts/auxiliar/doc-section.sh MANUAL SECTION
```

where `SECTION` is the name of the file containing the section to be built, and `MANUAL` is replaced by the name of the directory containing the section. So, for example, to build section 1.1 of the Notation Reference, use the command:

```
scripts/auxiliar/doc-section.sh notation pitches
```

You can then see the generated document for the section at

```
build/tempdocs/pitches/out/pitches.html
```

According to LilyPond issue 1236 (`https://sourceforge.net/p/testlilyissues/issues/1236/`), the location of the LilyPond Git tree is taken from `$LILYPOND_GIT` if specified, otherwise it is auto-detected.

It is assumed that compilation takes place in the `build/` subdirectory, but this can be overridden by setting the environment variable `LILYPOND_BUILD_DIR`.

Similarly, output defaults to `build/tempdocs/` but this can be overridden by setting the environment variable `LILYPOND_TEMPDOCS`.

This script will not work for building sections of the Contributors' Guide. For building sections of the Contributors' Guide, use:

```
scripts/auxiliar/cg-section.sh SECTION
```

where `SECTION` is the name of the file containing the sections to be built. For example, to build section 4 of the Contributors' Guide, use:

```
scripts/auxiliar/cg-section.sh doc-work
```

`cg-section.sh` uses the same environment variables and corresponding default values as `doc-section.sh`.

5.7.2 Scripts to create documentation

Stripping whitespace and generating menus

> **Note:** This script assumes that the file conforms to our doc policy, in particular with regard to Section 5.4.3 [Sectioning commands], page 37; a few files still need work in this regard.

To automatically regenerate `@menu` portions and strip whitespace, use:

```
scripts/auxiliar/node-menuify.py FILENAME
```

If you are adding documentation that requires new menus, you will need to add a blank `@menu` section:

```
@menu
@end menu
```

Updating doc with `convert-ly`

Don't. This should be done by programmers when they add new features. If you notice that it hasn't been done, complain to `lilypond-devel`.

5.8 Docstrings in scheme

Material in the Internals reference is generated automatically from our source code. Any doc work on Internals therefore requires modifying files in `scm/*.scm`. Texinfo is allowed in these docstrings.

Most documentation writers never touch these, though. If you want to work on them, please ask for help.

5.9 Translating the documentation

The mailing list `translations@lilynet.net` is dedicated to LilyPond web site and documentation translation; on this list, you will get support from the Translations Meister and experienced translators, and we regularly discuss translation issues common to all languages. All people interested in LilyPond translations are invited to subscribe to this list regardless of the amount of their contribution, by sending an email to `translations-request@lilynet.net` with subject `subscribe` and an empty message body. Unless mentioned explicitly, or except if a translations coordinator contacts you privately, you should send questions, remarks and patches to the list `translations@lilynet.net`. Please note that traffic is high on the English-speaking list `lilypond-user@gnu.org`, so it may take some time before your request or contribution is handled.

5.9.1 Getting started with documentation translation

First, get the sources of branch `translation` from the Git repository, see Chapter 3 [Working with source code], page 10.

Translation requirements

Working on LilyPond documentation translations requires the following pieces of software, in order to make use of dedicated helper tools:

- Python 3.5 or higher,
- GNU Make,
- Gettext,
- Git.

It is not required to build LilyPond and the documentation to translate the documentation. However, if you have enough time and motivation and a suitable system, it can be very useful to build at least the documentation so that you can check the output yourself and more quickly; if you are interested, see Chapter 4 [Compiling], page 20.

Before undertaking any large translation work, contributors are encouraged to contact the Section 13.3 [Meisters], page 122.

Which documentation can be translated

The makefiles and scripts infrastructure currently supports translation of the following documentation:

- the web site, the Learning Manual, the Notation Reference and Application Usage – Texinfo source, PDF and HTML output; Info output might be added if there is enough demand for it;
- the Changes document.

Support for translating the following pieces of documentation should be added soon, by decreasing order of priority:

- automatically generated documentation: markup commands, predefined music functions;

- the Snippets List;
- the Internals Reference.

Starting translation in a new language

At top of the source directory, do

```
./autogen.sh
```

or (if you want to install your self-compiled LilyPond locally)

```
./autogen.sh --prefix=$HOME
```

If you want to compile LilyPond – which is almost required to build the documentation, but is not required to do translation only – fix all dependencies and rerun `./configure` (with the same options as for `autogen.sh`).

Then `cd` into `Documentation/` and run

```
make ISOLANG=MY-LANGUAGE new-lang
```

where *MY-LANGUAGE* is the ISO 639 language code.

Finally, add a language definition for your language in `python/langdefs.py`, `Documentation/lilypond-texi2html-lang.init` and `Documentation/web/server/lilypond.org.htaccess`. Add this language definition and the corresponding section in `Documentation/lilypond-texi2html.init` and `scripts/build/create-weblinks-itexi.py`.

5.9.2 Documentation translation details

Please follow all the instructions with care to ensure quality work.

All files should be encoded in UTF-8.

Files to be translated

Translation of `Documentation/foo/bar` should be `Documentation/LANG/foo/bar`. Unmentioned files should not be translated.

Priorities:

- 1. delivery,
- 2. 3. 4. 5. 6. later,
- 7. optional.

Files of priority 1 should be submitted along all files generated by starting a new language in the same commit and thus a unique patch, and the translation of files marked with priority 2 should be committed to Git at the same time and thus sent in a single patch. Files marked with priority 3 or more may be submitted individually. Word counts (excluding LilyPond snippets) are given for each file. For knowing how to commit your work to Git, then make patches of your new translations as well as corrections and updates, see Chapter 3 [Working with source code], page 10.

```
-1- Web site
752   web.texi
6073  web/introduction.itexi
1174  web/download.itexi
1139  macros.itexi
9     po/lilypond-doc.pot (translate to po/MY_LANGUAGE.po)
0     search-box.ihtml
---   lilypond-texi2html.init (section TRANSLATIONS)
9147  total

-2- Tutorial
```

```
1279  web/manuals.itexi
124   learning.tely
2536  learning/tutorial.itely
4517  learning/common-notation.itely
8456  total

-3- Fundamental Concepts, starting of Usage and Community
11576 learning/fundamental.itely -- Fundamental concepts
135   usage.tely
6877  usage/running.itely
2097  usage/updating.itely
2359  web/community.itexi
23044 total

-4- Rest of Learning manual and Suggestions on writing LilyPond files
16582 learning/tweaks.itely -- Tweaking output
1236  learning/templates.itely -- Templates
2793  usage/suggestions.itely -- Suggestions on writing LilyPond files
20611 total

-5- Notation reference
361   notation.tely
91    notation/notation.itely -- Musical notation
5513  notation/pitches.itely
7098  notation/rhythms.itely
1907  notation/expressive.itely
1310  notation/repeats.itely
3001  notation/simultaneous.itely
3017  notation/staff.itely
1700  notation/editorial.itely
3572  notation/text.itely
81    notation/specialist.itely -- Specialist notation
5174  notation/vocal.itely
2177  notation/chords.itely
702   notation/piano.itely
1000  notation/percussion.itely
826   notation/guitar.itely
66    notation/strings.itely
242   notation/bagpipes.itely
5468  notation/ancient.itely
13941 notation/input.itely -- Input syntax
2164  notation/non-music.itely -- Non-musical notation
11050 notation/spacing.itely -- Spacing issues
17137 notation/changing-defaults.itely -- Changing defaults
5187  notation/programming-interface.itely -- Interfaces for programmers
3450  notation/notation-appendices.itely -- Notation manual tables
252   notation/cheatsheet.itely -- Cheat sheet
96487 total

-6- Rest of Application Usage
4212  usage/lilypond-book.itely -- LilyPond-book
1122  usage/converters.itely -- Converting from other formats
```

```
5334  total

-7- Appendices whose translation is optional
382   essay/literature.itely
1222  learning/scheme-tutorial.itely (should be revised first)
1604  total
```

In addition, not listed above, Snippets' titles and descriptions should be translated; they are a part of the Notation Reference and therefore their priority is 5.

Translating the Web site and other Texinfo documentation

Every piece of text should be translated in the source file, except Texinfo comments, text in `@lilypond` blocks and a few cases mentioned below.

Node names are translated, but the original node name in English should be kept as the argument of `@translationof` put after the section title; that is, every piece in the original file like

```
@node Foo bar
@section_command Bar baz
```

should be translated as

```
@node translation of Foo bar
@section_command translation of Bar baz
@translationof Foo bar
```

The argument of `@rglos` commands and the first argument of `@rglosnamed` commands must not be translated, as it is the node name of an entry in Music Glossary.

Every time you translate a node name in a cross-reference, i.e. the argument of commands `@ref, @rprogram, @rlearning, @rlsr, @ruser` or the first argument of their `*named` variants, you should make sure the target node is defined in the correct source file; if you do not intend to translate the target node right now, you should at least write the node definition (that is, the `@node @section_commmand @translationof` trio mentioned above) in the expected source file and define all its parent nodes; for each node you have defined this way but have not translated, insert a line that contains `@untranslated`. That is, you should end up for each untranslated node with something like

```
@node translation of Foo bar
@section_command translation of Bar baz
@translationof Foo bar

@untranslated
```

> **Note:** you do not have to translate the node name of a cross-reference to a node that you do not have translated. If you do, you must define an "empty" node like explained just above; this will produce a cross-reference with the translated node name in output, although the target node will still be in English. On the opposite, if all cross-references that refer to an untranslated node use the node name in English, then you do not have to define such an "empty" node, and the cross-reference text will appear in English in the output. The choice between these two strategies implies its particular maintenance requirements and is left to the translators, although the opinion of the Translation meister leans towards not translating these cross-references.

Please think of the fact that it may not make sense translating everything in some Texinfo files, and you may take distance from the original text; for instance, in the translation of the web site section Community, you may take this into account depending on what you know the community in your language is willing to support, which is possible only if you personally assume this support, or there exists a public forum or mailing list listed in Community for LilyPond in your language:

- Section "Bug reports" in *General Information*: this page should be translated only if you know that every bug report sent on your language's mailing list or forum will be handled by someone who will translate it to English and send it on bug-lilypond or add an issue in the tracker, then translate back the reply from developers.
- Section "Help us" in *Contributor's Guide*: this page should be translated very freely, and possibly not at all: ask help for contributing to LilyPond for tasks that LilyPond community in your language is able and going to handle.

In any case, please mark in your work the sections which do not result from the direct translation of a piece of English translation, using comments i.e. lines starting with '`@c`'.

Finally, press in Emacs `C-c C-u C-a` to update or generate menus. This process should be made easier in the future, when the helper script `texi-langutils.py` and the makefile target are updated.

Some pieces of text manipulated by build scripts that appear in the output are translated in a `.po` file – just like LilyPond output messages – in `Documentation/po`. The Gettext domain is named `lilypond-doc`, and unlike `lilypond` domain it is not managed through the Free Translation Project.

Take care of using typographic rules for your language, especially in `macros.itexi`.

If you wonder whether a word, phrase or larger piece of text should be translated, whether it is an argument of a Texinfo command or a small piece sandwiched between two Texinfo commands, try to track whether and where it appears in PDF and/or HTML output as visible text. This piece of advice is especially useful for translating `macros.itexi`.

Please keep verbatim copies of music snippets (in `@lilypond` blocs). However, some music snippets containing text that shows in the rendered music, and sometimes translating this text really helps the user to understand the documentation; in this case, and only in this case, you may as an exception translate text in the music snippet, and then you must add a line immediately before the `@lilypond` block, starting with

```
@c KEEP LY
```

Otherwise the music snippet would be reset to the same content as the English version at next `make snippet-update` run – see [Updating documentation translation], page 56.

When you encounter

```
@lilypondfile[<number of fragment options>,texidoc]{filename.ly}
```

in the source, open `Documentation/snippets/`*`filename`*`.ly`, translate the `texidoc` header field it contains, enclose it with `texidoc`*`MY-LANGUAGE`*` = "` and `"`, and write it into `Documentation/`*`MY-LANGUAGE`*`/texidocs/`*`filename`*`.texidoc`. Additionally, you may translate the snippet's title in `doctitle` header field, in case `doctitle` is a fragment option used in `@lilypondfile`; you can do this exactly the same way as `texidoc`. For instance, `Documentation/`*`MY-LANGUAGE`*`/texidocs/`*`filename`*`.texidoc` may contain

```
doctitlees = "Spanish title baz"
texidoces = "
Spanish translation blah
"
```

`@example` blocks need not be verbatim copies, e.g. variable names, file names and comments should be translated.

Finally, please carefully apply every rule exposed in Section 5.4 [Texinfo introduction and usage policy], page 36, and Section 5.5 [Documentation policy], page 44. If one of these rules conflicts with a rule specific to your language, please ask the Translation meister on `translations@lilynet.net` list and/or the Documentation Editors on `lilypond-devel@gnu.org` list.

Adding a Texinfo manual

In order to start translating a new manual, simply copy the English files within your language directory and translate them.

For example, if you want to translate the first chapter of the Learning Manual:

```
cp Documentation/learning.tely Documentation/LANG/learning.tely
cp Documentation/learning/tutorial.itely Documentation/LANG/tutorial.itely
```

5.9.3 Documentation translation maintenance

Several tools have been developed to make translations maintenance easier. These helper scripts make use of the power of Git, the version control system used for LilyPond development.

You should use them whenever you would like to update the translation in your language, which you may do at the frequency that fits your and your cotranslators' respective available times. In the case your translation is up-do-date (which you can discover in the first subsection below), it is enough to check its state every one or two weeks. If you feel overwhelmed by the quantity of documentation to be updated, see [Maintaining without updating translations], page 57.

Check state of translation

First pull from Git – see Section 3.2 [Git cheat sheet], page 11, but DO NOT rebase unless you are sure to master the translation state checking and updating system – then cd into `Documentation/` (or at top of the source tree, replace `make` with `make -C Documentation`) and run

```
make ISOLANG=MY_LANGUAGE check-translation
```

This presents a diff of the original files since the most recent revision of the translation. To check a single file, cd into `Documentation/` and run

```
make TRANSLATION_FILES=MY_LANGUAGE/manual/foo.itely check-translation
```

In case this file has been renamed since you last updated the translation, you should specify both old and new file names, e.g. `TRANSLATION_FILES=MY_LANGUAGE/{manual,user}/foo.itely`.

To see only which files need to be updated, do

```
make ISOLANG=MY_LANGUAGE check-translation | grep 'diff --git'
```

To avoid printing terminal colors control characters, which is often desirable when you redirect output to a file, run

```
make ISOLANG=MY_LANGUAGE NO_COLOR=1 check-translation
```

You can see the diffs generated by the commands above as changes that you should make in your language to the existing translation, in order to make your translation up to date.

> **Note:** do not forget to update the committish in each file you have completely updated, see [Updating translation committishes], page 56.

Global state of the translation is recorded in `Documentation/translations.itexi`, which is used to generate Translations status page. To update that page, do from `Documentation/`

```
make translation-status
```

This will also leave `out/translations-status.txt`, which contains up-to-dateness percentages for each translated file, and update word counts of documentation files in this Guide.

See also

[Maintaining without updating translations], page 57.

Updating documentation translation

Instead of running `check-translation`, you may want to run `update-translation`, which will run your favorite text editor to update files. First, make sure environment variable `EDITOR` is set to a text editor command, then run from `Documentation/`

```
make ISOLANG=MY_LANGUAGE update-translation
```

or to update a single file

```
make TRANSLATION_FILES=MY_LANGUAGE/manual/foo.itely update-translation
```

For each file to be updated, `update-translation` will open your text editor with this file and a diff of the file in English; if the diff cannot be generated or is bigger than the file in English itself, the full file in English will be opened instead.

> **Note:** do not forget to update the committish in each file you have completely updated, see [Updating translation committishes], page 56.

`.po` message catalogs in `Documentation/po/` may be updated by issuing from `Documentation/` or `Documentation/po/`

```
make po-update
```

> **Note:** if you run po-update and somebody else does the same and pushes before you push or send a patch to be applied, there will be a conflict when you pull. Therefore, it is better that only the Translation meister runs this command. Furthermore, it has been borken since the GDP: variable names and comments do no longer appear as translated.

Updating music snippets can quickly become cumbersome, as most snippets should be identical in all languages. Fortunately, there is a script that can do this odd job for you (run from `Documentation/`):

```
make ISOLANG=MY_LANGUAGE snippet-update
```

This script overwrites music snippets in *`MY_LANGUAGE/foo/every.itely`* with music snippets from *`foo/every.itely`*. It ignores skeleton files, and keeps intact music snippets preceded with a line starting with `@c KEEP LY`; it reports an error for each `.itely` that has not the same music snippet count in both languages. Always use this script with a lot of care, i.e. run it on a clean Git working tree, and check the changes it made with `git diff` before committing; if you don't do so, some `@lilypond` snippets might be broken or make no sense in their context.

See also

[Maintaining without updating translations], page 57, Section 7.2 [Adding and editing snippets], page 63.

Updating translation committishes

At the beginning of each translated file except PO files, there is a committish which represents the revision of the sources which you have used to translate this file from the file in English.

When you have pulled and updated a translation, it is very important to update this committish in the files you have completely updated (and only these); to do this, first commit possible

changes to any documentation in English which you are sure to have done in your translation as well, then replace in the up-to-date translated files the old committish by the committish of latest commit, which can be obtained by doing

```
git rev-list HEAD |head -1
```

Most of the changes in the LSR snippets included in the documentation concern the syntax, not the description inside `texidoc=""`. This implies that quite often you will have to update only the committish of the matching .texidoc file. This can be a tedious work if there are many snippets to be marked as up do date. You can use the following command to update the committishes at once:

```
cd Documentation/LANG/texidocs
sed -i -r 's/[0-9a-z]{40}/NEW-COMMITTISH/' *.texidoc
```

See also

Chapter 7 [LSR work], page 63.

5.9.4 Translations management policies

These policies show the general intent of how the translations should be managed, they aim at helping translators, developers and coordinators work efficiently.

Maintaining without updating translations

Keeping translations up to date under heavy changes in the documentation in English may be almost impossible, especially as during the former Grand Documentation Project (GDP) or the Grand Organization Project (GOP) when a lot of contributors brings changes. In addition, translators may be — and that is a very good thing — involved in these projects too.

it is possible — and even recommended — to perform some maintenance that keeps translated documentation usable and eases future translation updating. The rationale below the tasks list motivates this plan.

The following tasks are listed in decreasing priority order.

1. Update macros.itexi. For each obsolete macro definition, if it is possible to update macro usage in documentation with an automatic text or regexp substitution, do it and delete the macro definition from `macros.itexi`; otherwise, mark this macro definition as obsolete with a comment, and keep it in `macros.itexi` until the documentation translation has been updated and no longer uses this macro.
2. Update `*.tely` files completely with `make check-translation` – you may want to redirect output to a file because of overwhelming output, or call check-translation.py on individual files, see [Check state of translation], page 55.
3. In `.itelys`, match sections and .itely file names with those from English docs, which possibly involves moving nodes contents in block between files, without updating contents itself. In other words, the game is catching where has gone each section. In Learning manual, and in Notation Reference sections which have been revised in GDP, there may be completely new sections: in this case, copy `@node` and `@section`-command from English docs, and add the marker for untranslated status `@untranslated` on a single line. Note that it is not possible to exactly match subsections or subsubsections of documentation in English, when contents has been deeply revised; in this case, keep obsolete (sub)subsections in the translation, marking them with a line `@c obsolete` just before the node.

   Emacs with Texinfo mode makes this step easier:

   - without Emacs AucTeX installed, `C-c C-s` shows structure of current Texinfo file in a new buffer `*Occur*`; to show structure of two files simultaneously, first split Emacs window in 4 tiles (with `C-x 1` and `C-x 2`), press `C-c C-s` to show structure of one file

(e.g. the translated file), copy `*Occur*` contents into `*Scratch*`, then press `C-c C-s` for the other file.

If you happen to have installed AucTeX, you can either call the macro by doing `M-x texinfo-show-structure` or create a key binding in your `~/.emacs`, by adding the four following lines:

```
(add-hook 'Texinfo-mode-hook
          '(lambda ()
             (define-key Texinfo-mode-map "\C-cs"
              'texinfo-show-structure)))
```

and then obtain the structure in the `*Occur*` buffer with `C-c s`.

- Do not bother updating `@menu`s when all menu entries are in the same file, just do `C-c C-u C-a` ("update all menus") when you have updated all the rest of the file.
- Moving to next or previous node using incremental search: press `C-s` and type `node` (or `C-s @node` if the text contains the word 'node') then press `C-s` to move to next node or `C-r` to move to previous node. Similar operation can be used to move to the next/previous section. Note that every cursor move exits incremental search, and hitting `C-s` twice starts incremental search with the text entered in previous incremental search.
- Moving a whole node (or even a sequence of nodes): jump to beginning of the node (quit incremental search by pressing an arrow), press `C-SPACE`, press `C-s node` and repeat `C-s` until you have selected enough text, cut it with `C-w` or `C-x`, jump to the right place (moving between nodes with the previous hint is often useful) and paste with `C-y` or `C-v`.

4. Update sections finished in the English documentation; check sections status at
   `https://lilypondwiki.tuxfamily.org/index.php?title=Documentation_coordination`.
5. Update documentation PO. It is recommended not to update strings which come from documentation that is currently deeply revised in English, to avoid doing the work more than once.
6. Fix broken cross-references by running (from `Documentation/`)

   `make ISOLANG=`*`YOUR-LANGUAGE`* `fix-xrefs`

   This step requires a successful documentation build (with `make doc`). Some cross-references are broken because they point to a node that exists in the documentation in English, which has not been added to the translation; in this case, do not fix the cross-reference but keep it `"broken"`, so that the resulting HTML link will point to an existing page of documentation in English.

Rationale

You may wonder if it would not be better to leave translations as-is until you can really start updating translations. There are several reasons to do these maintenance tasks right now.

- This will have to be done sooner or later anyway, before updating translation of documentation contents, and this can already be done without needing to be redone later, as sections of documentation in English are mostly revised once. However, note that not all documentation sectioning has been revised in one go, so all this maintenance plan has to be repeated whenever a big reorganization is made.
- This just makes translated documentation take advantage of the new organization, which is better than the old one.
- Moving and renaming sections to match sectioning of documentation in English simplify future updating work: it allows updating the translation by side-by-side comparison, without bothering whether cross-reference names already exist in the translation.

- Each maintenance task except 'Updating PO files' can be done by the same person for all languages, which saves overall time spent by translators to achieve this task: the node names and section titles are in English, so you can do. It is important to take advantage of this now, as it will be more complicated (but still possible) to do step 3 in all languages when documentation is compiled with `texi2html` and node names are directly translated in source files.

Managing documentation translation with Git

This policy explains how to manage Git branches and commit translations to Git.

- Translation work is made on `translation` branch. This branch is merged on `master` once a week, approximately. Then, `master` branch is merged on `translation`, where the check-translation script (see [Check state of translation], page 55) shows changes in English docs which should be translated, and the cycle starts again.
- Translations may be merged directly to `master` only if they do not break compilation of LilyPond and its documentation. Those changes could be pushed to `translation` too, or alternatively translators could wait until they come from `master` the next time it is merged on `translation`. Similarly, changes matching `stable/X.Y` are preferably made on `X.Ytranslation`.
- `translation` Git branch may be merged into `master` branch only if LilyPond (`make all`) and documentation (`make doc`) compile successfully.
- `make` and `make doc` are usually successful in `master` Git branch because those tests should have already succeeded when merging the contained commits. `master` branch may be merged into `translation` when significant changes had been made in documentation in English in `master` branch.
- General maintenance may be done by anybody who knows what he does in documentation in all languages, without informing translators first. General maintenance include simple text substitutions (e.g. automated by sed), compilation fixes, updating Texinfo or lilypond-book commands, updating macros, updating ly code, fixing cross-references, and operations described in [Maintaining without updating translations], page 57.

5.9.5 Technical background

A number of Python scripts handle a part of the documentation translation process. All scripts used to maintain the translations are located in `scripts/auxiliar/`.

- `check_translation.py` – show diff to update a translation,
- `texi-langutils.py` – quickly and dirtily parse Texinfo files to make message catalogs and Texinfo skeleton files,
- `update-snippets.py` – synchronize ly snippets with those from English docs,
- `translations-status.py` – update translations status pages and word counts in the file you are reading,
- `tely-gettext.py` – gettext node names, section titles and references in the sources; WARNING only use this script once for each file, when support for "makeinfo –html" has been dropped.

Other scripts are used in the build process, in `scripts/build/`:

- `mass-link.py` – link or symlink files between English documentation and documentation in other languages.

Python modules used by scripts in `scripts/auxiliar/` or `scripts/build/` (but not by installed Python scripts) are located in `python/auxiliar/`:

- `manuals_definitions.py` – define manual names and name of cross-reference Texinfo macros,

- `buildlib.py` – common functions (read piped output of a shell command, use Git),
- `postprocess_html.py` (module imported by `www_post.py`) – add footer and tweak links in HTML pages.

And finally

- `python/langdefs.py` – language definitions module

6 Website work

6.1 Introduction to website work

The website is *not* written directly in HTML; instead it is autogenerated along with the documentation using Texinfo source files. Texinfo is the standard for documentation of GNU software and allows generating output in HTML, PDF, and Info formats, which drastically reduces maintenance effort and ensures that the website content is consistent with the rest of the documentation. This makes the environment for improving the website rather different from common web development.

If you have not contributed to LilyPond before, a good starting point might be incremental changes to the CSS file, to be found at `https://lilypond.org/css/lilypond-website.css` or in the LilyPond source code at `./Documentation/css/lilypond-website.css`.

Large scale structural changes tend to require familiarity with the project in general, a track record in working on LilyPond documentation as well as a prospect of long-term commitment.

The Texinfo source file for generating HTML are to be found in

```
Documentation/en/web.texi
Documentation/en/web/*.texi
```

Unless otherwise specified, follow the instructions and policies given in Chapter 5 [Documentation work], page 34. That chapter also contains a quick introduction to Texinfo; consulting an external Texinfo manual should be not necessary.

Exceptions to the documentation policies

- Sectioning: the website only uses chapters and sections; no subsections or subsubsections.
- @ref{}s to other manuals (@ruser, @rlearning, etc): you can't link to any pieces of automatically generated documentation, like the IR or certain NR appendices.
- The bibliography in Community->Publications is generated automatically from `.bib` files; formatting is done automatically by `texi-web.bst`.
- ...
- For anything not listed here, just follow the same style as the existing website texinfo files.

6.2 Uploading website

Overall idea

The website is generated by converting the `Documentation/*/web.texi` files to HTML, and reorganizing the resulting files into `out/website-root/`. This is controlled from toplevel `GNUmakefile` and `Documentation/GNUmakefile`.

To build the website, run `make website`. This leaves the website in `out/website-root/`.

The website is deployed onto `lilypond.org` in the following steps:

- Kick off a manual pipeline on `https://gitlab.com/lilypond/lilypond/-/pipelines`, clicking the "Run Pipeline" button, and confirming defaults.
- This runs `make website` and stores the result in a `website.zip` artifact.
- On `lilypond.org`, the downloader `https://gitlab.com/lilypond/infrastructure/-/blob/master/website/main.go` is run every 2 hours, from a systemd timed job. If a newer `website.zip` is found, it is unpacked into the `website` directory on `lilypond.org`.

6.3 Debugging website and docs locally

- Install Apache (you can use version 2, but keep in mind that the server hosting lilypond.org runs version 1.3). These instructions assume that you also enable `mod_userdir`, and use `$HOME/public_html` as DocumentRoot (i.e. the root directory of the web server).
- Build the online docs and website:

  ```
  make WEB_TARGETS="offline online" doc
  make website
  ```

  This will make all the language variants of the website. To save a little time, just the English version can be made with the command `make WEB_LANGS='' website` or the English and (for example) the French with `make WEB_LANGS='fr' website`.
- Choose the web directory where to copy the built stuff. If you already have other web projects in your DocumentRoot and don't need to test the `.htaccess` file, you can copy to `~/public_html/lilypond.org`. Otherwise you'd better copy to `~/public_html`. It's highly recommended to have your build dir and web dir on the same partition.
- Add the directory for the online documentation:

  ```
  mkdir -p ~/public_html/doc/v2.19/
  ```

  You may want to add also the stable documentation in `~/public_html/doc/v2.18/`, extracting the contents of the html directory present in the tarball available in Section "All" in *General Information*. Just in case you want to test the redirects to the stable documentation.
- Copy the files with rsync:

  ```
  rsync -av --delete out-website/website ~/public_html/
  cp out-website/.htaccess ~/public_html
  rsync -av --delete out-www/online-root/ ~/public_html/doc/v2.19/
  ```

6.4 Translating the website

As it has much more audience, the website should be translated before the documentation; see Section 5.9 [Translating the documentation], page 50.

In addition to the normal documentation translation practices, there are a few additional things to note:

- Build the website with:

  ```
  make website
  ```
- Some of the translation infrastructure is defined in python files; you must look at the `### translation data` sections in:

  ```
  scripts/build/create-weblinks-itexi.py
  scripts/build/website_post.py
  ```

  Do not submit a patch to add your language to this file unless `make website` completes with fewer than 5 warnings.
- Links to manuals are done with macros like `@manualDevelLearningSplit`. To get translated links, you must change that to `@manualDevelLearningSplit-es` (for es/Spanish translations, for example).

7 LSR work

7.1 Introduction to LSR

The LilyPond Snippet Repository (LSR) (`http://lsr.di.unimi.it/`) is a collection of lilypond examples. A subset of these examples are automatically imported into the documentation, making it easy for users to contribute to the docs without learning Git and Texinfo.

7.2 Adding and editing snippets

General guidelines

When you create (or find!) a nice snippet, if it is supported by the LilyPond version running on the LSR, please add it to the LSR. Go to LSR (`http://lsr.di.unimi.it/`) and log in – if you haven't already, create an account. Follow the instructions on the website. These instructions also explain how to modify existing snippets.

If you think the snippet is particularly informative and you think it should be included in the documentation, tag it with "docs" and one or more other categories, or ask on the development list for somebody who has editing permissions to do it .

Please make sure that the lilypond code follows the guidelines in Section 5.4.4 [LilyPond formatting], page 38.

If a new snippet created for documentation purposes compiles with LilyPond version currently on LSR, it should be added to LSR, and a reference to the snippet should be added to the documentation. Please ask a documentation editor to add a reference to it in an appropriate place in the docs. (Note – it should appear in the snippets document automatically, once it has been imported into git and built. See Section 7.4 [LSR to Git], page 64.

If the new snippet uses new features that are not available in the current LSR version, the snippet should be added to `Documentation/snippets/new` and a reference should be added to the manual.

Snippets created or updated in `Documentation/snippets/new` should be copied to `Documentation/snippets` by invoking at top of the source tree

```
scripts/auxiliar/makelsr.py
```

Be sure that `make doc` runs successfully before submitting a patch, to prevent breaking compilation.

Formatting snippets in `Documentation/snippets/new`

When adding a file to this directory, please start the file with

```
\version "2.x.y"
\header {
% Use existing LSR tags other than 'docs'; see makelsr.py for
% the list of tags used to sort snippets.  E.g.:
  lsrtags = "rhythms,expressive-marks"
% This texidoc string will be formatted by Texinfo
  texidoc = "
This code demonstrates ...
"
% Please put doctitle last so that the '% begin verbatim'
% mark will be added correctly by makelsr.py.
  doctitle = "Snippet title"
}
```

and name the file `snippet-title.ly`.

Please ensure that the version number you use at the top of the example is the minimum version that the file will compile with: for example, if the LSR is currently at 2.14.2 and your example requires 2.15.30, but the current development version of `lilypond` is 2.17.5, put `\version "2.15.30"` in the example.

Please also pay particular attention to the lines beginning `lsrtags =` and `doctitle =`. The tags must match tags used in the documentation, and the `doctitle` must match the filename.

7.3 Approving snippets

The main task of LSR editors is approving snippets. To find a list of unapproved snippets, log into LSR (`http://lsr.di.unimi.it/`) and select "No" from the dropdown menu to the right of the word "Approved" at the bottom of the interface, then click "Enable filter".

Check each snippet:

1. Does the snippet make sense and does what the author claims that it does? If you think the snippet is particularly helpful, add the "docs" tag and at least one other tag.
2. If the snippet is tagged with "docs", check to see if it matches our guidelines for Section 5.4.4 [LilyPond formatting], page 38.

   Also, snippets tagged with "docs" should not be explaining (replicating) existing material in the docs. They should not refer to the docs; the docs should refer to them.
3. If the snippet uses scheme, check that everything looks good and there are no security risks.

   > **Note:** Somebody could sneak a `#'(system "rm -rf /")` command into our source tree if you do not do this! Take this step **VERY SERIOUSLY**.

4. If all is well, check the box labelled "approved" and save the snippet.

7.4 LSR to Git

Introduction

Snippets used in the documentation are in `$LILYPOND_GIT/Documentation/snippets`. This directory contains a complete set of the snippets in the LSR which are tagged with 'docs'. The exact method for getting them there is described below, but in essence they come from downloading a tarball from the LSR and importing into the directory using the `makelsr` script.

Any snippets which are too bleeding edge to run on the LSR (which uses a stable development version) are put into `$LILYPOND_GIT/Documentation/snippets/new`. Once the LSR has been upgraded so that these will run, then they are transferred to the LSR and deleted from `/snippets/new`.

'Git' is the shorthand name for the Git repository that contains all the development code. For further information on setting this up see, Chapter 3 [Working with source code], page 10. An alternative to setting up a Git repository for people wanting to do LSR work is to get the source code from `https://lilypond.org/website/development.html`.

Importing the LSR to Git

1. Make sure that `convert-ly` script and the `lilypond` binary are a bleeding edge version – the latest release or even better, a fresh snapshot from Git master, with the environment variable `LILYPOND_BUILD_DIR` correctly set up, see Section 13.2 [Environment variables], page 122.

2. Start by creating a list of updated snippets from your local repository. From the top source directory, run:

   ```
   scripts/auxiliar/makelsr.py
   ```

   Commit the changes and make a patch. Check the patch has nothing other than minor changes. If all is good and you're confident in what you've done, this can be merged directly to `master`.

3. Next, download the updated snippets and run `makelsr.py` against them. From the top source directory, run:

   ```
   wget http://lsr.di.unimi.it/download/lsr-snippets-docs-`date +%F`.tar.gz
   tar -xzf lsr-snippets-docs-`date +%F`.tar.gz
   make -C $LILYPOND_BUILD_DIR
   scripts/auxiliar/makelsr.py lsr-snippets-docs-`date +%F`
   ```

   where `date +%F` gives the current date in format *YYYY-MM-DD* (the snippets archive is usually generated around 03:50 CET, you may want to use `date -d yesterday +%F` instead, depending on your time zone and the time you run this commands sequence). `make` is included in this sequence so that `makelsr` can run `lilypond` and `convert-ly` versions that match current source tree; you can select different binaries if desired or needed, to see options for this do

   ```
   scripts/auxiliar/makelsr.py --help
   ```

4. Follow the instructions printed on the console to manually check for unsafe files. These are:

   ```
   Unsafe files printed in lsr-unsafe.txt: CHECK MANUALLY!
     git add Documentation/snippets/*.ly
     xargs git diff HEAD < lsr-unsafe.txt
   ```

   First, it's important to check for any added files and add them to the files git is tracking. Run `git status` and look carefully to see if files have been added. If so, add them with `git add`.

   As the console says, `makelsr` creates a list of possibly unsafe files in `lsr-unsafe.txt` by running `lilypond` against each snippet using the `-dsafe` switch. This list can be quite long. However, by using the command `xargs git diff HEAD < lsr-unsafe.txt` git will take that list and check whether any of the snippets are different from the snippet already in master. If any is different it must be checked manually VERY CAREFULLY.

   > **Note:** Somebody could sneak a `#'(system "rm -rf /")` command into our source tree if you do not do this! Take this step **VERY SERIOUSLY**.

   If there is any doubt about any of the files, you are strongly advised to submit a merge request to get review.

5. If a review is not needed, merge to `master` after the changes passed automatic testing.

Note that whenever there is a snippet in `Documentation/snippets/new` and another from the LSR with the same file name, `makelsr.py` will overwrite the LSR version with the one from `Documentation/snippets/new`.

7.5 Fixing snippets in LilyPond sources

If some snippet from `Documentation/snippets` causes the documentation compilation to fail, the following steps should be followed to fix it reliably.

1. Look up the snippet filename *`foo`*`.ly` in the error output or log, then fix the file `Documentation/snippets/`*`foo`*`.ly` to make the documentation build successfully.

2. Determine where it comes from by looking at its first two lines, e.g. run

   ```
   head -2 Documentation/snippets/foo.ly
   ```

3. **If the snippet comes from the LSR**, also apply the fix to the snippet in the LSR and send a notification email to an LSR editor with CC to the development list – see Section 7.2 [Adding and editing snippets], page 63. The failure may sometimes not be caused by the snippet in LSR but by the syntax conversion made by `convert-ly`; in this case, try to fix `convert-ly` or report the problem on the development list, then run `makelsr.py` again, see Section 7.4 [LSR to Git], page 64. In some cases, when some features has been introduced or vastly changed so it requires (or takes significant advantage of) important changes in the snippet, it is simpler and recommended to write a new version of the snippet in `Documentation/snippets/new`, then run `makelsr.py`.
4. **If the snippet comes from** `Documentation/snippets/new`, apply the fix in `Documentation/snippets/new/foo.ly`, then run `makelsr.py` without argument from top of the source tree:

   ```
   scripts/auxiliar/makelsr.py
   ```

   Then, inspect `Documentation/snippets/foo.ly` to check that the fix has been well propagated.

   If the build failure was caused by a translation string, you may have to fix some `Documentation/lang/texidocs/foo.texidoc` instead; in case the build failure comes only from translation strings, it is not needed to run `makelsr.py`.
5. When you've done, commit your changes to Git and ensure they're pushed to the correct branch.

7.6 Renaming a snippet

Due to the potential duality of snippets (i.e. they may exist both in the LSR database, and in `Documentation/snippets/new/`), this process is a bit more involved than we might like.

1. Send an email LSR editor, requesting the renaming.
2. The LSR editor does the renaming (or debates the topic with you), then warns the LSR-to-git person (wanted: better title) about the renaming.
3. LSR-to-git person does his normal job, but then also renames any copies of the snippets in `Documentation/snippets/new/`, and any instances of the snippet name in the documentation.

   `git grep` is highly recommended for this task.

7.7 Updating the LSR to a new version

To update the LSR, perform the following steps:

1. Start by emailing the LSR maintainer, Sebastiano, and liaising with him to ensure that updating the snippets is synchronised with updating the binary running the LSR.
2. Download the latest snippet tarball from `http://lsr.di.unimi.it/download/` and extract it. The relevant files can be found in the `all` subdirectory. Make sure your shell is using an English language version, for example `LANG=en_US`, then run `convert-ly` on all the files. Use the command-line option `--to=version` to ensure the snippets are updated to the correct stable version.
3. Make sure that you are using `convert-ly` from the latest available release to gain best advantage from the latest `converting-rules-updates`.

   For example:

   - LSR-version: 2.12.2

- intended LSR-update to 2.14.2
- latest release 2.15.30

Use convert-ly from 2.15.30 and the following terminal command for all files:

```
convert-ly -e -t2.14.2 *.ly
```

4. There might be no conversion rule for some old commands. To make an initial check for possible problems you can run the script at the end of this list on a copy of the `all` subdirectory.
5. Copy relevant snippets (i.e. snippets whose version is equal to or less than the new version of LilyPond running on the LSR) from `Documentation/snippets/new/` into the set of files to be used to make the tarball. Make sure you only choose snippets which are already present in the LSR, since the LSR software isn't able to create new snippets this way. If you don't have a Git repository for LilyPond, you'll find these snippets in the source-tarball on `https://lilypond.org/website/development.html`. Don't rename any files at this stage.
6. Verify that all files compile with the new version of LilyPond, ideally without any warnings or errors. To ease the process, you may use the shell script that appears after this list.

   Due to the workload involved, we *do not* require that you verify that all snippets produce the expected output. If you happen to notice any such snippets and can fix them, great; but as long as all snippets compile, don't delay this step due to some weird output. If a snippet is not compiling, update it manually. If it's not possible, delete it for now.
7. Remove all headers and version-statements from the files. Phil Holmes has a `python` script that will do this and which needs testing. Please ask him for a copy if you wish to do this.
8. Create a tarball and send it back to Sebastiano. Don't forget to tell him about any deletions.
9. Use the LSR web interface to change any descriptions you want to. Changing the titles of snippets is a bit fraught, since this also changes the filenames. Only do this as a last resort.
10. Use the LSR web interface to add the other snippets from `Documentation/snippets/new/` which compile with the new LilyPond version of the LSR. Ensure that they are correctly tagged, including the tag `docs` and that they are approved.
11. When LSR has been updated, wait a day for the tarball to update, then download another snippet tarball. Verify that the relevant snippets from `Documentation/snippets/new/` are now included, then delete those snippets from `Documentation/snippets/new/`.
12. Commit all the changes. *Don't forget to add new files to the git repository with* `git add`. Run `make`, `make doc` and `make test` to ensure the changes don't break the build. Any snippets that have had their file name changed or have been deleted could break the build, and these will need correcting step by step.

Below is a shell script to run LilyPond on all `.ly` files in a directory. If the script is run with a -s parameter, it runs silently except for reporting failed files. If run with -c it also runs `convert-ly` prior to running LilyPond.

```
#!/bin/bash

while getopts sc opt; do
    case $opt in
        s)
            silent=true
            ;;
        c)
            convert=true
            ;;
    esac
done
param=$ if [ $silent ]; then
```

```
    param=${param:3}
fi
if [ $convert ]; then
    param=${param:3}
fi
filter=${param:-"*.ly"}

for LILYFILE in $filter
do
    STEM=$(basename "$LILYFILE" .ly)
    if [ $convert ]; then
        if [ $silent ]; then
            $LILYPOND_BUILD_DIR/out/bin/convert-ly -e "$LILYFILE" >& "$STEM".con.txt
        else
            $LILYPOND_BUILD_DIR/out/bin/convert-ly -e "$LILYFILE"
        fi
    fi
    if [ ! $silent ]; then
        echo "running $LILYFILE..."
    fi
    $LILYPOND_BUILD_DIR/out/bin/lilypond --format=png "$LILYFILE" >& "$STEM".txt
    RetVal=$?
    if [ $RetVal -gt 0 ]; then
       echo "$LILYFILE failed"
    fi
done
```

Output from LilyPond is in `filename.txt` and convert-ly in `filename.con.txt`.

8 Issues

This chapter deals with defects, feature requests, and miscellaneous development tasks.

8.1 Introduction to issues

> **Note:** All the tasks in this chapter require no programming skills and can be done by anyone with a web browser, an email client and the ability to run LilyPond.

The term 'issues' refers not just to software bugs but also includes feature requests, documentation additions and corrections as well as any other general code 'TODOs' that need to be kept track of.

8.2 The Bug Squad

TODO: This section needs updating since we no longer have a formal bug squad at the moment.

To help keep track and organize all issues are a group of tireless volunteers collectively known as the *Bug Squad*. Composed mainly of non-programmers, the Bug Squad's responsibilities include:

- Monitoring the LilyPond Bugs mailing list looking for any issues reported by other users ensuring that they are accurate and contain enough information for the developers to work with, preferably with Section "Tiny examples" in *General Information* and if applicable, screenshots.
- Adding new issues to the *issue tracker* or updating existing issues with new information.
- Verifying issues in the *issue tracker* that have been marked as 'fixed'; making sure either that the fix works or (in the case of Documentation for example) has at least been commited to the code base.

The Section 13.3 [Meisters], page 122, also helps check the current Chapter 9 [Regression tests], page 75, and highlights any significant changes (or problems) since the previous LilyPond release.

If you would like to be part of the Bug Squad, please contact the Section 13.3 [Meisters], page 122.

8.2.1 Bug Squad setup

We highly recommend that you configure your email client to use some kind of sorting and filtering as this will significantly reduce and simplify your workload. Suggested email folder names are mentioned below to work when sorted alphabetically.

1. Read every section of the Chapter 8 [Issues], page 69, chapter in this guide.
2. Subscribe your email account to `bug-lilypond`. See `https://lists.gnu.org/mailman/listinfo/bug-lilypond`.
3. Send your email address to the Section 13.3 [Meisters], page 122.
4. Create your own GitLab login (required to manage issues):
   - Go to `https://gitlab.com/users/sign_in`.
   - Click on the 'Register' tab to create a new account.
   - Fill in your details as required and click the *Register* button to complete the registration.

5. Go to `https://gitlab.com/lilypond` and 'Request access' to the group. Additionally send your GitLab *username* (not your email address) to `bug-lilypond@gnu.org`, asking to be given appropriate permissions to manage issues.
6. Configure your email client: Any email sent `To:` or `CC:` to

   `bug-lilypond`

   should be configured to go into a `bug-current` folder.

8.2.2 Bug Squad checklists

When you do Bug Squad work, start at the top of this page and work your way down. Stop when you've done 20 minutes.

Please use the email sorting described in Section 8.2.1 [Bug Squad setup], page 69. This means that (as Bug Squad members) you will only ever respond to emails sent or CC'd to the `bug-lilypond` mailing list.

Emails to you personally

You are not expected to work on Bug Squad matters outside of your 20 minutes, but sometimes a confused user will send a bug report (or an update to a report) to you personally. If that happens, please forward such emails to the `bug-lilypond` list so that the currently-active Bug Squad member(s) can handle the message.

Daily schedule as of July 2015

```
Monday: Federico Bruni
Tuesday: Graham Percival
Wednesday: Simon Albrecht
Thursday: Colin Campbell
Friday: Ralph Palmer
Saturday: Colin Campbell
Sunday: Graham Percival
```

Emails to `bug-answers`

Some of these emails will be comments on issues that you added to the tracker.

If they are asking for more information, give the additional information.

- If the email says that the issue was classified in some other manner, read the rationale given and take that into account for the next issue you add.
- Otherwise, move them to your `bug-ignore` folder.

Some of these emails will be discussions about Bug Squad work; read those.

Emails to `bug-current`

Dealing with these emails is your main task. Your job is to get rid of these emails in the first method which is applicable:

1. If the email has already been handled by a Bug Squad member (i.e. check to see who else has replied to it), delete it.
2. If the email is a question about how to use LilyPond, reply with this response:

   ```
   For questions about how to use LilyPond, please read our
   documentation available from:
     https://lilypond.org/website/manuals.html
   or ask the lilypond-user mailing list.
   ```
3. If the email mentions "the latest git", or any version number that has not yet been officially released, forward it to `lilypond-devel`.

4. If a bug report is not in the form of a Tiny example, direct the user to resubmit the report with this response:

   ```
   I'm sorry, but due to our limited resources for handling bugs, we
   can only accept reports in the form of Tiny examples.  Please see
   step 2 in our bug reporting guidelines:
     https://lilypond.org/website/bug-reports.html
   ```

5. If anything is unclear, ask the user for more information.

   How does the graphical output differ from what the user expected? What version of lilypond was used (if not given) and operating system (if this is a suspected cause of the problem)? In short, if you cannot understand what the problem is, ask the user to explain more. It is the user's responsibility to explain the problem, not your responsibility to understand it.

6. If the behavior is expected, the user should be told to read the documentation:

   ```
   I believe that this is the expected behaviour -- please read our
   documentation about this topic.  If you think that it really is a
   mistake, please explain in more detail.  If you think that the
   docs are unclear, please suggest an improvement as described by
   \Simple tasks -- Documentation" on:
     https://lilypond.org/website/help-us.html
   ```

7. If the issue already exists in the tracker, send an email to that effect:

   ```
   This issue has already been reported; you can follow the
   discussion and be notified about fixes here:
   ```

   (copy+paste the google code issue URL)

8. Accept the report as described in Section 8.4 [Adding issues to the tracker], page 72.

All emails should be CC'd to the `bug-lilypond` list so that other Bug Squad members know that you have processed the email.

> **Note:** There is no option for "ignore the bug report" – if you cannot find a reason to reject the report, you must accept it.

Regular maintenance

After **every release** (both stable and unstable):

- The official regression test comparison is online at:

  ```
  https://lilypond.org/test/
  ```

  If anything has changed suspiciously, ask if it was deliberate. If the text output from LilyPond (the logfile) changes, the differences will be displayed with a `+` before text added to the logfile and - before any text removed from the logfile. This may or may not be suspicious.

  More information is available from in Section 9.2 [Precompiled regression tests], page 75.

- Check for any incorrectly-classified items in the tracker. This generally just means looking at the grid to see any items without a Type.

8.3 Issue classification

We have several labels:

- Critical: normally a regression against the current stable version or the previous stable version. Alternatively, a regression against a fix developed for the current version. This does not apply where the "regression" occurred because a feature was removed deliberately – this is not a bug.

Currently, only Critical items will block a stable release.

- Maintainability: hinders future development.
- Crash: any input which produces a crash.
- Ugly: overlapping or other ugly notation in graphical output.
- Defect: a problem in the core program. (the `lilypond` binary, scm files, fonts, etc).
- Documentation: inaccurate, missing, confusing, or desired additional info. Must be fixable by editing a texinfo, ly, or scm file.
- Build: problem or desired features in the build system. This includes the makefiles, stepmake, python scripts, and GUB.
- Scripts: problem or desired feature in the non-build-system scripts. Mostly used for convertly, lilypond-book, etc.
- Enhancement: a feature request for the core program. The distinction between enhancement and defect isn't extremely clear; when in doubt, mark it as enhancement.
- Other: anything else.
- Regression: it used to work intentionally in the current stable release or the previous stable release. If the earlier output was accidental (i.e. we didn't try to stop a collision, but it just so happened that two grobs didn't collide), then breaking it does not count as a regression.

  To help decide whether the change is a regression, please adopt the following process:

  1. Are you certain the change is OK? If so, do nothing.
  2. Are you certain that the change is bad? Add it to the tracker as a regression.
  3. If you're not certain either way, add it to the tracker as a regression but be aware that it may be recategorised or marked invalid.

  In particular, anything that breaks a regression test is a regression.
- Frog: the fix is believed to be suitable for a new contributor (does not require a great deal of knowledge about LilyPond). The issue should also have an estimated time in a comment.
- Bounty: somebody is willing to pay for the fix. Only add this tag if somebody has offered an exact figure in US dollars or euros.
- Warning: graphical output is fine, but lilypond prints a false/misleading warning message. Alternately, a warning should be printed (such as a bar line error), but was not. Also applies to warnings when compiling the source code or generating documentation.
- Performance: performance issue.

In addition, the following labels may be used when closing an issue:

- Invalid: issue should not have been added in the current state.
- Duplicate: issue already exists in the tracker.
- Shelved: issue won't fix and was abandoned.

Assign an issue to yourself to indicate that you are currently working on it.

8.4 Adding issues to the tracker

> **Note:** This should only be done by the Bug Squad or experienced developers. Normal users should not do this; instead, they should follow the guidelines for Section "Bug reports" in *General Information*.

1. Check if the issue falls into any previous category given on the relevant checklists in Section 8.2.2 [Bug Squad checklists], page 70. If in doubt, add a new issue for a report.

We would prefer to have some incorrectly-added issues rather than lose information that should have been added.

2. Add the issue and classify it according to the guidelines in Section 8.3 [Issue classification], page 71. In particular, the item should have `Status` and type labels.

   Include output with the first applicable method:

   - If the issue has a notation example which fits in one system, generate a small `bug.preview.png` file with:

     ```
     lilypond -dpreview bug.ly
     ```

   - If the issue has an example which requires more than one system (i.e. a spacing bug), generate a `bug.png` file with:

     ```
     lilypond --png bug.ly
     ```

   - If the issue requires one or two pages of output, then generate a `bug.png` file with the normal:

     ```
     lilypond --png bug.ly
     ```

   - Images created as `bug.png` may be trimmed to a minimum size by using the `trimtagline.sh` script, which can be found at

     ```
     https://raw.github.com/gperciva/lilypond-extra/master/bug-squad/trimtagline.sh
     ```

     ```
     trimtagline.sh bug.ly
     ```

   - If the issue cannot be shown with less than three pages, then generate a `bug.pdf` file with:

     ```
     lilypond --pdf bug.ly
     ```

     Note that this is likely to be extremely rare; most bugs should fit into the first two categories above.

3. After adding the issue, please send a response email to the same group(s) that the initial patch was sent to. If the initial email was sent to multiple mailing lists (such as both `user` and `bugs`), then reply to all those mailing lists as well. The email should contain a link to the issue you just added.

8.5 Patch handling

> **Note:** This is not a Bug Squad responsibility; we have a separate person handling this task.

For contributors/developers: follow the steps in Section 3.3 [Lifecycle of a merge request], page 13.

8.6 Summary of project status

Project overview

All issues

```
https://gitlab.com/lilypond/lilypond/-/issues
```

Hindering development

These issues stop or slow development work:

```
https://gitlab.com/lilypond/lilypond/-/issues?label_name[]=Type%3A%3AMaintainability
```

Easy tasks

Issues tagged with `Frog` indicates a task suitable for a relatively new contributor. The time given is a quick (and probably inaccurate) estimate of the time required for somebody who is familiar with material in this manual, but does not know anything else about LilyPond development.

`https://gitlab.com/lilypond/lilypond/-/issues?label_name[]=Frog`

Patches currently in the Patch Review cycle

Overview

`https://gitlab.com/lilypond/lilypond/-/merge_requests?sort=label_priority`

New patches

`https://gitlab.com/lilypond/lilypond/-/merge_requests?label_name[]=Patch%3A%3Anew`

Patches under Review

`https://gitlab.com/lilypond/lilypond/-/merge_requests?label_name%5B%5D=Patch%3A%3Areview`

Patches on final Countdown

`https://gitlab.com/lilypond/lilypond/-/merge_requests?label_name%5B%5D=Patch%3A%3Acountdown`

Patches that can be pushed

`https://gitlab.com/lilypond/lilypond/-/merge_requests?label_name%5B%5D=Patch%3A%3Apush`

9 Regression tests

9.1 Introduction to regression tests

LilyPond has a complete suite of regression tests that are used to ensure that changes to the code do not break existing behavior. These regression tests comprise small LilyPond snippets that test the functionality of each part of LilyPond.

Regression tests are added when new functionality is added to LilyPond or when bugs are fixed.

The regression tests are compiled using special `make` targets. There are three primary uses for the regression tests. First, successful completion of the regression tests means that LilyPond has been properly built. Second, the output of the regression tests can be manually checked to ensure that the graphical output matches the description of the intended output. Third, the regression test output from two different versions of LilyPond can be automatically compared to identify any differences. These differences should then be manually checked to ensure that the differences are intended.

Regression tests ("regtests") are available in precompiled form as part of the documentation. Regtests can also be compiled on any machine that has a properly configured LilyPond build system.

9.2 Precompiled regression tests

Regression test output

As part of the release process, the regression tests are run for every LilyPond release. Full regression test output is available for every stable version and the most recent development version.

Regression test output is available in HTML and PDF format. Links to the regression test output are available at the developer's resources page for the version of interest.

The latest stable version of the regtests is found at:

`https://lilypond.org/doc/stable/input/regression/collated-files.html`

The latest development version of the regtests is found at:

`https://lilypond.org/doc/latest/input/regression/collated-files.html`

Regression test comparison

Each time a new version is released, the regtests are compiled and the output is automatically compared with the output of the previous release. The result of these comparisons is archived online:

`https://lilypond.org/test/`

Checking these pages is a very important task for the LilyPond project. You are invited to report anything that looks broken, or any case where the output quality is not on par with the previous release, as described in Section "Bug reports" in *General Information*.

What to look for

The test comparison shows all of the changes that occurred between the current release and the prior release. Each test that has a significant (noticeable) difference in output is displayed, with the old version on the left and the new version on the right.

Some of the small changes can be ignored (slightly different slur shapes, small variations in note spacing), but this is not always the case: sometimes even the smallest change means that

something is wrong. To help in distinguishing these cases, we use bigger staff size when small differences matter.

Staff size 30 generally means "pay extra attention to details". Staff size 40 (two times bigger than default size) or more means that the regtest **is** about the details.

Staff size smaller than default doesn't mean anything.

Regression tests whose output is the same for both versions are not shown in the test comparison.

- Images: green blurs in the new version show the approximate location of elements in the old version.

  There are often minor adjustments in spacing which do not indicate any problem.

- Log files: show the difference in command-line output.

  The main thing to examine are any changes in page counts – if a file used to fit on 1 page but now requires 4 or 5 pages, something is suspicious!

> **Note:** The automatic comparison of the regtests checks the LilyPond bounding boxes. This means that Ghostscript changes and changes in lyrics or text are not found.

9.3 Compiling regression tests

Developers may wish to see the output of the complete regression test suite for the current version of the source repository between releases. Current source code is available; see Chapter 3 [Working with source code], page 10.

For regression testing `../configure` should be run with the `--disable-optimising` option. Then you will need to build the LilyPond binary; see Section 4.5 [Compiling LilyPond], page 27.

Uninstalling the previous LilyPond version is not necessary, nor is running `make install`, since the tests will automatically be compiled with the LilyPond binary you have just built in your source directory.

From this point, the regtests are compiled with:

```
make test
```

If you have a multi-core machine you may want to use the `-j` option and *CPU_COUNT* variable, as described in [Saving time with CPU_COUNT], page 30. For a quad-core processor the complete command would be:

```
make -j5 CPU_COUNT=5 test
```

The regtest output will then be available in `input/regression/out-test`. `input/regression/out-test/collated-examples.html` contains a listing of all the regression tests that were run, but none of the images are included. Individual images are also available in this directory.

The primary use of '`make test`' is to verify that the regression tests all run without error. The regression test page that is part of the documentation is created only when the documentation is built, as described in Section 4.6.2 [Generating documentation], page 28. Note that building the documentation requires more installed components than building the source code, as described in Section 4.2.3 [Requirements for building documentation], page 24.

9.4 Regtest comparison

Before modified code is committed to `master`, a regression test comparison must be completed to ensure that the changes have not caused problems with previously working code. The comparison is made automatically upon compiling the regression test suite twice.

1. Before making changes to the code, establish a baseline for the comparison by checking out the current git master, going to the `$LILYPOND_GIT/build/` directory and running:

   ```
   make clean # whenever any files in mf/ are modified
   make test-baseline
   ```

2. Make your changes, or apply the patch(es) to consider.
3. Check for unintentional changes to the regtests:

   ```
   make check
   ```

   After this has finished, a regression test comparison will be available (relative to the current `build/` directory) at:

   ```
   out/test-results/index.html
   ```

   For each regression test that differs between the baseline and the changed code, a regression test entry will be displayed. Ideally, the only changes would be the changes that you were working on. If regressions are introduced, they must be fixed before committing the code.
4. If you are happy with the results, then skip to the final step.

   If you want to continue programming, then make any additional code changes, and continue.
5. Finally, you should verify that `make doc` completes successfully.

   Advanced note: Once a test baseline has been established, there is no need to run it again unless git master changed. In other words, if you work with several branches and want to do regtests comparison for all of them, you can `make test-baseline` with git master, checkout some branch, `make check` it, then switch to another branch, `make test-clean` and `make check` it without doing `make test-baseline` again.

9.5 Pixel-based regtest comparison

As an alternative to the `make test` method for regtest checking (which relies upon `.signature` files created by a LilyPond run and which describe the placing of grobs) there is a script which compares the output of two LilyPond versions pixel-by-pixel. To use this, start by checking out the version of LilyPond you want to use as a baseline, and run `make`. Then, do the following:

```
cd $LILYPOND_GIT/scripts/auxiliar/
./make-regtest-pngs.sh -j9 -o
```

The `-j9` option tells the script to use 9 CPUs to create the images - change this to your own CPU count+1. `-o` means this is the "old" version. This will create images of all the regtests in

```
$LILYPOND_BUILD_DIR/out-png-check/old-regtest-results/
```

Now checkout the version you want to compare with the baseline. Run `make` again to recreate the LilyPond binary. Then, do the following:

```
cd $LILYPOND_GIT/scripts/auxiliar/
./make-regtest-pngs.sh -j9 -n
```

The `-n` option tells the script to make a "new" version of the images. They are created in

```
$LILYPOND_BUILD_DIR/out-png-check/new-regtest-results/
```

Once the new images have been created, the script compares the old images with the new ones pixel-by-pixel and prints a list of the different images to the terminal, together with a count of how many differences were found. The results of the checks are in

```
$LILYPOND_BUILD_DIR/out-png-check/regtest-diffs/
```

To check for differences, browse that directory with an image viewer. Differences are shown in red. Be aware that some images with complex fonts or spacing annotations always display a few minor differences. These can safely be ignored.

9.6 Finding the cause of a regression

Git has special functionality to help tracking down the exact commit which causes a problem. See the git manual page for `git bisect`. This is a job that non-programmers can do, although it requires familiarity with git, ability to compile LilyPond, and generally a fair amount of technical knowledge. A brief summary is given below, but you may need to consult other documentation for in-depth explanations.

Even if you are not familiar with git or are not able to compile LilyPond you can still help to narrow down the cause of a regression simply by downloading the binary releases of different LilyPond versions and testing them for the regression. Knowing which version of LilyPond first exhibited the regression is helpful to a developer as it shortens the `git bisect` procedure.

Once a problematic commit is identified, the programmers' job is much easier. In fact, for most regression bugs, the majority of the time is spent simply finding the problematic commit.

More information is in Chapter 9 [Regression tests], page 75.

git bisect setup

We need to set up the bisect for each problem we want to investigate.

Suppose we have an input file which compiled in version 2.13.32, but fails in version 2.13.38 and above.

1. Begin the process:

   ```
   git bisect start
   ```

2. Give it the earliest known bad tag:

   ```
   git bisect bad release/2.13.38-1
   ```

   (you can see tags with: `git tag`)

3. Give it the latest known good tag:

   ```
   git bisect good release/2.13.32-1
   ```

   You should now see something like:

   ```
   Bisecting: 195 revisions left to test after this (roughly 8 steps)
   [b17e2f3d7a5853a30f7d5a3cdc6b5079e77a3d2a] Web: Announcement
   update for the new \LilyPond Report".
   ```

git bisect actual

1. Compile the source:

   ```
   make
   ```

2. Test your input file:

   ```
   out/bin/lilypond test.ly
   ```

3. Test results?

   - Does it crash, or is the output bad? If so:

     ```
     git bisect bad
     ```

   - Does your input file produce good output? If so:

     ```
     git bisect good
     ```

4. Once the exact problem commit has been identified, git will inform you with a message like:

   ```
   6d28aebbaaab1be9961a00bf15a1ef93acb91e30 is the first bad commit
   ```

```
%%% ... blah blah blah ...
```

If there is still a range of commits, then git will automatically select a new version for you to test. Go to step #1.

Recommendation: use two terminal windows

- One window is open to the `build/` directory, and alternates between these commands:

```
make
out/bin/lilypond test.ly
```

- One window is open to the top source directory, and alternates between these commands:

```
git bisect good
git bisect bad
```

9.7 MusicXML tests

LilyPond comes with a complete set of regtests for the MusicXML (`http://www.musicxml.org/`) language. Originally developed to test '`musicxml2ly`', these regression tests can be used to test any MusicXML implementation.

The MusicXML regression tests are found at `input/regression/musicxml/`.

The output resulting from running these tests through '`musicxml2ly`' followed by '`lilypond`' is available in the LilyPond documentation:

`https://lilypond.org/doc/latest/input/regression/musicxml/collated-files`

10 Programming work

10.1 Overview of LilyPond architecture

LilyPond processes the input file into graphical and musical output in a number of stages. This process, along with the types of routines that accomplish the various stages of the process, is described in this section. A more complete description of the LilyPond architecture and internal program execution is found in Erik Sandberg's master's thesis (`https://lilypond.gitlab.io/static-files/media/thesis-erik-sandberg.pdf`).

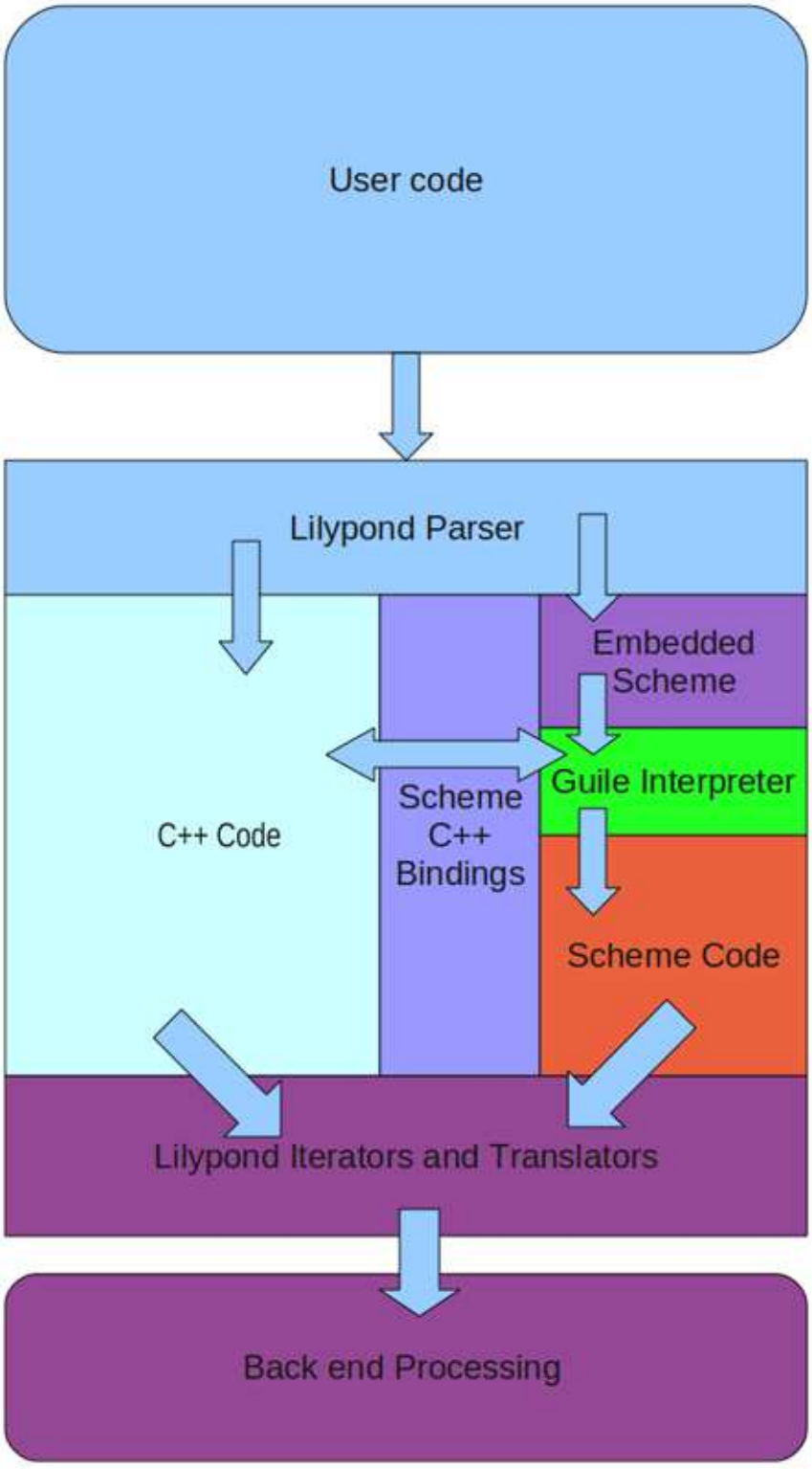
The first stage of LilyPond processing is *parsing*. In the parsing process, music expressions in LilyPond input format are converted to music expressions in Scheme format. In Scheme format, a music expression is a list in tree form, with nodes that indicate the relationships between various music events. The LilyPond parser is written in Bison.

The second stage of LilyPond processing is *iterating*. Iterating assigns each music event to a context, which is the environment in which the music will be finally engraved. The context is responsible for all further processing of the music. It is during the iteration stage that contexts are created as necessary to ensure that every note has a Voice type context (e.g. Voice, TabVoice, DrumVoice, CueVoice, MensuralVoice, VaticanaVoice, GregorianTranscriptionVoice), that the Voice type contexts exist in appropriate Staff type contexts, and that parallel Staff type contexts exist in StaffGroup type contexts. In addition, during the iteration stage each music event is assigned a moment, or a time in the music when the event begins.

Each type of music event has an associated iterator. Iterators are defined in `*-iterator.cc`. During iteration, an event's iterator is called to deliver that music event to the appropriate context(s).

The final stage of LilyPond processing is *translation*. During translation, music events are prepared for graphical or midi output. The translation step is accomplished by the polymorphic base class Translator through its two derived classes: Engraver (for graphical output) and Performer (for midi output).

Translators are defined in C++ files named `*-engraver.cc` and `*-performer.cc`. Much of the work of translating is handled by Scheme functions, which is one of the keys to LilyPond's exceptional flexibility.



10.2 LilyPond programming languages

Programming in LilyPond is done in a variety of programming languages. Each language is used for a specific purpose or purposes. This section describes the languages used and provides links to reference manuals and tutorials for the relevant language.

10.2.1 C++

The core functionality of LilyPond is implemented in C++.

C++ is so ubiquitous that it is difficult to identify either a reference manual or a tutorial. Programmers unfamiliar with C++ will need to spend some time to learn the language before attempting to modify the C++ code.

The C++ code calls Scheme/GUILE through the GUILE interface, which is documented in the GUILE Reference Manual (`http://www.gnu.org/software/guile/manual/html_node/index.html`).

10.2.2 Flex

The LilyPond lexer is implemented in Flex, an implementation of the Unix lex lexical analyser generator. Resources for Flex can be found here (`http://flex.sourceforge.net/`).

10.2.3 GNU Bison

The LilyPond parser is implemented in Bison, a GNU parser generator. The Bison homepage is found at gnu.org (`http://www.gnu.org/software/bison/`). The manual (which includes both a reference and tutorial) is available (`http://www.gnu.org/software/bison/manual/index.html`) in a variety of formats.

10.2.4 GNU Make

GNU Make is used to control the compiling process and to build the documentation and the website. GNU Make documentation is available at the GNU website (`http://www.gnu.org/software/make/manual/`).

10.2.5 GUILE or Scheme

GUILE is the dialect of Scheme that is used as LilyPond's extension language. Many extensions to LilyPond are written entirely in GUILE. The GUILE Reference Manual (`http://www.gnu.org/software/guile/manual/html_node/index.html`) is available online.

Structure and Interpretation of Computer Programs (`http://mitpress.mit.edu/sicp/full-text/book/book.html`), a popular textbook used to teach programming in Scheme is available in its entirety online.

An introduction to Guile/Scheme as used in LilyPond can be found in the Section "Scheme tutorial" in *Extending*.

10.2.6 MetaFont

MetaFont is used to create the music fonts used by LilyPond. A MetaFont tutorial is available at the METAFONT tutorial page (`http://metafont.tutorial.free.fr/`).

10.2.7 PostScript

PostScript is used to generate graphical output. A brief PostScript tutorial is available online (`http://local.wasp.uwa.edu.au/~pbourke/dataformats/postscript/`). The PostScript Language Reference (`http://www.adobe.com/products/postscript/pdfs/PLRM.pdf`) is available online in PDF format.

10.2.8 Python

Python is used for XML2ly and is used for building the documentation and the website.

Python documentation is available at python.org (`http://www.python.org/doc/`).

10.2.9 Scalable Vector Graphics (SVG)

Scalable Vector Graphics (SVG) is an XML-based markup language used to generate graphical output. A brief SVG tutorial is available online (`https://www.w3schools.com/graphics/svg_intro.asp`) through W3 Schools. The World Wide Web Consortium's SVG 1.2 Recommendation (`https://www.w3.org/TR/SVG/REC-SVG11-20110816.pdf`) is available online in PDF format.

10.3 Programming without compiling

Much of the development work in LilyPond takes place by changing `*.ly` or `*.scm` files. These changes can be made without compiling LilyPond. Such changes are described in this section.

10.3.1 Modifying distribution files

Much of LilyPond is written in Scheme or LilyPond input files. These files are interpreted when the program is run, rather than being compiled when the program is built, and are present in all LilyPond distributions. You will find `.ly` files in the `ly/` directory and the Scheme files in the `scm/` directory. Both Scheme files and `.ly` files can be modified and saved with any text editor. It's probably wise to make a backup copy of your files before you modify them, although you can reinstall if the files become corrupted.

Once you've modified the files, you can test the changes just by running LilyPond on some input file. It's a good idea to create a file that demonstrates the feature you're trying to add. This file will eventually become a regression test and will be part of the LilyPond distribution.

10.3.2 Desired file formatting

Files that are part of the LilyPond distribution have Unix-style line endings (LF), rather than DOS (CR+LF) or MacOS 9 and earlier (CR). Make sure you use the necessary tools to ensure that Unix-style line endings are preserved in the patches you create.

Tab characters should not be included in files for distribution. All indentation should be done with spaces. Most editors have settings to allow the setting of tab stops and ensuring that no tab characters are included in the file.

Scheme files and LilyPond files should be written according to standard style guidelines. Scheme file guidelines can be found at `http://community.schemewiki.org/?scheme-style`. Following these guidelines will make your code easier to read. Both you and others that work on your code will be glad you followed these guidelines.

For LilyPond files, you should follow the guidelines for LilyPond snippets in the documentation. You can find these guidelines at Section 5.4 [Texinfo introduction and usage policy], page 36.

10.4 Finding functions

When making changes or fixing bugs in LilyPond, one of the initial challenges is finding out where in the code tree the functions to be modified live. With nearly 3000 files in the source tree, trial-and-error searching is generally ineffective. This section describes a process for finding interesting code.

10.4.1 Using the ROADMAP

The file ROADMAP is located in the main directory of the lilypond source. ROADMAP lists all of the directories in the LilyPond source tree, along with a brief description of the kind of files found in each directory. This can be a very helpful tool for deciding which directories to search when looking for a function.

10.4.2 Using grep to search

Having identified a likely subdirectory to search, the grep utility can be used to search for a function name. The format of the grep command is

```
grep -i functionName subdirectory/*
```

This command will search all the contents of the directory subdirectory/ and display every line in any of the files that contains functionName. The `-i` option makes `grep` ignore case – this can be very useful if you are not yet familiar with our capitalization conventions.

The most likely directories to grep for function names are `scm/` for scheme files, ly/ for lilypond input (`*.ly`) files, and `lily/` for C++ files.

10.4.3 Using git grep to search

If you have used git to obtain the source, you have access to a powerful tool to search for functions. The command:

```
git grep functionName
```

will search through all of the files that are present in the git repository looking for *functionName*. It also presents the results of the search using `less`, so the results are displayed one page at a time.

10.4.4 Searching on the git repository at GitLab and Savannah

GitLab's web interface provides a built-in search.

- Go to `https://gitlab.com/lilypond/lilypond/`
- Type *functionName* in the search box on the top, and hit enter/return

Alternatively you can also use the equivalent of git grep on the Savannah server.

- Go to `https://git.sv.gnu.org/gitweb/?p=lilypond.git`
- In the pulldown box that says commit, select grep.
- Type *functionName* in the search box, and hit enter/return

This will initiate a search of the remote git repository.

10.5 Code style

This section describes style guidelines for LilyPond source code.

10.5.1 Languages

C++ and Python are preferred. Python code should use PEP 8.

10.5.2 Filenames

Definitions of classes that are only accessed via pointers (*) or references (&) shall not be included as include files.

```
filenames

    ".hh"   Include files
        ".cc"      Implementation files
```

```
          ".icc"     Inline definition files
          ".tcc"     non inline Template defs
```

in emacs:

```
          (setq auto-mode-alist
                (append '(("\\.make$" . makefile-mode)
                     ("\\.cc$" . c++-mode)
                     ("\\.icc$" . c++-mode)
                     ("\\.tcc$" . c++-mode)
                     ("\\.hh$" . c++-mode)
                     ("\\.pod$" . text-mode)
                     )
                   auto-mode-alist))
```

The class Class_name is coded in 'class-name.*'

10.5.3 Indentation

Standard GNU coding style is used.

Indenting files with `fixcc.py` (recommended)

LilyPond provides a python script that will adjust the indentation and spacing on a `.cc` or `.hh` file to very near the GNU standard:

```
scripts/auxiliar/fixcc.py FILENAME
```

This can be run on all files at once, but this is not recommended for normal contributors or developers.

```
scripts/auxiliar/fixcc.py \
  $(find flower lily -name '*cc' -o -name '*hh' | grep -v /out)
```

Indenting with emacs

The following hooks will produce indentation which is similar to our official indentation as produced with `fixcc.py`.

```
(add-hook 'c++-mode-hook
     '(lambda ()
        (c-set-style "gnu")
        (setq indent-tabs-mode nil))
```

If you like using font-lock, you can also add this to your `.emacs`:

```
(setq font-lock-maximum-decoration t)
(setq c++-font-lock-keywords-3
      (append
       c++-font-lock-keywords-3
       '(("\\b\\(a-zA-Z_?+_\\)\\b" 1 font-lock-variable-name-face) ("\\b\\(A-Z?+a-z_?+\
       ))
```

Indenting with vim

Although emacs indentation is the GNU standard, correct indentation for C++ files can be achieved by using the settings recommended in the GNU GCC Wiki (`https://gcc.gnu.org/wiki/FormattingCodeForGCC`). Save the following in `~/.vim/after/ftplugin/cpp.vim`:

```
setlocal cindent
setlocal cinoptions=>4,n-2,{2,^-2,:2,=2,g0,h2,p5,t0,+2,(0,u0,w1,m1
setlocal shiftwidth=2
```

```
setlocal softtabstop=2
setlocal textwidth=79
setlocal fo-=ro fo+=cql
" use spaces instead of tabs
setlocal expandtab
" remove trailing whitespace on write
autocmd BufWritePre * :%s/\s\+$//e
```

With these settings, files can be reindented automatically by highlighting the lines to be indented in visual mode (use V to enter visual mode) and pressing `=`, or a single line correctly indented in normal mode by pressing `==`.

A `scheme.vim` file will help improve the indentation of Scheme code. This one was suggested by Patrick McCarty. It should be saved in `~/.vim/after/syntax/scheme.vim`.

```
" Additional Guile-specific 'forms'
syn keyword schemeSyntax define-public define*-public
syn keyword schemeSyntax define* lambda* let-keywords*
syn keyword schemeSyntax defmacro defmacro* define-macro
syn keyword schemeSyntax defmacro-public defmacro*-public
syn keyword schemeSyntax use-modules define-module
syn keyword schemeSyntax define-method define-class

" Additional LilyPond-specific 'forms'
syn keyword schemeSyntax define-markup-command define-markup-list-command
syn keyword schemeSyntax define-safe-public define-music-function
syn keyword schemeSyntax def-grace-function

" All of the above should influence indenting too
setlocal lw+=define-public,define*-public
setlocal lw+=define*,lambda*,let-keywords*
setlocal lw+=defmacro,defmacro*,define-macro
setlocal lw+=defmacro-public,defmacro*-public
setlocal lw+=use-modules,define-module
setlocal lw+=define-method,define-class
setlocal lw+=define-markup-command,define-markup-list-command
setlocal lw+=define-safe-public,define-music-function
setlocal lw+=def-grace-function

" These forms should not influence indenting
setlocal lw-=if
setlocal lw-=set!

" Try to highlight all ly: procedures
syn match schemeFunc "ly:[^) ]\+"
```

For documentation work on texinfo files, identify the file extensions used as texinfo files in your `.vim/filetype.vim`:

```
if exists("did_load_filetypes")
  finish
endif
augroup filetypedetect
  au! BufRead,BufNewFile *.itely setfiletype texinfo
  au! BufRead,BufNewFile *.itexi setfiletype texinfo
  au! BufRead,BufNewFile *.tely  setfiletype texinfo
```

```
augroup END
```

and add these settings in `.vim/after/ftplugin/texinfo.vim`:

```
setlocal expandtab
setlocal shiftwidth=2
setlocal textwidth=66
```

Indenting Python files

Use the following settings:

```
autopep8 -ia --ignore=E402 file.py
```

10.5.4 Naming Conventions

Naming conventions have been established for LilyPond source code.

Classes and Types

Classes begin with an uppercase letter, and words in class names are separated with `_`:

`This_is_a_class`

Members

Member variable names end with an underscore:

`Type Class::member_`

Macros

Macro names should be written in uppercase completely, with words separated by `_`:

`THIS_IS_A_MACRO`

Variables

Variable names should be complete words, rather than abbreviations. For example, it is preferred to use `thickness` rather than `th` or `t`.

Multi-word variable names in C++ should have the words separated by the underscore character ('_'):

`cxx_multiword_variable`

Multi-word variable names in Scheme should have the words separated by a hyphen ('-'):

`scheme-multiword-variable`

10.5.5 Broken code

Do not write broken code. This includes hardwired dependencies, hardwired constants, slow algorithms and obvious limitations. If you can not avoid it, mark the place clearly, and add a comment explaining shortcomings of the code.

Ideally, the comment marking the shortcoming would include TODO, so that it is marked for future fixing.

We reject broken-in-advance on principle.

10.5.6 Code comments

Comments may not be needed if descriptive variable names are used in the code and the logic is straightforward. However, if the logic is difficult to follow, and particularly if non-obvious code has been included to resolve a bug, a comment describing the logic and/or the need for the non-obvious code should be included.

There are instances where the current code could be commented better. If significant time is required to understand the code as part of preparing a patch, it would be wise to add comments reflecting your understanding to make future work easier.

10.5.7 Handling errors

As a general rule, you should always try to continue computations, even if there is some kind of error. When the program stops, it is often very hard for a user to pinpoint what part of the input causes an error. Finding the culprit is much easier if there is some viewable output.

So functions and methods do not return errorcodes, they never crash, but report a programming_error and try to carry on.

Error and warning messages need to be localized.

10.5.8 Localization

This document provides some guidelines to help programmers write proper user messages. To help translations, user messages must follow uniform conventions. Follow these rules when coding for LilyPond. Hopefully, this can be replaced by general GNU guidelines in the future. Even better would be to have an English (en_GB, en_US) guide helping programmers writing consistent messages for all GNU programs.

Non-preferred messages are marked with '+'. By convention, ungrammatical examples are marked with '*'. However, such ungrammatical examples may still be preferred.

- Every message to the user should be localized (and thus be marked for localization). This includes warning and error messages.
- Do not localize/gettextify:
  - 'programming_error ()'s
  - 'programming_warning ()'s
  - debug strings
  - output strings (PostScript, TeX, etc.)
- Messages to be localized must be encapsulated in '_ (STRING)' or '_f (FORMAT, ...)'. E.g.:

```
warning (_ ("need music in a score"));
error (_f ("cannot open file: `%s'", file_name));
```

  In some rare cases you may need to call 'gettext ()' by hand. This happens when you pre-define (a list of) string constants for later use. In that case, you'll probably also need to mark these string constants for translation, using '_i (STRING)'. The '_i' macro is a no-op, it only serves as a marker for 'xgettext'.

```
char const* messages[] = {
  _i ("enable debugging output"),
  _i ("ignore lilypond version"),
  0
};

void
foo (int i)
{
  puts (gettext (messages i));
}
```

  See also `flower/getopt-long.cc` and `lily/main.cc`.
- Do not use leading or trailing whitespace in messages. If you need whitespace to be printed, prepend or append it to the translated message

```
message ("Calculating line breaks..." + " ");
```

- Error or warning messages displayed with a file name and line number never start with a capital, eg,

```
foo.ly: 12: not a duration: 3
```

Messages containing a final verb, or a gerund ('-ing'-form) always start with a capital. Other (simpler) messages start with a lowercase letter

```
Processing foo.ly...
`foo': not declared.
Not declaring: `foo'.
```

- Avoid abbreviations or short forms, use 'cannot' and 'do not' rather than 'can't' or 'don't' To avoid having a number of different messages for the same situation, well will use quoting like this '"message: '%s'"' for all strings. Numbers are not quoted:

```
_f ("cannot open file: `%s'", name_str)
_f ("cannot find character number: %d", i)
```

- Think about translation issues. In a lot of cases, it is better to translate a whole message. English grammar must not be imposed on the translator. So, instead of

```
stem at  + moment.str () +  does not fit in beam
```

have

```
_f ("stem at %s does not fit in beam", moment.str ())
```

- Split up multi-sentence messages, whenever possible. Instead of

```
warning (_f ("out of tune!  Can't find: `%s'", "Key_engraver"));
warning (_f ("cannot find font `%s', loading default", font_name));
```

rather say:

```
warning (_ ("out of tune:"));
warning (_f ("cannot find: `%s', "Key_engraver"));
warning (_f ("cannot find font: `%s', font_name));
warning (_f ("Loading default font"));
```

- If you must have multiple-sentence messages, use full punctuation. Use two spaces after end of sentence punctuation. No punctuation (esp. period) is used at the end of simple messages.

```
_f ("Non-matching braces in text `%s', adding braces", text)
_ ("Debug output disabled.  Compiled with NPRINT.")
_f ("Huh?  Not a Request: `%s'.  Ignoring.", request)
```

- Do not modularize too much; words frequently cannot be translated without context. It is probably safe to treat most occurrences of words like stem, beam, crescendo as separately translatable words.
- When translating, it is preferable to put interesting information at the end of the message, rather than embedded in the middle. This especially applies to frequently used messages, even if this would mean sacrificing a bit of eloquence. This holds for original messages too, of course.

```
en: cannot open: `foo.ly'
+   nl: kan `foo.ly' niet openen (1)
kan niet openen: `foo.ly'*   (2)
niet te openen: `foo.ly'*    (3)
```

The first nl message, although grammatically and stylistically correct, is not friendly for parsing by humans (even if they speak dutch). I guess we would prefer something like (2) or (3).

- Do not run make po/po-update with GNU gettext < 0.10.35

10.6 Warnings, Errors, Progress and Debug Output

Available log levels

LilyPond has several loglevels, which specify how verbose the output on the console should be:

- NONE: No output at all, even on failure
- ERROR: Only error messages
- WARN: Only error messages and warnings
- BASIC_PROGRESS: Warnings, errors and basic progress (success, etc.)
- PROGRESS: Warnings, errors and full progress messages
- INFO: Warnings, errors, progress and more detailed information (default)
- DEBUG: All messages, including full debug messages (very verbose!)

The loglevel can either be set with the environment variable `LILYPOND_LOGLEVEL` or on the command line with the `--loglevel=...` option.

Functions for debug and log output

LilyPond has two different types of error and log functions:

- If a warning or error is caused by an identified position in the input file, e.g. by a grob or by a music expression, the functions of the `Input` class provide logging functionality that prints the position of the message in addition to the message.
- If a message can not be associated with a particular position in an input file, e.g. the output file cannot be written, then the functions in the `flower/include/warn.hh` file will provide logging functionality that only prints out the message, but no location.

There are also Scheme functions to access all of these logging functions from scheme. In addition, the Grob class contains some convenience wrappers for even easier access to these functions.

The message and debug functions in `warn.hh` also have an optional argument `newline`, which specifies whether the message should always start on a new line or continue a previous message. By default, `progress_indication` does NOT start on a new line, but rather continue the previous output. They also do not have a particular input position associated, so there are no progress functions in the Input class. All other functions by default start their output on a new line.

The error functions come in three different flavors: fatal error messages, programming error messages and normal error messages. Errors written by the `error ()` function will cause LilyPond to exit immediately, errors by `Input::error ()` will continue the compilation, but return a non-zero return value of the LilyPond call (i.e. indicate an unsuccessful program execution). All other errors will be printed on the console, but not exit LilyPond or indicate an unsuccessful return code. Their only differences to a warnings are the displayed text and that they will be shown with loglevel `ERROR`.

If the Scheme option `warning-as-error` is set, any warning will be treated as if `Input::error` was called.

All logging functions at a glance

	C++, no location	**C++ from input location**
ERROR	`error ()`, `programming_error (msg)`, `non_fatal_error (msg)`	`Input::error (msg)`, `Input::programming_error (msg)`

WARN	`warning (msg)`	`Input::warning (msg)`
BASIC	`basic_progress (msg)`	-
PROGRESS	`progress_indication (msg)`	-
INFO	`message (msg)`	`Input::message (msg)`
DEBUG	`debug_output (msg)`	`Input::debug_output (msg)`

	C++ from a Grob	**Scheme, music expression**
ERROR	`Grob::programming_error (msg)`	-
WARN	`Grob::warning (msg)`	`(ly:music-warning music msg)`
BASIC	-	-
PROGRESS	-	-
INFO	-	`(ly:music-message music msg)`
DEBUG	-	-

	Scheme, no location	**Scheme, input location**
ERROR	-	`(ly:error msg args)`, `(ly:programming-error msg args)`
WARN	`(ly:warning msg args)`	`(ly:input-warning input msg args)`
BASIC	`(ly:basic-progress msg args)`	-
PROGRESS	`(ly:progress msg args)`	-
INFO	`(ly:message msg args)`	`(ly:input-message input msg args)`
DEBUG	`(ly:debug msg args)`	-

10.7 Debugging LilyPond

The most commonly used tool for debugging LilyPond is the GNU debugger gdb. The gdb tool is used for investigating and debugging core LilyPond code written in C++. Another tool is available for debugging Scheme code using the Guile debugger. This section describes how to use both gdb and the Guile Debugger.

10.7.1 Debugging overview

Using a debugger simplifies troubleshooting in at least two ways.

First, breakpoints can be set to pause execution at any desired point. Then, when execution has paused, debugger commands can be issued to explore the values of various variables or to execute functions.

Second, the debugger can display a stack trace, which shows the sequence in which functions have been called and the arguments passed to the called functions.

10.7.2 Debugging C++ code

The GNU debugger, gdb, is the principal tool for debugging C++ code.

Compiling LilyPond for use with gdb

In order to use gdb with LilyPond, it is necessary to compile LilyPond with debugging information. This is the current default mode of compilation. Often debugging becomes more complicated when the compiler has optimised variables and function calls away. In that case it may be helpful to run the following command in the main LilyPond source directory:

```
./configure --disable-optimising
make
```

This will create a version of LilyPond with minimal optimization which will allow the debugger to access all variables and step through the source code in-order. It may not accurately reproduce bugs encountered with the optimized version, however.

You should not do *make install* if you want to use a debugger with LilyPond. The *make install* command will strip debugging information from the LilyPond binary.

Typical gdb usage

Once you have compiled the LilyPond image with the necessary debugging information it will have been written to a location in a subfolder of your current working directory:

```
out/bin/lilypond
```

This is important as you will need to let gdb know where to find the image containing the symbol tables. You can invoke gdb from the command line using the following:

```
gdb out/bin/lilypond
```

This loads the LilyPond symbol tables into gdb. Then, to run LilyPond on `test.ly` under the debugger, enter the following:

```
run test.ly
```

at the gdb prompt.

As an alternative to running gdb at the command line you may try a graphical interface to gdb such as ddd:

```
ddd out/bin/lilypond
```

You can also use sets of standard gdb commands stored in a .gdbinit file (see next section).

Typical .gdbinit files

The behavior of gdb can be readily customized through the use of a *.gdbinit* file. A *.gdbinit* file is a file named *.gdbinit* (notice the "." at the beginning of the file name) that is placed in a user's home directory.

The *.gdbinit* file below is from Han-Wen. It sets breakpoints for all errors and defines functions for displaying scheme objects (ps), grobs (pgrob), and parsed music expressions (pmusic).

```
file $LILYPOND_GIT/build/out/bin/lilypond
```

```
b programming_error
b Grob::programming_error

define ps
   print ly_display_scm($arg0)
end
define pgrob
  print ly_display_scm($arg0->self_scm_)
  print ly_display_scm($arg0->mutable_property_alist_)
  print ly_display_scm($arg0->immutable_property_alist_)
  print ly_display_scm($arg0->object_alist_)
end
define pmusic
  print ly_display_scm($arg0->self_scm_)
  print ly_display_scm($arg0->mutable_property_alist_)
  print ly_display_scm($arg0->immutable_property_alist_)
end
```

10.7.3 Debugging Scheme code

Scheme code can be developed using the Guile command line interpreter `top-repl`. You can either investigate interactively using just Guile or you can use the debugging tools available within Guile.

Using Guile interactively with LilyPond

In order to experiment with Scheme programming in the LilyPond environment, it is necessary to have a Guile interpreter that has all the LilyPond modules loaded. This requires the following steps.

First, define a Scheme symbol for the active module in the `.ly` file:

```
#(module-define! (resolve-module '(guile-user))
                 'lilypond-module (current-module))
```

Now place a Scheme function in the `.ly` file that gives an interactive Guile prompt:

```
#(top-repl)
```

When the `.ly` file is compiled, this causes the compilation to be interrupted and an interactive guile prompt to appear. Once the guile prompt appears, the LilyPond active module must be set as the current guile module:

```
guile> (set-current-module lilypond-module)
```

You can demonstrate these commands are operating properly by typing the name of a LilyPond public scheme function to check it has been defined:

```
guile> fret-diagram-verbose-markup
#<procedure fret-diagram-verbose-markup (layout props marking-list)>
```

If the LilyPond module has not been correctly loaded, an error message will be generated:

```
guile> fret-diagram-verbose-markup
ERROR: Unbound variable: fret-diagram-verbose-markup
ABORT: (unbound-variable)
```

Once the module is properly loaded, any valid LilyPond Scheme expression can be entered at the interactive prompt.

After the investigation is complete, the interactive guile interpreter can be exited:

```
guile> (quit)
```

The compilation of the `.ly` file will then continue.

Using the Guile debugger

To set breakpoints and/or enable tracing in Scheme functions, put

```
\include "guile-debugger.ly"
```

in your input file after any scheme procedures you have defined in that file. This will invoke the Guile command-line after having set up the environment for the debug command-line. When your input file is processed, a guile prompt will be displayed. You may now enter commands to set up breakpoints and enable tracing by the Guile debugger.

Using breakpoints

At the guile prompt, you can set breakpoints with the `set-break!` procedure:

```
guile> (set-break! my-scheme-procedure)
```

Once you have set the desired breakpoints, you exit the guile repl frame by typing:

```
guile> (quit)
```

Then, when one of the scheme routines for which you have set breakpoints is entered, guile will interrupt execution in a debug frame. At this point you will have access to Guile debugging commands. For a listing of these commands, type:

```
debug> help
```

Alternatively you may code the breakpoints in your LilyPond source file using a command such as:

```
#(set-break! my-scheme-procedure)
```

immediately after the `\include` statement. In this case the breakpoint will be set straight after you enter the `(quit)` command at the guile prompt.

Embedding breakpoint commands like this is particularly useful if you want to look at how the Scheme procedures in the `.scm` files supplied with LilyPond work. To do this, edit the file in the relevant directory to add this line near the top:

```
(use-modules (scm guile-debugger))
```

Now you can set a breakpoint after the procedure you are interested in has been declared. For example, if you are working on routines called by *print-book-with* in `lily-library.scm`:

```
(define (print-book-with book process-procedure)
  (let* ((paper (ly:parser-lookup '$defaultpaper))
         (layout (ly:parser-lookup '$defaultlayout))
         (outfile-name (get-outfile-name book)))
    (process-procedure book paper layout outfile-name)))

(define-public (print-book-with-defaults book)
  (print-book-with book ly:book-process))

(define-public (print-book-with-defaults-as-systems book)
  (print-book-with book ly:book-process-to-systems))
```

At this point in the code you could add this to set a breakpoint at print-book-with:

```
(set-break! print-book-with)
```

Tracing procedure calls and evaluator steps

Two forms of trace are available:

```
(set-trace-call! my-scheme-procedure)
```

and

```
(set-trace-subtree! my-scheme-procedure)
```

`set-trace-call!` causes Scheme to log a line to the standard output to show when the procedure is called and when it exits.

`set-trace-subtree!` traces every step the Scheme evaluator performs in evaluating the procedure.

10.8 Tracing object relationships

Understanding the LilyPond source often boils down to figuring out what is happening to the Grobs. Where (and why) are they being created, modified and destroyed? Tracing Lily through a debugger in order to identify these relationships can be time-consuming and tedious.

In order to simplify this process, a facility has been added to display the grobs that are created and the properties that are set and modified. Although it can be complex to get set up, once set up it easily provides detailed information about the life of grobs in the form of a network graph.

Each of the steps necessary to use the graphviz utility is described below.

1. Installing graphviz

   In order to create the graph of the object relationships, it is first necessary to install Graphviz. Graphviz is available for a number of different platforms:

   ```
   http://www.graphviz.org/Download..php
   ```

2. Modifying config.make

   In order for the Graphviz tool to work, config.make must be modified. It is probably a good idea to first save a copy of config.make under a different name.

   In order to have the required functionality available, LilyPond needs to be compiled with the option `-DDEBUG`. You can achieve this by configuring with

   ```
   ./configure --enable-checking
   ```

3. Rebuilding LilyPond

   The executable code of LilyPond must be rebuilt from scratch:

   ```
   make clean && make
   ```

4. Create a graphviz-compatible `.ly` file

   In order to use the graphviz utility, the `.ly` file must include `ly/graphviz-init.ly`, and should then specify the grobs and symbols that should be tracked. An example of this is found in `input/regression/graphviz.ly`.

5. Run LilyPond with output sent to a log file

   The Graphviz data is sent to stderr by LilyPond, so it is necessary to redirect stderr to a logfile:

   ```
   lilypond graphviz.ly 2> graphviz.log
   ```

6. Edit the logfile

   The logfile has standard LilyPond output, as well as the Graphviz output data. Delete everything from the beginning of the file up to but not including the first occurrence of `digraph`.

   Also, delete the final LilyPond message about success from the end of the file.

7. Process the logfile with `dot`

   The directed graph is created from the log file with the program `dot`:

   ```
   dot -Tpdf graphviz.log > graphviz.pdf
   ```

The pdf file can then be viewed with any pdf viewer.

When compiled with `-DDEBUG`, LilyPond may run slower than normal. The original configuration can be restored by rerunning `./configure` with `--disable-checking`. Then rebuild LilyPond with

```
make clean && make
```

10.9 Adding or modifying features

When a new feature is to be added to LilyPond, it is necessary to ensure that the feature is properly integrated to maintain its long-term support. This section describes the steps necessary for feature addition and modification.

10.9.1 Write the code

You should probably create a new git branch for writing the code, as that will separate it from the master branch and allow you to continue to work on small projects related to master.

Please be sure to follow the rules for programming style discussed earlier in this chapter.

10.9.2 Write regression tests

In order to demonstrate that the code works properly, you will need to write one or more regression tests. These tests are typically `.ly` files that are found in `input/regression`.

Regression tests should be as brief as possible to demonstrate the functionality of the code.

Regression tests should generally cover one issue per test. Several short, single-issue regression tests are preferred to a single, long, multiple-issue regression test.

If the change in the output is small or easy to overlook, use bigger staff size – 40 or more (up to 100 in extreme cases). Size 30 means "pay extra attention to details in general".

Use existing regression tests as templates to demonstrate the type of header information that should be included in a regression test.

10.9.3 Write convert-ly rule

If the modification changes the input syntax, a convert-ly rule should be written to automatically update input files from older versions.

convert-ly rules are found in python/convertrules.py

If possible, the convert-ly rule should allow automatic updating of the file. In some cases, this will not be possible, so the rule will simply point out to the user that the feature needs manual correction.

Updating version numbers

If a development release occurs between you writing your patch and having it approved+pushed, you will need to update the version numbers in your tree. This can be done with:

```
scripts/auxiliar/update-patch-version old.version.number new.version.number
```

It will change all files in git, so use with caution and examine the resulting diff.

10.9.4 Automatically update documentation

`convert-ly` should be used to update the documentation, the snippets, and the regression tests. This not only makes the necessary syntax changes, it also tests the `convert-ly` rules.

The automatic updating is performed by moving to the top-level source directory, then running:

```
scripts/auxiliar/update-with-convert-ly.sh
```

If you did an out-of-tree build, pass in the relative path:

```
LILYPOND_BUILD_DIR=../build-lilypond/ scripts/auxiliar/update-with-convert-ly.sh
```

10.9.5 Manually update documentation

Where the convert-ly rule is not able to automatically update the inline LilyPond code in the documentation (i.e. if a NOT_SMART rule is used), the documentation must be manually updated. The inline snippets that require changing must be changed in the English version of the docs and all translated versions. If the inline code is not changed in the translated documentation, the old snippets will show up in the English version of the documentation.

Where the convert-ly rule is not able to automatically update snippets in Documentation/snippets/, those snippets must be manually updated. Those snippets should be copied to Documentation/snippets/new. The comments at the top of the snippet describing its automatic generation should be removed. All translated texidoc strings should be removed. The comment "% begin verbatim" should be removed. The syntax of the snippet should then be manually edited.

Where snippets in Documentation/snippets are made obsolete, the snippet should be copied to Documentation/snippets/new. The comments and texidoc strings should be removed as described above. Then the body of the snippet should be changed to:

```
\markup {
  This snippet is deprecated as of version X.Y.Z and
  will be removed from the documentation.
}
```

where X.Y.Z is the version number for which the convert-ly rule was written.

Update the snippet files by running:

```
scripts/auxiliar/makelsr.py
```

Where the convert-ly rule is not able to automatically update regression tests, the regression tests in input/regression should be manually edited.

Although it is not required, it is helpful if the developer can write relevant material for inclusion in the Notation Reference. If the developer does not feel qualified to write the documentation, a documentation editor will be able to write it from the regression tests. In this case the developer should raise a new issue with the Type=Documentation tag containing a reference to the original issue number and/or the committish of the pushed patch so that the need for new documention is not overlooked.

Any text that is added to or removed from the documentation should be changed only in the English version.

10.9.6 Edit changes.tely

An entry should be added to Documentation/changes.tely to describe the feature changes to be implemented. This is especially important for changes that change input file syntax.

Hints for changes.tely entries are given at the top of the file.

New entries in changes.tely go at the top of the file.

The changes.tely entry should be written to show how the new change improves LilyPond, if possible.

10.9.7 Verify successful build

When the changes have been made, successful completion must be verified by doing

```
make all
make doc
```

When these commands complete without error, the patch is considered to function successfully.

Developers on Windows who are unable to build LilyPond should get help from a GNU/Linux or OSX developer to do the make tests.

10.9.8 Verify regression tests

In order to avoid breaking LilyPond, it is important to verify that the regression tests succeed, and that no unwanted changes are introduced into the output. This process is described in Section 9.4 [Regtest comparison], page 77.

Typical developer's edit/compile/test cycle

- Initial test:

```
make clean                      ## when needed (see below)
make [-jX CPU_COUNT=X] test-baseline
```

- Edit/compile/test cycle:

```
## edit source files, then...

make clean                      ## when needed (see below)
make [-jX]                      ## when needed (see below)
make [-jX CPU_COUNT=X] check    ## retest cases differing from baseline
```

- Reset:

```
make test-clean
```

If you have modified LilyPond source files that have to be compiled (such as `.cc` or `.hh` files in `flower/` or `lily/`), the regression-test targets automatically rebuild LilyPond before running the tests.

If you have modified any font definitions in the `mf/` directory, then you must run `make clean` before running regression tests. This works around incomplete makefile dependencies. The subsequent regression-test target rebuilds all of LilyPond and the fonts before running the tests.

Regression-test targets do not necessarily rebuild everything that a simple `make` builds. You may omit `make` from the debugging cycle to save time, but it is still important to run `make` before committing.

Running `make check` leaves an HTML page `out/test-results/index.html`. This page shows all the important differences that your change introduced, whether in the layout, MIDI, performance or error reporting.

You only need to use `make test-clean` to retest all cases. To retest mismatching cases only, all that is needed is to repeat `make check`.

10.9.9 Post patch for comments

See Section 3.3.1 [Uploading a patch for review], page 13.

10.9.10 Push patch

Once all the comments have been addressed, the patch can be pushed.

If the author has push privileges, the author will push the patch. Otherwise, a developer with push privileges will push the patch.

10.9.11 Closing the issues

Once the patch has been pushed, all the relevant issues should be closed.

If the changes were in response to a feature request on the issue tracker for LilyPond, the author should change the label to 'Status::Fixed' and set the milestone to the version where the issue was fixed.

10.10 Iterator tutorial

TODO – this is a placeholder for a tutorial on iterators

Iterators are routines written in C++ that process music expressions and sent the music events to the appropriate engravers and/or performers.

See a short example discussing iterators and their duties in Section 10.16.4 [Articulations on EventChord], page 111.

10.11 Engraver tutorial

Engravers are C++ classes that catch music events and create the appropriate grobs for display on the page. Though the majority of engravers are responsible for the creation of a single grob, in some cases (e.g. `New_fingering_engraver`), several different grobs may be created.

Engravers listen for events and acknowledge grobs. Events are passed to the engraver in time-step order during the iteration phase. Grobs are made available to the engraver when they are created by other engravers during the iteration phase.

10.11.1 Useful methods for information processing

An engraver inherits the following public methods from the Translator base class, which can be used to process listened events and acknowledged grobs:

- `virtual void initialize ()`
- `void start_translation_timestep ()`
- `void process_music ()`
- `void process_acknowledged ()`
- `void stop_translation_timestep ()`
- `virtual void finalize ()`

These methods are listed in order of translation time, with `initialize ()` and `finalize ()` bookending the whole process. `initialize ()` can be used for one-time initialization of context properties before translation starts, whereas `finalize ()` is often used to tie up loose ends at the end of translation: for example, an unterminated spanner might be completed automatically or reported with a warning message.

10.11.2 Translation process

At each timestep in the music, translation proceeds by calling the following methods in turn:

`start_translation_timestep ()` is called before any user information enters the translators, i.e., no property operations (\set, \override, etc.) or events have been processed yet.

`process_music ()` and `process_acknowledged ()` are called after all events in the current time step have been heard, or all grobs in the current time step have been acknowledged. The latter tends to be used exclusively with engravers which only acknowledge grobs, whereas the former is the default method for main processing within engravers.

`stop_translation_timestep ()` is called after all user information has been processed prior to beginning the translation for the next timestep.

10.11.3 Preventing garbage collection for SCM member variables

In certain cases, an engraver might need to ensure private Scheme variables (with type SCM) do not get swept away by Guile's garbage collector: for example, a cache of the previous key signature which must persist between timesteps. The method `virtual derived_mark () const` can be used in such cases:

```
Engraver_name::derived_mark ()
```

```
{
  scm_gc_mark (private_scm_member_)
}
```

10.11.4 Listening to music events

External interfaces to the engraver are implemented by protected macros including one or more of the following:

- `DECLARE_TRANSLATOR_LISTENER (event_name)`
- `IMPLEMENT_TRANSLATOR_LISTENER (Engraver_name, event_name)`

where *event_name* is the type of event required to provide the input the engraver needs and *Engraver_name* is the name of the engraver.

Following declaration of a listener, the method is implemented as follows:

```
IMPLEMENT_TRANSLATOR_LISTENER (Engraver_name, event_name)
void
Engraver_name::listen_event_name (Stream event *event)
{
  ...body of listener method...
}
```

10.11.5 Acknowledging grobs

Some engravers also need information from grobs as they are created and as they terminate. The mechanism and methods to obtain this information are set up by the macros:

- `DECLARE_ACKNOWLEDGER (grob_interface)`
- `DECLARE_END_ACKNOWLEDGER (grob_interface)`

where *grob_interface* is an interface supported by the grob(s) which should be acknowledged. For example, the following code would declare acknowledgers for a `NoteHead` grob (via the `note-head-interface`) and any grobs which support the `side-position-interface`:

```
DECLARE_ACKNOWLEDGER (note_head)
DECLARE_ACKNOWLEDGER (side_position)
```

The `DECLARE_END_ACKNOWLEDGER ()` macro sets up a spanner-specific acknowledger which will be called whenever a spanner ends.

Following declaration of an acknowledger, the method is coded as follows:

```
void
Engraver_name::acknowledge_interface_name (Grob_info info)
{
  ...body of acknowledger method...
}
```

Acknowledge functions are called in the order engravers are `\consist`-ed (the only exception is if you set `must-be-last` to `#t`).

There will always be a call to `process-acknowledged ()` whenever grobs have been created, and *reading* stuff from grobs should be delayed until then since other acknowledgers might *write* stuff into a grob even after your acknowledger has been called. So the basic workflow is to use the various acknowledgers to *record* the grobs you are interested in and *write* stuff into them (or do read/write stuff that more or less is accumulative and/or really unrelated to other engravers), and then use the `process-acknowledged ()` hook for processing (including *reading*) the grobs you had recorded.

You can create new grobs in `process-acknowledged ()`. That will lead to a new cycle of `acknowledger ()` calls followed by a new cycle of `process-acknowledged ()` calls.

Only when all those cycles are over is `stop-translator-timestep ()` called, and then creating grobs is no longer an option. You can still 'process' parts of the grob there (if that means just reading out properties and possibly setting context properties based on them) but `stop-translation-timestep ()` is a cleanup hook, and other engravers might have already cleaned up stuff you might have wanted to use. Creating grobs in there is not possible since engravers and other code may no longer be in a state where they could process them, possibly causing a crash.

10.11.6 Engraver declaration/documentation

An engraver must have a public macro

- `TRANSLATOR_DECLARATIONS (Engraver_name)`

where `Engraver_name` is the name of the engraver. This defines the common variables and methods used by every engraver.

At the end of the engraver file, one or both of the following macros are generally called to document the engraver in the Internals Reference:

- `ADD_ACKNOWLEDGER (Engraver_name, grob_interface)`
- `ADD_TRANSLATOR (Engraver_name, Engraver_doc, Engraver_creates, Engraver_reads, Engraver_writes)`

where `Engraver_name` is the name of the engraver, `grob_interface` is the name of the interface that will be acknowledged, `Engraver_doc` is a docstring for the engraver, `Engraver_creates` is the set of grobs created by the engraver, `Engraver_reads` is the set of properties read by the engraver, and `Engraver_writes` is the set of properties written by the engraver.

The `ADD_ACKNOWLEDGER` and `ADD_TRANSLATOR` macros use a non-standard indentation system. Each interface, grob, read property, and write property is on its own line, and the closing parenthesis and semicolon for the macro all occupy a separate line beneath the final interface or write property. See existing engraver files for more information.

10.12 Callback tutorial

TODO – This is a placeholder for a tutorial on callback functions.

10.13 Understanding pure properties

Pure properties are some of the most difficult properties to understand in LilyPond but, once understood, it is much easier to work with horizontal spacing. This document provides an overview of what it means for something to be 'pure' in LilyPond, what this purity guarantees, and where pure properties are stored and used. It finishes by discussing a few case studies for the pure programmer to save you some time and to prevent you some major headaches.

10.13.1 Purity in LilyPond

Pure properties in LilyPond are properties that do not have any 'side effects'. That is, looking up a pure property should never result in calls to the following functions:

- `set_property`
- `set_object`
- `suicide`

This means that, if the property is calculated via a callback, this callback must not only avoid the functions above but make sure that any functions it calls also avoid the functions above. Also, to date in LilyPond, a pure function will always return the same value before line breaking (or, more precisely, before any version of `break_into_pieces` is called). This convention makes

it possible to cache pure functions and be more flexible about the order in which functions are called. For example; `Stem.length` has a pure property that will *never* trigger one of the functions listed above and will *always* return the same value before line breaking, independent of where it is called. Sometimes, this will be the actual length of the Stem. But sometimes it will not. For example; stem that links up with a beam will need its end set to the Y position of the beam at the stem's X position. However, the beam's Y positions can only be known after the score is broken up in to several systems (a beam that has a shallow slope on a compressed line of music, for example, may have a steeper one on an uncompressed line). Thus, we only call the impure version of the properties once we are *absolutely certain* that all of the parameters needed to calculate their final value have been calculated. The pure version provides a useful estimate of what this Stem length (or any property) will be, and the art of creating good pure properties is trying to get the estimation as close to the actual value as possible.

Of course, like Gregory Peck and Tintin, some Grobs will have properties that will always be pure. For example, the height of a note-head in not-crazy music will never depend on line breaking or other parameters decided late in the typesetting process. Inversely, in rare cases, certain properties are difficult to estimate with pure values. For example, the height of a Hairpin at a certain cross-section of its horizontal span is difficult to know without knowing the horizontal distance that the hairpin spans, and LilyPond provides an over-estimation by reporting the pure height as the entire height of the Hairpin.

Purity, like for those living in a convent, is more like a contract than an *a priori*. If you write a pure-function, you are promising the user (and the developer who may have to clean up after you) that your function will not be dependent on factors that change at different stages of the compilation process (compilation of a score, not of LilyPond).

One last oddity is that purity, in LilyPond, is currently limited exclusively to things that have to do with Y-extent and positioning. There is no concept of 'pure X' as, by design, X is always the independent variable (i.e. from column X1 to column X2, what will be the Y height of a given grob). Furthermore, there is no purity for properties like color, text, and other things for which a meaningful notion of estimation is either not necessary or has not yet been found. For example, even if a color were susceptible to change at different points of the compilation process, it is not clear what a pure estimate of this color would be or how this pure color could be used. Thus, in this document and in the source, you will see purity discussed almost interchangeably with Y-axis positioning issues.

10.13.2 Writing a pure function

Pure functions take, at a minimum, three arguments: the *grob*, the starting column at which the function is being evaluated (hereafter referred to as *start*), and the end column at which the grob is being evaluated (hereafter referred to as *end*). For items, *start* and *end* must be provided (meaning they are not optional) but will not have a meaningful impact on the result, as items only occupy one column and will thus yield a value or not (if they are not in the range from *start* to *end*). For spanners however, *start* and *end* are important, as we may can get a better pure estimation of a slice of the spanner than considering it on the whole. This is useful during line breaking, for example, when we want to estimate the Y-extent of a spanner broken at given starting and ending columns.

10.13.3 How purity is defined and stored

Purity is defined in LilyPond with the creation of an unpure-pure container (unpure is not a word, but hey, neither was LilyPond until the 90s). For example:

```
#(define (foo grob)
  '(-1 . 1))

#(define (bar grob start end)
```

```
'(-2 . 2))
```

```
\override Stem.length = #(ly:make-unpure-pure-container foo bar)
```

Note that items can only ever have two pure heights: their actual pure height if they are between 'start' and 'end', or an empty interval if they are not. Thus, their pure property is cached to speed LilyPond up. Pure heights for spanners are generally not cached as they change depending on the start and end values. They are only cached in certain particular cases. Before writing a lot of caching code, make sure that it is a value that will be reused a lot.

10.13.4 Where purity is used

Pure Y values must be used in any functions that are called before line breaking. Examples of this can be seen in `Separation_items::boxes` to construct horizontal skylines and in `Note_spacing::stem_dir_correction` to correct for optical illusions in spacing. Pure properties are also used in the calculation of other pure properties. For example, the `Axis_group_interface` has pure functions that look up other pure functions.

Purity is also implicitly used in any functions that should only ever return pure values. For example, extra-spacing-height is only ever used before line-breaking and thus should never use values that would only be available after line breaking. In this case, there is no need to create callbacks with pure equivalents because these functions, by design, need to be pure.

To know if a property will be called before and/or after line-breaking is sometimes tricky and can, like all things in coding, be found by using a debugger and/or adding *printf* statements to see where they are called in various circumstances.

10.13.5 Case studies

In each of these case studies, we expose a problem in pure properties, a solution, and the pros and cons of this solution.

Time signatures

A time signature needs to prevent accidentals from passing over or under it, but its extent does not necessarily extend to the Y-position of accidentals. LilyPond's horizontal spacing sometimes makes a line of music compact and, when doing so, allows certain columns to pass over each other if they will not collide. This type of passing over is not desirable with time signatures in traditional engraving. But how do we know if this passing over will happen before line breaking, as we are not sure what the X positions will be? We need a pure estimation of how much extra spacing height the time signatures would need to prevent this form of passing over without making this height so large as to overly-distort the Y-extent of an system, which could result in a very 'loose' looking score with lots of horizontal space between columns. So, to approximate this extra spacing height, we use the Y-extent of a time signature's next-door-neighbor grobs via the pure-from-neighbor interface.

- pros: By extending the extra spacing height of a time signature to that of its next-door-neighbors, we make sure that grobs to the right of it that could pass above or below it do not.
- cons: This over-estimation of the vertical height could prevent snug vertical spacing of systems, as the system will be registered as being taller at the point of the time signature than it actually is. This approach can be used for clefs and bar lines as well.

Stems

As described above, Stems need pure height approximations when they are beamed, as we do not know the beam positions before line breaking. To estimate this pure height, we take all the stems in a beam and find their pure heights as if they were not beamed. Then, we find the union

of all these pure heights and take the intersection between this interval (which is large) and an interval going from the note-head of a stem to infinity in the direction of the stem so that the interval stops at the note head.

- pros: This is guaranteed to be at least as long as the beamed stem, as a beamed stem will never go over the ideal length of the extremal beam of a stem.
- cons: Certain stems will be estimated as being too long, which leads to the same problem of too-much-vertical-height as described above.

10.13.6 Debugging tips

A few questions to ask yourself when working with pure properties:

- Is the property really pure? Are you sure that its value could not be changed later in the compiling process due to other changes?
- Can the property be made to correspond even more exactly with the eventual impure property?
- For a spanner, is the pure property changing correctly depending on the starting and ending points of the spanner?
- For an Item, will the item's pure height need to act in horizontal spacing but not in vertical spacing? If so, use extra-spacing-height instead of pure height.

10.14 LilyPond scoping

The LilyPond language has a concept of scoping, i.e. you can do:

```
foo = 1

#(begin
   (display (+ foo 2)))
```

with `\paper`, `\midi` and `\header` being nested scope inside the `.ly` file-level scope. `foo = 1` is translated in to a scheme variable definition.

This implemented using modules, with each scope being an anonymous module that imports its enclosing scope's module.

LilyPond's core, loaded from `.scm` files, is usually placed in the `lily` module, outside the `.ly` level. In the case of

```
lilypond a.ly b.ly
```

we want to reuse the built-in definitions, without changes effected in user-level `a.ly` leaking into the processing of `b.ly`.

The user-accessible definition commands have to take care to avoid memory leaks that could occur when running multiple files. All information belonging to user-defined commands and markups is stored in a manner that allows it to be garbage-collected when the module is dispersed, either by being stored module-locally, or in weak hash tables.

10.15 Scheme->C interface

Most of the C functions interfacing with Guile/Scheme used in LilyPond are described in the API Reference of the GUILE Reference Manual (`http://www.gnu.org/software/guile/manual/html_node/index.html`).

The remaining functions are defined in `lily/lily-guile.cc`, `lily/include/lily-guile.hh` and `lily/include/lily-guile-macros.hh`. Although their names are meaningful there's a few things you should know about them.

10.15.1 Comparison

This is the trickiest part of the interface.

Mixing Scheme values with C comparison operators won't produce any crash or warning when compiling but must be avoided:

```
scm_string_p (scm_value) == SCM_BOOL_T
```

As we can read in the reference, `scm_string_p` returns a Scheme value: either `#t` or `#f` which are written `SCM_BOOL_T` and `SCM_BOOL_F` in C. This will work, but it is not following to the API guidelines. For further information, read this discussion:

```
http://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00646.html
```

There are functions in the Guile reference that returns C values instead of Scheme values. In our example, a function called `scm_is_string` (described after `string?` and `scm_string_p`) returns the C value 0 or 1.

So the best solution was simply:

```
scm_is_string (scm_value)
```

There a simple solution for almost every common comparison. Another example: we want to know if a Scheme value is a non-empty list. Instead of:

```
(scm_is_true (scm_list_p (scm_value)) && scm_value != SCM_EOL)
```

one can usually use:

```
scm_is_pair (scm_value)
```

since a list of at least one member is a pair. This test is cheap; `scm_list_p` is actually quite more complex since it makes sure that its argument is neither a 'dotted list' where the last pair has a non-null `cdr`, nor a circular list. There are few situations where the complexity of those tests make sense.

Unfortunately, there is not a `scm_is_[something]` function for everything. That's one of the reasons why LilyPond has its own Scheme interface. As a rule of thumb, tests that are cheap enough to be worth inlining tend to have such a C interface. So there is `scm_is_pair` but not `scm_is_list`, and `scm_is_eq` but not `scm_is_equal`.

General definitions

bool to_boolean (SCM b)

Return `true` if *b* is `SCM_BOOL_T`, else return `false`.

This should be used instead of `scm_is_true` and `scm_is_false` for properties since in LilyPond, unset properties are read as an empty list, and by convention unset Boolean properties default to false. Since both `scm_is_true` and `scm_is_false` only compare with `##f` in line with what Scheme's conditionals do, they are not really useful for checking the state of a Boolean property.

bool ly_is_[something] (args)

Behave the same as scm_is_[something] would do if it existed.

bool is_[type] (SCM s)

Test whether the type of *s* is [type]. [type] is a LilyPond-only set of values (direction, axis...). More often than not, the code checks LilyPond specific C++-implemented types using

[Type *] unsmob<Type> (SCM s)

This tries converting a Scheme object to a pointer of the desired kind. If the Scheme object is of the wrong type, a pointer value of `0` is returned, making this suitable for a Boolean test.

10.15.2 Conversion

General definitions

bool to_boolean (SCM b)

Return `true` if *b* is `SCM_BOOL_T`, else return `false`.

This should be used instead of `scm_is_true` and `scm_is_false` for properties since empty lists are sometimes used to unset them.

[C type] ly_scm2[C type] (SCM s)

Behave the same as scm_to_[C type] would do if it existed.

[C type] robust_scm2[C type] (SCM s, [C type] d)

Behave the same as scm_to_[C type] would do if it existed. Return *d* if type verification fails.

10.16 LilyPond miscellany

This is a place to dump information that may be of use to developers but doesn't yet have a proper home. Ideally, the length of this section would become zero as items are moved to other homes.

10.16.1 Spacing algorithms

Here is information from an email exchange about spacing algorithms.

On Thu, 2010-02-04 at 15:33 -0500, Boris Shingarov wrote: I am experimenting with some modifications to the line breaking code, and I am stuck trying to understand how some of it works. So far my understanding is that Simple_spacer operates on a vector of Grobs, and it is a well-known Constrained-QP problem (rods = constraints, springs = quadratic function to minimize). What I don't understand is, if the spacer operates at the level of Grobs, which are built at an earlier stage in the pipeline, how are the changes necessitated by differences in line breaking, taken into account? in other words, if I take the last measure of a line and place it on the next line, it is not just a matter of literally moving that graphic to where the start of the next line is, but I also need to draw a clef, key signature, and possibly other fundamental things – but at that stage in the rendering pipeline, is it not too late??

Joe Neeman answered:

We create lots of extra grobs (eg. a BarNumber at every bar line) but most of them are not drawn. See the break-visibility property in item-interface.

Here is another e-mail exchange. Janek Warchoł asked for a starting point to fixing 1301 (change clef colliding with notes). Neil Puttock replied:

The clef is on a loose column (it floats before the head), so the first place I'd look would be lily/spacing-loose-columns.cc (and possibly lily/spacing-determine-loose-columns.cc). I'd guess the problem is the way loose columns are spaced between other columns: in this snippet, the columns for the quaver and tuplet minim are so close together that the clef's column gets dumped on top of the quaver (since it's loose, it doesn't influence the spacing).

10.16.2 Info from Han-Wen email

In 2004, Douglas Linhardt decided to try starting a document that would explain LilyPond architecture and design principles. The material below is extracted from that email, which can be found at `http://thread.gmane.org/gmane.comp.gnu.lilypond.devel/2992`. The headings reflect questions from Doug or comments from Han-Wen; the body text are Han-Wen's answers.

Figuring out how things work.

I must admit that when I want to know how a program works, I use grep and emacs and dive into the source code. The comments and the code itself are usually more revealing than technical documents.

What's a grob, and how is one used?

Graphical object - they are created from within engravers, either as Spanners (derived class) -slurs, beams- or Items (also a derived class) -notes, clefs, etc.

There are two other derived classes System (derived from Spanner, containing a "line of music") and Paper_column (derived from Item, it contains all items that happen at the same moment). They are separate classes because they play a special role in the linebreaking process.

What's a smob, and how is one used?

A C(++) object that is encapsulated so it can be used as a Scheme object. See GUILE info, "19.3 Defining New Types (Smobs)"

When is each C++ class constructed and used?

- Music classes

  In the parser.yy see the macro calls MAKE_MUSIC_BY_NAME().
- Contexts

  Constructed during "interpreting" phase.
- Engravers

  Executive branch of Contexts, plugins that create grobs, usually one engraver per grob type. Created together with context.
- Layout Objects

  = grobs
- Grob Interfaces

  These are not C++ classes per se. The idea of a Grob interface hasn't crystallized well. ATM, an interface is a symbol, with a bunch of grob properties. They are not objects that are created or destroyed.
- Iterators

  Objects that walk through different music classes, and deliver events in a synchronized way, so that notes that play together are processed at the same moment and (as a result) end up on the same horizontal position.

  Created during interpreting phase.

  BTW, the entry point for interpreting is ly:run-translator (ly_run_translator on the C++ side)

Can you get to Context properties from a Music object?

You can create music object with a Scheme function that reads context properties (the \apply-context syntax). However, that function is executed during Interpreting, so you can not really get Context properties from Music objects, since music objects are not directly connected to Contexts. That connection is made by the Music_iterators

Can you get to Music properties from a Context object?

Yes, if you are given the music object within a Context object. Normally, the music objects enter Contexts in synchronized fashion, and the synchronization is done by Music_iterators.

What is the relationship between C++ classes and Scheme objects?

Smobs are C++ objects in Scheme. Scheme objects (lists, functions) are manipulated from C++ as well using the GUILE C function interface (prefix: scm_)

How do Scheme procedures get called from C++ functions?

scm_call_*, where * is an integer from 0 to 4. Also scm_c_eval_string (), scm_eval ()

How do C++ functions get called from Scheme procedures?

Export a C++ function to Scheme with LY_DEFINE.

What is the flow of control in the program?

Good question. Things used to be clear-cut, but we have Scheme and SMOBs now, which means that interactions do not follow a very rigid format anymore. See below for an overview, though.

Does the parser make Scheme procedure calls or C++ function calls?

Both. And the Scheme calls can call C++ and vice versa. It's nested, with the SCM datatype as lubrication between the interactions

(I think the word "lubrication" describes the process better than the traditional word "glue")

How do the front-end and back-end get started?

Front-end: a file is parsed, the rest follows from that. Specifically,

Parsing leads to a Music + Music_output_def object (see parser.yy, definition of toplevel_expression)

A Music + Music_output_def object leads to a Global_context object (see ly_run_translator ())

During interpreting, Global_context + Music leads to a bunch of Contexts (see Global_translator::run_iterator_on_me ()).

After interpreting, Global_context contains a Score_context (which contains staves, lyrics etc.) as a child. Score_context::get_output () spews a Music_output object (either a Paper_score object for notation or Performance object for MIDI).

The Music_output object is the entry point for the backend (see ly_render_output ()).

The main steps of the backend itself are in

- `paper-score.cc` , Paper_score::process_
- `system.cc` , System::get_lines()
- The step, where things go from grobs to output, is in System::get_line(): each grob delivers a Stencil (a Device independent output description), which is interpreted by our outputting backends (`scm/output-tex.scm` and `scm/output-ps.scm`) to produce TeX and PS.

Interactions between grobs and putting things into .tex and .ps files have gotten a little more complex lately. Jan has implemented page-breaking, so now the backend also involves Paper_book, Paper_lines and other things. This area is still heavily in flux, and perhaps not something you should want to look at.

How do the front-end and back-end communicate?

There is no communication from backend to front-end. From front-end to backend is simply the program flow: music + definitions gives contexts, contexts yield output, after processing, output is written to disk.

Where is the functionality associated with KEYWORDs?

See `my-lily-lexer.cc` (keywords, there aren't that many) and `ly/*.ly` (most of the other backslashed `/\words` are identifiers)

What Contexts/Properties/Music/etc. are available when they are processed?

What do you mean exactly with this question?

See `ly/engraver-init.ly` for contexts, see `scm/define-*.scm` for other objects.

How do you decide if something is a Music, Context, or Grob property?

Why is part-combine-status a Music property when it seems (IMO) to be related to the Staff context?

The Music_iterators and Context communicate through two channels

Music_iterators can set and read context properties, idem for Engravers and Contexts

Music_iterators can send "synthetic" music events (which aren't in the input) to a context. These are caught by Engravers. This is mostly a one way communication channel.

part-combine-status is part of such a synthetic event, used by Part_combine_iterator to communicate with Part_combine_engraver.

Deciding between context and music properties

I'm adding a property to affect how \autoChange works. It seems to me that it should be a context property, but the Scheme autoChange procedure has a Music argument. Does this mean I should use a Music property?

\autoChange is one of these extra strange beasts: it requires look-ahead to decide when to change staves. This is achieved by running the interpreting step twice (see `scm/part-combiner.scm` , at the bottom), and storing the result of the first step (where to switch staves) in a Music property. Since you want to influence that where-to-switch list, your must affect the code in make-autochange-music (`scm/part-combiner.scm`). That code is called directly from the parser and there are no official "parsing properties" yet, so there is no generic way to tune \autoChange. We would have to invent something new for this, or add a separate argument,

```
\autoChange #around-central-C ..music..
```

where around-central-C is some function that is called from make-autochange-music.

More on context and music properties

From Neil Puttock, in response to a question about transposition:

Context properties (using \set & \unset) are tied to engravers: they provide information relevant to the generation of graphical objects.

Since transposition occurs at the music interpretation stage, it has no direct connection with engravers: the pitch of a note is fixed before a notehead is created. Consider the following minimal snippet:

```
{ c' }
```

This generates (simplified) a NoteEvent, with its pitch and duration as event properties,

```
(make-music
  'NoteEvent
  'duration
  (ly:make-duration 2 0 1 1)
```

```
'pitch
(ly:make-pitch 0 0 0)
```

which the Note_heads_engraver hears. It passes this information on to the NoteHead grob it creates from the event, so the head's correct position and duration-log can be determined once it's ready for printing.

If we transpose the snippet,

```
\transpose c d { c' }
```

the pitch is changed before it reaches the engraver (in fact, it happens just after the parsing stage with the creation of a TransposedMusic music object):

```
(make-music
 'NoteEvent
 'duration
 (ly:make-duration 2 0 1 1)
 'pitch
 (ly:make-pitch 0 1 0)
```

You can see an example of a music property relevant to transposition: untransposable.

```
\transpose c d { c'2 \withMusicProperty #'untransposable ##t c' }
```

-> the second c' remains untransposed.

Take a look at `lily/music.cc` to see where the transposition takes place.

How do I tell about the execution environment?

I get lost figuring out what environment the code I'm looking at is in when it executes. I found both the C++ and Scheme autoChange code. Then I was trying to figure out where the code got called from. I finally figured out that the Scheme procedure was called before the C++ iterator code, but it took me a while to figure that out, and I still didn't know who did the calling in the first place. I only know a little bit about Flex and Bison, so reading those files helped only a little bit.

Han-Wen: GDB can be of help here. Set a breakpoint in C++, and run. When you hit the breakpoint, do a backtrace. You can inspect Scheme objects along the way by doing

```
p ly_display_scm(obj)
```

this will display OBJ through GUILE.

10.16.3 Music functions and GUILE debugging

Ian Hulin was trying to do some debugging in music functions, and came up with the following question (edited and adapted to current versions):

HI all, I'm working on the Guile Debugger Stuff, and would like to try debugging a music function definition such as:

```
conditionalMark =
#(define-music-function () ()
  #{ \tag instrumental-part {\mark \default} #} )
```

It appears `conditionalMark` does not get set up as an equivalent of a Scheme

```
(define conditionalMark = define-music-function () () ...
```

although something gets defined because Scheme apparently recognizes

```
#(set-break! conditionalMark)
```

later on in the file without signalling any Guile errors.

However the breakpoint trap is never encountered as `define-music-function` passed things on to `ly:make-music-function`, which is really C++ code `ly_make_music_function`, so Guile never finds out about the breakpoint.

The answer in the mailing list archive at that time was less than helpful. The question already misidentifies the purpose of `ly:make-music-function` which is only called once at the time of *defining* `conditionalMark` but is not involved in its later *execution*.

Here is the real deal:

A music function is not the same as a GUILE function. It boxes both a proper Scheme function (with argument list and body from the `define-music-function` definition) along with a call signature representing the *types* of both function and arguments.

Those components can be reextracted using `ly:music-function-extract` and `ly:music-function-signature`, respectively.

When LilyPond's parser encounters a music function call in its input, it reads, interprets, and verifies the arguments individually according to the call signature and *then* calls the proper Scheme function.

While it is actually possible these days to call a music function *as if* it were a Scheme function itself, this pseudo-call uses its own wrapping code matching the argument list *as a whole* to the call signature, substituting omitted optional arguments with defaults and verifying the result type.

So putting a breakpoint on the music function itself will still not help with debugging uses of the function using LilyPond syntax.

However, either calling mechanism ultimately calls the proper Scheme function stored as part of the music function, and that is where the breakpoint belongs:

```
#(set-break! (ly:music-function-extract conditionalMark))
```

will work for either calling mechanism.

10.16.4 Articulations on EventChord

From David Kastrup's email `http://lists.gnu.org/archive/html/lilypond-devel/2012-02/msg00189.html`:

LilyPond's typesetting does not act on music expressions and music events. It acts exclusively on stream events. It is the act of iterators to convert a music expression into a sequence of stream events played in time order.

The EventChord iterator is pretty simple: it just takes its "elements" field when its time comes up, turns every member into a StreamEvent and plays that through the typesetting process. The parser currently appends all postevents belonging to a chord at the end of "elements", and thus they get played at the same point of time as the elements of the chord. Due to this design, you can add per-chord articulations or postevents or even assemble chords with a common stem by using parallel music providing additional notes/events: the typesetter does not see a chord structure or postevents belonging to a chord, it just sees a number of events occuring at the same point of time in a Voice context.

So all one needs to do is let the EventChord iterator play articulations after elements, and then adding to articulations in EventChord is equivalent to adding them to elements (except in cases where the order of events matters).

11 Release work

11.1 Development phases

There are 2 states of development on `master`:

1. **Normal development**: Any commits are fine.
2. **Build-frozen**: Do not require any additional or updated libraries or make non-trivial changes to the build process. Any such patch (or branch) may not be merged with master during this period.

   This should occur approximately 1 month before any alpha version of the next stable release, and ends when the next unstable branch begins.

After announcing a beta release, branch `stable/2.x`. There are 2 states of development for this branch:

1. **Normal maintenance**: The following patches **MAY NOT** be merged with this branch:
   - Any change to the input syntax. If a file compiled with a previous `2.x` (beta) version, then it must compile in the new version.

     Exception: any bugfix to a Critical issue.
   - New features with new syntax *may be committed*, although once committed that syntax cannot change during the remainder of the stable phase.
   - Any change to the build dependencies (including programming libraries, documentation process programs, or python modules used in the buildscripts). If a contributor could compile a previous lilypond `2.x`, then he must be able to compile the new version.
2. **Release prep**: Only translation updates and important bugfixes are allowed.

11.2 Minor release checklist

A "minor release" means an update of `y` in `2.x.y`.

Pre-release

1. Don't forget to prepare the GUB build machine by deleting and moving unneeded files: see "Subsequent builds" in Section 11.5 [Notes on builds with GUB], page 117.
2. Using any system with git pull access (not necessarily the GUB build machine), use the commands below to do the following:
   - switch to the release branch
   - update the release branch from origin/master
   - update the translation files
   - create the release announcement
   - update the build versions.
     - VERSION_DEVEL = the current development version (previous VERSION_DEVEL + 0.01)
     - VERSION_STABLE = the current stable version (probably no change here)
   - update the "Welcome to LilyPond" version numbers to the version about to be released

   This requires a system which has the release/unstable branch. If you get a warning saying you are in `detached HEAD` state, then you should create a release/unstable branch with `git checkout release/unstable`.

   Check the environment variables are set as in Section 13.2 [Environment variables], page 122.

You need to ensure you have a clean index and work tree. If the checkout displays modified files, you might want to run `git reset --hard` before continuing.

```
git fetch
git checkout release/unstable
git merge origin/master
make -C $LILYPOND_BUILD_DIR po-replace
mv $LILYPOND_BUILD_DIR/po/lilypond.pot po/
gedit Documentation/en/web/news-new.itexi Documentation/en/web/news-old.itexi
gedit Documentation/en/web/news-headlines.itexi
gedit VERSION
gedit ly/Wel*.ly
```

Editing the `news-headlines.itexi` file is a bit tricky, since it contains URLs with escaped characters. An example of what is needed is that releasing `2.19.50` after the release of `2.19.49` needed the line:

```
@uref{news.html#LilyPond-2_002e19_002e49-released-October-16_002c-2016,
  LilyPond 2.19.49 released - @emph{October 16, 2016}}
```

to be changed to:

```
@uref{news.html#LilyPond-2_002e19_002e50-released-November-6_002c-2016,
  LilyPond 2.19.50 released - @emph{November 6, 2016}}
```

Don't forget to update the entry above that line to show the latest release version.

3. Commit, push, switch back to master (or wherever else):

```
git commit -m "Release: bump VERSION_DEVEL." VERSION
git commit -m "PO: update template." po/lilypond.pot
git commit -m "Release: update news." Documentation/en/web/
git commit -m "Release: bump Welcome versions." ly/Wel*.ly
git push origin HEAD:release/unstable
git checkout master
```

4. If you do not have the previous release test-output tarball, download it and put it in `regtests/`
5. Prepare GUB environment by running:

```
### my-gub.sh
# special terminal, and default PATH environment.
# import these special environment vars:
#   HOME, HTTP_PROXY, TERM
env -i \
  HOME=$HOME \
  HTTP_PROXY=$HTTP_PROXY \
  bash --rcfile my-bashrc
```

```
### my-bashrc
export PS1="\[\e[1;33mGUB-ENV \w\]$ \[\e[0m\]"
export PATH=$PATH
export TERM=xterm
```

6. Build release on GUB by running:

```
make LILYPOND_BRANCH=release/unstable lilypond
```

or something like:

```
make LILYPOND_BRANCH=stable/2.16 lilypond
```

7. Check the regtest comparison in `uploads/webtest/` for any unintentional breakage. More info in Section 9.2 [Precompiled regression tests], page 75.

8. If any work was done on GUB since the last release, upload binaries to a temporary location, ask for feedback, and wait a day or two in case there's any major problems.

> **Note:** Always do this for a stable release.

Actual release

1. If you're not the right user on the webserver, remove the `t` from the rsync command in:

```
test-lily/rsync-lily-doc.py
test-lily/rsync-test.py
```

2. Upload GUB by running:

```
make lilypond-upload \
  LILYPOND_REPO_URL=git://git.sv.gnu.org/lilypond.git \
  LILYPOND_BRANCH=release/unstable
```

or something like:

```
make lilypond-upload \
  LILYPOND_REPO_URL=git://git.sv.gnu.org/lilypond.git \
  LILYPOND_BRANCH=stable/2.12
```

Post release

1. Update the current `master` branch with the current news:

```
git fetch
git checkout origin/master
git merge origin/release/unstable
```

2. Update `VERSION` in lilypond git and upload changes:

```
gedit VERSION
```

- VERSION = what you just did +0.0.1

```
git commit -m "Release: bump VERSION." VERSION
git push origin HEAD:release/unstable
```

3. Create a merge request from `release/unstable` to merge the changes into `master`.
4. Wait a few hours for the website to update.
5. Email release notice to `info-lilypond`

11.3 Major release checklist

A "major release" means an update of `x` in `2.x.0`.

Main requirements

These are the current official guidelines.

- 0 Critical issues for two weeks (14 days) after the latest release candidate.

Potential requirements

These might become official guidelines in the future.

- Check reg test
- Check all 2ly scripts
- Check for emergencies the docs:

```
grep FIXME --exclude "misc/*" --exclude "*GNUmakefile" \
  --exclude "snippets/*" ????*/*
```

- Check for altered regtests, and document as necessary:

```
git diff -u -r release/2.FIRST-CURRENT-STABLE \
  -r release/2.LAST-CURRENT-DEVELOPMENT input/regression/
```

Housekeeping requirements

Before the release:

- write release notes. note: stringent size requirements for various websites, so be brief.
- Run convert-ly on all files, bump parser minimum version.
- Update lilypond.pot:

```
make -C $LILYPOND_BUILD_DIR po-replace
mv $LILYPOND_BUILD_DIR/po/lilypond.pot po/
```

- Make directories on lilypond.org:

```
~/download/sources/v2.NEW-STABLE
~/download/sources/v2.NEW-DEVELOPMENT
```

- Shortly after the release, move all current contributors to previous contributors in `Documentation/included/authors.itexi`.
- Delete old material in `Documentation/changes.tely`, but don't forget to check it still compiles! Also update the version numbers:

```
@node Top
@top New features in 2.NEW-STABLE since 2.OLD-STABLE
```

- Website:
  - make a link from the old unstable to the next stable in lilypond.org's `/doc/` dir. Keep all previous unstable->stable doc symlinks.

    Also, make the old docs self-contained – if there's a redirect in `/doc/v2.OLD-STABLE/Documentation/index.html` , replace it with the `index.html.old-2.OLD-STABLE` files.

    The post-2.13 docs will need another way of handling the self-containment. It won't be hard to whip up a python script that changes the link to `../../../../manuals.html` to `../website/manuals.html`, but it's still a 30-minute task that needs to be done before 2.16.
  - doc auto redirects to `v2.NEW-STABLE`
  - add these two lines to `Documentation/web/server/robots.txt`:

```
Disallow: /doc/v2.OLD-STABLE/
Disallow: /doc/v2.NEW-DEVELOPMENT/
```

  - if needed, update the htaccess redirections (`/latest/`, `/stable/` etc.) in `Documentation/web/server/lilypond.org.htaccess`.
  - if needed, add a link to the previous stable version's announcement, list of changes and contributors acknowledgements to the 'Attic' page, in `Documentation/web/community.itexi`.

Unsorted

- submit po template for translation: send url of tarball to `coordinator@translationproject.org`, mentioning lilypond-VERSION.pot
- update links to distros providing lilypond packages? link in: `Documentation/web/download.itexi`

  This has nothing to do with the release, but it's a "periodic maintenance" task that might make sense to include with releases.

- Send announcements to...

  News:

  ```
  comp.music.research
  comp.os.linux.announce

  comp.text.tex
  rec.music.compose
  ```

  Mail:

  ```
  info-lilypond@gnu.org
  info-gnu@gnu.org
  planet@gnu.org

  linux-audio-announce@lists.linuxaudio.org
  linux-audio-user@lists.linuxaudio.org
  linux-audio-dev@lists.linuxaudio.org
  consortium@lists.linuxaudio.org
  planetccrma@ccrma.stanford.edu

  tex-music@tug.org

  rosegarden-user@lists.sourceforge.net
  denemo-devel@gnu.org
  ```

  Web (forums):

  ```
  imslpforums.org
  abcusers (Yahoo group)
  canorus (Github? Freenode IRC?)
  musescore.org/forum
  reddit.com/lilypond
  linuxquestions.org
  Slashdot
  ```

  Web (websites and aggregators):

  ```
  lilypond.org
  https://savannah.gnu.org/news/submit.php?group_id=1673
  freshmeat.sourceforge.net
  linuxtoday.com
  lxer.com
  fossmint.com
  fsdaily.com
  freesoftwaremagazine.com
  lwn.net
  hitsquad.com/smm

  in French: linuxfr.org; framalibre.org
  ```

11.4 Release extra notes

Regenerating regression tests

Regenerating regtests (if the lilypond-book naming has changed):

- git checkout release/lilypond-X.Y.Z-A
- take lilypond-book and any related makefile updates from the latest git.
- configure; make; make test
- tar -cjf lilypond-X.Y.Z-A.test-output.tar.bz2 input/regression/out-test/
- mv lilypond-X.Y.Z-A.test-output.tar.bz2 ../gub/regtests/
- cd ../gub/regtests/
- make lilypond

stable/2.12

If releasing stable/2.12, then:

- apply doc patch: patches/rsync-lily.patch (or something like that)
- change infodir in gub/specs/lilypond-doc.py from "lilypond.info" to "lilypond-web.info"

Updating a release (changing a in x.y.z-a)

Really tentative instructions, almost certainly can be done better.

1. change the VERSION back to release you want. push change. (hopefully you'll have forgotten to update it when you made your last release)
2. make sure that there aren't any lilypond files floating around in target/ (like usr/bin/lilypond).
3. build the specific package(s) you want, i.e.

   ```
   bin/gub mingw::lilypond-installer
   make LILYPOND_BRANCH=stable/2.12 -f lilypond.make doc
   bin/gub --platform=darwin-x86 \
     'git://git.sv.gnu.org/lilypond-doc.git?branch=stable/2.12'
   ```

   or

   build everything with the normal "make lilypond", then (maybe) manually delete stuff you don't want to upload.
4. manually upload them. good luck figuring out the rsync command(s). Hints are in test-lily/

   or

   run the normal lilypond-upload command, and (maybe) manually delete stuff you didn't want to upload from the server.

11.5 Notes on builds with GUB

Building GUB

GUB - the Grand Unified Builder - is used to build the release versions of LilyPond. For background information, see [Grand Unified Builder (GUB)], page 19. The simplest way to set up a GUB build environment is to use a virtual machine with LilyDev (Section 2.1 [LilyDev], page 5). Follow the instructions on that page to set this up. Make sure that your virtual machine has enough disk space - a GUB installation takes over 30 GBytes of disk space, and if you allocate too little, it will fail during the setting up stage and you will have to start again. 64 GBytes should be sufficient.

While GUB is being built, any interruptions are likely to make it almost impossible to restart. If at all possible, leave the build to continue uninterrupted.

Download GUB and start the set up:

```
git clone git://github.com/gperciva/gub.git
cd gub
make bootstrap
```

This will take a very long time, even on a very fast computer. You will need to be patient. It's also liable to fail - it downloads a number of tools, and some will have moved and others won't respond to the network. For example, the perl archive. If this happens, download it from `http://www.cpan.org/src/5.0/perl-5.10.0.tar.gz`, saving the archive to `gub/downloads/perl/`. Continue the set up with:

```
make bootstrap
```

Once this has completed successfully, you can build the LilyPond release package. However, this uses an archived version of the regression tests, so it is better to download this first. Download the test output from lilypond.org (you will need to replace `2.15.33-1` with the latest build):

```
https://lilypond.org/downloads/binaries/test-output/lilypond-2.15.33-1.test-output.tar.bz2
```

Copy the tarball into `regtests/`, and tell the build system that you have done this:

```
touch regtests/ignore
```

Now start the GUB build:

```
make lilypond
```

That's it. This will build LilyPond from current master. To build the current unstable release, run:

```
make LILYPOND_BRANCH=release/unstable lilypond
```

The first time you do this, it will take a very long time.

Assuming the build has gone well, it can be uploaded using:

```
make lilypond-upload
  LILYPOND_BRANCH=release/unstable
  LILYPOND_REPO_URL=git://git.sv.gnu.org/lilypond.git
```

Output files

GUB builds the files it needs into the directory `gub/target/`. As a general rule, these don't need to be touched unless there is a problem building GUB (see below). The files to be uploaded are in `gub/uploads/`. Once the build has completed successfully, there should be 8 installation files and 3 archives, totalling about 600MB. There are also 4 directories:

```
gub/signatures
gub/localdoc
gub/webdoc
gub/webtest
```

`signatures` contains files that are used to track whether some of the archives have already been built. Don't touch these.

`localdoc` probably contains local copies of the documentation.

`webdoc` contains the documentation to be uploaded.

`webtest` contains the regtest comparison, which should be checked before upload, and is also uploaded for subsequent checking.

The total upload is about 700 MB in total, and on an ADSL connection will take about 4 hours to upload.

Subsequent builds

In principle, building the next release of LilyPond requires no action other then following the instructions in Section 11.2 [Minor release checklist], page 112. Because much of the infrastructure has already been built, it will take much less time - about an hour on a fast computer.

Continuing to build LilyPond without any other archiving/deletion of previous builds is likely to be successful, but will take up a fair amount of disk space (around 2GB per build) which may be a problem with a Virtual Machine. It's therefore recommended to move (not copy) `gub/uploads` to another machine/disk after each build, if space is at a premium.

However, if a significant change has been made to the LilyPond source (e.g. added source files) the build may fail if tried on top of a previous build. If this happens, be sure to move/delete `gub/uploads` and all mentions of LilyPond in `gub/target`. The latter can be achieved with this command:

```
rm -rf target/*/*/*lilypond*
```

Be *very* careful with this command. Typing it wrongly could wipe your disk completely.

Updating the web site

The `make lilypond-upload` command updates the documentation on the LilyPond web site.

The website (which is served on `lilypond.org`) is updated by executing a manual pipeline on Gitlab. See Section 6.2 [Uploading website], page 61, for more details.

So - to update the front page of the website, it's necessary to update `VERSION` and `news-headlines.itexi` in master, run the manual pipeline, and then wait for the cron jobs to run.

12 Modifying the Emmentaler font

12.1 Overview of the Emmentaler font

Emmentaler was created specifically for use in LilyPond. The font consists of two *sub-sets* of glyphs. “Feta”, used for clasical notation and “Parmesan”, used for Ancient notation. The sources of which are all found in mf/*.mf.

The font is merged from a number of subfonts. Each subfont can contain at most 224 glyphs. This is because each subfont is limited to a one-byte address space (256 glyphs maximum) and we avoid the first 32 points in that address space, since they are non-printing control characters in ASCII.

In LilyPond, glyphs are accessed by a ‘glyph name’, rather than by code point. Therefore, the name of a glyph is significant.

Information about correctly creating glyphs is found in `mf/README`. Please make sure you read and understand this file.

TODO – we should get mf/README automatically generated from texinfo source and include it here.

12.2 Font creation tools

The sources for Emmentaler are written in metafont. The definitive reference for metafont is "The METAFONT book" – the source of which is available at CTAN.

mf2pt1 is used to create type 1 fonts from the metafont sources.

FontForge is used to postprocess the output of mf2pt1 and clean up details of the font. It can also be used by a developer to display the resulting glyph shapes.

12.3 Adding a new font section

The font is divided into sections, each of which contains less than 224 glyphs. If more than 224 glyphs are included in a section, an error will be generated.

Each of the sections is contained in a separate `.mf` file. The files are named according to the type of glyphs in that section.

When adding a new section, it will be necessary to add the following:

- The code for the glyphs, in a file `<section-name>.mf`
- Driver files used to create the font in different sizes
- An entry in the generic file used to create the font, or a new generic file
- If necessary, new entries in the GNUmakefile
- An entry in `scripts/build/gen-emmentaler-scripts.py`

See the examples in `mf/` for more information.

12.4 Adding a new glyph

Adding a new glyph is done by modifying the .mf file to which the glyph will be added.

Necessary functions to draw the glyph can be added anywhere in the file, but it is standard to put them immediately before the glyph definition.

The glyph definition begins with:

```
fet_beginchar ("glyph description", "glyphname");
```

with `glyph description` replaced with a short description of the glyph, and `glyphname` replaced with the glyphname, which is chosen to comply with the naming rules in `mf/README`.

The metafont code used to draw the glyph follows the `fet_beginchar` entry. The glyph is finished with:

```
fet_endchar;
```

12.5 Building the changed font

In order to rebuild the font after making the changes, the existing font files must be deleted. The simplest and quickest way to do this is to do:

```
rm mf/out/*
make
```

12.6 METAFONT formatting rules

There are special formatting rules for METAFONT files.

Please do not use tabs for the indentation of commands.

When a path contains more than two points, put each point on a separate line, with the operator at the beginning of the line. The operators are indented to the same depth as the initial point on the path using spaces. The indentation mechanism is illustrated below.

```
def draw_something (expr test) =
  set_char_box (staff_space#, 1.6 linethickness# / 2,
                0.5 staff_space#, 0.5 staff_space#);
  if test:
    fill z1
         -- z2
         -- z3
         .. cycle;
  fi;
enddef;
```

13 Administrative policies

This chapter discusses miscellaneous administrative issues which don't fit anywhere else.

13.1 Meta-policy for this document

The Contributor's Guide as a whole is still a work in progress, but some chapters are much more complete than others. Chapters which are "almost finished" should not have major changes without a discussion on `-devel`; in other chapters, a disorganized "wiki-style dump" of information is encouraged.

Do not change (other than spelling mistakes) without discussion:

- Chapter 1 [Introduction to contributing], page 1,
- Chapter 3 [Working with source code], page 10,

Please dump info in an appropriate @section within these manuals, but discuss any large-scale reorganization:

- Chapter 4 [Compiling], page 20,
- Chapter 5 [Documentation work], page 34,
- Chapter 8 [Issues], page 69,
- Chapter 9 [Regression tests], page 75,
- Chapter 10 [Programming work], page 80,

Totally disorganized; do whatever the mao you want:

- Chapter 6 [Website work], page 61,
- Chapter 7 [LSR work], page 63,
- Chapter 11 [Release work], page 112,
- Chapter 13 [Administrative policies], page 122,

13.2 Environment variables

Some maintenance scripts and instructions in this guide rely on the following environment variables. They should be predefined in LilyDev distribution (see Section 2.1 [LilyDev], page 5); if you set up your own development environment, you can set them by appending these settings to your `~/.bashrc` (or whatever defines your default environment variables for the user account for LilyPond development), then logging out and in (adapt directories to your setup):

```
LILYPOND_GIT=~/lilypond-git
export LILYPOND_GIT
LILYPOND_BUILD_DIR=~/lilypond-git/build
export LILYPOND_BUILD_DIR
```

The standard build and install procedure (with `autogen.sh`, `configure`, `make`, `make install`, `make doc` ...) does not rely on them.

In addition, for working on the website, `LILYPOND_WEB_MEDIA_GIT` should be set to the repository lilypond-extra, see [lilypond-extra], page 19.

13.3 Meisters

We have four primary jobs to help organize all our contributors:

The Bug Meister

The Bug Meister's responsibilities are:

- To organize the individual Bug Squad volunteers, making sure that each member is aware of their responsibilities. See Section 8.2 [The Bug Squad], page 69.
- To train new Bug Squad volunteers in the Issue Tracker process. See Chapter 8 [Issues], page 69.
- To have the final say on our policies for Issues and their classification. See Section 8.3 [Issue classification], page 71.

Current Bug Meister: Colin Hall `bug-lilypond@gnu.org`

The Doc Meister

The Doc Meister's responsibilities are:

- To train new volunteers in our Documentation style and policy, including organizing LilyPond Snippet Repository (LSR) work.
- To organize the individual volunteers – who does what on which job – and to check that everything is running smoothly.
- To have final say on any Documentation policy. See Section 5.5 [Documentation policy], page 44.

Current Doc Meister: None

The Patch Meister

The Patch Meister's responsibilities are:

- To keep track of all patches submitted for testing and review. This includes scanning the bug and dev email lists looking for any patches submitted by 'random' contributors and advising them on how to submit a patch for testing and review. See Section 3.3 [Lifecycle of a merge request], page 13.
- Updates all Issue statuses for all patches that are currently in the testing and review process periodically – currently every 3 - 4 days. See Section 8.5 [Patch handling], page 73.

> **Note:** The Patch Meister's role is a purely administrative one and no programming skill or judgement is assumed or required.

Currently: James Lowe `pkx@gnu.org`

The Translation Meister

The Translation Meister's responsibilities are:

- To train new documentation translators in the translation process. See Section 5.9 [Translating the documentation], page 50.
- To update the translation priority list and handle the merging of the translation branches (in both directions).
- To have final say on any Translation management policies. See Section 5.9 [Translating the documentation], page 50.

Currently: Francisco Vila `translations@lilynet.net`

13.4 Administrative mailing list

A mailing list for administrative issues is maintained at `lilypond-hackers@gnu.org`.

This list is intended to be used for discussions that should be kept private. Therefore, the archives are closed to the public.

Subscription to this list is limited to certain senior developers.

At the present time, the list is dormant.

13.5 Grand Organization Project (GOP)

GOP has two goals:

- Clarify the various development tasks by writing down the policies and techniques and/or simplifying the tasks directly.
- Get more people involved in development: specifically, find people to do easy tasks to allow advanced developers to concentrate on difficult tasks.

13.5.1 Motivation

Most readers are probably familiar with the LilyPond Grand Documentation Project, which ran from Aug 2007 to Aug 2008. This project involved over 20 people and resulted in an almost complete rewrite of the documentation. Most of those contributors were normal users who decided to volunteer their time and effort to improve lilypond for everybody. By any measure, it was a great success.

The Grand Organization Project aims to do the same thing with a larger scope – instead of focusing purely on documentation, the project aims to improve all parts of LilyPond and its community. Just as with GDP, the main goal is to encourage and train users to become more involved.

If you have never contributed to an open-source project before – especially if you use Windows or OSX and do not know how to program or compile programs – you may be wondering if there's anything you can do. Rest assured that you *can* help.

"Trickle-up" development

One of the reasons I'm organizing GOP is "trickle-up" development. The idea is this: doing easy tasks frees up advanced developers to do harder tasks. Don't ask "am I the *best* person for this job"; instead, ask "am I *capable* of doing this job, so that the current person can do stuff I *can't* do?".

For example, consider lilypond's poor handling of grace notes in conjunction with clef and tempo changes. Fixing this will require a fair amount of code rewriting, and would take an advanced developer a few weeks to do. It's clearly beyond the scope of a normal user, so we might as well sit back and do nothing, right?

No; we *can* help, indirectly. Suppose that our normal user starts answering more emails on lilypond-user. This in turn means that documentation writers don't need to answer those emails, so they can spend more time improving the docs. I've noticed that all doc writers tackle harder and harder subjects, and when they start writing docs on scheme programming and advanced tweaks, they start contributing bug fixes to lilypond. Having people performing these easy-to-moderate bug fixes frees up the advanced developers to work on the really hard stuff... like rewriting the grace note code.

Having 1 more normal user answering emails on lilypond-user won't have a dramatic 'trickle-up' effect all by itself, of course. But if we had 8 users volunteering to answer emails, 6 users starting to write documentation, and 2 users editing LSR... well, that would free up a lot of current bug-fixing-capable contributors to focus on that, and we could start to make a real dent

in the number of bugs in lilypond. Quite apart from the eased workload, having that many new helpers will provide a great moral boost!

13.5.2 Ongoing jobs

Although GOP is a short-term project, the main goal is to train more people to handle ongoing jobs. The more people doing these jobs, the lighter the work will be, and the more we can get done with lilypond!

Also, it would be nice if we had at least one "replacement" / "understudy" for each role – too many tasks are only being done by one person, so if that person goes on vacation or gets very busy with other matters, work in that area grinds to a halt.

Jobs for normal users

- Consultant: LilyPond is sometimes critized for not listening to users, but whenever we ask for opinions about specific issues, we never get enough feedback. This is somewhat aggravating. We need a group of users to make a dedicated effort to test and give feedback. If there's new documentation, read it. If there's an experimental binary, download it and try compiling a score with it. If we're trying to name a new command, think about it and give serious suggestions.
- lilypond-user support: I think it would be nice if we had an official team of users helping other users.
- LilyPond Report: Keeping a monthly newsletter running is a non-trivial task. A lot of work is needed to organize it; it would be great if we could split up the work. One person could write the Snippet of the Month, another person could do Quotes of the Month, another person could do interviews, etc.
- Documentation: Although GDP (the Grand Documentation Project) did great work, there's still many tasks remaining.
- Translations: Keeping the documentation translations is a monumental task; we need all the help we can get!

Jobs for advanced users for developers

- Git help for writers: We often receive reports of typos and minor text updates to the documentation. It would be great if somebody could create properly-formatted patches for these corrections.

  Technical requirements: ability to run Section 2.1 [LilyDev], page 5.
- LSR editor: LSR contains many useful examples of lilypond, but some snippets are out of date and need updating. Other snippets need to be advertized, and new snippets need to be sorted. We could use another person to handle LSR.

  Technical requirements: use of a web browser. LilyPond requirements: you should be familiar with most of Notation chapters 1 and 2 (or be willing to read the docs to find out).
- Join the Frogs: "Frogs" are a team of bug-fixers (because frogs eat bugs, and you often find them in Ponds of Lilies) and new feature implementors.

  Technical requirements: development environment (such as Section 2.1 [LilyDev], page 5), ability to read+write scheme and/or C++ code.

13.5.3 Policy decisions

There are a number of policy decisions – some of them fairly important – which we have been postponing for a few years. We are now discussing them slowly and thoroughly; agenda and exact proposals are online:

`https://lilypond.org/~graham/gop/index.html`

Below is a list of policies which are not "on the agenda" yet.

Note that the presence of an item on this list does *not* mean that everybody thinks that something needs to be done. Inclusion in this simply means that one developer thinks that we should discuss it. We are not going to filter this list; if any developer thinks we should discuss something, just add it to the bottom of the list. (the list is unsorted)

As GOP progresses, items from this list will be put on the agenda and removed from this list. I generally try to have one month's discussion planned in advance, but I may shuffle things around to respond to any immediate problems in the developer community.

There are some item(s) not displayed here; these are questions that were posed to me privately, and I do not feel justified in discussing them publicly without the consent of the person(s) that brought them up. They will initially be discussed privately on the lilypond-hackers mailing list – but the first question will be "do we absolutely need to do this privately", and if not, the discussion will take place on lilypond-devel like the other items.

In most policy discussions in lilypond over the past few years, the first half (or more) is wasted arguing on the basis of incorrect or incomplete data; once all the relevant facts are brought to light, the argument is generally resolved fairly quickly. In order to keep the GOP discussions focused, each topic will be introduced with a collection of relevant facts and/or proposals. It is, of course, impossible to predict exactly which facts will be relevant to the discussion – but spending an hour or two collecting information could still save hours of discussion.

> **Note:** The estimated time required for "prep work", and the following discussion, has been added to each item. At the moment, there is an estimated 30 hours of prep work and 140 hours of discussion.

- **Patch reviewing**: At the time of this writing, we have 23 (known) patches waiting for review. Some from main developers; some from new developers. We desperately need more people helping with lilypond, but ignoring patches is the best way to drive potential contributors away. This is not good.

  (prep: 2 hours. discuss: 10 hours)
- **Official links to other organizations?**: There's something called the "software freedom conservancy", and in general, there's a bunch of "umbrella organizations". Joining some of these might give us more visibility, possibly leading to more users, more developers, maybe even financial grants or use in schools, etc.

  (prep: 2 hours. discuss: 5 hours)
- **Issue tracking with google code**: We use the google issue tracker, but this means that we are relying on a commercial entity for a large part of our development. Would it be better (safer in the long run) to use the savannah bug tracker?

  (prep: 1 hour. discuss: 5 hours)
- **Patch review tool**: Rietveld is inconvenient in some respects: it requires a google account, and there's no way to see all patches relating to lilypond. Should we switch to something like gerrit? `https://sourceforge.net/p/testlilyissues/issues/1184/`

  (prep: 5 hours. discuss: 15 hours)
- **Clarity for sponsorships**: We currently do not advertize bounties and sponsorships on the webpage. How much advertising do we want, and what type? Should we change the "structure" / "framework" for bounties?

  (prep: 2 hours. discuss: 10 hours)
- **code readability**: "Our aim when producing source code for LilyPond in whatever language is that it should be totally comprehensible to a relatively inexperienced developer at the second reading."

Rationale: - aids maintainability of code base - "second reading" so newer developers can look up unfamiliar stuff - will help to keep things simple, even if the code is doing complex stuff discourages "secret squirrel" coding, e.g. "how much functionality can I squeeze into as few characters as possible" "comments are for wimps" - will aid not *discouraging* new developers to join the project

(prep: 2 hours. discuss: 10 hours)

- **C++ vs. scheme**: what should be in scheme, what should be in C++, what can/should be ported from one to the other, etc. Questions of maintainability, speed (especially considering guile 2.0), and the amount of current material in either form, are important.

  (prep: 5 hours. discuss: 15 hours)

- **always make an issue number for patches**: there is a proposal that we should always have a google code issue number for every patch. This proposal is closely tied to our choice of patch review tool; if we switch to a different tool (as suggested in a different proposal), this proposal may become moot.

  (prep: 1 hour. discuss: 5 hours)

- **initalizer lists**: shoudl we use initalizer lists for C++? AFAIK they make no difference for built-in types, but there's some weird case where it's more efficient for objects, or something.

  Probably not worth making this a weekly thing on its own, but we can probably wrap it up with some other code-related questions.

  (prep: 15 minutes. discuss: 3 hours)

13.5.4 Policy decisions (finished)

Here is a record the final decisions, along with links to the discussions.

13.5.4.1 GOP-PROP 1 - python formatting

We will follow the indentation described in PEP-8. `http://www.python.org/dev/peps/pep-0008/`

- use 4 spaces per indentation level
- never mix tabs and spaces (for indentation)
- Code indented with a mixture of tabs and spaces should be converted to using spaces exclusively

  Once this is done, we should add `python -tt` to the build system to avoid such errors in the future.

There should be absolutely no tab characters for indentation in any `.py` file in lilypond git. All such files should be converted to use spaces only.

Discussions

`https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00060.html`
`https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00084.html`
`https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00310.html`
`https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00574.html`

13.5.4.2 GOP-PROP 2 - mentors and frogs

Nothing much was decided. The list of responsibilities was slightly altered; see the new one in Section 1.4 [Mentors], page 3. We should encourage more use of the Frogs mailing list. There's a list of contributor-mentor pairs in:

`https://github.com/gperciva/lilypond-extra/blob/master/people/mentors.txt`

That's pretty much it.

Discussions

https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00311.html

13.5.4.3 GOP-PROP 3 - C++ formatting

Speaking academically, C++ code style is a "solved problem". Let's pick one of the existing solutions, and let a computer deal with this. Humans should not waste their time, energy, and creativity manually adding tabs or spaces to source code.

We have modified `fixcc.py` to use astyle, along with extra regex tweaks.

- the final script will be run **blindly** on the lilypond source code. We will accept whatever formatting the final version of this script produces, with no manual tweaking.
- patches which have been run through this tool will not be rejected for style reasons. Any code formatting "desires" which are not enforced by `fixcc.py` will not be considered grounds for rejecting a patch.
- for now, this style will not be enforced. It is not cause for concern if patches which do not follow the formatting done by `fixcc.py` are pushed. From time to time, Graham will run the formatter on the entire code base, and commit the resulting changes.

  In a few months, we will tighten up this policy item (with some sort of automatic processing), but that is outside the scope of this policy item and is a matter for later discussion.
- after the proposal is accepted, we will leave some time for existing patches to be accepted and pushed. The script was run on the source code on **2011 August 01**.

GNU code

LilyPond is a GNU project, so it makes sense to follow the GNU coding standards. These standards state:

> We don't think of these recommendations as requirements, because it causes no problems for users if two different programs have different formatting styles.
>
> But whatever style you use, please use it consistently, since a mixture of styles within one program tends to look ugly. If you are contributing changes to an existing program, please follow the style of that program.

(`http://www.gnu.org/prep/standards/html_node/Formatting.html`)

With that in mind, we do not think that we must blindly follow the formatting given by the currrent version of Emacs.

Implementation notes

We can avoid some of the style change pollution in git history by ignoring whitespaces changes:

```
git diff -w
```

Discussions

https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00526.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00796.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00200.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00525.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00751.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00751.html

13.5.4.4 GOP-PROP 4 - lessons from 2.14

History

A brief history of releases:

date (YYYY-MM-DD)	version	comment
2008-10-28	2.11.63	nobody checking regtests
2008-11-17	2.11.64	
2008-11-29	2.11.65	
2008-12-23	2.12.0	
2009-01-01		somewhere around here, Graham becomes officially release manager, but Han-Wen still builds the actual releases
2009-01-01	2.12.1	
2009-01-25	2.12.2	
2009-02-28	2.13.0	
2009-06-01	2.13.1	note jump in time!
2009-06-27	2.13.2	first Graham release?
2009-07-03	2.13.3	
2009-09-09		Graham arrives in Glasgow, gets a powerful desktop computer, and begins serious work on GUB (sending bug reports to Jan). It takes approximately 100 hours until GUB is stable enough to make regular releases.
2009-09-24	2.13.4	
2009-10-02	2.13.5	
2009-10-22	2.13.6	
2009-11-05	2.13.7	
...		
2010-01-13	2.12.3	
...		
2010-03-19	2.13.16	Bug squad starts doing a few regtest comparisons, but IIRC the effort dies out after a few weeks (BLUE)
...		
2010-08-04	2.13.29	Phil starts checking regtests (BLUE)
...		
2011-01-12	2.13.46	release candidate 1 (GREEN)
...		
2011-05-30	2.13.63	release candidate 7 (GREEN)

2011-06-06 2.14.0

Carl's analysis of the bugs

A `csv` spreadsheet is available.

```
https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00852.html
```

```
lilypond-issues-analysis.csv
lilypond-issues-analysis-trim-duplicates.csv
```

There 148 issues marked with Priority=Critical in the tracker.

I've done an analysis, and it looks to me like there was initially a backlog of critical issues that weren't fixed, and little work was being done to eliminate critical issues.

Somewhere about 2010-08-01, critical issues started to disappear, but occasional new ones appeared.

There were a couple of major changes that introduced unanticipated regressions (new spacing code, beam collision avoidance). These produced more than the expected number of regressions.

It appears to me that we didn't really get serious about eliminating critical bugs until about 2010-06-15 or so. After that point, the number of critical bugs more-or-less steadily decreased until we got to a release candidate.

Of particular interest, the first release candidate of 2.14 was released on 2011-01-12. Over the next 10 days, about a dozen bugs were reported and fixed. Release candidate 2 came out on 2011-02-09. No surge of bugs occurred with this release. Candidate 3 came out on 2011-03-13; we got 2 bugs per week. Candidate 4 came out on 2011-03-29; 2 new bugs. Candidate 6 came out on 2011-04-07. We got a couple of bugs per week.

Notes, commentary, and opinions

```
Han-Wen: Overall, I think this cycle took too long
Mike: I agree
Graham: +1
```

Discussions

```
https://lists.gnu.org/archive/html/lilypond-devel/2011-06/msg00797.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00364.html
```

13.5.4.5 GOP-PROP 5 - build system output (not accepted)

This proposal was too broad; after a month of discussion, Graham withdrew the proposal. Portions of it will be introduced in later proposals.

Discussions

```
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00320.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00527.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00753.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg01042.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00116.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00310.html
```

13.5.4.6 GOP-PROP 6 - private mailing list

Potentially sensitive or private matters will be referred to Graham. He will then decide who should discuss the matter on an ad-hoc basis, and forward or CC them on future emails.

For emphasis, the project administrators are Han-Wen, Jan, and Graham; those three will always be CC'd on any important discussions.

The lilypond-hackers mailing list will be removed.

History

There is some unhappy history about this idea in our development community:

```
http://lists.gnu.org/archive/html/lilypond-devel/2010-09/msg00178.html
http://web.archive.org/web/20110325004849/http://news.lilynet.net/spip.
php?article121
http://lists.gnu.org/archive/html/lilypond-devel/2010-11/msg00076.html
```

Other projects

The idea of private mailing lists is hardly uncommon in open-source software. For example,

```
http://lwn.net/Articles/394660/   about debian-private
http://subversion.apache.org/mailing-lists.html  private@
http://www.freebsd.org/administration.html#t-core
http://foundation.gnome.org/legal/   board members pledge
to keep certain matters confidential

every security team of every GNU/Linux distribution and OS
```

In fact, Karl Fogel's "Producing Open Source Software" explicitly suggests a private mailing list for some circumstances:

```
[on granting commit/push access to a contributor]

But here is one of the rare instances where secrecy is
appropriate. You can't have votes about potential committers
posted to a public mailing list, because the candidate's feelings
(and reputation) could be hurt.

http://producingoss.com/en/consensus-democracy.html#electorate
```

Board of governers, voting, etc?

Many projects have an official board of directors, or a list of "core developers", with set term limits and elections and stuff.

I don't think that we're that big. I think we're still small enough, and there's enough trust and consensus decisions, that we can avoid that. I would rather that we kept on going with trust+consensus for at least the next 2-3 years, and spent more time+energy on bug fixes and new features instead of administrative stuff.

Project administrators are Han-Wen, Jan, and Graham.

Discussions

```
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg00783.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg01004.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00117.html
```

13.5.4.7 GOP-PROP 7 - developers as resources

We shall treat developers (and contributors) as **Independent volunteers**: each person does whatever they want, whenever they want. We have busy careers and lives; we make no expectations of action from anybody (with the exception of the 6 people in "Meister" positions).

Discussions

```
https://lists.gnu.org/archive/html/lilypond-devel/2011-07/msg01092.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00087.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00497.html
```

13.5.4.8 GOP-PROP 8 - issue priorities

We will delete the "priority" field of the issue tracker altogether. The "type" system will be tweaked.

Type-critical:

- a reproducible failure to build either `make` or `make doc`, from an empty build tree, in a first run, if `configure` does not report any errors.
- any program behaviour which is **unintentionally** worse than the previous stable version or the current development version. Developers may always use the "this is intentional", or even the "this is an unavoidable effect of an improvement in another area", reason to move this to a different type.
- anything which stops contributors from helping out (e.g. source tree(s) not being available, LilyDev being unable to compile Git master, inaccurate instructions in the Contributor's Guide 2 Quick start).

  To limit this scope of this point, we will assume that the contributor is using the latest LilyDev and has read the relevant part(s) of the Contributor's Guide. Problems in other chapters of the CG are not sufficient to qualify as Type-Critical.

More new/changed types and labels

Unless otherwise specified, the current types and labels will continue to be used. The new types introduced by this proposal are:

- Type-crash: any segfault, regardless of what the input file looks like or which options are given. Disclaimer: this might not be possible in some cases, for example certain guile programs (we certainly can't predict if a piece of scheme will ever stop running, i.e. the halting problem), or if we rely on other programs (i.e. ghostscript). If there are any such cases that make segfault-prevention impossible, we will document those exceptions (and the issue will remain as a "crash" instead of "documentation" until the warning has been pushed).
- Type-maintainability: anything which makes it difficult for serious contributors to help out (e.g. difficult to find the relevant source tree(s), confusing policies, problems with automatic indentation tools, etc).
- Type-ugly: replaces Type-collision, and it will include things like bad slurs in addition to actual collision.

A new label will be added:

- (label) Needs_evidence: it is not clear what the correct output should look like. We need scans, references, examples, etc.

Reminding users about stars

We can remind users that they can "star" an issue to indicate that they care about it. Since we resolved to treat developers as independent volunteers, there is no expectation that anybody will look at those stars, but if any developer want to organize their work schedule according to the stars, they are welcome to do so.

Discussions

https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00019.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00277.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00413.html
https://lists.gnu.org/archive/html/lilypond-devel/2011-08/msg00624.html

13.5.4.9 GOP-PROP 9 - behavior of make doc

If there are build problems, then it should be easier to find out why it's failing. This will be achieved with log files, as well as possibly including scripts which automatically display portions of those log files for a failing build.

We will also add targets for building a specific manual (for quick+easy checking of doc work), as well as for building all documentation in a specific language (either English or a translated language).

When you run `make doc`,

- All output will be saved to various log files, with the exception of output directly from `make(1)`.

  Note that `make(1)` refers to a specific executable file on unix computers, and is not a general term for the build system.

- By default, no other output will be displayed on the console, with one exception: if a build fails, we might display some portion(s) of log file(s) which give useful clues about the reason for the failure.

  The user may optionally request additional output to be printed; this is controlled with the `VERBOSE=x` flag. In such cases, all output will still be written to log files; the console output is strictly additional to the log files.

- Logfiles from calling lilypond (as part of lilypond-book) will go in the relevant `$LILYPOND_BUILD_DIR/out/lybook-db/12/lily-123456.log` file. All other logfiles will go in the `$LILYPOND_BUILD_DIR/logfiles/` directory.

  A single `make doc` will therefore result in hundreds of log files. Log files produced from individual lilypond runs are not under our control; apart from that, I anticipate having one or two dozen log files. As long as it is clear which log file is associated with which operation(s), I think this is entirely appropriate. The precise implementation will be discussed for specific patches as they appear.

- Both stderr and stdout will be saved in `*.log`. The order of lines from these streams should be preserved.

- There will be no additional "progress messages" during the build process. If you run `make --silent`, a non-failing build should print absolutely nothing to the screen.

- Assuming that the loglevels patch is accepted, lilypond (inside lilypond-book) will be run with –loglevel=WARN. `http://codereview.appspot.com/4822055/`

- Ideally, a failing build should provide hints about the reason why it failed, or at least hints about which log file(s) to examine.

If this proposal is accepted, none of these policies will be assumed to apply to any other aspect of the build system. Policies for any other aspect of the build system will be discussed in separate proposals.

Don't cause more build problems

However, there is a danger in this approach, that vital error messages can also be lost, thus preventing the cause of the failure of a make being found. We therefore need to be exceptionally careful to move cautiously, include plenty of tests, and give time for people to experiment/find problems in each stage before proceeding to the next stage.

This will be done by starting from individual lilypond calls within lilypond-book, and slowly moving to "larger" targets of the build system – after the individual lilypond calls are are producing the appropriate amount of output and this is saved in the right place and we can automatically isolate parts of a failing build, we will work on lilypond-book in general, and only then will we look at the build system itself.

Implementation notes

There is an existing make variable QUIET_BUILD, which alter the amount of output being displayed (`https://lilypond.org/doc/v2.15/Documentation/contributor/useful-make-variables`). We are not planning on keeping this make variable.

The standard way for GNU packages to give more output is with a `V=x` option. Presumably this is done by increasing `x`? If we support this option, we should still write log files; we would simply print more of the info in those log files to screen.

The command `tee` may be useful to write to a file and display to stdout (in the case of VERBOSE).

13.6 Unsorted policies

Language-specific mailing lists

A translator can ask for an official lilypond-xy mailing list once they've finished all "priority 1" translation items.

Performing yearly copyright update ("grand-replace")

At the start of each year, copyright notices for all source files should be refreshed by running the following command from the top of the source tree:

```
make grand-replace
```

Internally, this invokes the script `scripts/build/grand-replace.py`, which performs a regular expression substitution for old-year -> new-year wherever it finds a valid copyright notice.

Note that snapshots of third party files such as `texinfo.tex` should not be included in the automatic update; `grand-replace.py` ignores these files if they are listed in the variable `copied_files`.

Push git access

Git access is given out when a contributor has a significant record of patches being accepted without problems. If existing developers are tired of pushing patches for a contributor, we'll discuss giving them push access. Unsolicited requests from contributors for access will almost always be turned down.

Appendix A GNU Free Documentation License

Version 1.3, 3 November 2008

Copyright © 2000, 2001, 2002, 2007, 2008 Free Software Foundation, Inc.
`https://fsf.org/`

Everyone is permitted to copy and distribute verbatim copies
of this license document, but changing it is not allowed.

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document *free* in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondarily, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

The "publisher" means any person or entity that distributes copies of the Document to the public.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

   You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

   You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

   If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both

covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.

B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.

C. State on the Title page the name of the publisher of the Modified Version, as the publisher.

D. Preserve all the copyright notices of the Document.

E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.

F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.

G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.

H. Include an unaltered copy of this License.

I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its

Title Page, then add an item describing the Modified Version as stated in the previous sentence.

J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.

K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.

L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.

M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.

N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.

O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements."

6. COLLECTIONS OF DOCUMENTS

   You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

   You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

   A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

   If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

   Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

   If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

   You may not copy, modify, sublicense, or distribute the Document except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, or distribute it is void, and will automatically terminate your rights under this License.

   However, if you cease all violation of this License, then your license from a particular copyright holder is reinstated (a) provisionally, unless and until the copyright holder explicitly and finally terminates your license, and (b) permanently, if the copyright holder fails to notify you of the violation by some reasonable means prior to 60 days after the cessation.

   Moreover, your license from a particular copyright holder is reinstated permanently if the copyright holder notifies you of the violation by some reasonable means, this is the first time you have received notice of violation of this License (for any work) from that copyright holder, and you cure the violation prior to 30 days after your receipt of the notice.

Termination of your rights under this section does not terminate the licenses of parties who have received copies or rights from you under this License. If your rights have been terminated and not permanently reinstated, receipt of a copy of some or all of the same material does not give you any rights to use it.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See `https://www.gnu.org/copyleft/`.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation. If the Document specifies that a proxy can decide which future versions of this License can be used, that proxy's public statement of acceptance of a version permanently authorizes you to choose that version for the Document.

11. RELICENSING

"Massive Multiauthor Collaboration Site" (or "MMC Site") means any World Wide Web server that publishes copyrightable works and also provides prominent facilities for anybody to edit those works. A public wiki that anybody can edit is an example of such a server. A "Massive Multiauthor Collaboration" (or "MMC") contained in the site means any set of copyrightable works thus published on the MMC site.

"CC-BY-SA" means the Creative Commons Attribution-Share Alike 3.0 license published by Creative Commons Corporation, a not-for-profit corporation with a principal place of business in San Francisco, California, as well as future copyleft versions of that license published by that same organization.

"Incorporate" means to publish or republish a Document, in whole or in part, as part of another Document.

An MMC is "eligible for relicensing" if it is licensed under this License, and if all works that were first published under this License somewhere other than this MMC, and subsequently incorporated in whole or in part into the MMC, (1) had no cover texts or invariant sections, and (2) were thus incorporated prior to November 1, 2008.

The operator of an MMC Site may republish an MMC contained in the site under CC-BY-SA on the same site at any time before August 1, 2009, provided the MMC is eligible for relicensing.

ADDENDUM: How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

```
Copyright (C)  year  your name.
Permission is granted to copy, distribute and/or modify this document
under the terms of the GNU Free Documentation License, Version 1.3
or any later version published by the Free Software Foundation;
with no Invariant Sections, no Front-Cover Texts, and no Back-Cover
Texts.  A copy of the license is included in the section entitled ``GNU
Free Documentation License''.
```

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the "with. . . Texts." line with this:

```
with the Invariant Sections being list their titles, with
the Front-Cover Texts being list, and with the Back-Cover Texts
being list.
```

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.