Reaper Plugins for the LilypondToBandVideoConverter (Version 1.1)

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Contents

1. Introduction

1.1 Overview

The "Reaper Plugins for the LilypondToBandVideoConverter" package provides Lua plugins for being used in the Reaper DAW [Reaper]; they assist in using the LilypondToBandVideoConverter tool chain for generating notation videos from arrangement text files.

LilypondToBandVideoConverter (or short ltbvc, [LTBVC]) is a command line audio processing tool written in Python for Unix, Windows and Mac OS that uses standard command-line tools to convert a music piece (a song) written in the lilypond notation to

- a PDF score of the whole song,
- several PDF voice extracts,
- a MIDI file with all voices (with additional preprocessing applied to achieve some humanization),
- audio mix files with several subsets of voices (specified by configuration), and
- video files for several output targets visualizing the score notation pages and having the mixes as mutually selectable audio tracks as backing tracks.

Because that command-line oriented approach is a bit tedious, the current package provides several scripts for the Reaper DAW to make this process easier.

1.2 Available Scripts

The following scripts are provided:

AdaptTracksToLTBVCConventions.lua:
applies specific theme and layouts to the tracks and routes audio according to LTBVC conventions,

AdjustSoXEffectNames.lua:
sets the effect names of the SoX effects to the command line strings required for processing outside of the Reaper DAW,

ExportLilypond.lua:
transforms the notes of the selected MIDI item into a textual lilypond note/chord sequence and returns them in a text box,

ImportMidi.lua:
scans the current project for tracks with single MIDI items with names conforming to some pattern and replaces those by the corresponding track in an associated MIDI file filtering out unwanted MIDI items before import,

MakeRegionsFromRegionStructureTrack.lua:
either makes regions based on a track with structural MIDI items or generates that region structure track with MIDI items from the current regions, and

NormalizeStructuredVoiceTracks.lua:
scans all tracks with some specific prefix and normalizes their enclosed MIDI items by removing reverb, chorus and delay control codes, setting note velocities to some default and quantizing the note start and end positions.

2. Installation of the Plugins

The installation is as follows:

1. Copy the Reaper Plugins for the LilypondToBandVideoConverter archive from the repository in [LTBVCPlugins] and unpack it to some temporary directory.
2. Close the Reaper application (if open).
3. Copy the lua-files from the archive subdirectory src into the Lua subdirectory of the Reaper installation (typically in \Program Files\Reaper\Lua or /Applications/Reaper.app/Lua in MacOS).
4. If helpful, also copy the documentation file from the archive subdirectory doc to the Lua sub-directory.
5. Restart Reaper. You should now be able to access the scripts as actions in the Actions menu of Reaper. It is helpful to define some keyboard shortcuts for those actions for a quicker access.

Alternatively — and a little bit easier — you can use the ReaPack plugin [ReaPack] and do an automatic install via the index.xml file in the repository [LTBVCPlugins]. After the installation via ReaPack all the scripts can be found in the action list of the Reaper installation via the prefix LTBVCPlugins_; so, for example, the lilypond export script has the action name LTBVCPlugins_ExportLilypond.lua.

3. Description of the Plugins

3.1 Motivation for the Plugins

Motivation for all the scripts presented here is to allow input and adaptation of MIDI notes of some arrangement in the Reaper DAW, but then easily integrate that into a ltbvc pipeline. Part of this approach is also that one can quickly import the tracks of the generated MIDI file from that external pipeline for checking whether the ltbvc and the DAW project are in sync.

To be able to do this, one should first organize MIDI items in the DAW corresponding to the voices and the musical structure of the piece into *structured voice tracks*. It is also helpful when the names of those tracks adhere to some naming pattern (because one of the tools relies on that).

When you have your project organized in such a way is then possible to

- reflect the musical structure as regions based on the items in some track (see section 3.5),
- sets the tracks' layouts in the mixer according to LTBVC conventions and routes the audio accordingly (see section 3.2),
- normalize the structured voice tracks by removing unwanted control codes and quantizing the note positions to a raster compatible with the later lilypond export (see section 3.6),
- export MIDI items in the structured voice tracks as lilypond fragments (see section 3.3),
- repeatedly import the MIDI file generated by ltbvc into special project tracks e.g. for a detailed comparison with the structured voice tracks (see section 3.4), and
- adjust the effect names of the SoX effects in the DAW to the command line fragments needed when doing an external rendering (see section 3.7) and also make all of them available in a dialog windows.

Figure 1 shows the structuring of the demo song from the ltbvc. Note that this Reaper DAW file is also included in the current distribution.

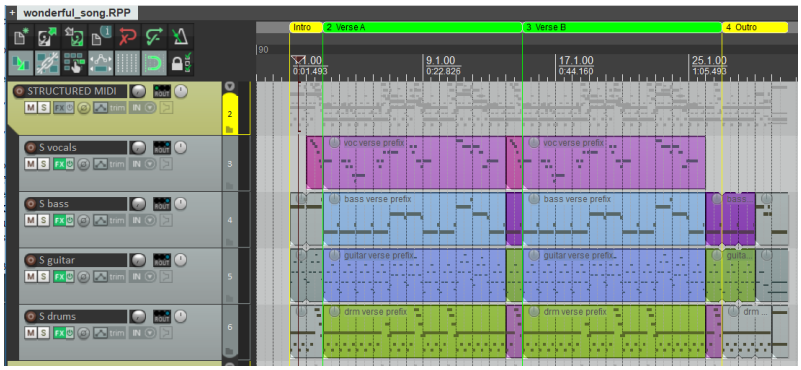


Figure 1: Structured MIDI Representation of Demo Song from ltbvc

3.2 AdaptTracksToLTBVCConventions

When a project in a DAW is aimed at emulating the ltbvc tool chain, it is helpful to organize the tracks in a certain manner.

There are seven groups of tracks:

- (optional) tracks with original audio as reference material,
- structured MIDI voice tracks that contain MIDI data for the voices and have loops or aliases indicating the musical structure of voice/song (with MIDI converted to audio by some VST instrument),
- MIDI voice tracks generated by the "midi" phase of the external tool chain (where all structure is expanded, but the MIDI data should be almost identical to the structured MIDI tracks see 3.4), which also have their MIDI converted to audio by some VST instrument,
- raw audio voice tracks generated by the "rawaudio" phase of the external tool chain (where MIDI is rendered as audio but no SoX effects have been applied),
- plain effect voice tracks containing all the SoX effects applied to each voice similar to the "refinedaudio" phase of the external tool chain,
- refined audio voice tracks generated by the "refinedaudio" phase of the external tool chain (as reference tracks), and
- final audio voice tracks where refined audio is panned and has its volume adjusted for the final mix

Each group has its own "folder track" such that they can be individually muted.

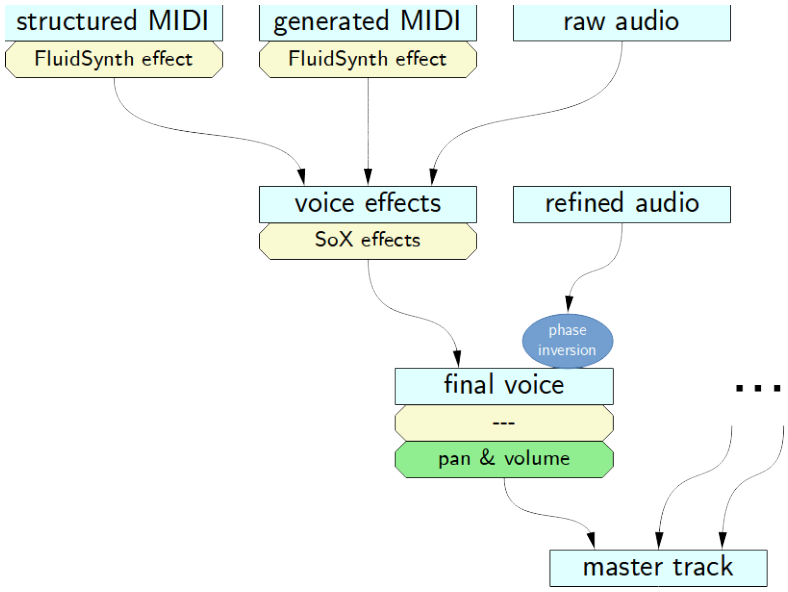


Figure 2: Audio Routing Along Voice Tracks

This project structure seems to be overly complex, but the idea behind that is to factor out commonalities between the tracks.

For each voice the following is done (as shown in figure 2):

- The structured MIDI track, the generated MIDI track and the raw audio track are routed into the plain SoX effect track for that voice. Routing is pre-FX for the raw audio track and post-FX for both the MIDI tracks.

  This means that the identical SoX effect chain is applied to all those audio source. Because the MIDI tracks have a FluidSynthPlugin as their MIDI-to-audio converter, in principle all those tracks should provide the same audio signal (apart from the missing humanization in the structured track).

- The output of the voice SoX effect track and the refined audio track are both routed into the voice mix track to have pan and volume applied for the final mix. Routing is pre-FX for the refined audio track and post-FX for the effect track.

  As an additional trick the refined audio track is phase inverted. This means that when both effect track and refined audio track deliver some audio signal, **those should completely cancel out**. This helps when checking whether the internal and external effects chain is identical.

- Finally all voice mix tracks are mixed into the (stereo) master track post-fader.

It is also clear, that not all tracks need all kinds of interaction, for example in the mixer panel. An effect track or a raw audio track does not have to have a volume fader or a pan control because those are handled in the voice mix track. A raw or refined audio track does not need any effects: its media is just routed into another track following.

Hence it is helpful to change the appearance of the tracks accordingly. Reaper allows to customize the track layout as required, so there is a layout style to be preferably applied to an ltbvc project.

The whole proceedure looks tedious: routing tracks and setting their layout to reflect their function manually.

Fortunately the script AdaptTracksToLTBVCConventions does all that. It connects tracks as given in figure 2 via some naming conventions and also applies track layouts to them.

Both naming convention and layout assignment is handled by the script based on a so-called "configuration file". This is a text file that defines several variables and is either located in the script directory or in the directory .luasettings in the user's home directory. (For a detailed description of configuration files see the ltbvc documentation [LTBVC].)

The variables relevant for this script are trackKindToNamePatternMap, trackNamePatternWithParentDisabledList, and trackNamePatternToConnectionDataMap.

trackNamePatternToConnectionDataMap tells the routing partners for specific name patterns signifying track categories (e.g. effects or raw audio tracks). The variable maps each of those category track name pattern (in convention of the programming language Lua) as the connection source onto a capturing pattern giving the destination track name together with the position of the send and the information whether some phase inversion is done.

For example, the map entry

```
"'^E%s+(%S.*)' : [ '^F%s+%1', 'postFX', true  ],"
```

tells that an effect track (starting with an "E" character and some white space followed by the voice name) is connected to a correspondig track starting with an "F" letter and some white space followed by the same track name. Routing is post-FX and a phase inversion is also applied.

Hence the default variable definition matching figure might look like

```
trackNamePatternToConnectionDataMap = "{"
    "'^E%s+(%S.*)' : [ '^F%s+%1', 'postFX', false ],"
    "'^M%s+(%S.*)' : [ '^E%s+%1', 'postFX', false ],"
    "'^RA%s+(%S.*)': [ '^E%s+%1', 'preFX',  false ],"
    "'^RF%s+(%S.*)': [ '^F%s+%1', 'preFX',  true  ],"
    "'^S%s+(%S.*)' : [ '^E%s+%1', 'postFX', false ]"
"}"
```

That default naming convention for the track routing assumes track names

TRACK KIND	TRACK NAME PREFIX
original track	O␣
structured MIDI track	S␣
generated MIDI track	M␣
raw audio track	RA␣
effect track	E␣
refined audio track	RF␣
mix track	M␣

Figure 3: Default Naming Conventions for Tracks

as given by the table in figure 3.

The variable trackNamePatternWithParentDisabledList gives a list of patterns for tracks names that are not directly connected to the master track.

So for example the setting

```
trackNamePatternWithParentDisabledList = "["
    "'^E%s+%S.*$', '^RA%s+%S.*$'," ...
"]"
```

makes sure that effect tracks as well as raw audio track (with the convention from above!) are not connected to the master track.

trackNamePatternToColorAndLayoutMap is a map with each entry being a regular expression string mapped onto a pair of colour and name of some layout in Reaper.

For example, the entry

```
"'^E%s+': [ 0xFF8080, 'gf - Effect Bus' ]"
```

tells that a track with name starting with "E" followed by at least one blank shall be set to colour light blue (=0xFF8080 in BGR-notation) and to a layout named "gf - Effect Bus".

So the variable could be set to

```
trackNamePatternToColorAndLayoutMap = "{"
    "'^EFFECTS': [ 0xFF0000, 'gc - Grouping without FX'],"
    "'^E%s+':    [ 0xFF8080, 'gf - Effect Bus' ]"
"}"
```

When the script is run on the demo project, the routing is adapted (as shown in figure 2) and the mixer will look like shown in figure 4.

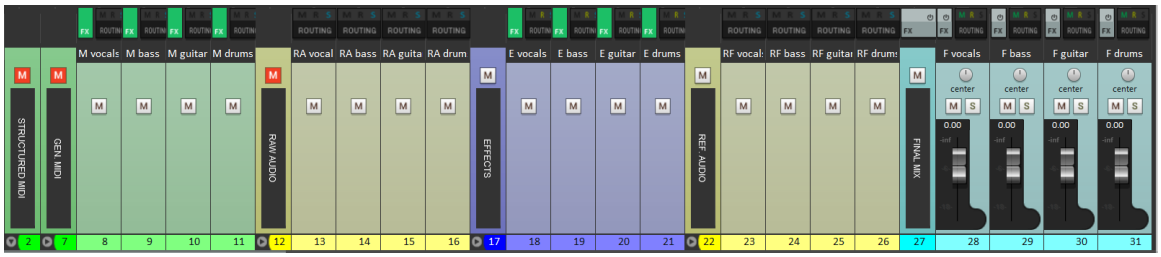


Figure 4: Standardized ltbvc Track Layout in Mixer

3.3 ExportLilypond

The command here is applied to some selected MIDI item and transforms its notes into a textual lilypond note/chord sequence and finally returns it in the Reaper message box. One can then copy the text into the clipboard and insert it into a lilypond file for the song and later processing by the ltbvc.

The notes produced by the script are in English notation. That means for example, an $f\sharp$ (**f** **s**harp) note is "fs", an $e\flat$ (**e** **f**lat) note is "ef". The algorithm analyzes the underlying MIDI notes along the measures and groups them into the least possible number of notes still conforming to score guidelines. Chords are automatically detected.

This generation of notes is dependent on a line in the project settings defining the key. E.g. the line key=f in figure 5 defines the key of some song to be "f" (major). Only major keys can be defined, but, however, this only affects whether accidentals used shall be sharps or flats.

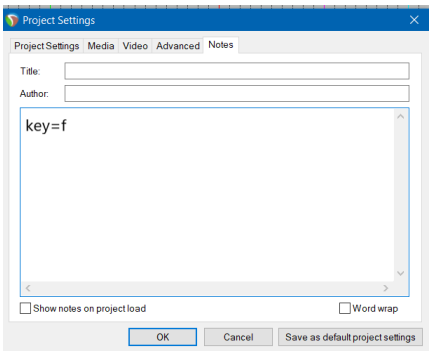


Figure 5: Key Definition for ExportLilypond

All instruments have a default octave defined by their names, where the note sequences start as follows:

- bass, keyboardBottom $\rightarrow C_1$,
- keyboard $\rightarrow C_2$,

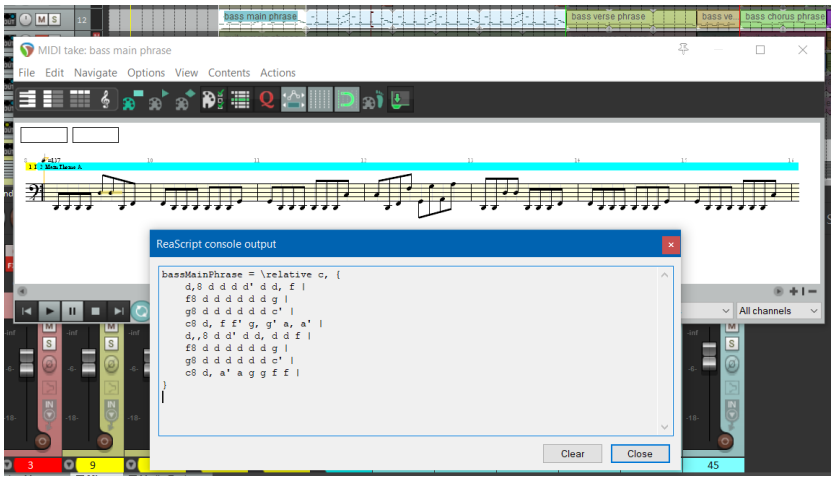


Figure 6: Exporting a Bass MIDI Item

- guitar, keyboardTop, strings $\rightarrow C_3$,
- vocals $\rightarrow C_4$, and
- drums, percussion $\rightarrow$ drum clef

So, for example, a guitar fragment will start with the lilypond text \relative c' $(= C_3)$, a bass fragment with \relative c, $(= C_1)$.

Activating the action on some MIDI item puts the resulting MIDI fragment into the message box as shown in figure 6.

Doing the same for some drum MIDI item puts the resulting MIDI fragment also into the message box as shown in figure 7, but uses drum notation instead. This is triggered by the item name starting with either "drums " or "percussion ".

The durations in the output are optimized for being conformant to standard notation practice and also switch from and to triplets when appropriate.

A note will be split into parts tied together when its duration is not allowed its start position due to notation standards. For example, when in a measure a quarter note follows a sixteenth note, it will be split into a sixteenth note and a dotted eighth note to conform to notation guidelines. Figure 8 shows how a simple note sequence is transformed by the algorithm.

Note that the minimum note duration allowed is a 32^{nd}-note or a 32^{nd}-triplet. If the item converted is not quantized accordingly, typically some strange note durations like "e?77?" will occur in the result where this signifies a note with a duration of 77 MIDI ticks (which is 77/240 of a quarter note) that cannot be split into meaningful durations.

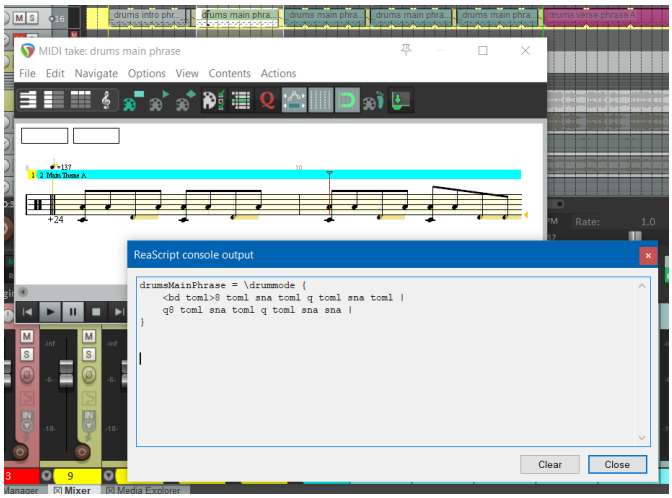
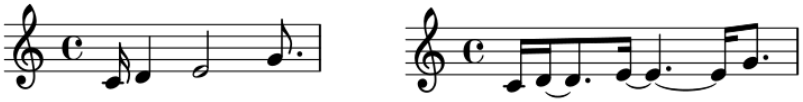


Figure 7: Exporting a Drums MIDI Item



notes before split notes after split

Figure 8: Splitting Notes on Musical Raster Positions

3.4 ImportMidi

The ltbvc pipeline produces a temporary MIDI file with some humanization applied. It is helpful to import that file into tracks repeatedly to see the consequences of changes in the lilypond file.

Doing this manually is tedious, especially because MIDI tracks in the project may be at arbitrary positions.

Fortunately the tracks generated by the ltbvc have a predictable structure and naming of tracks. Hence this script scans the DAW project for tracks conforming to that convention: those are tracks with a single MIDI item, where its item name ends with ".mid" and it gives the voice name followed by the name of the MIDI file.

For example, a MIDI item "bass - wonderful_song-std.mid" is the bass voice in an imported MIDI file "wonderful_song-std.mid" from the ltbvc.

For the import the location of the MIDI file has to be specified; this is done by the configuration variable midiFilePath in the project settings (see figure 9). It gives the relative path of the directory containing the MIDI file from ltbvc.

The processing by the script is as follows:

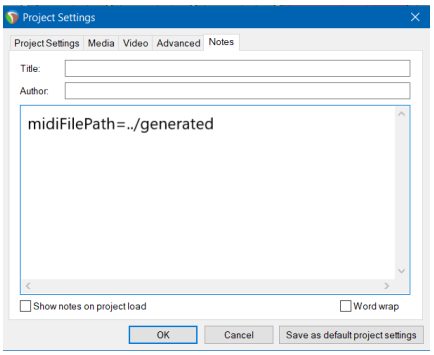


Figure 9: Relative Path Definition for MIDI Import

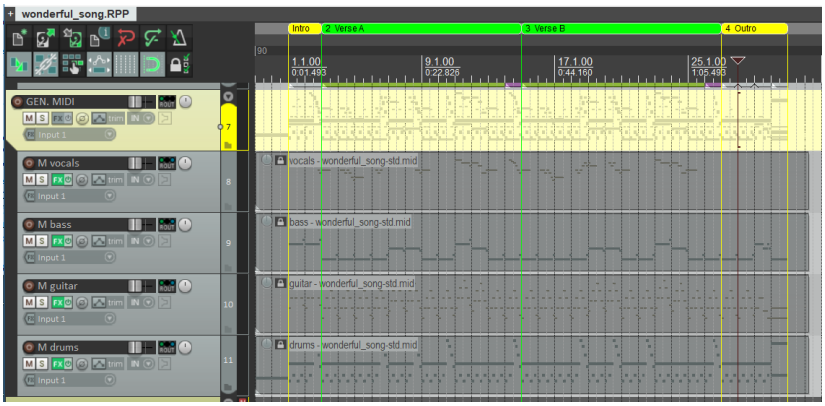


Figure 10: "Updateable" MIDI Tracks of Demo Song

- The referenced MIDI file is imported into new temporary tracks.
- All existing tracks with matching names ("«instrument name» - «MIDI file name»" are updated from the imported tracks.
- The new temporary tracks are deleted.
- Some filtering is done on the imported MIDI items: pan, reverb and volume control codes are removed (because they shall be provided by DAW controls and effects).
- All those items are set to "locked" (because they should not be changed manually, because they will be overwritten by the next import).

The example song has four MIDI tracks for each of the voices; figure 10 shows those tracks, their items with the appropriated names in the demo Reaper project.

3.5 MakeRegionsFromRegionStructureTrack

As mentioned in section 3.3 it is practical to structure the MIDI items according to the song structure. Reaper provides so-called *regions* along the timeline, which are very helpful in organizing a project.

Unfortunately they are a bit tedious to use: duplicating them or coloring them requires many clicks even when you use the "Region/Marker Manager" of Reaper.

The script MakeRegionsFromRegionStructureTrack simplifies this at the expense of using another track with the region information encoded into items. It makes regions from the MIDI items in a track called "STRUCTURE" by copying their positions and also reuses their coloring and naming. So you can quickly adjust the MIDI items in the structure track and then regenerate the regions from it.

It is also possible to vice versa generate that "STRUCTURE" track with this script.

When the script is started the dialog of figure 11 appears.

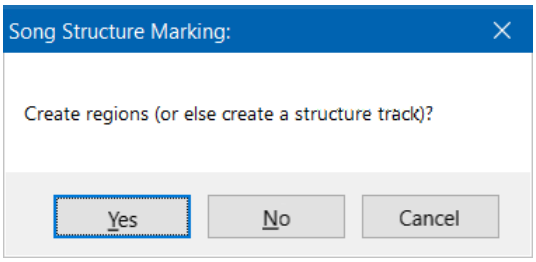


Figure 11: Selection Dialog for MakeRegionsFromRegionStructureTrack

Depending on the selection (assuming you do not select cancel) the following happens:

- For a selection of "Yes" (create regions) a track called "STRUCTURE" is searched for. First each region is deleted. Then for each MIDI item on that track a new region is created having the same start time, end time, name and color as the item.
- For a selection of "No" (create structure track) a track called "STRUCTURE" is searched for and is created if non-existent. Each existing MIDI item on that track is deleted. Then for each region a new MIDI item is created on that track having the same start time, end time, name and color as the region.

Figure 12 shows the structure track and the generated regions for the demo song.

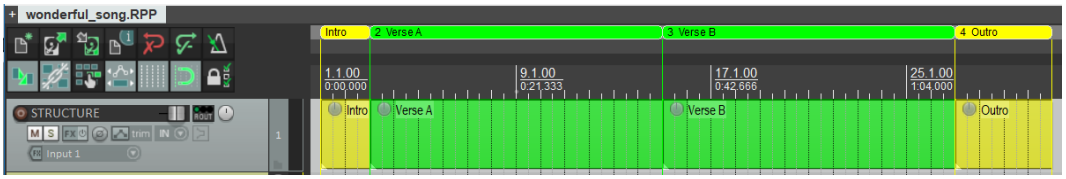


Figure 12: Regions and Structure Track in Comparison

3.6 NormalizeStructuredVoiceTracks

The list of MIDI items for the structured approach as describe in section 3.3 should be located in tracks that adhere to some naming pattern.

In that case, the script NormalizeStructuredVoiceTracks can be used. It scans all MIDI items in structured MIDI voice tracks and normalizes their note velocity, quantizes note to the raster necessary for later export and removes unwanted MIDI control events.

Only those MIDI items in tracks are considered whose track names conform to a certain naming pattern. That pattern is — as with other scripts — defined in a line in the project settings using the variable structuredMidiTrackNamePattern and it specifies the regular expression a voice track name has to match. For example, the line structuredMidiTrackNamePattern="S␣.*" in figure 13 defines the name pattern for the voice track names to be "S␣.*". This means the name of a voice structure track must start with a capital "S" followed by a blank character. Note that that is the default when you do not specify any pattern.

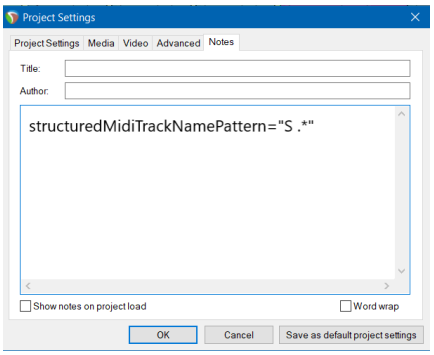


Figure 13: Settings for Selection of Structured MIDI Tracks

Each MIDI item in the voice structure tracks is transformed as follows:

- Note velocities are set to a default value (80).
- Note positions and lengths are moved to the raster necessary for later lilypond export by the script Exportlilypond.

- MIDI control codes for volume, pan and reverb are removed (because they shall be provided by DAW controls and effects).

3.7 AdjustSoXEffectNames

In the "refinedaudio" phase of the external tool chain SoX is used for applying audio effects to the raw audio. In the DAW the SoX plugins from [SoXPlugins] emulate the external SoX program bit-identically.

When tweaking the SoX plugins, the command lines for the SoX program can be easily extracted from the DAW. This is done by the script AdjustSoXEffectNames.

The script does two things:

- The correct command line text for the corresponding SoX effect is used as the name of the SoX plugin in the DAW.
- For all tracks containing SoX plugins, track name and the command line for the effects are written into Reaper's message window.

Figure 14 shows an example of the command line generation for a SoX phaser effect.

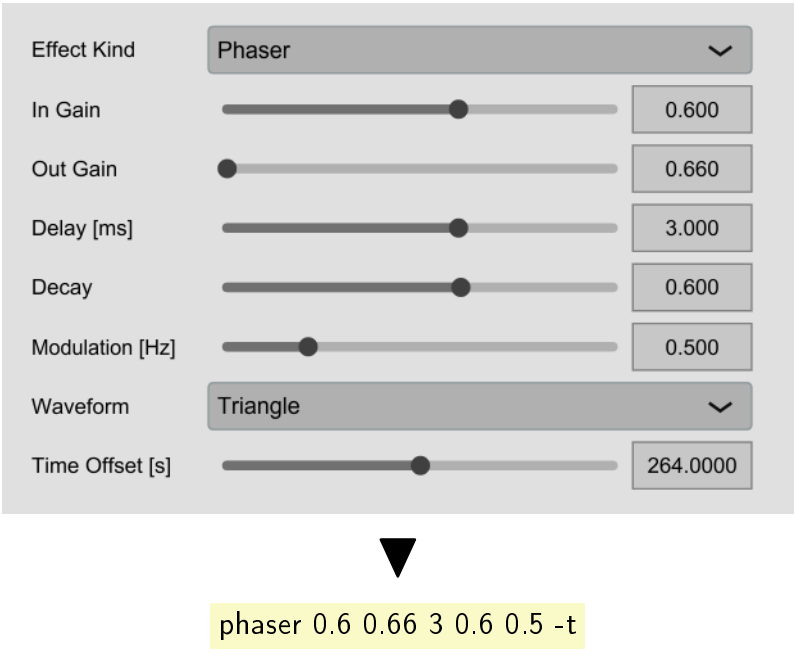


Figure 14: Extraction of Command Line Fragment for SoX Effect Plugin

4. Demo Song

Included in this installation is a Reaper demo file with tracks for the demo song of the ltbvc.

The following tracks are contained in the project:

- a region structure track,
- structured voice tracks for all four voices (vocals, bass, guitar and drums) routed to the corresponding effect tracks,
- the MIDI tracks from the generated MIDI file routed to the corresponding effect tracks,
- raw audio tracks (generated by the ltbvc pipeline) routed to the corresponding effect tracks,
- effect tracks enhancing MIDI or raw audio tracks, and
- refined audio tracks (generated by the ltbvc pipeline)

Because this project file should work with a standard Reaper installation without any additional plugins, the MIDI to audio conversion is done with the stock ReaSamplOmatic plugin plus some external samples; also the audio effects for refinement are stock effects. This is acceptable for trying out the plugins described in this document, but does not faithfully reproduce the sound of the external pipeline.

For a realistic impression of the external MIDI to audio conversion, one also needs a soundfont player fully compatible with the fluidsynth player [Fluidsynth] used in the ltbvc pipeline. One candidate is the FluidSynthPlugin that almost faithfully emulates the external fluidsynth player (apart from some deviations described in its documentation [FluidSynthPlugin]).

If you want to emulate the SoX effects from the external pipeline (as mentioned in the ltbvc documentations) you'll have to install specific SoX emulation plugins (for example, the SoX plugins from [SoXPlugins]) and then adapt the effect tracks accordingly.

5. Coping with Errors

If one of the scripts does not work as expected or even issues an error message, how can you find out what really went wrong?

All the scripts do some fine-grained entry-exit-tracing of relevant function calls into a log file; its last lines should give you some indication about the error.

The log files are written into a directory given by the environment variables REAPERLOGS, TEMP and TMP (in the order given). If none of those variables is set, the directory "/tmp" is used.

The log file name is "reaper_" followed by the script name, so, for example, the script exportLilypond writes its log to the file "reaper_exportLilypond.log" in the directory given by one of the environment variables given above.

Figure 15 shows how a log file looks like. Each line shows either an entry of a function (">>"), an exit from a function ("<<") and a log line within a function ("--") together with a time indication.

```
                              ...
>>Reaper.Project.current
>>Reaper.Project._make
<<Reaper.Project._make: Project(0)
<<Reaper.Project.current: Project(0)
>>ImportMIDI.findMidiFileFromTracks: Project(0)
>>Reaper.Project.trackList: Project(0)
>>Reaper.Project.trackCount: Project(0)
<<Reaper.Project.trackCount: 21
>>Reaper.Generics.makeList: container = Project(0), kind = Track, count = 21
--Reaper.Generics.makeList: processing element 1
>>Reaper.Project.trackByIndex: self = Project(0), index = 1
>>Reaper.Project.trackCount: Project(0)
<<Reaper.Project.trackCount: 21
>>Reaper.Generics.findElementByIndexRaw: container = Project(0), index = 1
>>Reaper.Track._make
<<Reaper.Track._make: Track(id = '{93AA75D3-5F86-49B1-AFF1-31DC7C0C349C}', name
= 'STRUCTURE')
<<Reaper.Generics.findElementByIndexRaw: Track(id = '{93AA75D3-5F86-49B1-AFF1-31
DC7C0C349C}', name = 'STRUCTURE')
<<Reaper.Project.trackByIndex: Track(id = '{93AA75D3-5F86-49B1-AFF1-31DC7C0C349C
}', name = 'STRUCTURE')
                              ...
```

Figure 15: Extract from a Log File (for ImportMidi)

Bibliography

[Fluidsynth] *FluidSynth - Software synthesizer based on the SoundFont 2 specifications.*
https://fluidsynth.org

[FluidSynthPlugin] Thomas Tensi.
FluidSynth-Plugins
https://github.com/prof-spock/FluidSynthPlugin

[LTBVC] Dr. Thomas Tensi.
LilypondToBandVideoConverter - Generator for Notation Backing Track Videos from Lilypond Files.
https://github.com/prof-spock/LilypondToBandVideoConverter

[LTBVCPlugins] Dr. Thomas Tensi.
Reaper Plugins for the LilypondToBandVideoConverter.
https://github.com/prof-spock/Reaper-LTBVC-Plugins

[ReaPack] Christian Fillion.
ReaPack: Package manager for REAPER.
https://reapack.com

[Reaper] Cockos Incorporated.
Reaper Digital Audio Workstation.
https://reaper.fm

[SoXPlugins] Dr. Thomas Tensi.
SoX Plugins - A Reimplementation of the SoX Commandline Processor as DAW Plugins.
https://github.com/prof-spock/SoX-Plugins