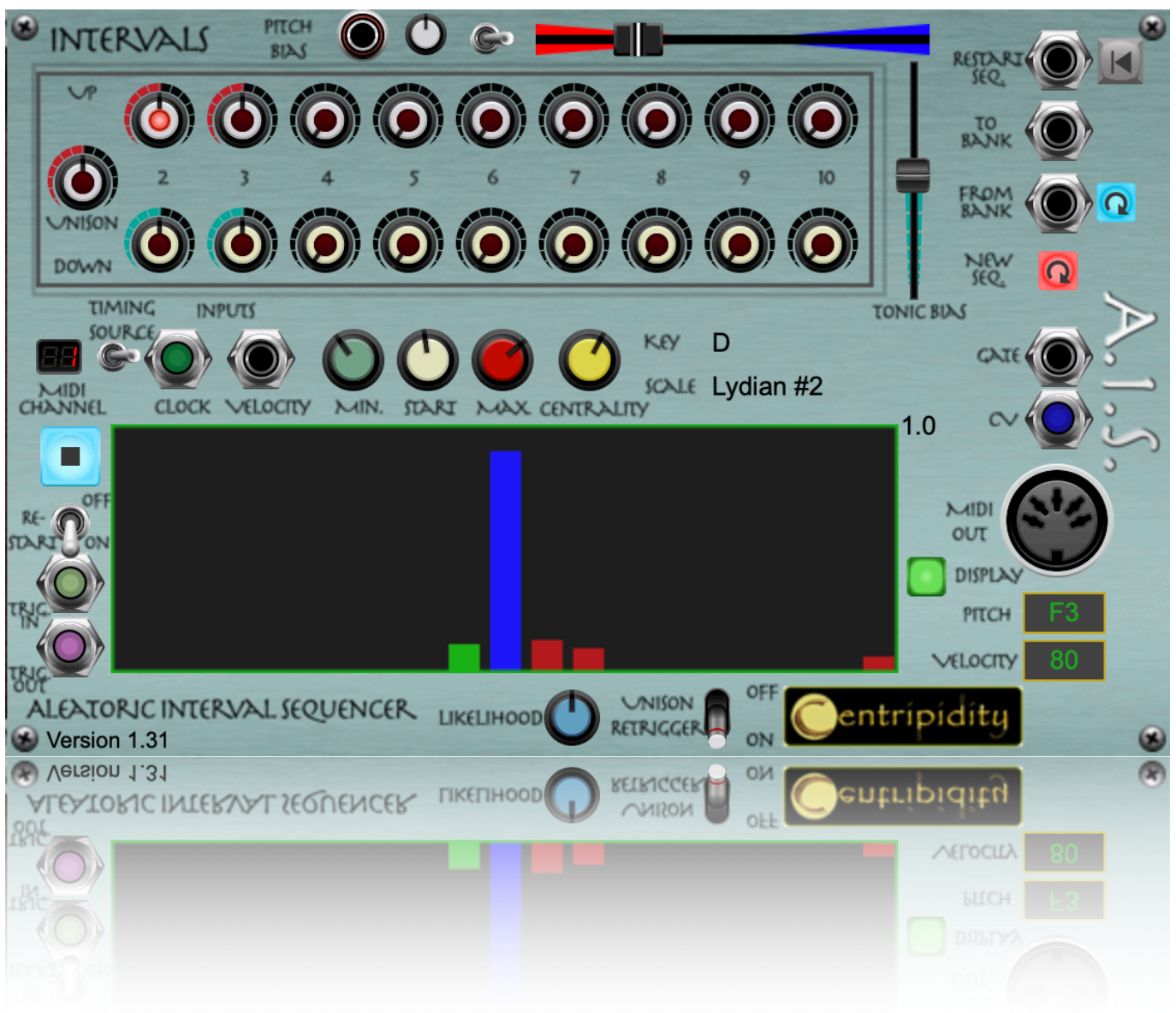# Centripidity

Aleatoric Interval Sequencer

Introduction

The term *aleatoric* music relates to some element of randomness and comes from the Latin, *alea* (dice). The idea became popular in Western music in the middle of the twentieth century when Werner Meyer-Eppler defined it as "a process is said to be aleatoric if its course is determined in general but depends on chance in detail".

More recently, the term has been used to describe any form of random music generation. In the early years of analogue synthesis the most obvious example of random note generation was the connection of a white noise generator into a clocked Sample and Hold circuit with the output being used as the pitch cv for an oscillator.

This module adheres more closely to Meyer-Eppler's definition in that it uses random numbers to create each individual note but the overarching structure of which notes are possible, and how likely they are to occur next, is user driven.

Basic Principle

The AIS is, ultimately, a random note generator but less simplistic. The AIS uses random numbers, not to directly select the next note, but to select the interval between the current and next notes. In the case of purely random note generation the next note could occur anywhere within the allowed range of notes but random interval generation lets the user specify the probability that the jump to the next note will be large or small, up or down.

The AIS also limits generated notes to fall within a user-nominated key and heptatonic scale.

So, the next note to be played is determined by:

- The last note played, as the next note will be a random interval above or below it.
- The upper and lower note boundaries set for the sequencer's output.
- The user-chosen key and scale.
- The likelihood of each interval, as set by the user on the various Interval Likelihood knobs.
- The degree of centrality, set by the user, which reduces the probability of selecting an interval that would bring the next note close to the upper or lower note boundary.
- The High/Low bias control which determine whether to favour the interval moving higher or lower.
- The Tonic bias which increases the probability of selecting an interval that would make the new note return to the tonic of the chosen scale.

See page 8 for what's new in this version.

The Interface

The figure below highlights all of the main controls available on the AIS.

Interval Likelihood Controls
Controls to set the relative likelihood that any given interval will be chosen by the sequencer.

Each knob also contains a LED which, while the sequencer is running, lights up to show the currently chosen (and playing) interval.

Pitch Bias Controls
Various controls to bias interval selection towards rising or falling intervals and towards the tonic.

Restart Sequence
Takes the random number generator back to its initial, as loaded, condition. If all other controls remain unchanged this will restart the same sequence of notes.

This can also be triggered via gate or trigger input.

Phone Bank Interface
Components for interfacing with a Phone Bank module.

New Sequence
Pressing this button will set the random generator in a new state and hence produce a new sequence.

Input Controls
The triggering of each note can be driven by either an external clock signal or via MIDI note messages received from the host application.

Note Controls
These knobs set the pitch limits for the sequencer and the starting note for the sequence. It will never output a note above the settings on the Max knob nor below that of the Min knob.

This range can be set as large as the entire MIDI note range, or as small as a single note.

Centrality Control
Reduces the likelihood of selecting intervals that would push the note close to the note boundary limits.

Key and Scale
Menus for choosing the key and scale to be employed.

Output
Pitch CV, MIDI Notes and Gate signals appears from these jacks along with information regarding the latest MIDI note output.

The Gate signal may be the same as the input clock but not necessarily, depending upon the settings of the Unison Retrigger controls.

Unison Retrigger Controls
Used to determine what will happen if a unison is chosen. Will the same note retrigger or just sustain?

Probability Display
When engaged, this area shows a plot of the probability histogram that any interval will be the next selected.

Hovering over this display will show the probability of the interval under the mouse cursor.

Control Details

Interval Likelihood Knobs

The primary way to influence how the sequence develops is via the Interval Likelihood knobs. For each of the available musical intervals, unison and up or down anything from a second to a tenth, the corresponding knob sets how likely that interval is to be chosen when the sequencer is running. Each knob can be set between zero and ten. The chosen values are relative likelihoods. Knobs set to zero mean that interval can never be chosen, knobs set to the same value have equal underlying likelihoods that their interval will be selected and a knob with a value of six means its interval is, before adjustment as explained below, twice as likely to be selected as an interval with its knob set to three.

Key and Scale

All of the available scales are heptatonic, that is, they contain exactly seven distinct pitches. The interval controls determine the basic likelihood that the currently playing note will jump by that interval within the specified key and scale.

A total of 36 distinct scales are available.

Note Controls

Min. and Max.

The Min. and Max. note limit knobs specify, respectively, the lowest and highest notes that the AIS is allowed to produce. These controls will always specify a note within the current key/scale combination.

To achieve this, as the currently played note approaches one of these boundaries, the probability of an interval that would breach that boundary drops to zero no matter what the setting on that interval's likelihood knob.

Start

This controls allows setting the first note that will be played when the module is first loaded, or when the Restart controls are triggered. Its value will always be within the range specified by Max. and Min. and will be a valid note within the chosen key and scale.

Centrality

This control biases interval selection towards the unison. As mentioned above, the probability of any interval drops to zero if it would take the next note across the note boundary limits. Raising the Centrality also reduces the probability of those intervals which would take the next note close to, but not over, those boundaries.

Pitch Bias

Ascending/Descending

This control biases interval selection to either ascending or descending intervals so that the melody produced will gradually rise or fall. Of course, if it is left strongly biased either way the melody will eventually end up staying close to either the upper or lower note boundary. To allow for manual operation the slider can be manipulated by an external MIDI controller.

Alternatively, if the switch next to this slider is toggled to the left and a cv is applied to the adjacent input, the position of this slider can be controlled with an external voltage source such as an LFO.

Normally a peak-to-peak voltage of ±5V will sweep the slider through its full traverse but a knob is provided to control the depth of the modulation whereby the input cv can be attenuated or amplified.

Tonic

One way to make the resulting sequence "feel" more in key is to have the tonic note of the key occur more frequently than other notes. The Tonic Bias slider achieves this. At the Botton of its throw the Tonic is just as likely to occur as any other possible note but, as this slider is raised, it increases the probability of intervals that would lead to the tonic as the next note.

Unison Retrigger

These controls determine what will happen if the interval generated is a unison. In that case the new note will be the same as the previous one so the question is whether it should retrigger this as a new note or just add it to the duration of the already sounding, previous note.

The Unison Retrigger offer three possibilities:

- With the toggle switch in the down (On) position unisons are treated the same as any other interval and so if the same note occurs multiple times in a row each will be sounded as a distinct, triggered note.

- With the toggle switch in the upper (off) position unisons do not retrigger a new note but simply extend the duration of the original note.

- With the toggle switch in the middle position the decision whether or not to retrigger is left to chance and the likelihood of retriggering is determined by the provided **Likelihood** knob. If the knob is set fully clockwise it is the same as having the switch down and fully anti-clockwise is the same as having the switch in the up position.

If the Max. and Min. Knobs are set to the same note then the unison is the only possible interval. Setting the toggle in the middle position and manipulating the retrigger likelihood can generate some potentially interesting rhythms.

Of course, producing the same note simply means leaving the pitch cv output unchanged. Unison retriggering is implemented by the Gate output as explained below.

Input Controls

The AIS takes care of the notes that are played but the rhythm must, other than the issue of unison retriggering, come from some external source. Two possibilities are provided.

With the toggle switch set to the right timing is controlled by whatever clock signal is supplied to the Clock Input jack. This is essentially a gate input that triggers a new note as the rising signal passes the threshold of +3.5V. Each time the clock rises above 3.5V a new interval/note is played by the sequencer. When the falling clock signal passes through 3.5V the gate is closed and a MIDI Note Off message is sent.

With the switch toggled to the left any clock input is ignored and timing is controlled by MIDI Note On and Note Off messages received from the host application. The connection to host MIDI is automatic so does not require cabling from VM's IO Panel. When in MIDI mode it is advisable, but not essential, to set Unison Retrigger to On.

However, MIDI triggering is not *omni* but will respond only to a single MIDI channel. That channel is displayed to the left of the toggle switch. To change the channel simple click and hold on the channel display and drag up or down to increase or decrease the channel respectively.

There is also a Velocity Input. This has no bearing upon the internal operation of the AIS but, as explained below, one of the outputs of this motor is a stream of MIDI note messages and this input supplies the Note On velocities used at the MIDI output. The full range of velocities (0 - 127) corresponds to an input range of 0 - 5V.

Probability Display

Every time a new note is produced the relationships between intervals, the note limits and the tonic changes and so all interval probabilities need to be recalculated, This area displays a histogram of the interval probabilities for the next note to be generated. The unison is plotted in blue, the ascending intervals are red and the descending, green.

Hovering the mouse over the display will indicate the interval displayed at that point and the value of its corresponding probability.

To the right of the display a toggle button is provided to turn this display on and off.

Outputs

The AIS provides a variety of outputs.

- CV sends the voltage corresponding to the currently playing pitch.

- MIDI send note on and off messages that, in essence, play the notes generated by the sequencer. The velocity used is based on the voltage provided on the *Velocity* cv input at the time.

- Gate sends what it almost an exact copy of the incoming clock signal except that it follows whatever results the *Unison Retrigger* controls create. So, to play an oscillator with the AIS use the pitch cv to set the oscillators pitch and the gate output to drive the envelope generator.

Below these output are text displays that show the currently playing note and the velocity sent with the MIDI note on message.

New Sequence

The output of the AIS is, in part, based upon random numbers but computers use a formula to generate these and so they are really only pseudo-random. Essentially what that means is that the numbers generated depend upon the initial state of the generator and that if the generator is given the same initial state it will generate the same sequence of supposedly random numbers.

When first added to a patch, the random generator will use another technique, based on some rapidly changing parameters in your computer, to put itself into a pseudo-random initial state. When a patch is saved that initial state will be preserved along with the rest of the controls and so, each time it is loaded, it should perform the same sequence.

But that might not be what you want, hence the *New Sequence Button*. Pressing this button will set the random number generator into a new initial state and hence produce a new sequence.

Restart Sequence

Either pressing the Restart button or providing a positive trigger voltage greater than 3.5V on the provided inout jack will restart the sequence. What actually happens is that the random number generator is set back to its initial state and so the same sequence of notes will be produced.

However, note that this Restart is only providing the same random stream and not resetting any other controls. If any other controls that influence interval probability have changed then the sequence will change. Such controls include: all nineteen Interval Likelihood knobs, Bias controls, Unison Retrigger controls and the three Note controls.

Having the Unison Retrigger switch in the middle position will generate the same sequence of intervals but not necessarily the same gate output signal.

Phone Bank Interface

This module is **Phone Bank** compatible. The Phone Bank is a free module, initially released with the Dodecaphone which allows these random number initial states to be stored, named and recalled.

See the Phone Bank user manual for more details.

New Controls for Version 1.3

Run/Stop Button

When in the Stop position any gate signals arriving, either via the Clock input or via MIDI are not passed onto the sequencer and so it does not run.

When depressed, this button will light up blue and switch to being a Stop button. This starts the sequence by allowing gate pulses from the selected source to pass into the sequencer.

Restart Switch

In the up/off position this switch has no effect but when switched on/down an internal connection is made between the Run/Stop button and the Restart input jack.

Effectively this means that when:

- the switch is Off the Stop button pauses the sequence and subsequently pressing Play will continue the sequence from where it stopped,

- in the On position pressing Stop then Play will restart the sequence from the beginning.

Trigger In Jack

This jack allows external control of the Stop/Play button. Each time the voltage on this jack passes up through 3.5V the Stop/Play button will be toggled.

Trigger Out Jack

This jack allows the Stop/Play button to control other devices for the purpose of synchronisation. Every time the Stop/Play button is toggled a short (one sample) 5V pulse is passed out through this jack.

Run Controls
In Version 1.2 the sequencer ran whenever gate signals. Version 1.3 introduces controls and jacks to control running the sequencer and coordinate

Bug Fixes in Version 1.3

Fixed a bug where the restarting and playing a sequence would miss the first note from the original, first play through.

Fixed a bug where the values of Max Note and Start Note were not always correctly restored when a preset was loaded.