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1. Overview

Just provides a means of exploring arbitrary tuning systems using standard representations (pitch, musical interval, cents, frequency, and ratio), as well as exploiting theoretical systems such as Just Intonation and N-tone equal temperament. *Just* organizes these features into two main window styles and a few auxiliary panels. The two window styles: Keyboard and Matrix, contain Keys that may be tuned and played with the mouse. A Tuning Panel provides controls that are used to tune, play, compare, or change the tuning of selected keys.

The user may also play standard NeXT and MIDI score files. These scores may be retuned from tuning information in Keyboard or Matrix Windows.

1.1 Keyboard Windows

Keyboard windows contain an arbitrary number of marimba style keys. Keys are sounded by clicking with the mouse. Multiple keys may be selected at one time. This is useful for listening to chords, or examining relationships within a subset of a tuning.

Keys are moved within or between Keyboards with the standard *cut*, *copy*, and *paste* mechanisms. Each Key may be tuned and presented in a variety of representation styles:

Pitch
Cents Relative to a Reference Key*
Cents Relative to the Previous Key
Hertz
Ratio Relative to a Reference Key*
Ratio Relative to the Previous Key
Interval from Reference Key*
Interval from Previous Key
MIDI Key Number
User Label (arbitrary names, i.e Do, Re, Mi)

* The *Reference Key* is no different than other keys except that it acts as base in relative tuning representations. Any key can be made the *Reference* by using the *Tuning Panel*.

1.2 Matrix Windows

There are two types of Matrices available: Transpositional and Extended Just. Each presents a palette of ratios to be used in the formation of new Keyboards.

An Extended Just Matrix provides a system of ratios. Each axis represents powers of a specified ratio, reduced and brought to within an octave of the origin (1/1), which is centered in the matrix.

A Transposition matrix is formed by selecting two keyboards as axes, and creating a matrix consisting of each keyboard transposed by each step of the other.

1.3 Tuning a Keyboard or Matrix

The Tuning Panel is the mechanism used to tune a key or change its representation. Controls in the Tuning Panel are applied to the last key played. The desired representation or tuning style for individual Keys or an entire Keyboard/Matrix are chosen with the Tuning Panel.

1.4 Tuning a Score

Once a tuning is described, it may be used to affect the performance of a score. Re-tuning a score is accomplished by installing a Keyboard's tuning as the default tuning system for Musickit performance. A score may be heard with a variety of tunings by installing those from different Keyboards.

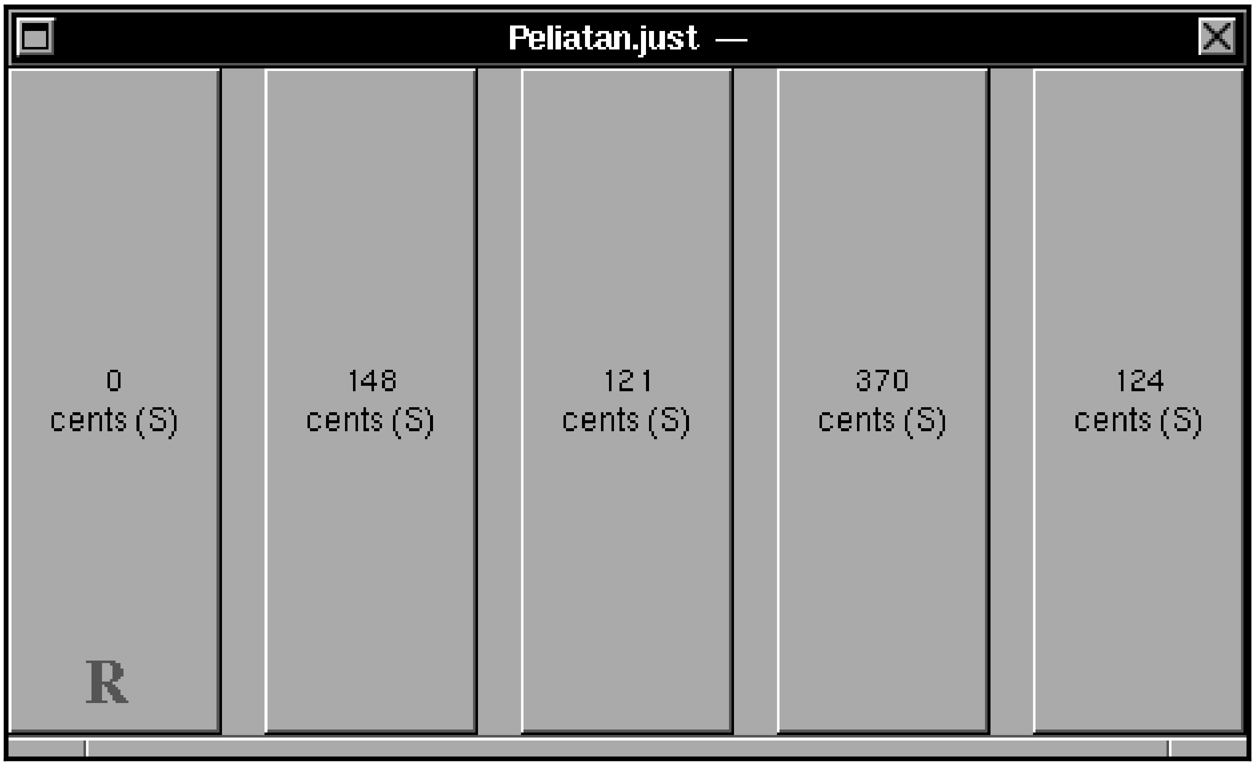
2. Windows and Panels

2.1 Keyboard Windows

Keyboard windows contain an arbitrary number of marimba style keys. Each Key may be presented in a variety of representation styles:

Pitch
Cents Relative to a Reference Key*
Cents Relative to the Previous Key
Hertz
Ratio Relative to a Reference Key*
Ratio Relative to the Previous Key
Interval from Reference Key*
Interval from Previous Key
MIDI Key Number
User Label (arbitrary names, i.e Do, Re, Mi)

The desired representation style is chosen with the upper pop-up list in the **Tuning Panel** (**Tuner...** in the **Tools** menu. See *Tuning a Keyboard*). The selected Key's value in the chosen representation appears in the display above this pop-up list.



Each window has its own **Reference** Key (indicated with an **R**) from which base relative tunings are derived. The Reference Key is changed by selecting a Key and choosing the **Reference*** button in the **Tuning Panel**. Keys are moved within or between keyboards with standard *cut*, *copy*, and *paste* operations. Windows may be resized with the resize bar, and Key sizes may be changed by resizing their window with the **Command-Key** key pressed.

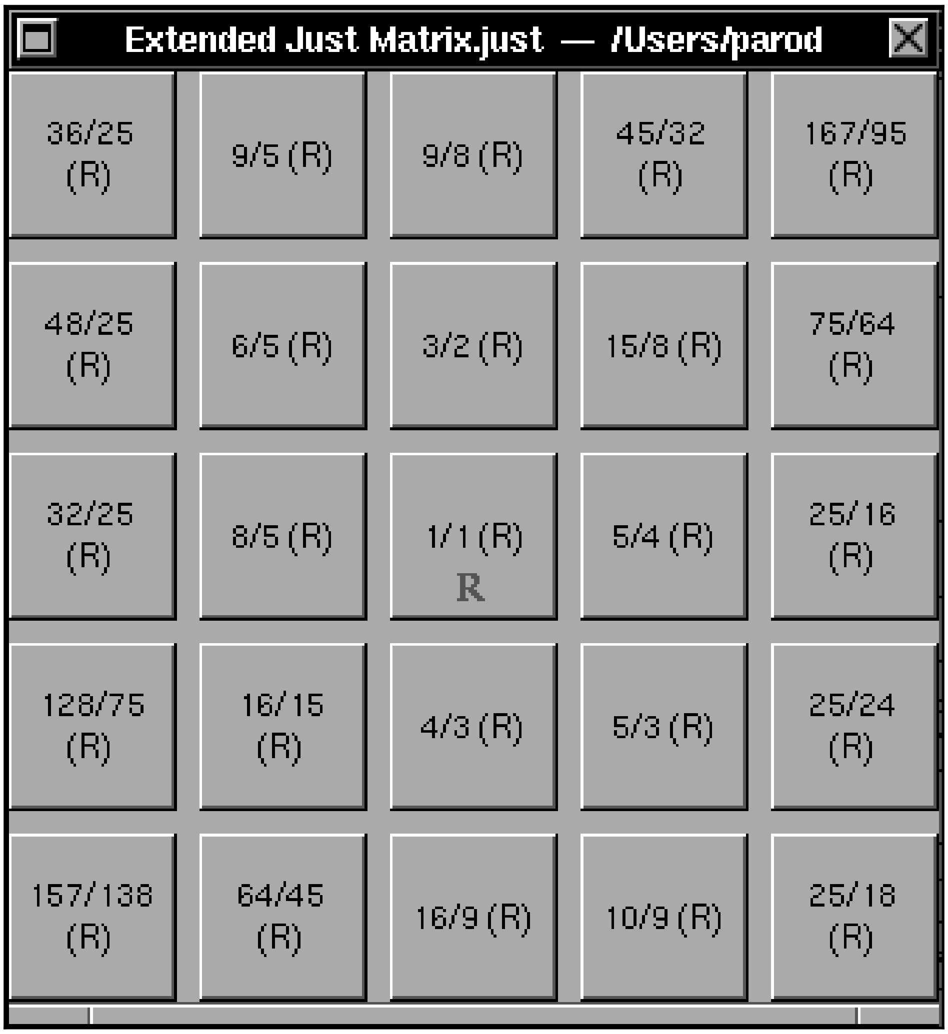
Keys are played by clicking with the mouse. The Key's note is sounded when the mouse button is pressed and ended when the mouse button is released. The **Command-Key** may be used as a sustain pedal, allowing Keys to ring after the mouse button is released. There is also a **Sustain Pedal** button in the **Tuning Panel** for holding sustain on.

Use **New Keyboard...** in the **Tuning** menu to create a new Keyboard. This item displays a Panel for describing the initial tuning and size of the Keyboard. Indicate the *first Key*, the *last Key* or *interval*, and the *number of Keys* for the Keyboard. Either the first Key or the last Key may be described relative (cents, ratio, or interval) to the other. If tuning is described by *first Key* and an interval size, Keys will be tuned equally spaced by that interval, starting at *first Key*.

* The *Reference Key* is no different than other keys except that it acts as the base in relative tuning representations. Any key can be made the *Reference* by using the *Tuning Panel*.

2.2 Matrices

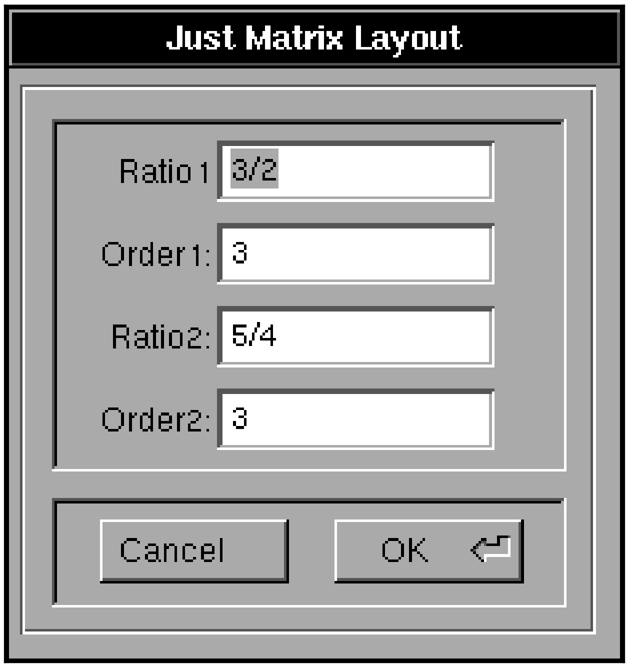
There are two types of Matrices in *Just*: **Transpositional** and **Extended Just**. Each presents a palette of ratios to be used in the formation of new Keyboards.



2.2.1 Extended Just Matrix

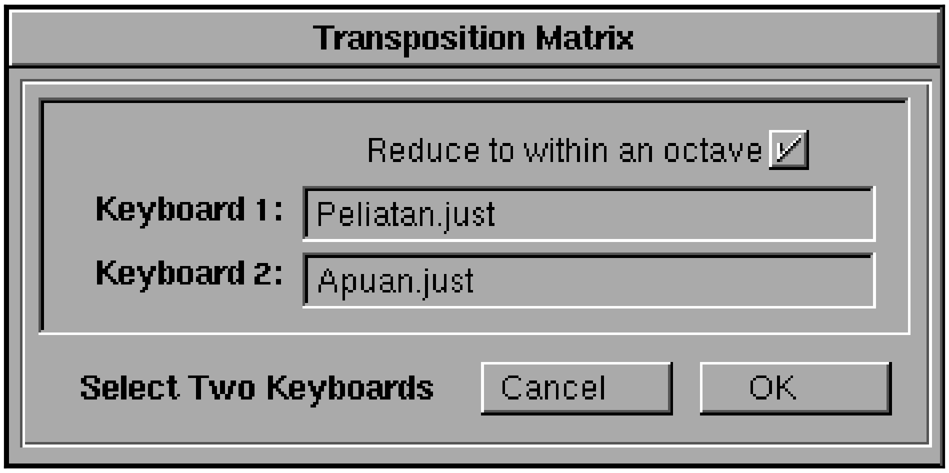
An Extended Just Matrix provides a system of ratios. Each axis represents powers of a specified ratio, reduced and brought to within an octave of the origin (1/1), which is centered in the matrix. The axes display both positive and negative exponents of the ratios that generate them. Keys of the matrix not on an axis are multiplicative combinations of ratios at their axial coordinates.

These matrices are formed by using the **Just Matrix Layout Panel** obtained from the **New Matrix...** item of the **Tuning** submenu. Specify a ratio and power for each dimension.



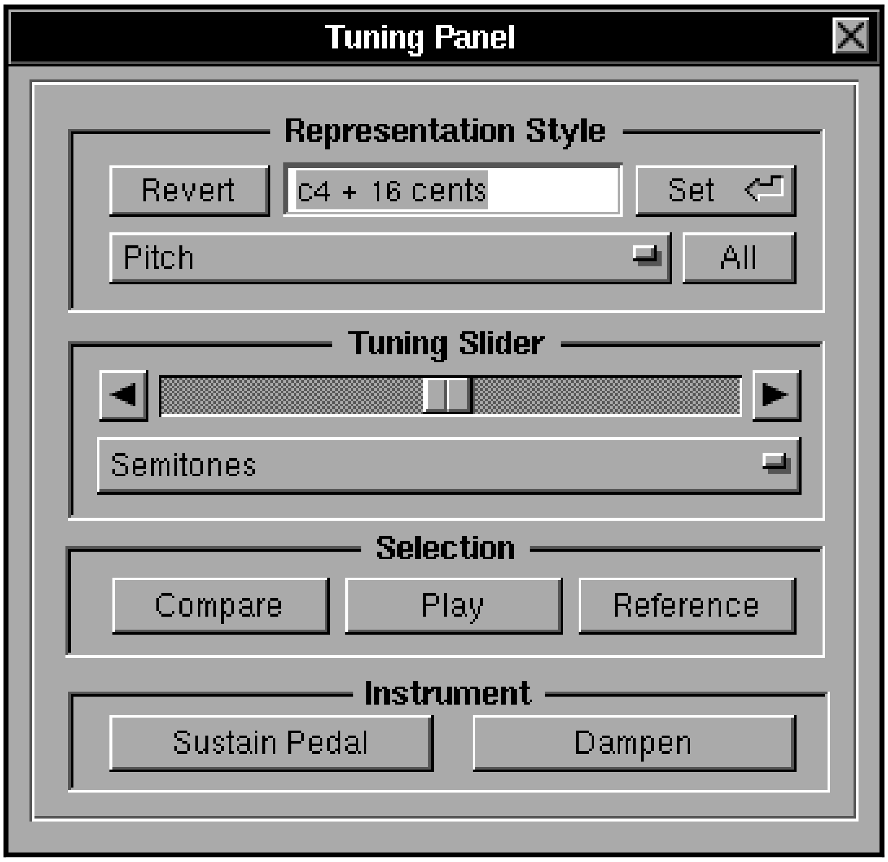
2.2.2 Transposition Matrix

A **Transposition** matrix is formed by selecting two Keyboards as axes, yielding a matrix of ratios that are products of the two keyboards (cell ij = celli0 * cell0j). This forms a set consisting of each Keyboard transposed by each step of the other. Use the **Transposition Matrix...** item of the **Tools** submenu to create a **Transpositional Matrix**. After choosing **Transposition Matrix...** click on any two Keyboards you want to multiply. After you've selected your Keyboards, choose **OK** in the **Transposition Matrix Panel**.



2.3 Tuning Panel

The **Tuning Panel** contains controls for tuning a Key or changing its representation. Controls in the Tuning Panel are applied to the last Key played.



In the center is a **Tuning Slider**. The unit of change for the slider is selected and displayed with the "pop-up" list below it. The value of the key during tuning is shown in the panel's display, in the box above the slider. The Representation used for this display is chosen with the "pop-up" list below it. One can, for example, use the slider to tune a key in frequency, while viewing the result in cents. Tuning may also be achieved by entering values in the display field by hand.

You can change the representation of a Key or an entire window by choosing the desired representation style in the pop-up list below the display, and choosing **Set** for a single Key, or **All** for the window.

The **Selection** box contains buttons that affect the Selection of the current keyboard. Multiple keys may be selected at one time. This is useful for listening to chords, or examining relationships within a subset of a tuning. With multiple Keys selected, the **Compare** button will show their relationship in the chosen representation. **Play** will play the chord described by the selection. **Reference** will make the last Key played the Reference Key for the window.

3. Menus

3.1 Info Menu

Standard Info Panel showing the application name and author.

Help panel containing a list of available topics. Help is also available by **Control-clicking** on an object for which help is needed.

Copy/Paste Preference

The user may use these standard edit functions to move Keys within or between Keyboard windows. Since each Key has both a relative designation (cents, ratio, interval) as well as an absolute one (Hertz, pitch), this item controls which should be used when moving a Key to another Keyboard.

Reference Tuning Lock Preference

Each Keyboard contains a Reference Key from which the tuning of the other Keys may be described by cents, ratio, or interval. This preference item controls whether reference relations should be maintained when tuning the reference Key. If the lock is on, tuning the Reference Key will cause the tuning of all other Keys in the Keyboard to change in order to maintain their interval relation to the Reference as the Reference is changed. If the lock is off, the Reference Key may be tuned independently of the other Keys in the Keyboard.

Keyboard Synthpatch Allocation Preference

Whenever a Key is played there must be an appropriate Synthpatch allocated in the DSP to perform the synthesis. There are two allocation methods available: automatic and manual.

In automatic mode, Synthpatches are allocated dynamically as needed until there is no more capacity in the DSP. If you have too many sounding Keys, you may find that subsequent Key strokes will not sound. Dampening already sounding keys will allow new Keys to be played.

In manual allocation, a given number of Synthpatches are put aside in advance. Synthpatches are then assigned from this pool as needed. If a new one is requested and all are in use, the longest sounding synthpatch is preempted for the new request. The user may request a specific number of manually allocated Synthpatches.

It should be kept in mind that when a score is played, it's Instruments must allocate synthpatches for the performance. If the user has already manually allocated a given number of Synthpatches for the Keyboards and there are not enough remaining DSP resources for the score performance, the allocation mode will be changed to automatic and the user may try again to open the score. If the score requires all available DSP resources for the performance, no Synthpatches will be available for Keyboard use until the score is closed.

3.2 Tuning Menu

Open a saved Tuning Keyboard or Matrix.

New Keyboard... displays a Panel for describing a new tuning and the size of the Keyboard. The layout of the Panel allows the user to indicate the first Key, the last Key or interval, and the number of Keys requested. Either the first Key or the last Key may be described relative (cents, ratio, or interval) to the other. If tuning is described by first Key and an interval size, Keys will be tuned equally spaced by that interval.

New Matrix... displays the Matrix Layout Panel for describing an Extended Just Matrix of Keys. Here each axis represents powers of a specified ratio, reduced and brought within an octave of the origin (1/1), which is centered in this matrix. The axes display both positive and negative exponents of the ratios that generate them. Keys of the matrix not on an axis are multiplicative combinations of ratios at their axial coordinates. The user must specify a ratio and maximum power for each dimension.

New From Score

If a score is currently open, New From Score will create a new Keyboard containing one Key for each unique frequency in the score. This offers a starting point for retuning a score. retuning is accomplished by associating the desired frequency with a given MIDI KeyNum. Many scores that contain non-12-tone Equal Tempered frequencies may contain different frequencies that, because of their proximity to each other have the same MIDI KeyNum. For example, if a score contains notes with frequencies of 440 Hz. and 443Hz, both may likely have MIDI KeyNums of "a4". So "retuning" "a4" will result in both notes having the same frequency.

New From Parts

If a score is currently open, New From Parts will create a new Keyboard for each part in the score. Each Keyboard will contain one Key for each unique frequency in the part.

New From Selection

Multiple Keys in a Keyboard may be selected using the standard (Drag, Shift, Alt) selection mechanism. This item will create a new Keyboard containing Keys from those selected in the currently Key Keyboard or Matrix window.

Duplicate d

Create a dupicate of the currently Key Keyboard or Matrix window.

Save s

Save the currently Key Keyboard or Matrix window to a file.

Save As... S

Save the currently Key Keyboard or Matrix window to a file with a potentially different name than it is currently saved in.

Install Tuning ▷

Revert Equal Temperament

Install a 12 Tone Equal tempered tuning system as the current tuning system.

Install Tuning System

Install the tuning system described by the currently Key Keyboard or Matrix Window as the current tuning system.

Install Tuning w. Octaves

Install the tuning system described by the currently Key Keyboard or Matrix Window as the current tuning system and expand octave tunings as well.

Utilities ▷

The Utilities submenu provides a number of handy tools for manipulating tunings:

Sort by Frequency

Sort Keys in a Keyboard lowest to highest in terms of frequency.

Remove Duplicate Freqs

Remove any duplicate copies of Keys having the same frequency.

Remove Duplicate KeyNums

Remove any duplicate copies of Keys having the same MIDI KeyNumbers.

Remove Octaves

Remove octaves of Keys.

Collapse to Octave

Reduce or expand the octave of all Keys as necessary to collapse within an octave of the Reference Key.

Sequential KeyNums

Assign sequential Keynums for each Key starting from the first Key in the Keyboard.

Sequential Keynums for Selection

Assign sequential Keynums for each Key in the Selection.

Map KeyNums to Score

Map the KeyNum/Frequency associations from the Key Window to the currently opened score. This will compare frequencies defined in the Keyboard with those found in Notes in the Score. Where a match is found, the Note’s KeyNum in the score is changed to that defined for the same frequency in the Keyboard. This is useful after a Keyboard is created from a Score (New From Score...). Many scores that that contain non-12 Tone Equal Tempered frequencies may contain different frequencies that, because of their proximity to each other have the same MIDI KeyNumber. For example, if a score contains notes with frequencies of 440 Hz. and 443Hz, both may likely have MIDI KeyNumbers of "a4". So "retuning" "a4" will result in both notes having the same frequency. The user may give these frequencies distinct MIDI KeyNums in the Keyboard Window and then map these associations to the score by using "Map KeyNums to score."

Miniaturize

The standard mini-window feature. Miniaturize the current main window.

Close w

Close the Key window, first prompting for Save if the window has been edited.

3.3 Edit Menu

This submenu contains the standard cut/copy/paste functions. When used within Keyboards and Matrices, these functions will operate on Keys. Keys may only be *copied* from Matrices, not *cut* or *pasted*. Keys may be *cut copied*, or *pasted* within or between Keyboards.

3.4 Instrument Menu

The instrument used for Keyboards and Matrices may be changed by selecting another with the Instrument menu. New instruments may be added to this menu by placing *.score files in the directory "Just.app/Instruments".

In addition to installed instruments, you may load instruments from arbitrary score files. This is done using Other... in the Instrument menu. Other... presents an Open Panel for selecting score files. A list of Parts for the selected score is presented, and the instrument for the selected Part is then loaded for *Just*'s Keyboards and Matrices.

3.5 Score Menu

This menu is used to access score files for performance.

Open...

Open a score file for playing.

Save

Save the currently open score to a file. This will save tuning information by setting frequency parameters in the score's notes reflecting the currently installed tuning system.

Save As...

Save the currently open score to a file with a potentially different name than it is currently saved in. This will save tuning information by setting frequency parameters in the score's notes reflecting the currently installed tuning system.

Close

Prompt for Save if the score has been edited, then close the score.

Strip Freqs

This will strip the frequency parameter from all the score's notes, substituting a KeyNum parameter if not already present. This forces tuning to be referenced through the installed tuning system. Now a score's tuning may be changed by installing a tuning system from a Keyboard that defines KeyNum/Frequency associations for the score. A score may be heard with different tunings by installing different tunings from different Keyboards. (See the Install items in the Tuning submenu).

3.6 Tools Menu

This menu contains tools for manipulating Keyboard windows.

Tuner... T

The Tuner... item brings up one of the most important Panels in the application. The **Tuning Panel** is the mechanism used to tune a key or change its representation. Controls in the Tuning Panel are applied to the last key played.

In the center is a **Tuning Slider**. The unit of change for the slider is selected and displayed with the "pop-up" list below it. The value of the key during tuning is shown in the panel's display, in the box above the slider. The Representation used for this display is chosen with the "pop-up" list below it. One can, for example, use the slider to tune a key in frequency, while viewing the result in cents relative to its neighbor. Tuning may also be achieved by entering values in the display field by hand. You can change the representation of a Key or an entire window by choosing the desired representation style in the pop-up list below the display, and choosing Set for a single Key, or All for the window.

The box at the bottom of the Tuning Panel contains buttons that affect the Selection of the current keyboard. Multiple keys may be selected at one time. This is useful for listening to chords, or examining relationships within a subset of a tuning. With multiple keys selected, the Compare button will show their relationship in the chosen representation. (See 2.3).

Calculator... C

This Calculator Panel offers a handy tool for performing ratio arithmetic.

Transposition Matrix... displays a modal panel for selecting two Keyboards to form a Transposition Matrix. A Transposition Matrix is formed by selecting two keyboards as axes, yielding a matrix of ratios that are products of the two keyboards (cell ij = celli0 * cell0j). This forms a set consisting of each keyboard transposed by each step of the other. After choosing Transposition Matrix, click on any two Keyboards that you want to multiply. After you've selected your Keyboards, choose OK in the Transposition Matrix Panel.

Since Keyboards and Matrices are saved to files in an object format, there is the need to have access to the tuning information in ascii for copying to documents or inclusion in scores. This Text Panel provides this tuning information in a variety of ascii formats. The desired format(s) may be chosen with a button panel and the right of the scrolling text view.

Reinitialize the DSP, Stopping, reallocating, and starting the keyboard and score instruments.

3.7 Windows Menu

This is the standard Window submenu for selecting and arranging open Windows.

3.8 Hide Menu

This is the standard Hide item for removing all the application's windows (except it's icon) from the screen without quitting the application.

3.9 Quit Menu

This is the standard Quit item. If there are any unsaved edited windows, it will alert the user before quitting.

4. Tuning a Score

Once a tuning is described, it can be used to affect the performance of a score. Notes in a score that refer to pitch names or MIDI Key Numbers, rely on the installed tuning system for their actual frequencies. To retune a score:

> Insure that notes in a score contain MIDI Key Number parameters or pitch names rather that actual frequencies.
>
> Install a tuning system that describes the desired associations between key numbers (or pitch names) and frequencies.

Each Keyboard maintains a tuning system that may be installed via the **Tuning** menu. Once you have a tuning described in *Just* (See *Keyboard Windows* or *Menus* in the **Help Panel**), installing it is straightforward. Insuring that your score uses key numbers or pitch names rather that absolute frequencies, and creating a Keyboard that contains Keys for all the pitches in a score is a little more involved. The difficulty of this task depends mainly on the score.

If the score employs a regular 12-tone equal-tempered tuning, then there is a predictable 1-to-1 correspondence between pitch names and frequencies. In this case you may describe a regular 12-tone equal-tempered Keyboard with default key numbers, then retune individual keys to their desired frequencies. To install a tuning for this kind of score you need only use steps 4) through 6) below.

If the score employs non-Western tuning, associations between pitch names and actual frequencies may be arbitrary. These scores require a little more work.

1) New From Score...

To determine what frequencies and key numbers are used in a score, create a new Keyboard with the **New From Score...** menu item in the **Tuning/New** menu. This will create a Keyboard containing a Key for each unique frequency in the score. Not all scores use MIDI KeyNums for pitch information. Many use an explicit frequency parameter. In these cases, key numbers given in the Keyboard will be those closest in frequency to each Key. For 12-tone equal tempered scores, key numbers and frequencies have the normal associations found on a piano. Scores that are not in 12-tone equal tempered tuning will have key number to frequency associations that are not standard, and may, in fact, contain distinct frequencies that, because of their proximity to each other do not have distinct MIDI key numbers. For example, if a score contains notes with frequencies of 440 Hz. and 443Hz, both may likely have MIDI KeyNums of "a4". In this case there is not a 1-to-1 correspondence between MIDI Key and frequency in the score. To retune this score, one of these KeyNums needs to be changed to a KeyNum unique for the score.

2) Sequence KeyNums

If you don't wish to inspect and change duplicate key numbers by hand, you may insure unique key numbers for all Keys in a Keyboard by using the **Sequential KeyNums** menu item in the **Tuning/Utilities** menu. This will assign sequential KeyNums to all Keys starting with the KeyNum set for the lowest Key. If you wish to sequence a subset of your Keyboard, you may select multiple Keys and use the **Sequence KeyNums for Selection** menu item. This will sequence only those Keys currently selected starting with the KeyNum for the lowest Key in the selection.

3) Map KeyNums to Score

Once you have unique key numbers for each frequency in the Keyboard, you need to transfer these unique KeyNum/frequency associations to your score. This will insure that distinct frequencies in the score have distinct KeyNums as well. Use the **Map KeyNums to Score** item of the **Tuning/Utilities** menu for this. This will change KeyNums/frequency associations in the score to those given in the Keyboard.

4) Strip Freqs

Now that you have a score with unique key number parameters for each unique frequency, you need to remove any explicit frequency parameters in the score. This will force the score to rely on the installed tuning system via it's key numbers for tuning. This is done with the **Strip Freqs** item of the **Score** submenu.

5) Install Tuning

Now the tuning described in your Keyboard may be installed with the **Install Tuning System** or the **Install Tuning w. Octaves** items in the **Tuning/Install Tuning** menu. The score may now be played with the tuning described in the Keyboard just installed. Your Keyboard may be used as a tuning template for this score. It may be duplicated (**Duplicate** in the **Tuning** menu) and retuned to describe different tunings for the score. User this template to create other tunings for your score.

6) Save Your Score

Be sure to save your score if you want to retain it's new Keynum mappings. Saving a score will cause all the tuning information to be saved as well.

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