BARRY04

A granular compositional tool written for CsoundQt V1.2

Eugenio Giordani

USER MANUAL

A LEMS production
Conservatorio Rossini – Pesaro
A.A. 2014/15

This Cosund orchestra implements a granular synthesis algorithm based on fixed waveforms (no samples) with slight variations. This work is dedicated to Barry Truax to whom I owe much gratitude for introducing me to back in 1988 to the fantastic world of granular synthesis possibilities.

Thanks to his teachings I have made several algorithms that over the years have inspired my work in the field of teching, musical works and recently powerful applications for iPad and iPhone as "Density" written by my former student Alessandro Petrolati.
(http://www.apesoft.it/)

The first work done was carried out in 1989 using a granular texture generation strategy starting from a sum of independent "grain streams" (GSC4 - published in "Virtual Sound" - Bianchini / Cipriani - Ed. Contempo) . At that time were not available integrated operational codes for the granulation.

Eugenio Giordani - 2015

Barry04 - User Manual (Preliminary)

This orchestra Csound (CsoundQt) called Barry04 (Ver1.2), implements a custom version of granular synthesis. The algorithm does not use any of the opcode present in Csound library, but provides for the construction of the envelope counter and oscillators required for the synthesis. For this reason, the generation efficiency is limited in practice to 5/600 grains per second (density), that does not detract in the aspect of sound generation itself. The orchestra provides three alternative modes of operation:

1) LIVE mode
2) ACTION mode
3) JITTER mode

The LIVE mode is used to generate the sound and control the parameters through action on the control panels called GRAINS LIVE CONTROL, EFX and FUNCTION / SELECT DISPLAY. This is the default mode and when the orchestra starts you should listen to a sound type corresponding to the last configuration of the parameters used. It may happen that you do not hear any sound for the simple fact that the last of the algorithm use the listening level had been brought to zero and that is related to actions that will be highlighted below. When there should be a lack of sound will then simply call one of the "presets" stored with the orchestra on selecting spin-box denominanta Recall Preset or clicking with the right mouse button on the GUI and selecting the same item from the context menu. In any case it is always advisable to check the status of the Volume slider.

THE SUOND GENERATION AND THE LIVE MODE

BARRY04 produces the sound through the generation of sound grains identified by a series of parameters that specify the spectrum-morphological characteristics and time-structural. The main parameters are the following:

DURATION

This parameter refers to the time interval between the instant of start and end of a grain and comprises a deterministic component and a random component (random) whose areas are respectively:

Deterministic duration:	0.008 < *Dur* < 0.45	(sec)
Randomic duration:	0 < *DurRnd* < 10	(percentage of deterministic duration)

For example, if Dur = 0.1 and DurRnd = 10 it will be possible to obtain maximum total deviations of duration equal to 0.1 ± 0.01seconds. In practice, when DurRnd is different from zero, the average durations are different from each other but centered around the value Dur.

DENSITY
The generation rate of the grains in time is regulated instead by two other parameters (one for the deterministic part and one for the random part) denominated Dens and DensRnd and precisely, respectively:

Deterministic Density: 1 < *Dens* < 500 (grains per sec)
Randomic Density: 0 < *DensRnd* < 100 (number of grains in excess or defect)

The density is closely related to the "rhythm" of the grains generation. When the part is nothing random and deterministic component is low (some units), the grains produce a regular pulse of sound packages (grains).

FREQUENCY
Each grain has a constant frequency for the entire duration that is also controlled by two components (deterministic / random) that are respectively:

Deterministic Frequency: 50 < *Freq* < 12000 (Hz)
Randomic Frequency: 0.01 < *FreqRnd* < 200 (number of cycles in excess or defect)

For example, if Freq = 500 and FreqRnd = 100, it will be possible to obtain maximum frequency deviations of 500 ± 100 Hz. When the random part is zero, the sound is strongly focused on a constant value pitch.

RISE TIME
This parameter indicates the rise time (and identically the release time) of the amplitude envelope of each grain. Unlike the other parameters examined only it features a deterministic component:

Rise time : 0.002 < *Rise* < 0.1 (sec)

Basically, the envelope of the grains is constituted by a trapezoidal function as shown in Figure 1.

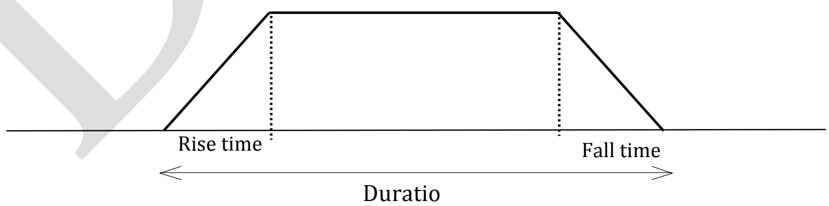


Figure 1 –Trapezoidal structure of the basic grain envelope

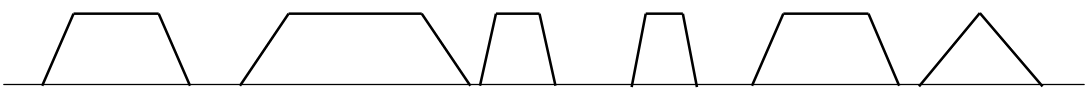


Figure 2 – Sequence of varying length and shape envelopes

PAUSE

This parameter, then added, it allows superimpose to the base texture of the grains further statistical component that allows the introduction of breaks (rests or pauses) so they can produce alternate sound empty gestures and textures employees from major generation parameters. The associated parameter is:

Pause : $0.0 < \mathit{Pause} < 0.95$

The meaning of the parameter is that of a threshold value with respect to a statistical variable that is extracted and associated with each generated grain. For example, if the parameter is set to 0.5, there will be a 50% chance to generate a pause corresponding to the duration of the grain that should have been effettivamanete product. With this mechanism, only high values of the parameter (next to 1) will be able to produce more frequent breaks, while low values will reduce the frequency of breaks up to full reset (Pause = 0).

As we see, the parameter range has the maximum value 0.95, because if it came to 1, be generated only pauses and then no sound would be produced.

This parameter, at present, is not included in the time schedule and can only be used in LIVE mode.

The parameters described here are grouped up as graphical widgets in the panel called GRAINS LIVE CONTROL shown in Figure 3:

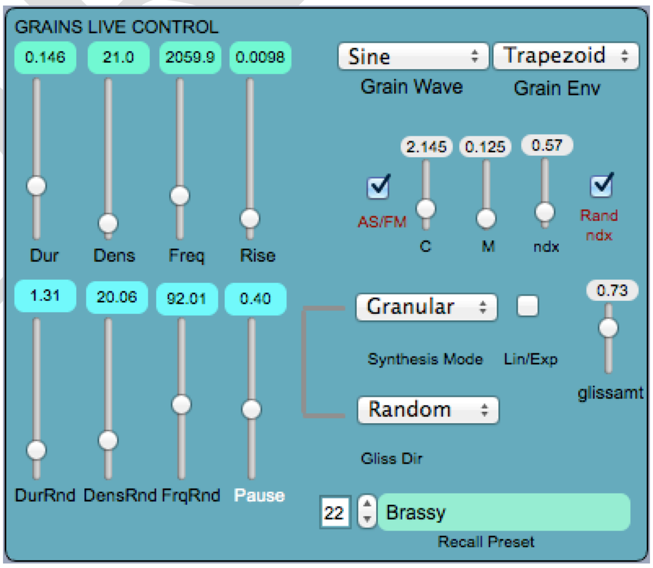


Figure 3 - The control panel of the synthesis parameters

GRAINS ENVELOPE

As already mentioned, the envelope of the grains has a trapezoidal morphology with an attack and decay modeled by a linear ramp of identical duration. This allows to shape the single grain in a symmetrical manner and therefore in palindromic form. When the duration of the attack (decay ramp) equals half the duration of the entire grain, the trapezoid degenerates into a triangular shape (as shown by the last envelope in Figure 2).

In Figure 4 it is shown a series of grains with trapezoidal envelope sequence with the following parameters set, while in Figure 5, the three randomic parameters are all zero.

Dur	: 0.05 s	DurRnd	: 3 %
Dens	: 16 gps	DensRnd	: 20 gps
Freq	: 500 Hz	FreqRnd	: 160 Hz
Rise	: 0.05 s	--	

As can seen, the grains have different durations, different frequencies and irregular positions in time, but identical trapezoidal envelope.

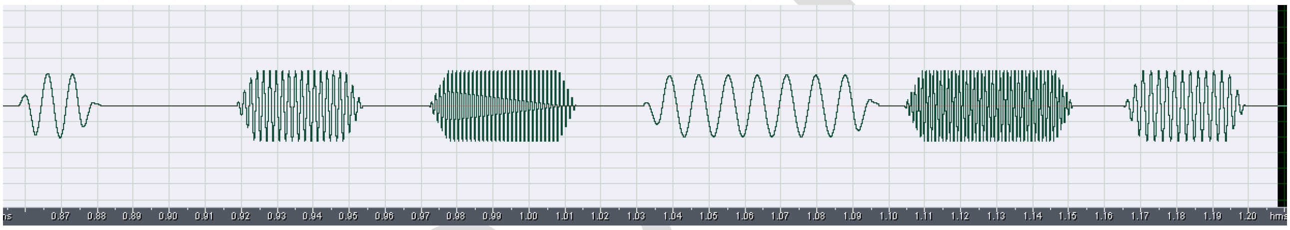


Figure 4 – Irregular sequence of grains. Only the envelope shape and rise time stay constant

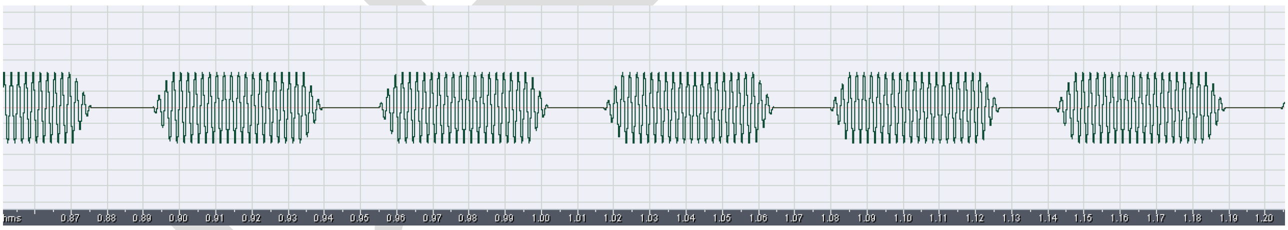


Figure 5 – Regular sequence of grains. All parameters are constant.

The envelope shape of the grains can be changed by selecting a choice through the Grain Env menu. The menu contains five different choices, the first of which obviously refers to the base form:

1) Trapezoid
2) Gauss
3) Exp
4) Twin Pulse
5) CUSTOM

We see in detail the other forms:

Gauss Envelope: with this choice, the envelope shape will be that relating to a combination of a trapezoid and a Gaussian curve (bell curve) in the sense that the rise and fall ramps of the trapezoid will be made to match the left and right sides of the Gaussian as shown in figure 6.

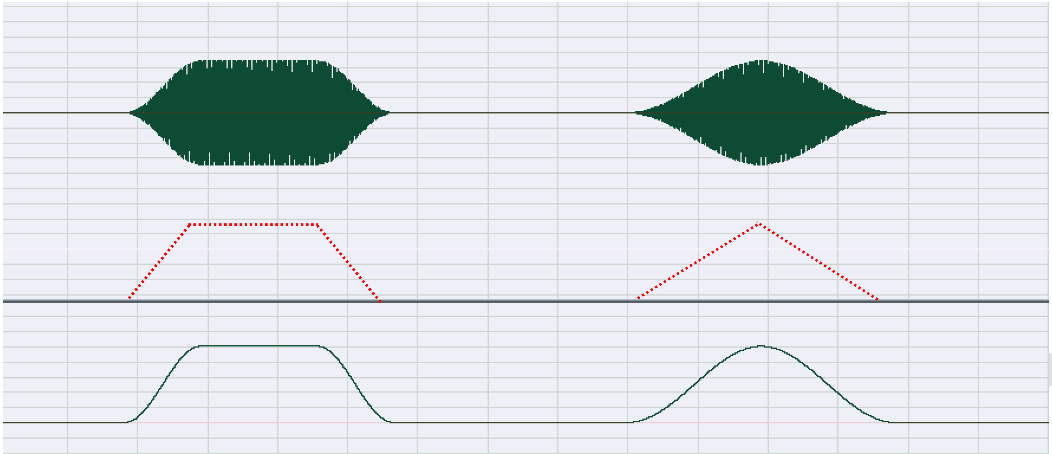


Figure 6 – Gaussian grain envelope

The first grain shows a rising slope and shaped of descent from the Gaussian curve and a constant value and sustain identical to that of the trapezoid. In the second grain, since the rise time of the ramp is equal to half of the entire length of the grain, the trapezoid basis degenerates into a triangle and then the envelope is precisely the Gaussian curve. The smoothing of the rising and fall of the envelope substantially reduces the spurious modulation components that are derived from the angular profiles of the trapezium and in the second case such effects are almost completely eliminated.

Exp Envelope: with this choice, the envelope shape will be the one relating to a decreasing exponential function as shown in Figure 7.

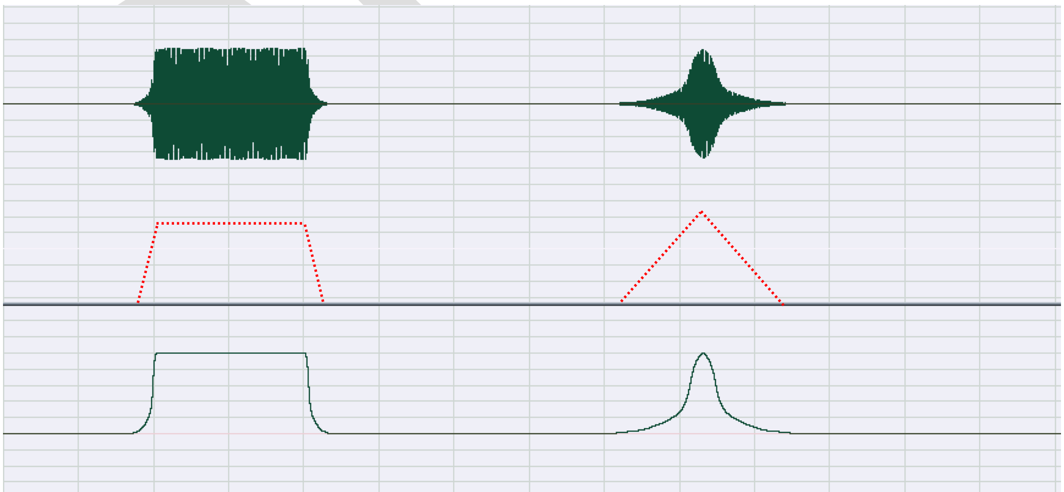


Figure 7 – Exponential grain envelope

Twin Pulse : with this choice, the envelope shape will be that relative to a pair of Gaussian pulses as shown in Figure 8. As can be seen from this figure, the duration of the rise time influence the degree of temporal proximity of the two Gaussian pulses.

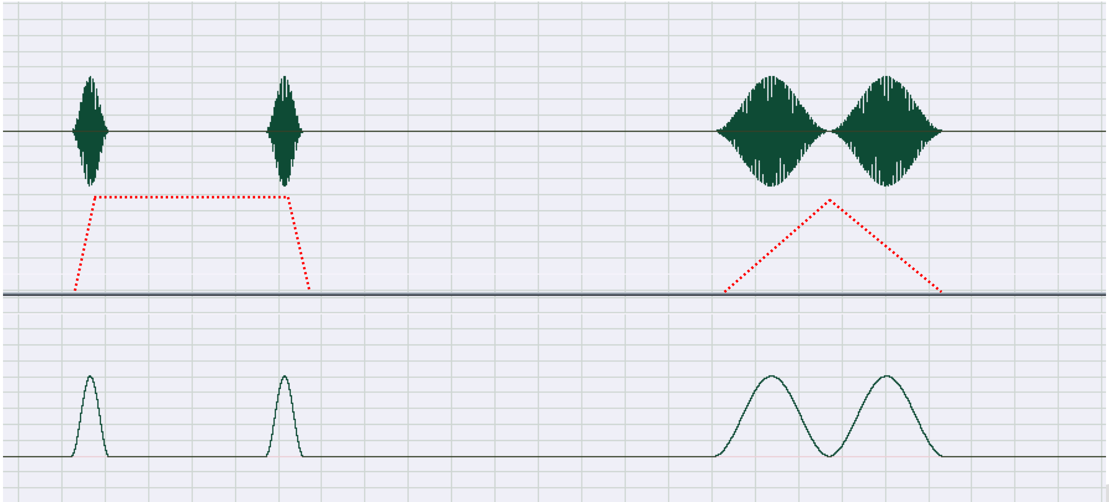


Figure 8 –Twin Pulse type grain envelope

CUSTOM : with this choice, the envelope shape may be arbitrarily constructed using a graphical tool that consists in the determination of a function in which the amplitude of 16 equally spaced breakpoint is specified. Acting with the mouse (left click) on each of the histogram bars you can build a feature profile that will be calculated through a spline technique (see dashed outline)

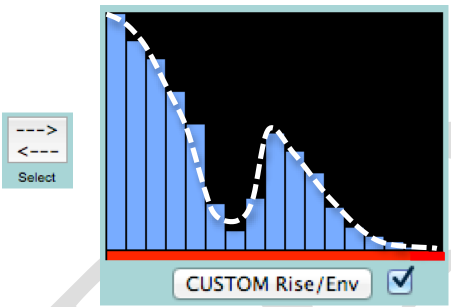


Figure 9 – Costruction of CUSTOM grain envelope

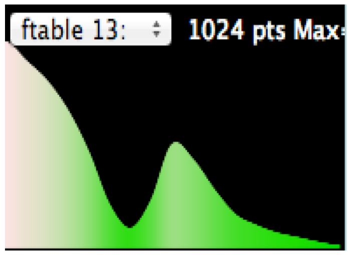


Figure 10 – Effective generated function

To create a CUSTOM type envelope must first select the right graphic display by clicking on the Select button to its left. This toggle button switches each time the focus on the left or right display. The body has been selected will be indicated by a horizontal bar in the red at the base of the histogram of the selected display. Once you configured the histogram you must press the CUSTOM Rise / Env button to actually generate the designed function. When pressing this button will automatically display in the graph below (Graph Widget) shows the actual calculated function. This allows you to refine the histogram profile in order to obtain the desired function aggiustandone values and creating a new function every time the CUSTOM Rise / Env button.
The obtained the envelope function is actually used when you select the CUSTOM menu entry Grain Env. In figure 10 it is shown the result of operations arising from previous actions.

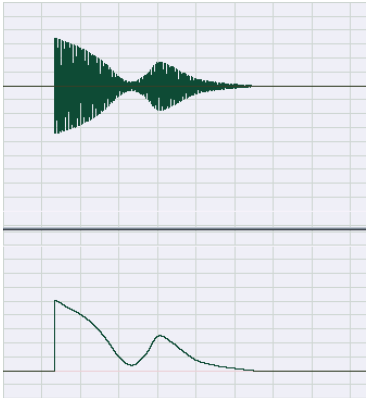


Figura 12 – Effective resulting waveform with CUSTOM envelope

! NOTE! : although the editing and the construction of a CUSTOM type envelope can be made while the generation is in operation, the function of the refresh can be due to some dropout (click) the audio for which it is advisable to do so in the process of design and testing, and not in phase of performance.

The CUSTOM envelope finally provides two modes of the function of creation. These two modes are selected alternately and exclusively by acting on the switch box to the right of CUSTOM Rise / Env button, so you will have:

a) *Env mode* (check box checked) : is the mode described above.
b) *Rise mode* (chek box unchecked) : in this mode, the generated function with the same actions is only used to map the on / off ramp envelope trapezoidal base as evidenced by Figure 13. This second mode is generally used a custom increasing function as shown in Figure 14

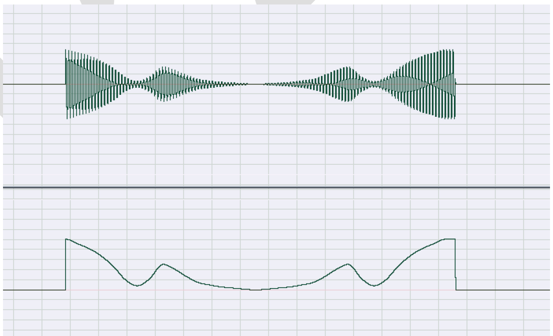


Figura 13 – CUSTOM mode Rise with decreasing function

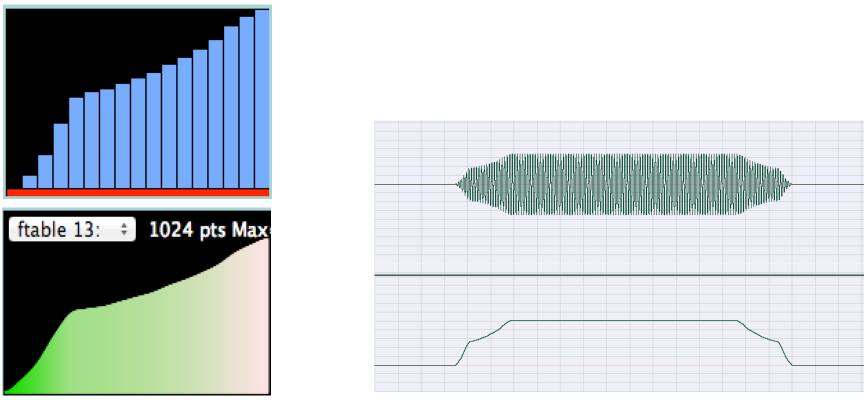


Figura 14 - CUSTOM mode Rise with increasing function

GRAIN WAVEFORMS

Each single grain may contain a type of waveform specified by the Grain Wave menu. The following choices are provided:

1. Sine : sine wave
2. Square : square wave
3. Ramp : ramp
4. Pulse : positive impulse
5. Vocal_Eh : italian E vocal (as in RED word)
6. Vocal_Ah : italian A vocal (as in RUN word)
7. Formante : formant
8. CUSTOM : built wave
9. randomsel : random selection
10. White Noise : white noise

The selection of each type of waveform can be made without interruption during the generation of the audio stream. The waveforms from 1 to 7 immediately select the type of signal indicated. Selecting the CUSTOM choice you can use an arbitrary waveform created directly through the use of a graphical tool fully similar to that already described for the envelopes. In this case you must first select the left side graphic display by clicking on the "Select" button to the right.
This time, unlike the case for the construction of the envelope, the histogram represents the spectral description of a waveform cycle obtained with Fourier harmonic sum. For example, in Figure 15 is shown a spectral composition of a waveform cycle consists of the first five components whose amplitudes are given by the respective values of the histogram. In Figure 16 it is shown the effective waveform resulting when pressing the Custom Wave button.

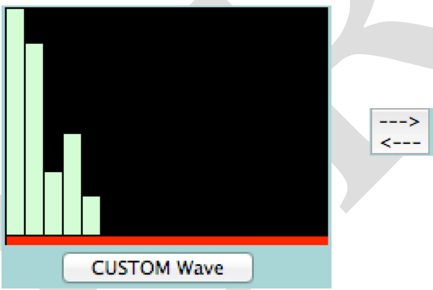


Figure 15 – Building a CUSTOM waveform from spectrum

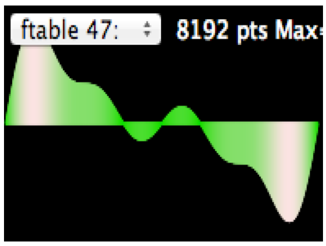


Figura 16 – Effective generated waveform

Selecting option 9 (Random Sel) from *Grain Wave* menu, each grain generated will contain a waveform randomly chosen among those identified by the options from 1 to 7.

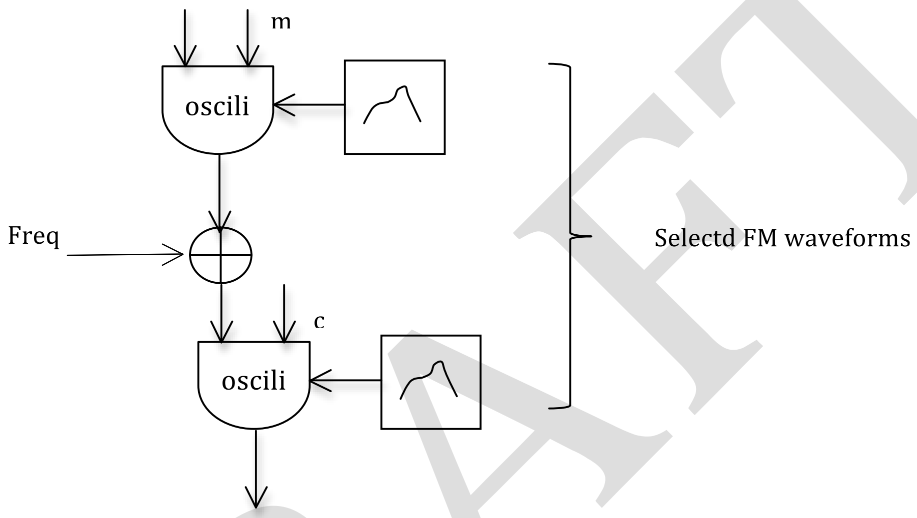
Selecting option 10 (White Noise option) from *Grain Wave* menu, each grain will contain a colored white noise fragment with a resonant filter whose center frequency is controlled by the parameters *Freq* and *FreqRnd* and whose duration and envelope are controlled by all other parameters related to the envelope of the grains.

AS/FM MODE

As already said, the waveforms available, both internal default ones and those specified with the CUSTOM option, are built with additive Fourier technique. For all these waveforms, with the exception of the option White Noise, it can also be used the FM synthesis. The alternative choice depends on the state of the checkbox AS / FM (cfr. Fig. 18):

a) AS/FM checkbox unchecked: the grains contain the waveforms selected
b) AS/FM checkbox checked: the grains contain the FM waveforms selected

In practice, the sounds will be produced by a simple configuration in which the bringing-the modulating waveforms (for both oscillators) are those currently selected as shown in Figure 17:



FM

Figure 17 – Basic FM patch

For this option, the following three parameters are available as shown in Figure 16:

1) c : carrier value expressed as a numerator of a frequency ratio
2) m : modulating value expressed as a denominator of a frequency ratio
3) ndx : modulation index

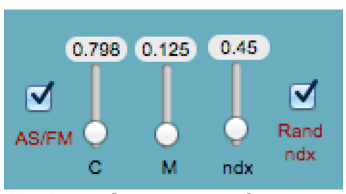


Figura 18– Control parameters for FM synthesis

! NOTE ! : when the checkbox AS / FM is selected, the parameters c, m and ndx are not active

The activation of FM synthesis allows you to get very rich timbre timbres with very large bandwidth that might exceed the Nyquist frequency.
In addition, two further options can be selected using the check box *Rand- ndx* that is:

a) *Rand-ndx* check box deselected

   The FM modulation index varies from zero to the maximum value indicated by *ndx* parameter for the first half of the duration of the grain and from maximum to zero for the second half. With this mode the timbre of each grain will always have the same spectral variability

b) *Rand-ndx* check box selected

   The FM modulation index varies from zero to a random value between zero and a random value extracted in the range of 0 and *ndx*. In this mode, the timbre of each grain will be statistically different grain by grain.

SYNTHESIS MODE (Glisson Synthesis)

There are two basic modes for the generation of the grains:

a) Standard granular synthesis
b) Glisson granular synthesis

Normally (selection Granular), within each grain, the frequency remains constant for its entire duration, that is, the frequency values are assigned to each grain as init value and do not vary as long as the grain is not completed. Conversely if Glisson Syntehsis Mode is selected, the frequency of each single grain will undergo a shift (glissando) to a target value typically different from the initial value.

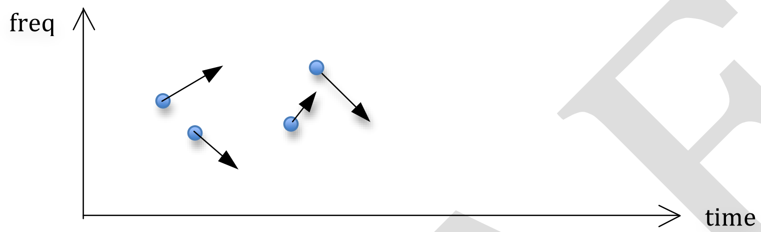


Figura 19 – Frequency trajectories of grains in time time

This continuous glissando will be:

a) Up: ascending (each grain starts from its nominal frequency and rises to a higher frequency)
b) Down: descending (each grain starts from its nominal frequency and falls to a lower frequency)
c) Random: : randomly ascending or descending

The arrival frequency target is calculated internally and externally controlled by a parameter called *glissamt* that represents the percentage of rate increases / decreases compared to the nominal frequency:

Glissato amount: 0.01 < glissamt < 100 %

In addition, the type of glissando may be selected between two possible choices:

a) <u>linear</u> : LinExp checkbox checked
b) <u>exponential</u> : LinExp checkbox unchecked

Even the glissati, as other parameters of the grains, are synchronous with the beginning of each grain and the frequency variation is distributed throughout the single duration.

SUOND PRODUCTION AND AUTOMATIC MODE OF OPERATION (ACTION)

Most of the parameters in the Live section can be programmed in time in order to produce temporal sequences in which these parameters vary automatically in a manner which will be described below. In a granular context this timeline can be called "cloud" .
Each of the parameters concerned is programmed through a function that consists of three successive segments as shown in Figure 20
.

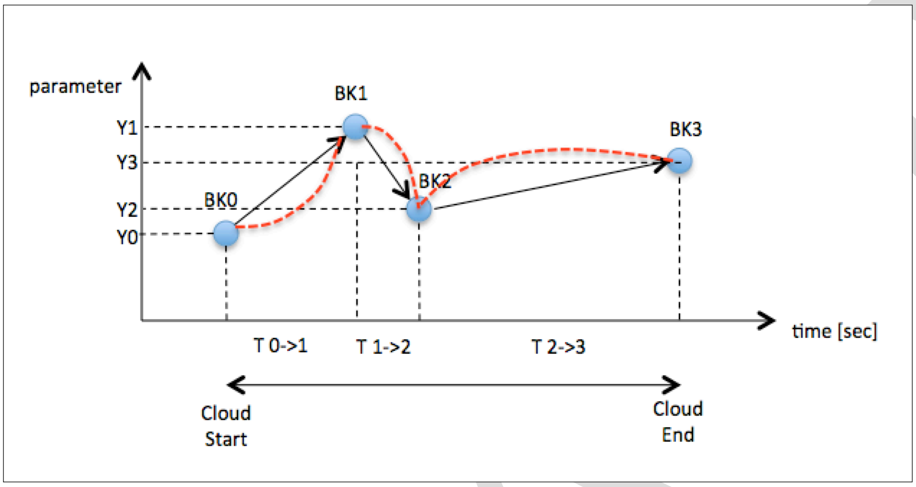


Figure 20 – Control function for one cloud parameter . Here are shown both linear and exponential curves.

In practice, each of the circles (breakpoints BK0,1,2,3) represents a state of the synthesis parameters and the passage through them implies a gradual transformation of the cloud shape which correspond to the following values:

Y0 : initial value of the parameter (first parameter value)
T 0 ->1 : time (sec) of transizition between the state Y0 and Y1
Y1 : second parameter value
T 1 ->2 : time (sec) of transizition between the state Y1 and Y2
Y2 : third parameter value
T 2 ->3 : time (sec) of transizition between the state Y2 and Y3
Y3 : final value of parameter (last parameetr value)

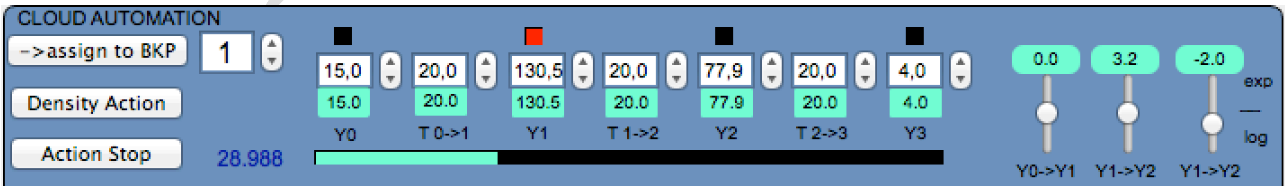


Figure 21 - Control widgets for the programming of the parameter "density of grains" in the "cloud". Notice the two Start/Stop buttons (Density Action/ Action Stop), the progress bar, the data entry fields and the sliders to set the ramp mode of the transition function and the widgets for the selection of th breakpoints and for the quick input of all values related to a certain breakpoint. In particolar, we will have:
for t = 0 s   : the average density of the grains is 15 gps (Y0)
for t = 20 s : (0 + 20)   : the average density of the grains is 130.5 gps with lineare transition   (Y0->Y1 = 0)
for t = 40 s : (20 + 20) : the average density of the grains is   77.9 gps with exponential transition (Y1->Y2 > 0)
for t = 60 s : (40 + 20) : the average density of the grains is   4.0 gps with logarithm transition   (Y2->Y3 < 0)

The Figure 21 shows the input fields of the values of the individual breakpoints:
the two buttons on the left (Density Action Action and Stop) are used to start and stop the control function for the density parameter (gps). The values of breakpoints can be entered directly inserted or by using the scroll number (colored green field) or by writing the same value in the spin-box or using the two small vertical arrows. Below the data entry widget, the figure displays a progress bar that marks the temporal advancement of the transition function and on its left is shown the instantaneous value of the parameter. The transition times between Y0, Y1 and Y2 can be any values.
On the right are also visible three small sliders which are used to influence the performance of the function connecting the different breakpoints. Each slider can be set to values between -5 and + 5. We will then have:

0 < slider < 5 : the function tract will be exponential (slight curvature for small positive values and greater curvature to values close to 5 as it appears in the dashed curve in Fig. 20)

slider = 0   the function tract will be perfectlylinear

-5 < slider < 0 : the function tract will be logarithmic (slight curvature for small positive values and greater curvature to values close to 5)

In the same figure 21 are visible 4 red indicators (LEDs like) in correspondence with the values Y0, Y1, Y2 and Y3. These LEDs are lit exclusively by acting on the spin box to the left of the first LED. When you select one of the Yi values, you can assign all the values for the other time parameters (Dur, Freq, Rise, ecc...) from the current settings of the Grains Live Control Panel after clicking on the button ->Assign to BKP. In this way questo we can quickly set the four breakpoints values without having to write or set individually.

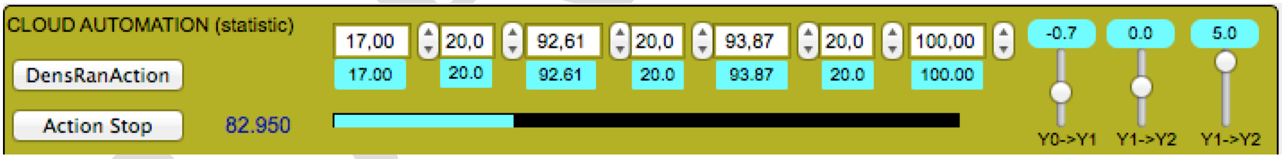


Figura 22 - Control widgets for the programming of the "randomic grains duration in the "cloud". Notice the two Start/Stop buttons, The progress bar, the input data fields dati and the slider for select the ramp mode of thetransition function.

Using the same criteria similar controls are available for statistical parameters belonging to the "cloud": these are recognizable because they are filled in a panel with a different background color (see fig. 22). In the same figure they are also shown further controls for the insertion of the time values between the various breakpoints when you want to synchronize them with each other. In fact, it is not necessary that the various parameters and the same time values of a parameter are identical: in that case, the total duration of the cloud will be equal to the largest value of the sum of the transition times of each parameter.

To complete the parameterization of the cloud you need to set the global parameters of the cloud itself, contained in the panel of figure 23.

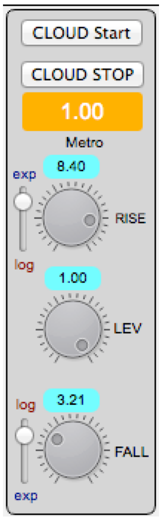


Figura 23 Control panel for the global cloud amplitude and the metronome.

In this panel are visible various controls:
Cloud Start : starts all the transition functions of the cloud
Cloud Stop : stops all the transition functions of the cloud
Rise : controls the rise time of a global amplitude envelope of the della cloud
Exp/log : controls of the rise type segment of the global envelope(exp-lin-log)
Lev : controls the maximum amplitude global envelope
Fall : controls the fall time of a global amplitude envelope of the della cloud
Exp/log : controls of the fall type segment of the global envelope(exp-lin-log)
Metro: a metronome control. When this valoue is set to 1 the temporal values of the cloud are as shown in the panels (fig. 21 / 22) while when it is different from, the cloud flows faster (> 1) or more slowly (<1) in a proportional way..

For example, if the values T0- > T1, T1-> T2->T3 are all set to 20 (20 sec), the cloud duration is of 60 seconds. At this point, bringing the meter parameter to the value 2, the clouds will last a total of 30 seconds, and that is half the time. Conversely, if the parameter is 0.5 meters, the cloud will last a total of two minutes (120 seconds).

NOTE: the two Cloud Start / Stop buttons start or stop all envelope of the cloud simultaneously.

REVERBERATION

The EFX panel contains controls for the reverb, which is exactly the length of the sound tail, the absorption of high frequencies and the amount of reverb same whose respective ranges are:

$0 < \text{RevLen} < 1$ (reverberation length)
$0 < \text{RevCut} < 1$ (hi-freq damping)
$0 < \text{RevLev} < 1$ (reverberation amount)

To these three common basic parameters of the reverb is added another that allows you to choose his operational mode RevMode through a two-option menu. The two modes are:

a) *Global* mode : all the grainsare equally reverberated
b) *SingleRandom* mode: each grain enters the reverberator with a certain level by a statistical variable. In this way, each grain will appear more or less in the background / foreground depending on the value of this variable.

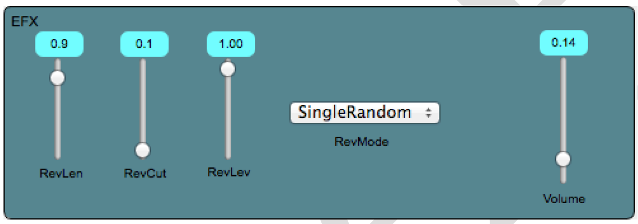


Figure 24 - Reverberation controls and overall level (EFX panel)

NOTE: The spatial distribution of the grains also depends on another random variable that extracts, grain by grain, a panning value between Left and Right.

As can be seen, the panel that contains the controls for the reverb (EFX) also contains a control (slider) to the general level (Volume).

MIDI AND AUTOMATION

This section lets you control much of the synthesis parameters via MIDI control from internal and external sources. 8 independent controls are available, each of which responds to a CC (continuous MIDI controller) associated to 10 different parameters of synthesis:

N/A : not assigned
DUR : cc assigned to the grain duration
DENS : cc assigned to the density
FREQ : cc assigned to the frequency
RISE : cc assigned to the envelope rise time
NDX : cc assigned to FM modulation index
REV : cc assigned to reverberation amount
VOLUME : cc assigned to overall level
DURrnd : cc assigned to randomic duration
DENSrnd : cc assigned to randomic density
FREQrnd : cc assigned to randomic frequency

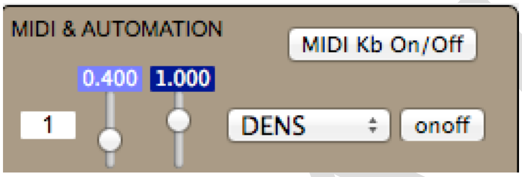


Figure 25 - Controls for MIDI automation

In the MIDI panel & AUTOMATION (Figure 25) are visible widgets related to one of the controls, and that is from left to right

> a scroll number that allows to select selezionare the MIDI cc
> two vertical sliders (riscale *cc* value inside a specified minimum/maximum range). In figure 24 th external cc 1 is scaled between 40 and 100% of its value.
> a menu for the selection of the internal parameter to control
> a switch to activate/de-atctivate the control

The further to the right top button allows you to associate the parameter of the grains rate to a connected MIDI keyboard.

JITTER CONTROL

his section contains the widgets for the automatic management and statistical analysis of the synthesis parameters. Pressing the pulstante jitter, the main widgets LIVE panel and the amount of reverb are no longer manageable by hand and the grains are generated in accordance with laws individual statistics associated with each parameter. The only thing possible is to define the scope of the parameters controlled between a minimum value and a maximum value as shown in Figure 26

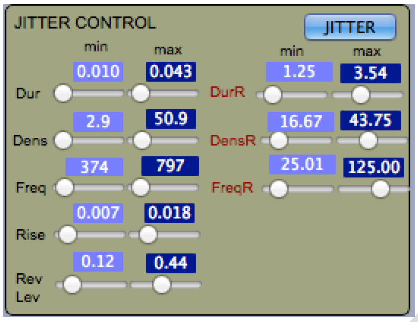


Figure 26 - Jitter Control Panel

his section is in the testing phase, and therefore subject to change.

LIVE IN CONTROL

... in progress

PRESET

As in any CsoundQt orchestra, you can save / recall the normal state of all parameters via an integrated preset list. In this particular orchestra, since some of the synthesis components can depend on particular states of widgets, it may happen that by calling a certain preset, the sound does not match what was expected or at least may be inaudible. There are then two possible things to do:

1) create the two functions (waveform and envelope) through the create button
2) recall a new preset and recall the previous

Also this section is being redefined and will occur in the subsequent versions.