Generative Chaos - Modulating a Granular Synthesizer

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ABSTRACT

This paper and the Max8 patch, presented alongside displays various forms of Generative algorithms and concepts and how to implement them to modulate parameters of a Synthesizer, in this case a Granular Synthesizer. Strange attractors and other forms of chaos such as the Lorenz Attractor are used in the Patch. Unique and complicated forms of deterministic modulation are common so, implementing a complex generative/chaotic (non-deterministic and deterministic) modulation source into a synthesizer will give some interesting results. The Max/MSP patch is designed to be easily flexible and easily adapted to modulate any source.

Author Keywords

generative, chaos, modulation, granular synthesis

1. INTRODUCTION

Generative algorithms and concepts and how to implement them to modulate parameters of a Synthesizer. The Patch is based in Max8. It features a full Granular Synth, Chaotic Modulation Generator, and a I/O Scaling Patch to easily adapt the modulation to any Synth based in a Max Patch.

Various topics from Deterministic Modulation to Strange Attractors will be explored and compared as a modulation source. Ways to implement these methods into Max8 with also be show using advanced objects that extend the functionality of Max such as [gen~].

2. GENERATIVE (MODULATION)

Generative Modulation can come from several directions, Creative/Procedural, Interactive/Behavioural, Biological/Emergent and Structural/Lingustic.

Various forms of simple generative objects are available as a Max object, [drunk] and [random]:

[random] outputs numbers based of the range given as an argument. The random generator can optionally also be given a specific seed. [drunk] is similar to the random object however instead of fully random, it “steps” to the next number with the specified step range. This object can also be seeded. The object is based off a form of Brownian motion.

These 2 objects are used frequently in the granular synth made to show off the modulation. Specifically, being a random number, or a [drunk] walk between the minimum and maximum number given.

2.1 Deterministic

Deterministic is a form of Structural/Lingustic generative.
The random object mentioned earlier, [random] Is a pseudorandom number generator therefore it must be a deterministic source. More obvious forms of deterministic is the oscillator objects used in LFO part of the Patch, specifically, Sine Wave [cycle~], Saw Wave [phasor~], Triangle Wave [tri~], Square Wave [rect~]. This part of the patch allows the user to combine and offset the frequencies of all 4 oscillators to produce values to modulate with.

2.2 Non-Deterministic

This form of Generative comes under the Biological/Emergent category.

The [drunk] MaxMSP object mentioned earlier is Non-Deterministic as the output depends on random choices and will result in different outcomes when repeated multiple times.

A Markov Chain as (Hayes, 2013) States that “A Markov Chain describes a set of states and transitions between them.” It also falls into this category as a Non-Deterministic Algorithm as the state of the previous event depends on the next event. This was considered for the Patch however it would be more suitable to show off in a drum machine style of Patch, triggering certain drum hits, with various probabilities for example.

2.3 Chaos

Although Chaos is technically Deterministic as (David, 2016) states,

> “chaos has been termed "deterministic chaos" since, although it is determined by simple rules, its property of sensitive dependence on initial conditions makes a chaotic system, in practice, largely unpredictable.”

When given the same starting conditions the Chaos will always generate the same result, however something as small as a computational error can change the course of the chaos drastically. As summarized by Mathematician (Edward Lorenz, 1961) Chaos, is when the present determines the future, but the approximate present does not approximately determine the future.

This brings to a form of Chaos known as a Strange Attractor. A Strange Attractors are unique and never close in on themselves and are non-periodic.

The Lorenz Attractor is made up of a set of three nonlinear equations.

$$dx = a * (y - x) * dt$$
$$dy = (x * (b - z)) - y * dt$$
$$dz = (x * y) - (z * c) * dt$$

Fig 1. Lorenz Attractor Nonlinear Equations

As (Bradley, 2010) states,
a: ratio of fluid viscosity to its thermal conductivity
b: represents the difference in temperature between the top and the bottom of the system
c: ratio of the width to height of the box used to hold the system.

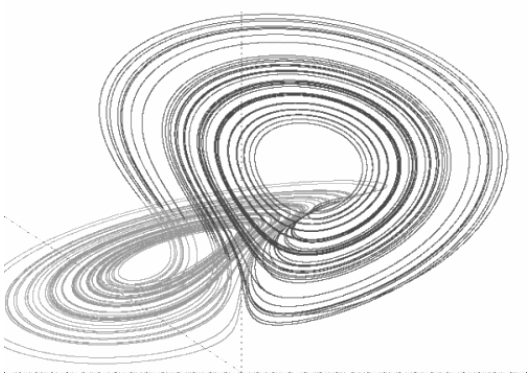

Fig 2. Lorenz Attractor

In the Patch the user has control over variables a, b and c. A small change to these values produces vastly different results. The patch only displays the dx and dy on the [scope~] object however all three outputs are available as modulation sources. The user is also given control of the speed of the attractor. The default values given in the patch are a = 10, b = 28 and c = 8/3 (2.6667). This is also the projection of the attractor (results plotted in three dimensions seen above) **Fig 2.**

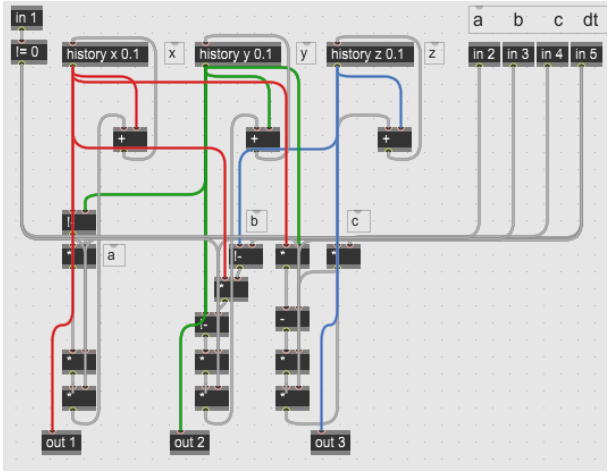

Fig 3. How Lorenz Attractor is Implemented within [gen~]

Other interesting, strange attractors are Hénon attractor and the Rössler attractor. If the project were to go further implementing these attractors into the Max8 Patch would be one of the next steps. As seen above in **Fig 3.** This was how the Lorenz Attractor was implemented into the Patch using the equation show in **Fig 1.** And an object called [gen~] which enables the user to have access to efficient code and instant audio processes

without latency making it ideal for a project like a Strange Attractor.

3. GRANULAR SYNTHESIS

Granular synthesis is the mode in which the various types of modulation are shown in the Patch. This Synthesis type was chosen before the methods of modulation were chosen.

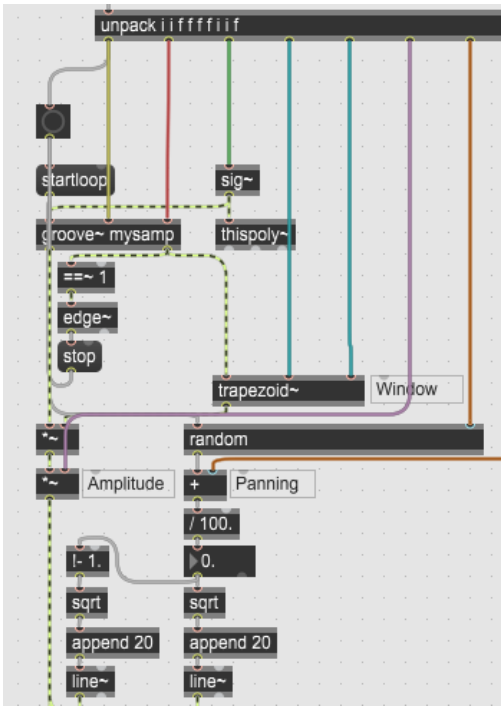

Fig 4. a Grain within [poly~] in Max8

The Granular Synth built for this project has various aspects to modulate, such as Grain Spray (the spread of the grain from the initial start position), Grain Size (the length of each grain), Grain Speed (the pitch of each grain), Length Between Grains, Grain Window (add zero crossing, reduces harsh pops at the start of each grain), Grain Amplitude and Grain Pan. The number of grains available to synth can also be easily changed.

Objects like [buffer~] [poly~] [groove~] [trapezoid~] are used to create this Synth **Fig 4.** Shows what is inside the [poly~] object, in this case each instance of poly (default for this patch is 100) is a grain available to the Synth.

[poly~ Grainbuffer 100 @steal args #0]

The arguments used in the patch allow not only a variable number of grains, but for those grains to have “voice stealing” so if all grains are used the oldest grain is replaced.

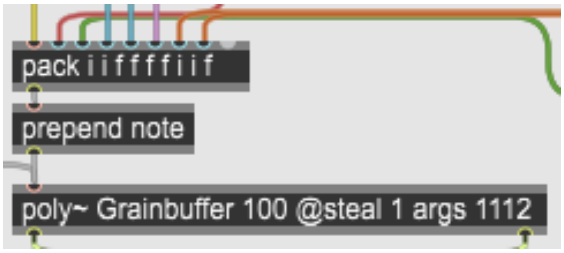

Fig 5. The poly object and its arguments used.

As seen above in **Fig 5.** All of the different grain parameters get packed and then “note” is prepended onto the information so the poly object can handle the distribution of “voices” / “grains”.

4. FUTURE WORK

As mentioned earlier the next step for the project would be in implementing more algorithms and generative methods into the Patch. This would include; a markov chain system for triggering a drum machine or in this case a single grain; More Strange Attractors like Hénon attractor and the Rössler attractor; Implementation of Logistic Map as a modulation source; Finding a way to implement a model of a Flock of Birds into a patch; Modelling and implementing the analog Duffing Oscillator into Max8.

Exploring and applying machine learning libraries such as the package ml.lib and ml.star could be a whole project in itself and is an area of expansion for this project. There is an extremely long list of generative techniques, chaotic algorithms and different deterministic processes that could be implemented and would fit the scope of this project. It would have been great to be able to implement all these generative systems in the patch and in this paper however, with the given time constraints only a few could be chosen.

5. CONCLUSION

As stated in the introduction, this paper was aimed to show the use of various Generative methods such as Deterministic, Non-Deterministic and Chaos in modulating different parameters of a Granular Synthesizer

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