Musician's Workbench
User's Guide

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Introduction

The Musician's Workbench is a collection of interoperating tools which will allow the musician to produce music score by playing their instrument.

The Musician's Workbench is designed to work on a desktop computer running Widows Vista or later. Windows 7 and Windows 8.1 were used during development. It will not run on Windows XP, Linux, or iOS. The Musician's Workbench will run on a Windows tablet. The user interface is not designed to be finger friendly so this is not recommended.

The Musician's Workbench is the flagship product of Sound Analysis. There may be other products in the future with reduced functionality designed for Windows tablets. Most development effort will be spent on developing new tools and functionality for the Musician's Workbench.

Installation

Before installing the Musician's Workbench; make sure that you have version 4.5 (or later) of the .NET framework installed. If not you can get it from Microsoft at:

http://www.microsoft.com/en-us/download/details.aspx?id=30653

If you have a previous version or the Musician's Workbench installed uninstall that first. You will not lose your saved settings.

The installation files are delivered as a zip file. Extract the file to any location on your computer, and then run setup.exe.

The Workbench Metaphor

The Musician's Workbench consists of 4 panes. The left hand pane has fixed tools including a tool store. The other three panes are initially empty. Tools from the tool store can be dragged into any of the empty panes; tools may be dragged from one pane to another. Multiple tools can exist in any pane. All of the panes are completely resizable. This will allow the musician to configure the Musician's Workbench to his liking. The Musician's Workbench saves the configuration on exit so that next time the Musician's Workbench starts it has the previous configuration.

Tools may be disposed of by clicking the X in the tab; this will completely dispose of the tool and all of its state. Or the tool may be dragged into the recycling bin where it will be inactive, but will retain its state. Tools in the recycle bin may be recovered. Recycling bin contents are lost when the Musician's Workbench is closed.

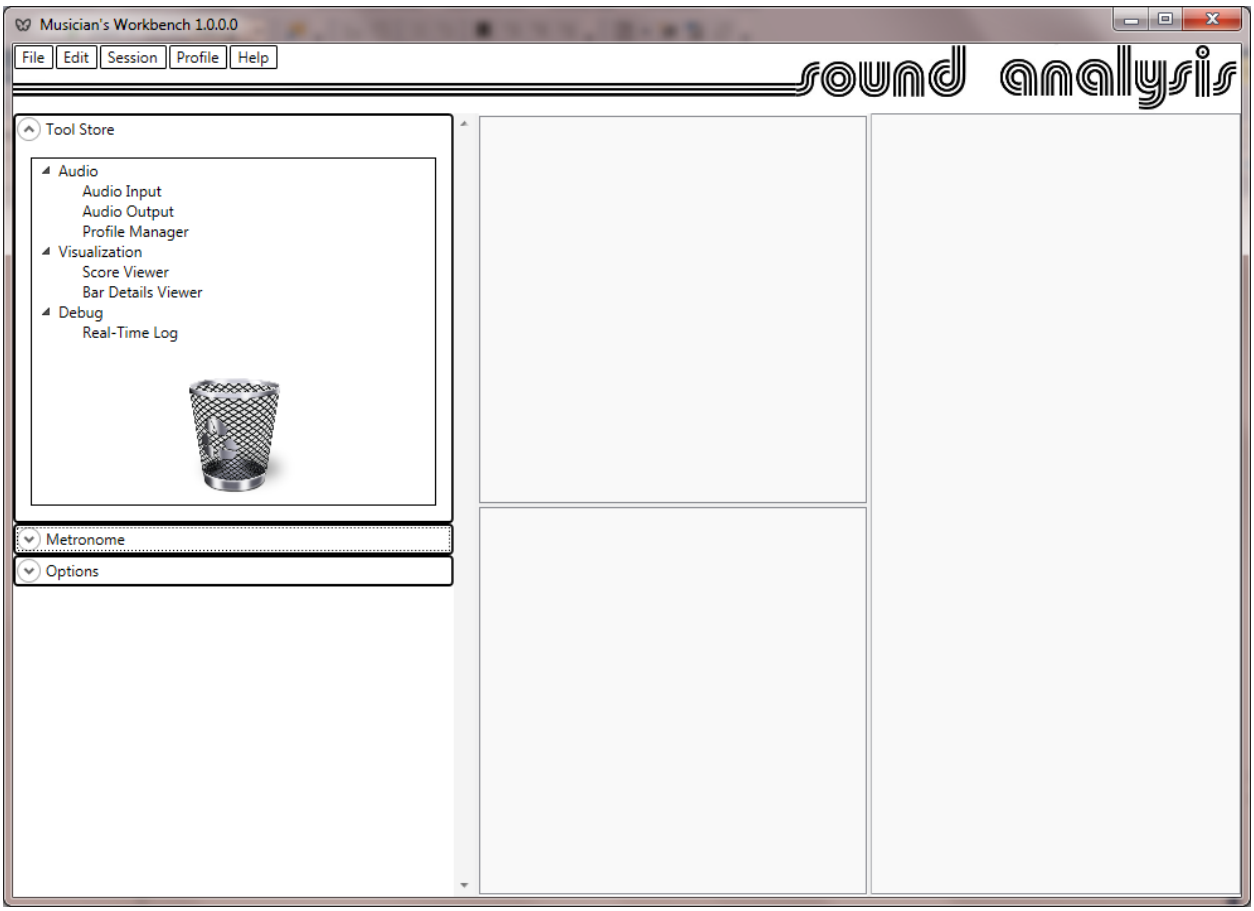


Figure 1 : Musician's Workbench initial state.

Help

Clicking Show Users Guide under the Help Menu will launch this document.

The info symbol ⓘ will appear in many places, clicking this will bring up a help message about the control associated with the symbol.

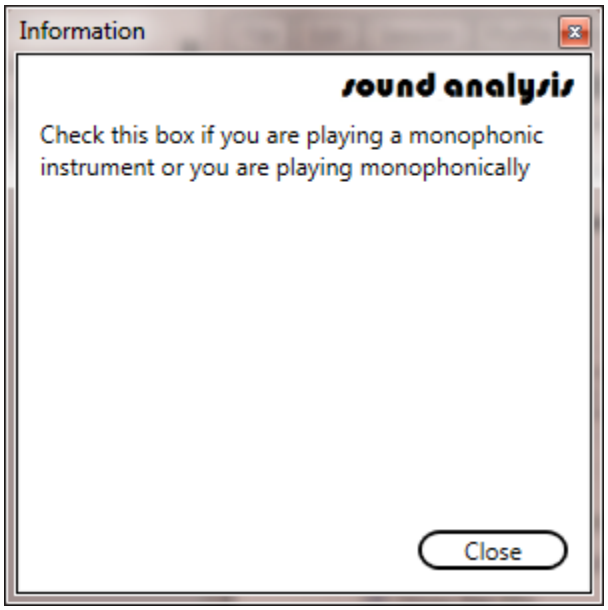


Figure 2 : Help dialog for the Monophonic check box

Tool Store

The tool store lists the tools available for use with the Musician's Workbench. The tools listed may be instantiated in any Musician's Workbench panes by using the right mouse button to drag and drop them into a pane.

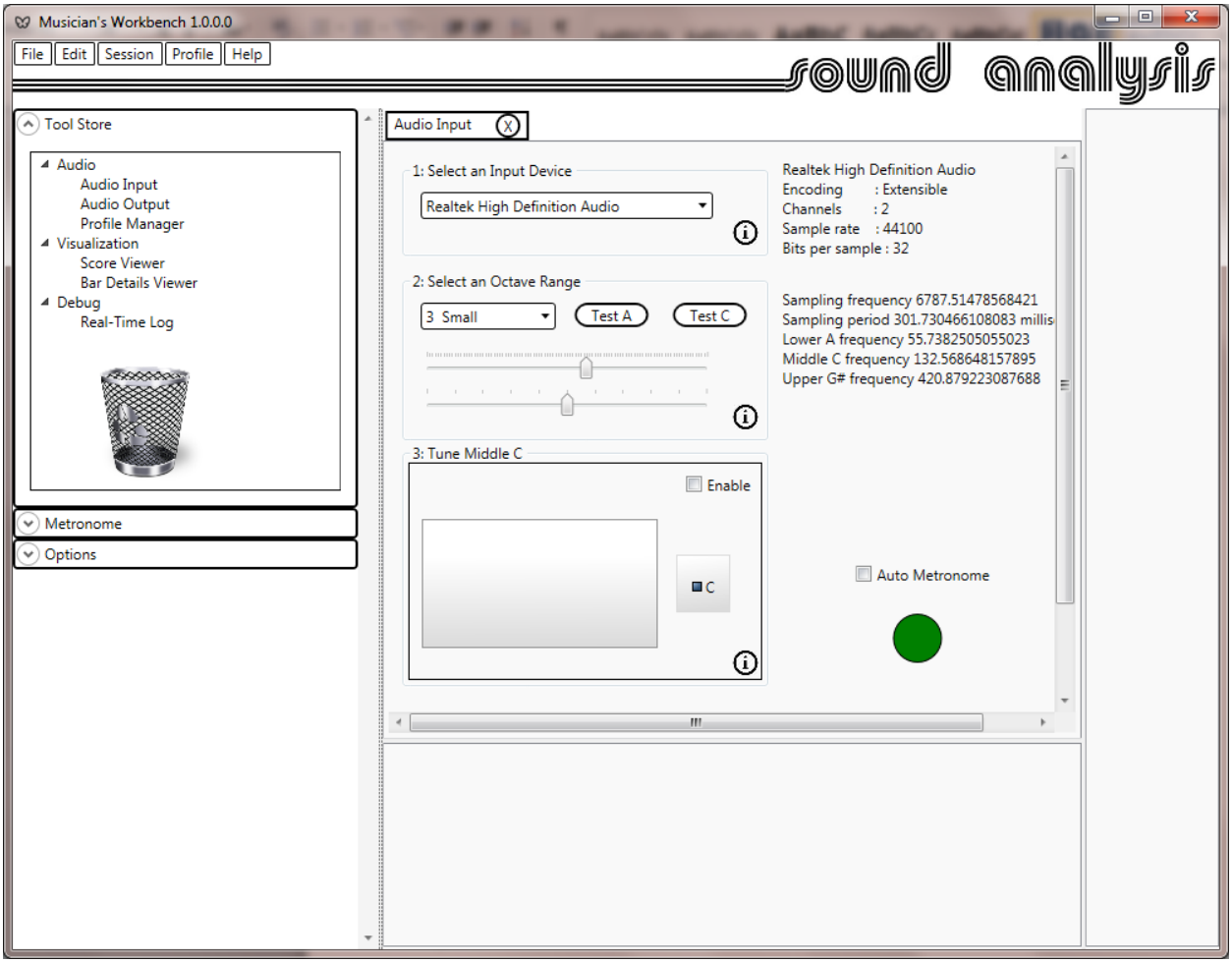


Figure 3 : The Musician's Workbench with one tool instantiated

Once a tool has been dragged into a pane it will appear within a tab. The name of the tool will appear in the tab along with a delete button. Clicking the delete will dispose of the tool instance permanently. You can always drag another instance from the tool store.

Recycling Bin

To dispose of tools in a less permanent way you can drag them to the recycling bin in the tool store. There they will be inactive, but, retain their existing state. To retrieve a tool from the bin right click on the bin, a list of tools in the bin will appear. Click to select the tool you wish to retrieve, then use the right mouse button to drag it back to any pane.

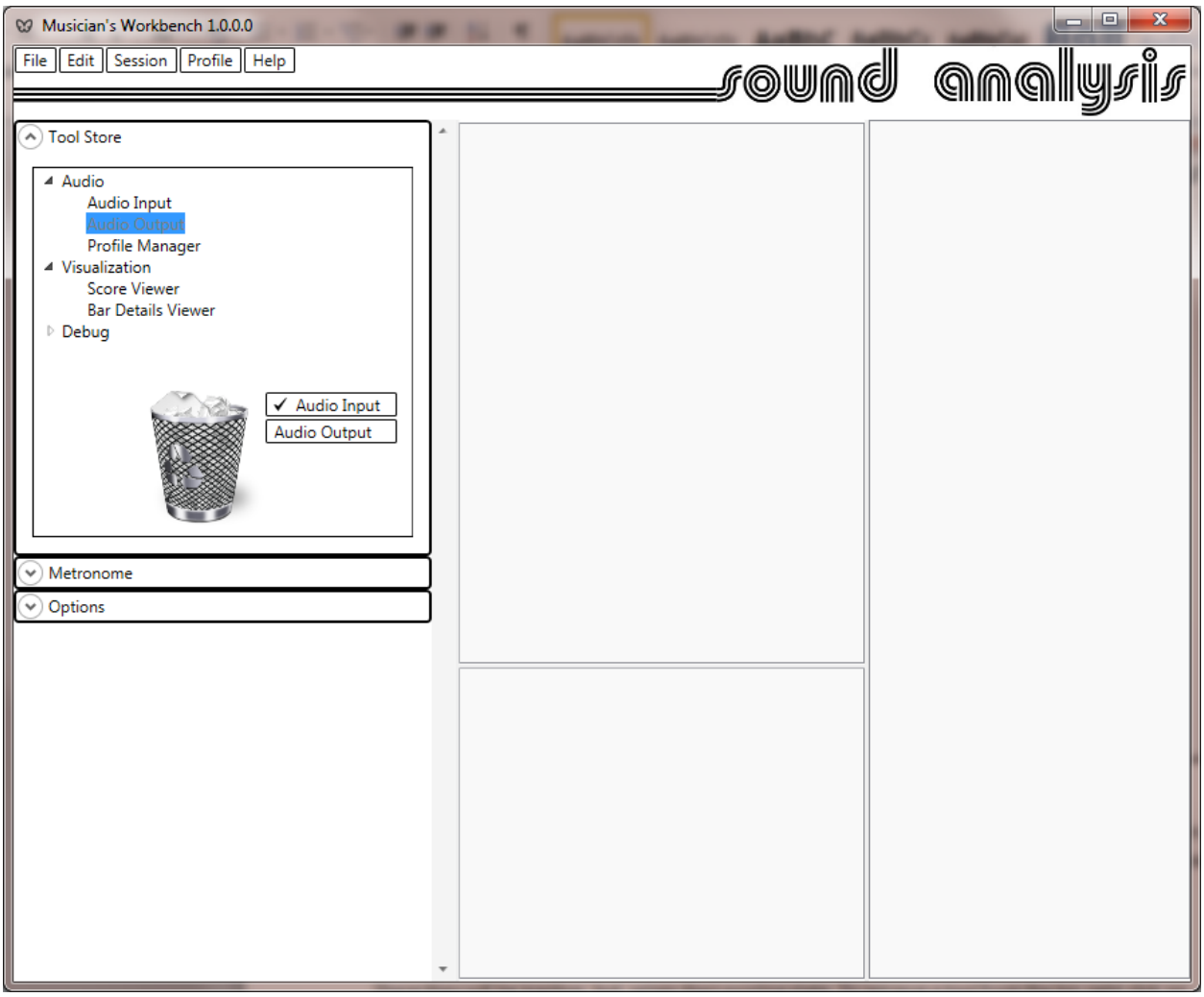


Figure 4 : Recycle bin content selection

Metronome

The second of the fixed tools is the Metronome. This tool defines beat and time signature.

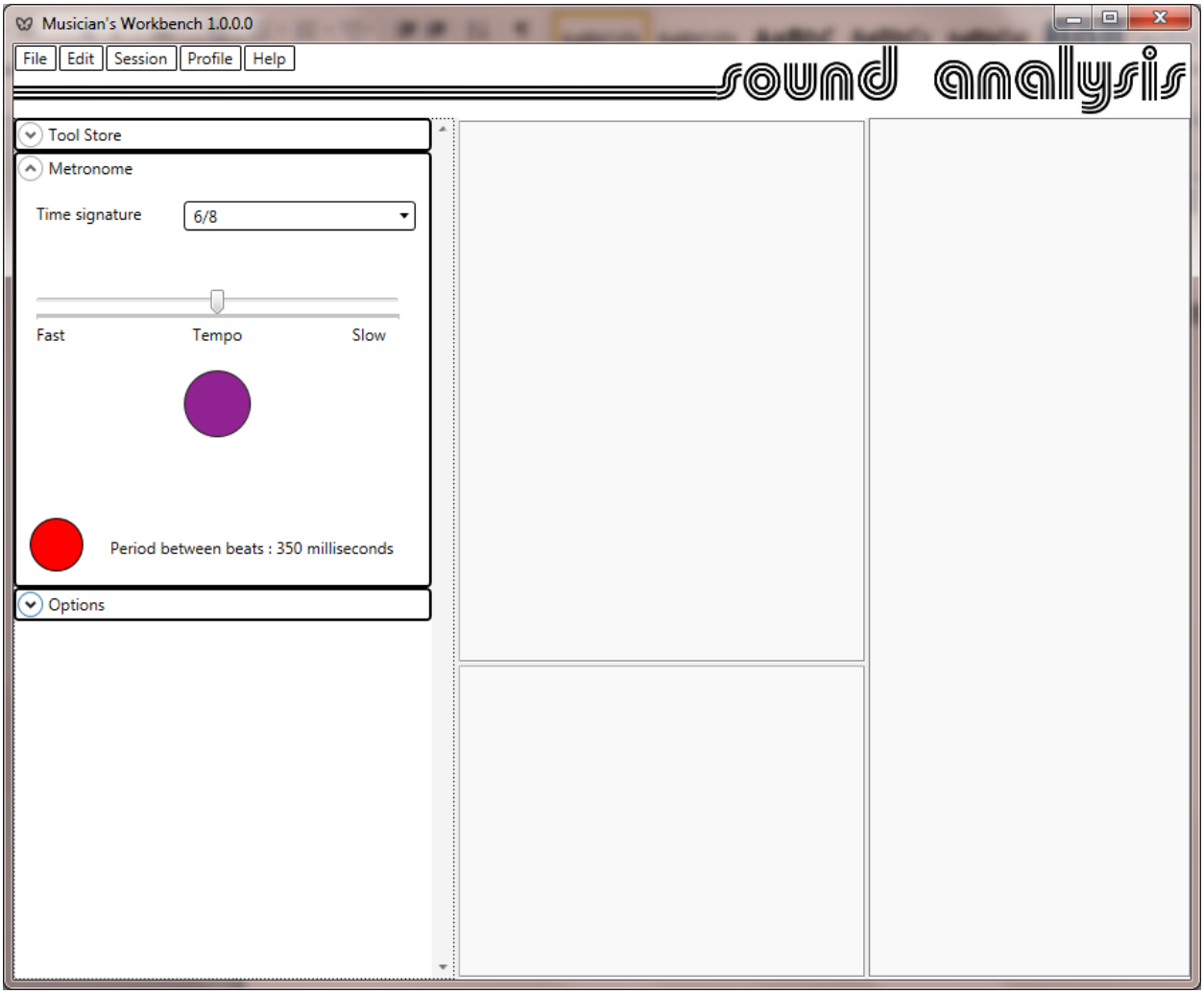


Figure 5 : The Metronome

The Metronome will provide a visible and audible beat. The selected time signature will define the rhythm of the Metronome and also the time signature used to score the music. The Metronome drives the entire transcription process by timing the audio samples captured by the audio input tool.

Options

The options shown are concerned with score display.

The signal processing options are concerned with fine tuning the transcription pipeline. Generally you should leave these in their default or recommended settings. These will be discussed later in the Digging Deeper section.

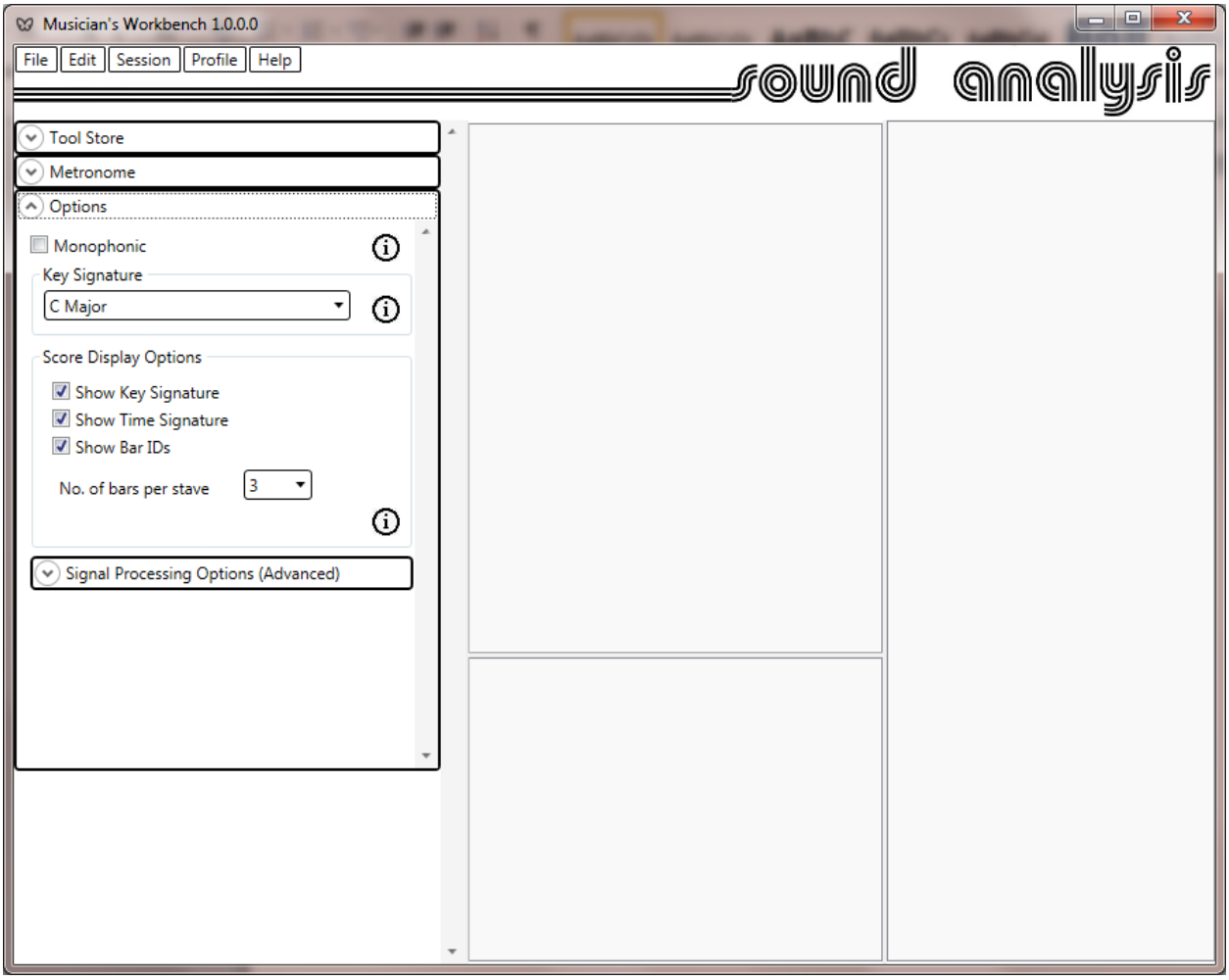


Figure 6 : Options

The Monophonic check box should be ticked if you are playing a monophonic instrument or are playing monophonically.

The Key Signature should be chosen so as minimize the number of accidentals in the score. The first example shows the best selection with no accidentals required

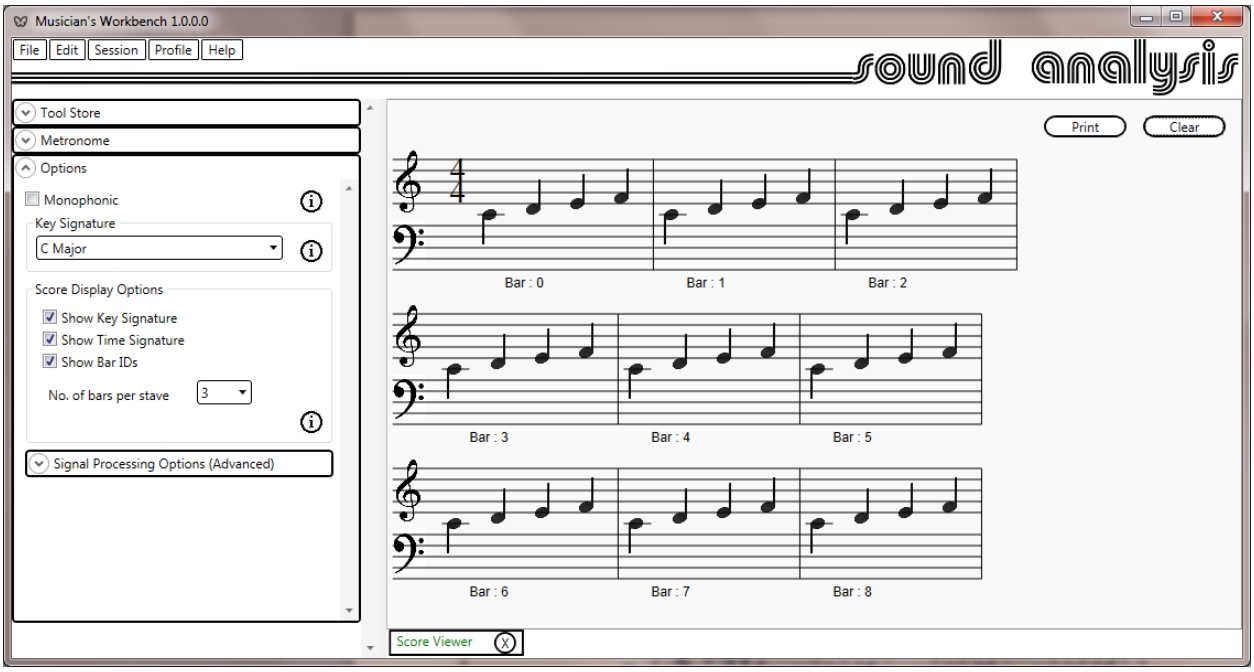


Figure 7 : C D E F in C Major

This second example with exactly the same notes played shows the worst possible selection, requiring every note to be preceded by an accidental.

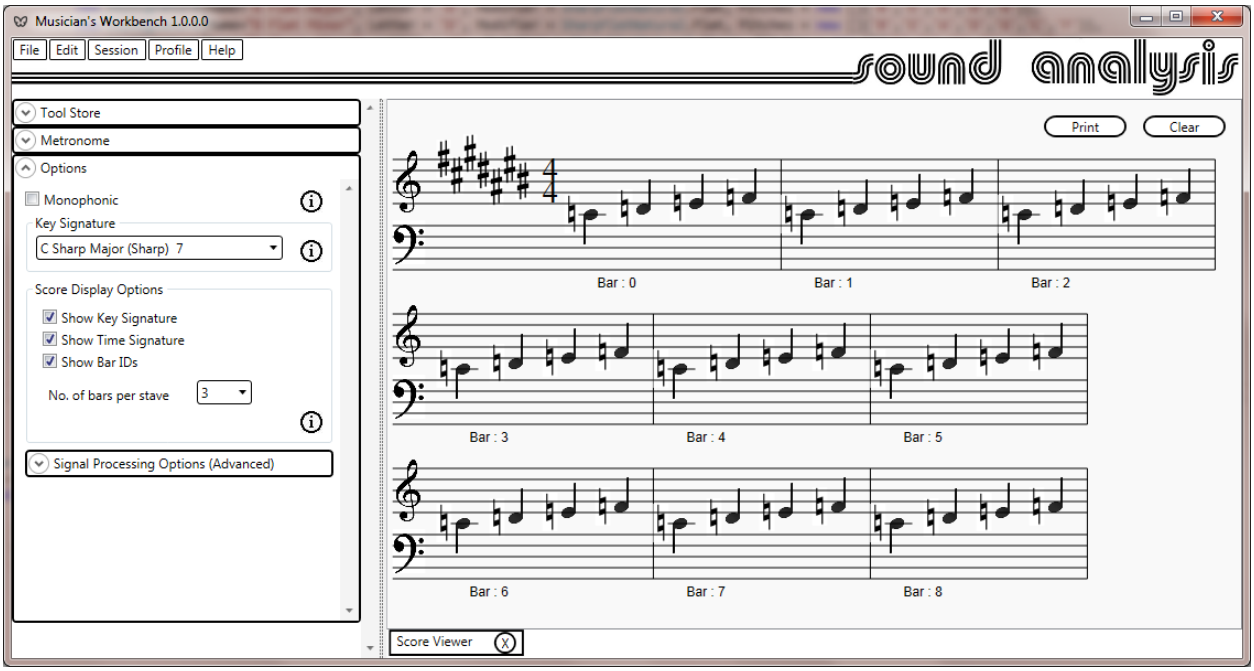


Figure 8 : C D E F in C Sharp Major

Once a session is complete it can be reprocessed with a different key signature by clicking Session -> Reprocess Session from the menu bar.

The score display options will control the score shown in the score viewer. Key and time signature will usually be required before printing. The bar ID will not be wanted on the final score, but will be useful for deeper analysis. There will be more details later.

The number of bars per stave should be adjusted to control the width of the score before printing. This will vary depending on the time signature selected; for 4/4 time 3 bars is the best choice, but for 8/8 time 2 bars will be better.

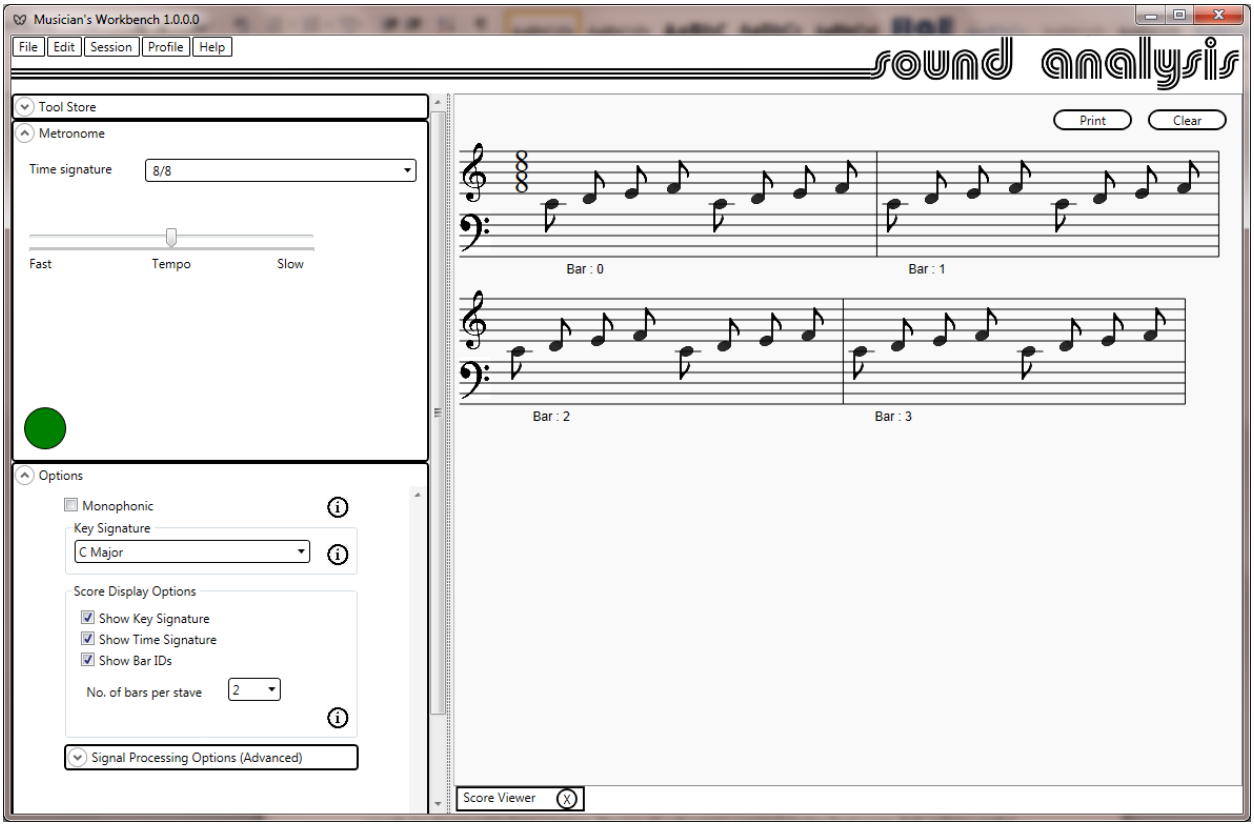


Figure 9 : 8/8 time with 2 bars per stave

Audio Input Tool

Connecting your instrument

There are a few ways to connect your instrument to the computer.

Most modern electronic keyboards will have a USB connection available. There are products such as Guitar Link http://www.behringer.com/EN/Products/UCG102.aspx which will convert a ¼" mono jack cable to USB. Or an external or built-in microphone could be used.

Once you have connected your instrument check that the sound can be sampled by opening the properties dialog for the recording device, checking 'Listen to this device'. You should now be able to hear your instrument through the computers speakers. If you can, you are good to go. You can uncheck the 'Listen to this device' check box.

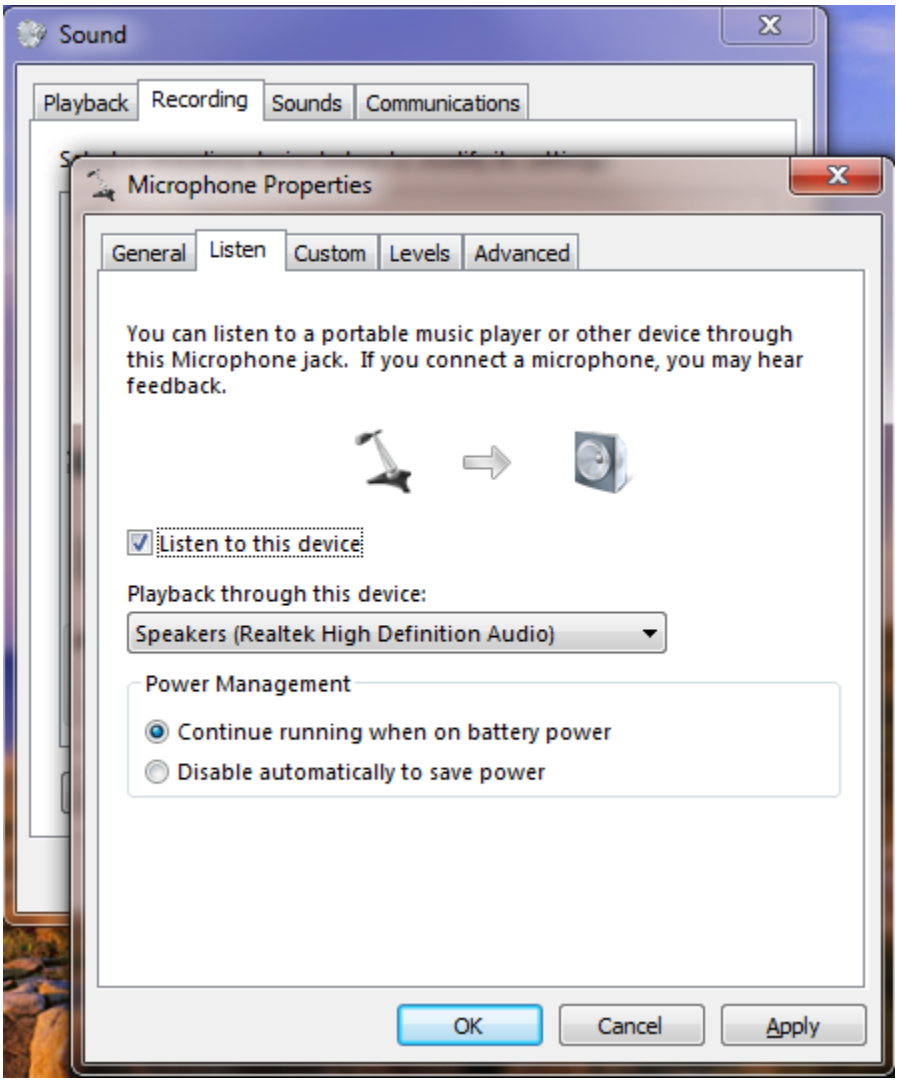


Figure 10 : Checking your instruments connection

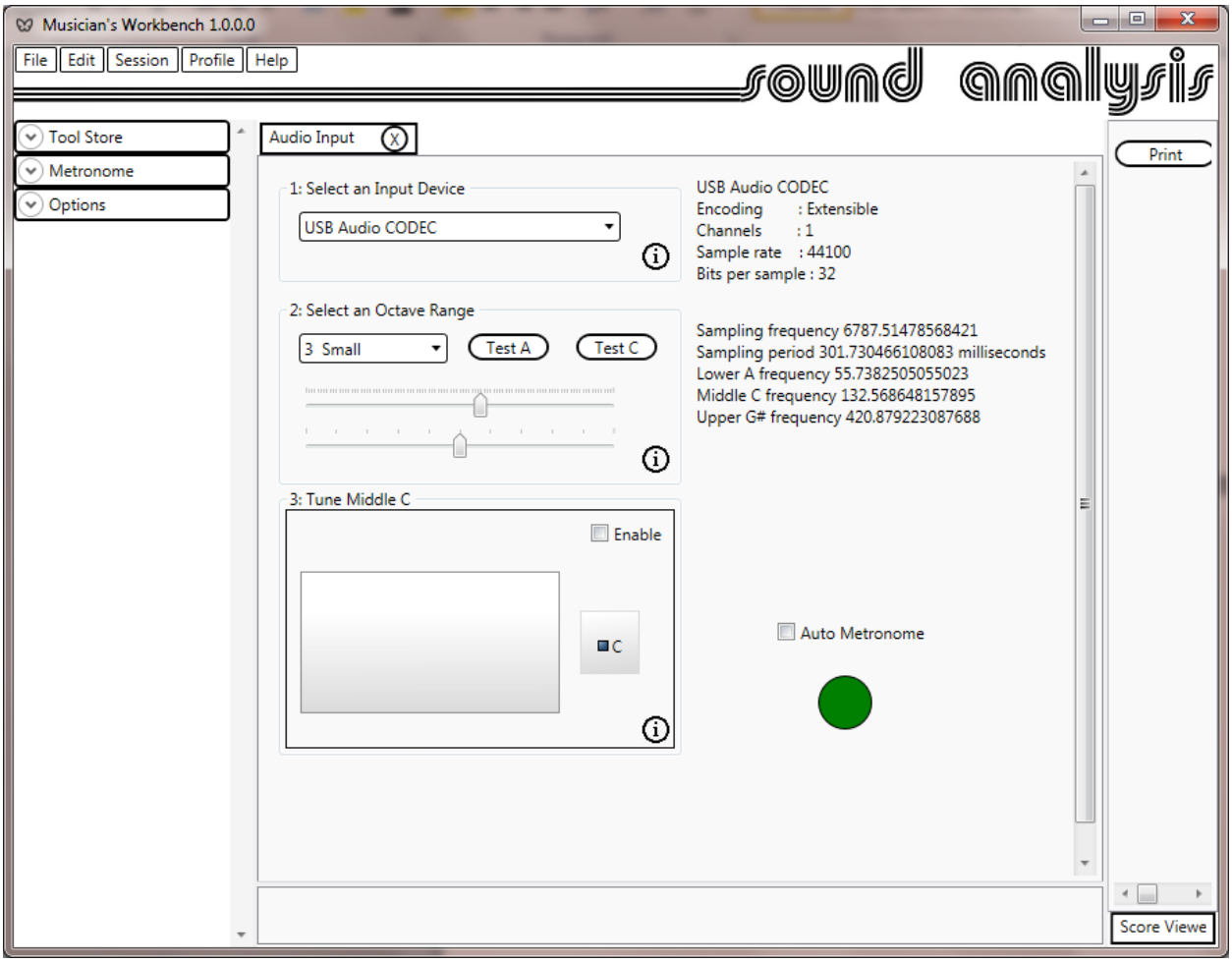


Figure 11 : The Audio Input tool

Now that your instrument is connected, use the drop down to select the audio input.

Tuning the Audio Input to your instrument

The Musician's Workbench supports 7 octave ranges; from contra to four-lined. Octave designations are explained here http://en.wikipedia.org/wiki/C_(musical_note)

You should select the octave to align middle C with your instrument. The test C button will sound the selected middle C for the selected octave.

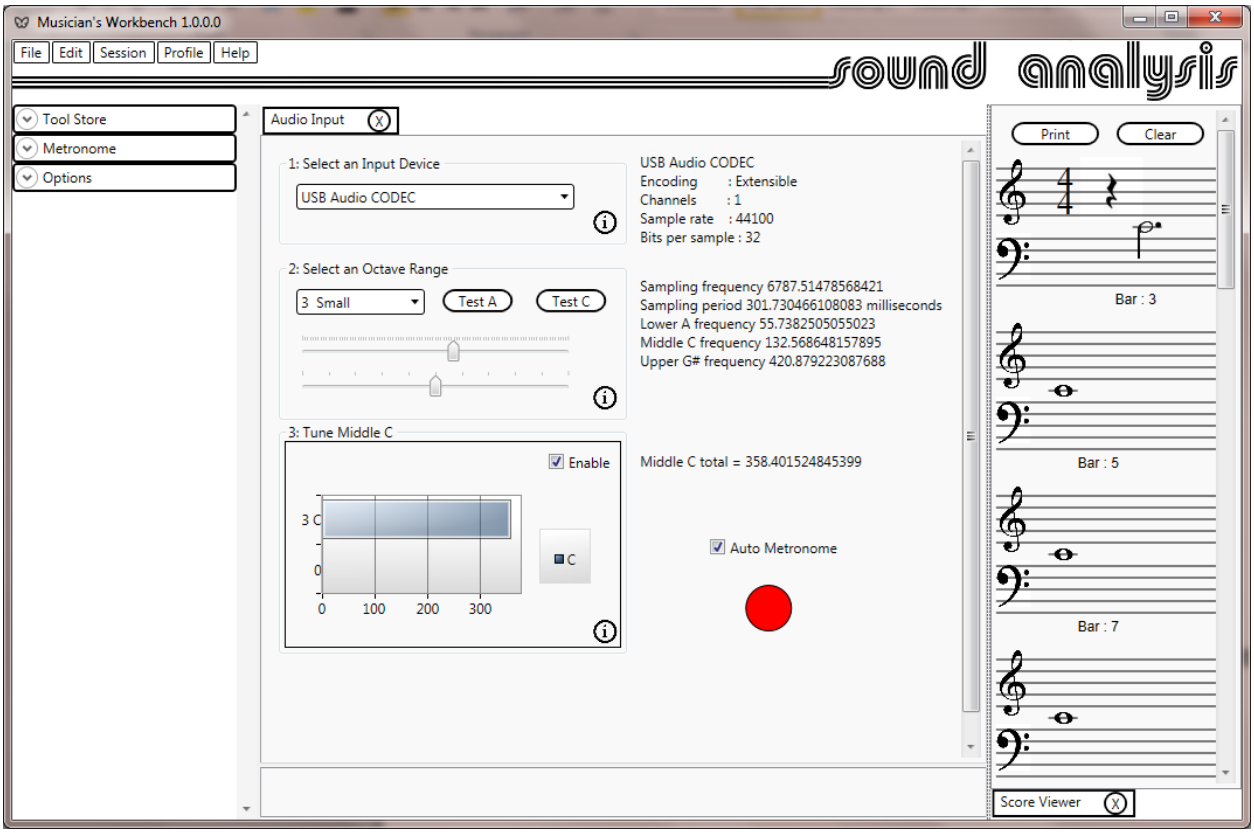


Figure 12 : Fine tuning

Now that the correct octave is selected fine tuning is required. You will need to tune middle C.

1. In the 'Tune Middle C' display check the enable check box.
2. Check the auto metronome check box.
3. Click the Green button which will turn red.
4. Play Middle C on your instrument.
5. Use the upper slider then the lower slider to maximize the Middle C total value.
6. If you have the score viewer open you should see a score with just middle C on it.
7. Uncheck enable and auto metronome.

You will only need to do this once as the workshop will remember these settings when it is closed, so it is worth spending a little time to be accurate.

Metronome and tuning relationship

The tuning of middle C defines the effective sampling frequency required. The number of samples is fixed so that the sampling period will vary.

This means that the metronome period must be long enough to accommodate the sampling period (plus a small overhead). Playing a bass instrument to a fast metronome cannot work. If the metronome is too fast for the tuning a warning will appear at the bottom of the Audio Input tool.

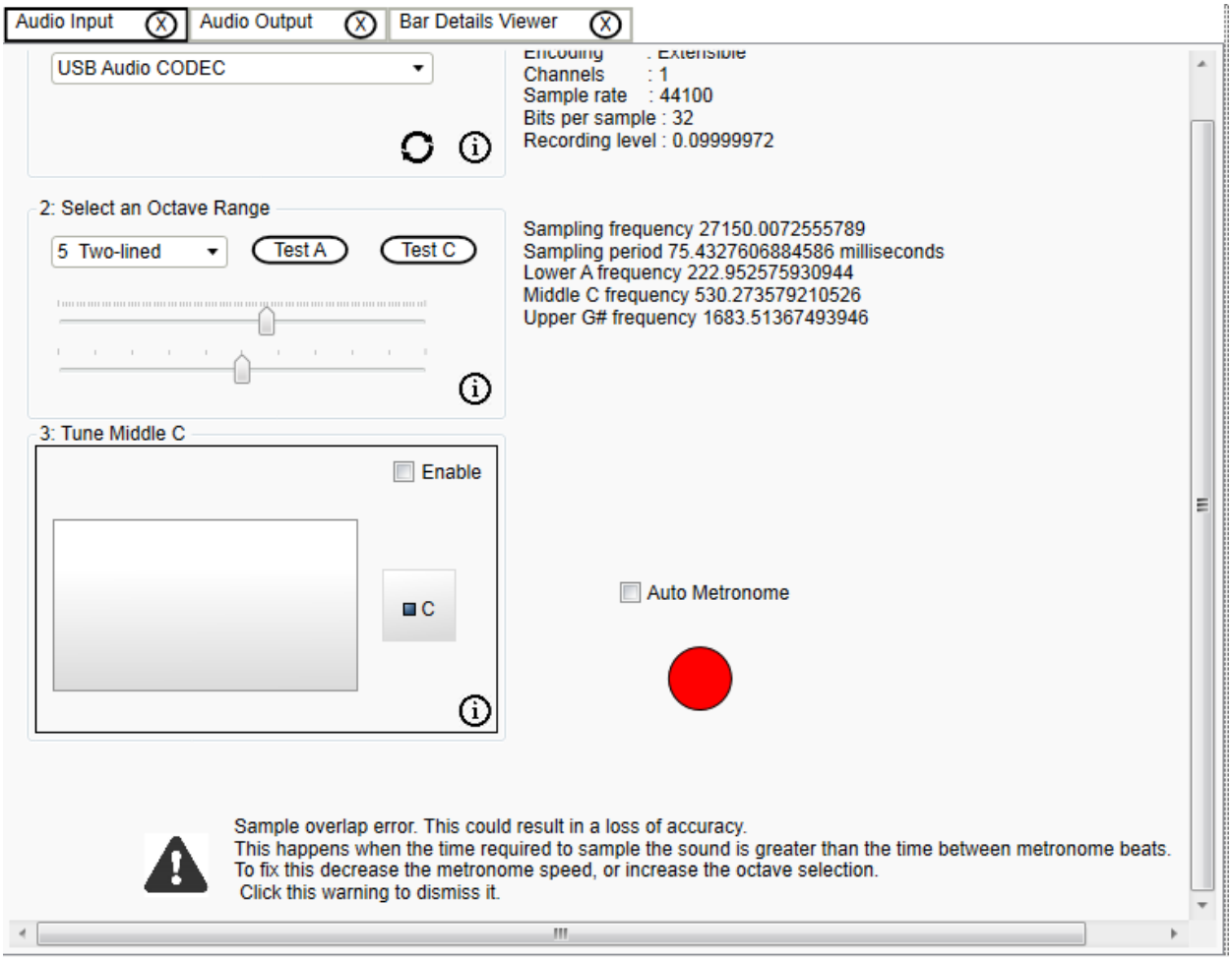


Figure 13 : Sample overlap error

Metronome Tolerance

A less obvious problem is that if you play a high pitched instrument to a slow metronome the sampling period is just a fraction of the available sound. Sampling exactly on the metronome may not produce the best results and in some cases miss the note altogether. The Audio Input tool will adjust for this by ignoring as much leading silence after the metronome as it can, so as to sample the played note. This feature is called metronome tolerance as it will also help in cases where the musician is playing after the metronome beat.

Scoring that first tune

More tools will be described later, but we have enough now to get going. The minimum you will need is the metronome, the audio input, and the score viewer.

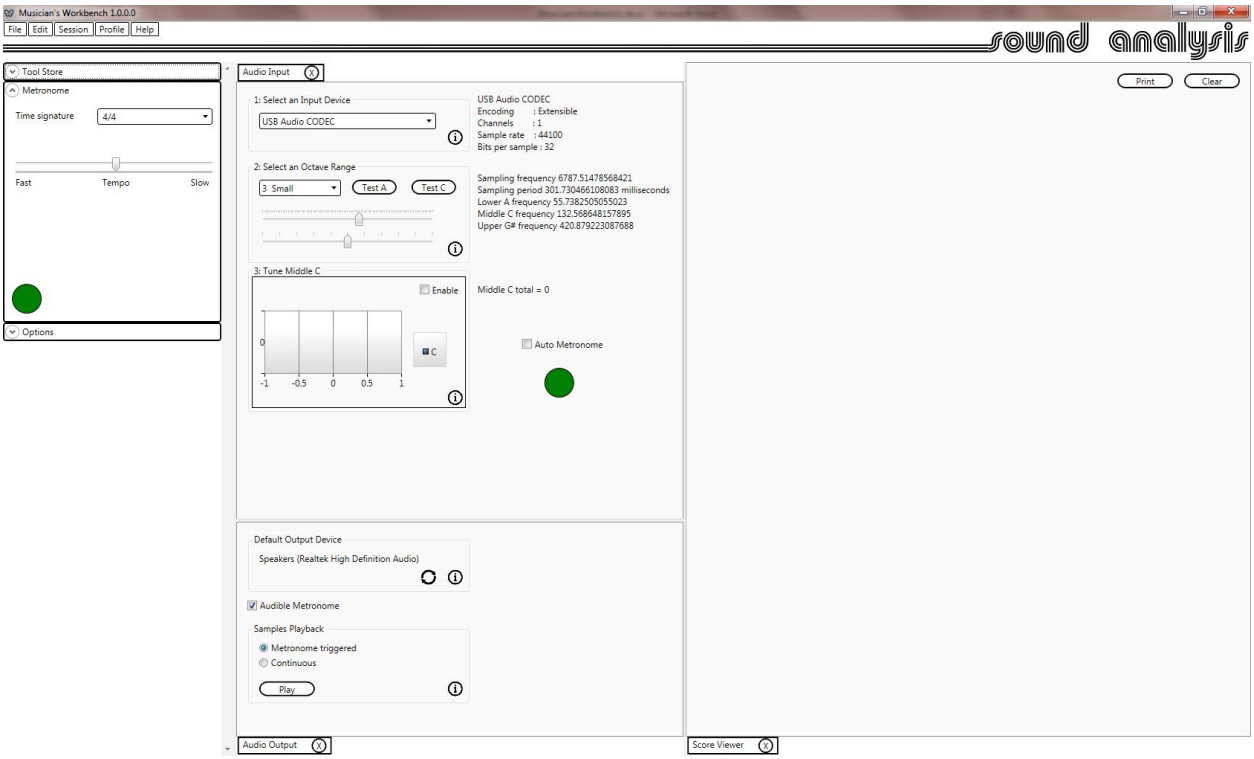
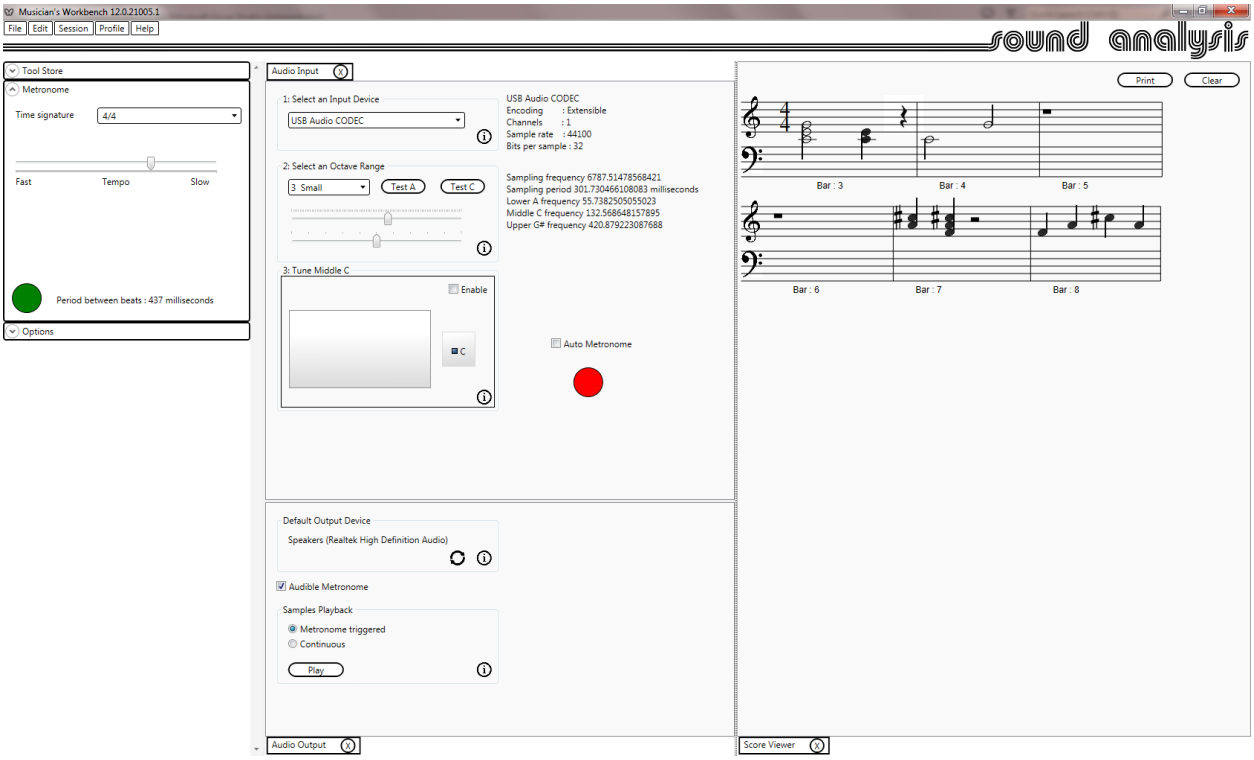


Figure 14 : Ready to play

Click the green metronome button, which will turn red. The audio input will turn on if it is not already. If you want the metronome to be audible open the Audio Output tool and make sure that 'Audible Metronome' is checked. Adjust the metronome to taste (slow is good).

Get in time with the metronome and start to play.



The notes you play will appear in the score viewer. When you are finished stop the metronome.

To print the score just click print. This will take you to the usual windows print dialog.

To save this session click Session -> Save Session on the menu bar. This will save the captured samples, and the current profile (there will be more about profiles in the improving accuracy section).

To reprocess this session click Session -> Reprocess Session on the menu bar. This will reprocess the captured samples again and show the same score again. As the original samples were reprocessed you can change any of the options, the key signature, or even the time signature and reprocess with these settings.

Starting the metronome will clear the current session and start a new one.

Improving Accuracy

If you are playing monophonically with the ‘Monophonic’ check box clicked you can skip this section. Monophonic transcription is a great deal simpler than polyphonic.

If you want to play chords you still have some more work to do to get the best results.

The problem is that played notes (woodwind excluded) are not pure frequencies but have overtones. Distinguishing the overtones from played notes requires some knowledge of the sound of your instrument.

Creating a Profile

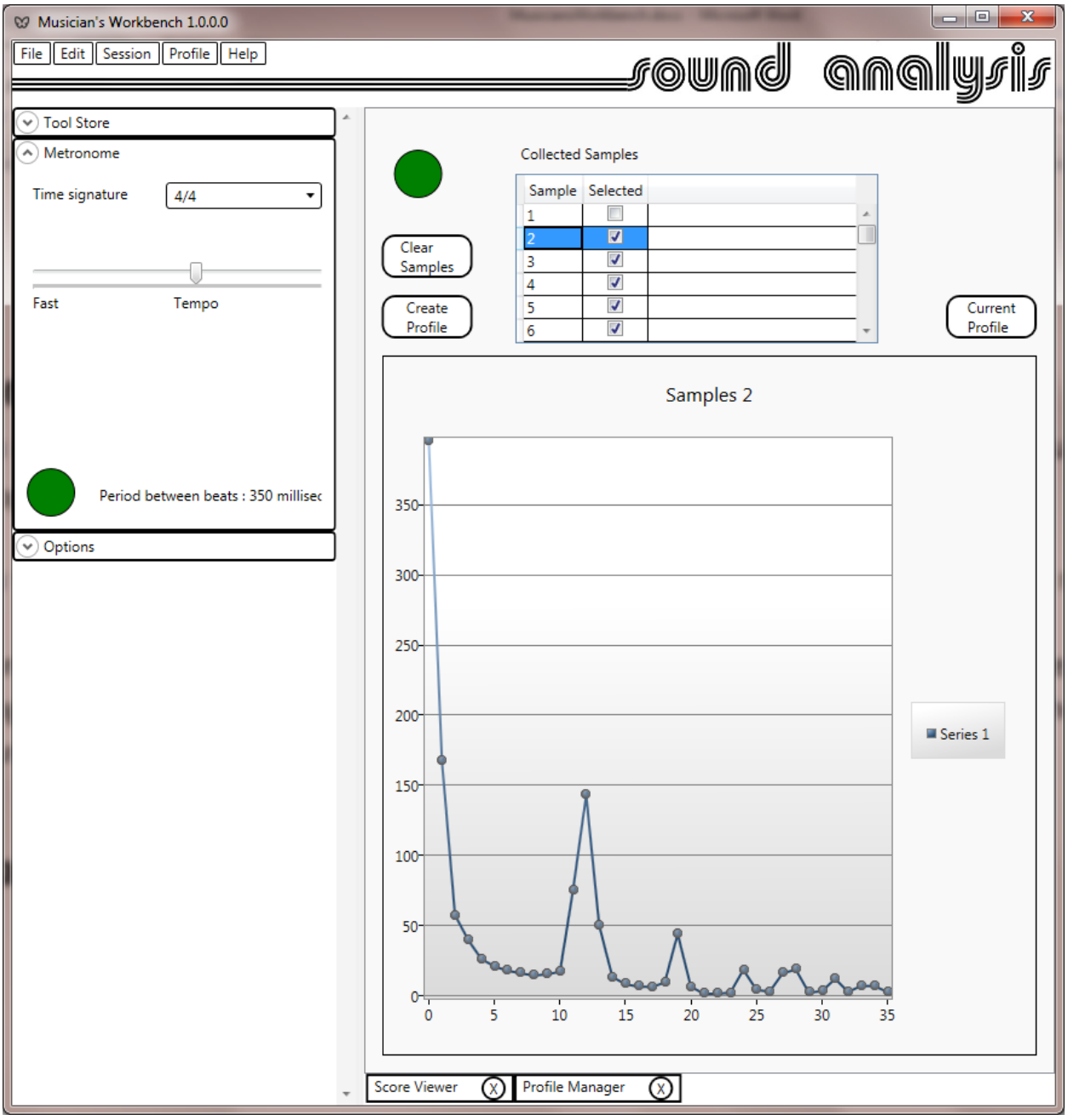


Figure 15 : Profile Creation

To create a profile:

1. Open the profile manager.
2. Click the green button which turns red.
3. Start the metronome
4. Play middle C on every beat for 10 – 20 beats.
5. Stop the profile manager, and the metronome.
6. You will see a list of collected samples which you can display by selecting them. They should all look very similar.
7. Work down the list and un-check any samples which look different from the pack.
8. Once you are satisfied with the selected samples click ‘Create Profile’.
9. The created profile will be displayed.
10. To save it; click Profile -> Save Profile from the menu bar.

The Musician’s Workbench will remember the profile when it is closed and reopen it again on startup. Click ‘Current Profile’ to see the currently loaded profile.

The Score Editor

The Score Editor tool is designed to allow the user to easily make quick fixes to the transcribed score.

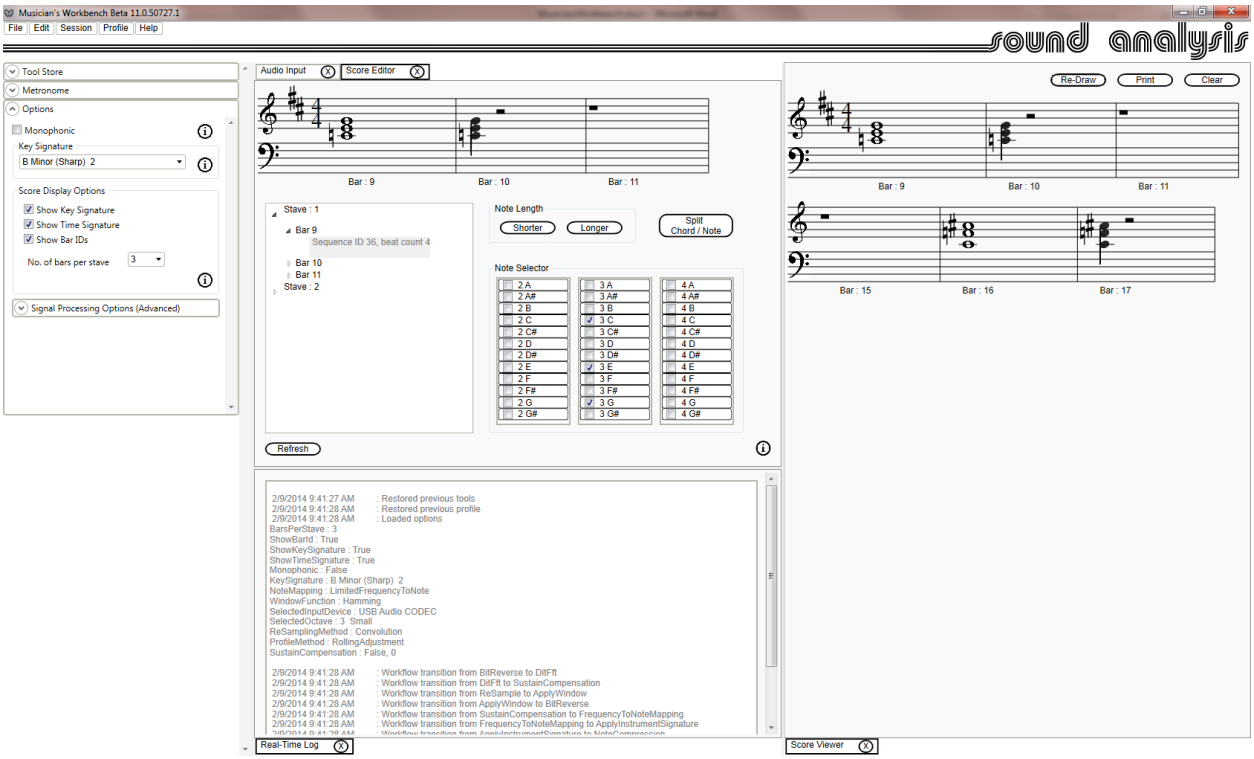


Figure 16 : The Score Editor

The editor provides a tree view of the current score. Expand this to the stave, bar and chord/note/rest. Double click the chord/note/rest (Sequence Id) of interest. The selected stave will be displayed; the notes in the chord/note/rest will be selected in the note selector.

Use the note selector to change the notes in the chord/note/rest; the displayed stave will update automatically.

The longer and shorter buttons can be used to change the length of the chord/note/rest. The number of beats to the bar will be maintained. The following chord/note/rest will be adjusted to maintain the beats to the bar; if necessary an extra rest will be added.

The Split Chord/Note button will divide the selected chord/note/rest into two. The tree view will update automatically.

Within the editor, the score and tree view will update automatically as changes are made. The score viewer will update when the Re-Draw button is clicked.

Changing the score will not affect the rest of the session data, samples, etc. So reprocessing the session will overwrite the edited changes. To preserve the changes you should save the session.

Digging Deeper

To view the details of the session just processed (either just played, or restored and reprocessed) open the bar details viewer. Click the refresh button to load the current session data. Each metronome beat gets a sequence ID. Open up the tree view to the bar and sequence ID for the note or chord of interest and double click it. This will provide a graphical display of the audio samples, the FFT output, the note values, and the profiler results.

Open the sequence ID and click on the note of interest, this will display the note details above the charts.

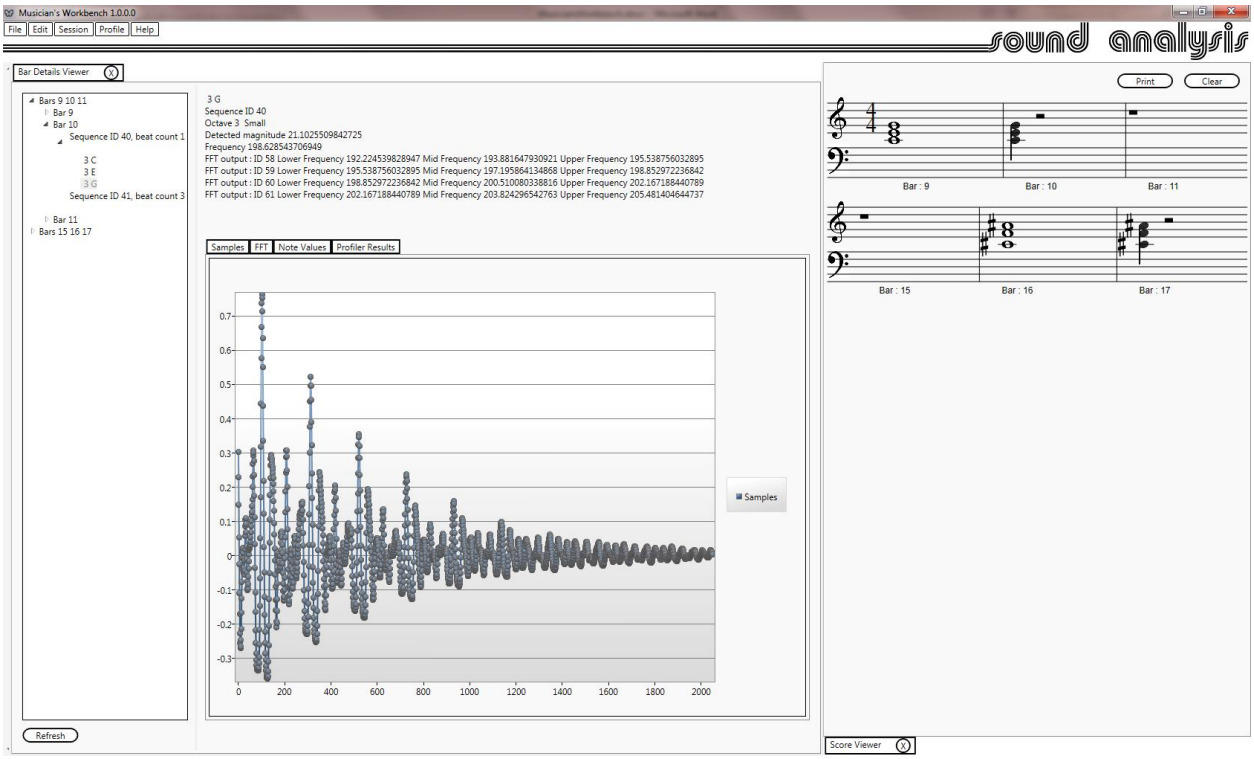


Figure 17 : The Bar Details Viewer

Sample Replay

The audio samples for the current session are available. It is possible to replay these from the Audio Output tool. These are the captured samples, not the full recorded session.

Selecting the metronome triggered checkbox and clicking ‘Play’ will start the metronome and play the samples one per beat. The tempo will be defined by the current metronome setting.

Continuous playback will play the samples one after the other.

To change the output device you will need to use the windows sound dialog. The display is for information only. The refresh button will update the display.

For playback the Audio Input tool must have been opened and the original input device selected. The playback will use the most recently selected input device sample rate and octave range sampling frequency to reconstruct the original sound from the resampled samples. Shifting the Audio Input octave selection before replay will shift the replay octave.

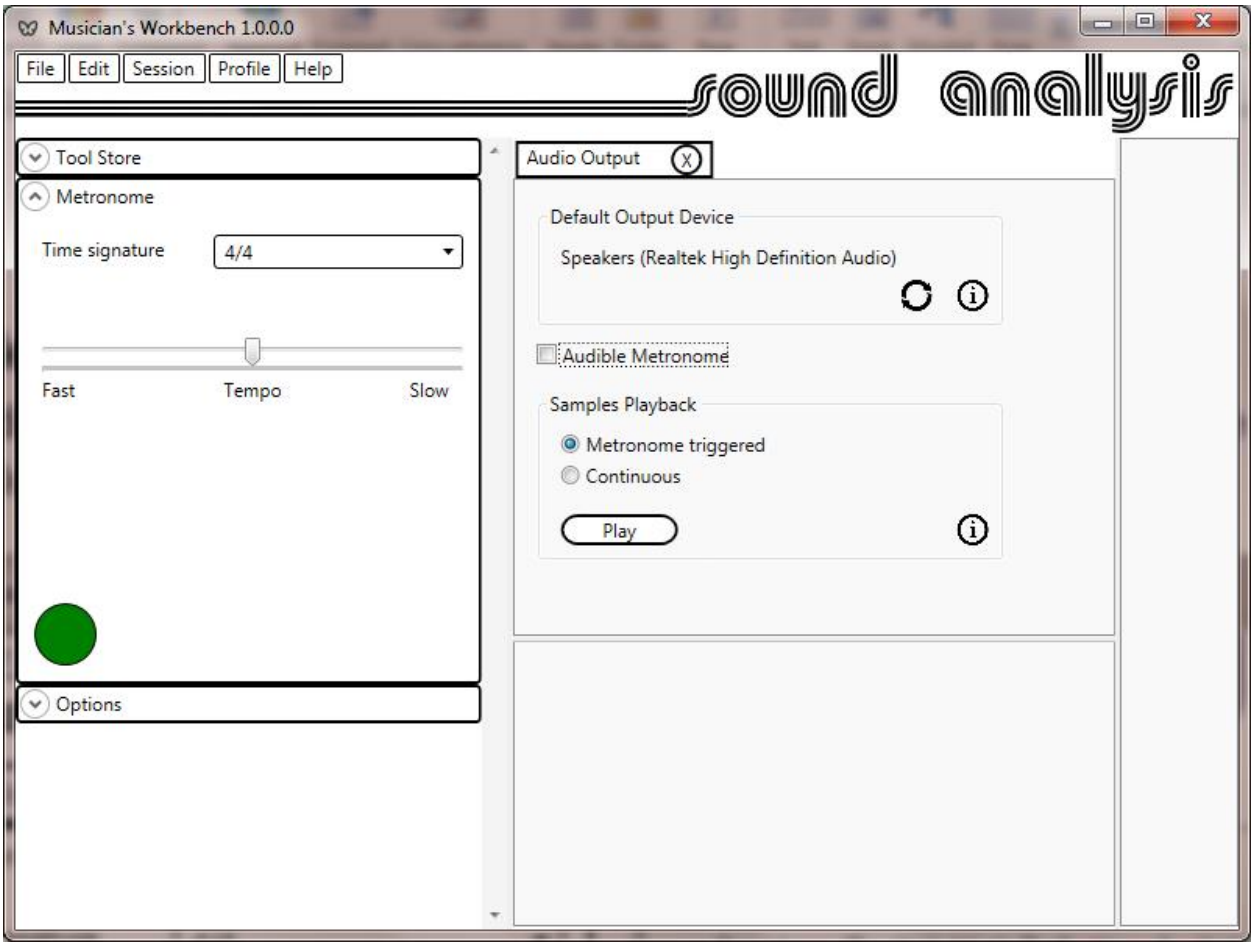


Figure 18 : Audio Output

Signal Processing Options

These options are used to make changes to the transcription pipeline.

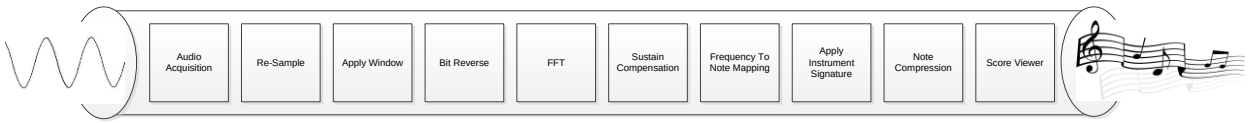


Figure 19 : The Transcription Pipeline

Window Function

This will change the way that the audio samples are windowed before the FFT is applied. A full description of window functions can be found at http://en.wikipedia.org/wiki/Window_function

Re-sampling Method

The audio input device samples at a higher rate than the sample rate required. Re-sampling is applied to reduce the effective sample rate. Interpolation is recommended. In practice the computational overhead of convolution is not prohibitive, and is an effective way to mimic an anti-aliasing filter.

Note Mapping

The output frequencies of the FFT must be mapped to notes. The actual mapping is generated during tuning. The application of this mapping is performed during processing. This option affects the way that the mapping is applied. Limited frequency range to note is highly recommended.

Profile Method

This affects the way that the profile (instrument signature) is implemented. Rolling Adjustment is recommended. Turning off the profile is a good way to assess the profiles effectiveness.

Sustain Compensation

This will help to prevent notes from bleeding over into the next sample. The amount of compensation is variable from 0 – 0.7.

Real-Time Log

This tool will display real time logging information. If you are having problems with the Musician's Workbench that you wish to report to Sound Analysis, open the log, reproduce the problem, then click 'Send To Sound Analysis'. This will send an email with the logging information and session data to Sound Analysis where we can take a look at the problem.

The Musician's Workbench does not send any personal information with the log. If you use the note dialog to add contact information and any other notes to the email we will be able to get back to you.