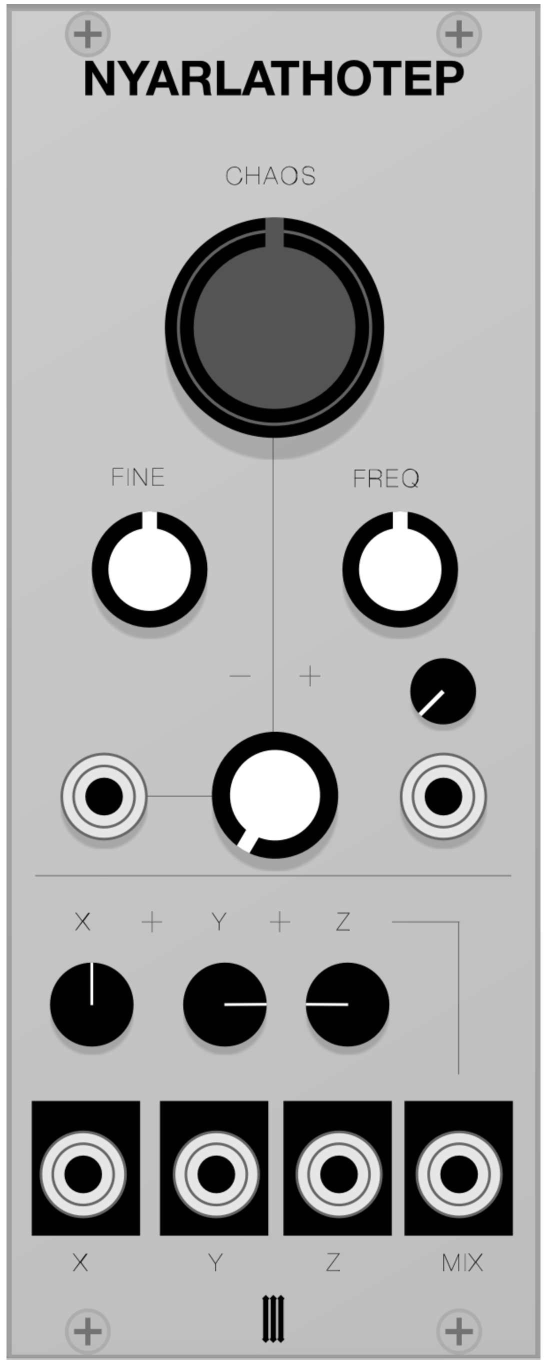
NYARLATHOTEP
CHAOS
FINE
FREQ
–
+
X
+
Y
+
Z
X
Y
Z
MIX

Nyarlathotep

Nyarlathotep . . . the crawling chaos . . . I am the last . . . I will tell the audient void. . . .

- Howard Philips Lovecraft

Nyarlathotep is a multidimensional ~~being~~ chaotic low-frequency oscillator (LFO). It is produced by the same formless chaos that created Azathoth, but moves at rates imperceptible to humans (it is perhaps more dangerous because of this). The frequency of its semi-periodic oscillations can be manually controlled via the frequency knob. It has manual control and voltage-control for both the frequency and the chaotic attractor. The chaotic attractor can also be fine-tuned via an additional knob. The control input for the chaotic attractor passes through an attenuator, while the knob for setting the chaotic attractor acts as an offset.

Three chaotic dimensions are available via the X, Y, and Z outputs. A user-defined mix of all three is available via the mix output. NOTE: the X,Y and Z attenuates do not attenuate the signal of the individual outputs, only the mix output.

A Word on Chaos:

Chaotic systems are, technically speaking, deterministic — that is, not random. Given the state of a chaotic system at one moment, it is possible to compute — with full certainty — the state of the system at the next moment. This is different from random systems, in which there is, by definition, some amount of uncertainty involved. Chaos, however, is often understood colloquially to be synonymous with randomness, and the confusion comes from the odd fact that, in practice, chaotic systems can be unpredictable. This uncertainty, however, comes from factors external to the system. Chaotic systems are so sensitive to small deviations that very tiny measurement errors (or even floating point truncation error) can cause significant divergences in output, making the system difficult to predict, practically speaking.

While there is a lot to understand about chaos (we strongly recommend James Gleick's book *Chaos: The Making of a New Science* as a primer on the basic concepts), the preceding information is all you need to begin using the module. You may be familiar with LFOs or random voltage sources from traditional subtractive synthesizers, the outputs of Nyarlothotep are not always periodic or aperiodic, some are quasi-periodic and offer (usually small) variations on patterns or shapes. We encourage you to experiment with Nyarlothotep. Although it is capable of producing chaos, this does not necessarily imply the aesthetic qualities typically associated with the colloquial use of the word "chaos" (ie. messiness, noisiness, a lack of order), we have found use for it in traditionally melodic patches to emulate the drift of analog oscillators, to name one example.

While chaos is interesting from a technical and philosophical perspective, you may be curious what the musical consequences of chaos are, and why you might reach for a computationally expensive chaotic oscillator instead of a random source. Let's look at a few musically relevant properties of chaos:

1. Sensitive dependence to chaotic attractor shape. The shape of the chaotic oscillator is very sensitive to small changes (that's why we include a fine tune knob), so it can be seemingly unpredictable when modulated, or just too sensitive to control effectively. There's a lot of fun in those "edges of chaos" between chaotic attractors.

2. Most of the patterns produced by the chaotic oscillator are more structured (more periodic) than random signals. SO it's not necessarily a source of randomness but more like a source of continued variation on a theme. You get these wonky loops but the loops are a little bit different each time through.

I/O:

Knobs:

- **Attractor:** Chaotic attractor, or waveform shape. This knob controls a variable resistance in the circuit model. Adjusting it brings the oscillator through a family of double and single scroll attractors, including chaotic waveforms as well as sinusoidal, periodic, and quasi-periodic patterns.
- **Attractor Fine:** Fine-tune adjustment to chaotic attractor.
- **Frequency:** Oscillator frequency. Note, frequency values are *approximate* because the resonant frequency of the oscillator is dependent on the current attractor as well!
- **X Mix:** X mix level.
- **Y Mix:** Y mix level.
- **Z Mix:** Z mix level.
- **Attractor CV Attenuverter:** Attractor CV input attenuverter.
- **Frequency CV Attenuator:** Frequency CV input attenuator.

Inputs/Outputs:

- **Attractor (CV in):** Attractor CV input.
- **Frequency (CV in):** Frequency CV input.
- **X Output:** Oscillator output.
- **Y Output:** First derivative of oscillator output.
- **Z Output:** Second derivative of oscillator output.
- **Mix Output:** Mixed signal output.

Right-click options

- **Actions** (Reset Initial Conditions): Reset oscillator signals to initial starting values. Use this to reset the oscillator (if it blows up) without clearing your parameters (as a full "Initialize" would do).
- **CPU Load (**Low, Medium, High, Very High): These values determine the numerical solver accuracy (time step). Higher accuracy solutions require a greater CPU load. Higher accuracy tends to sound "smoother," as the oscillator stays closer to the true signal orbit
- **Solver** (Euler, Rk2, Rk4): Selects between different numerical solver algorithms. Euler requires the lowest CPU load and Rk4 the highest. Each solver has slightly different noise profiles. Due to the particular nonlinearities of this oscillator, increasing the accuracy ("CPU Load") is generally better (more accurate) than using a more computationally expensive solver.

A few notes from dk

- The "Attractor" knob adjusts a variable resistance in the circuit model, which affects the oscillator waveform pattern.
- Transitions between attractor patterns can be extremely sensitive and difficult to control, which is why we have a fine-tune knob.
- The oscillator attractor (waveform pattern) exhibits hysteresis — the waveform pattern is dependent not just on the current "attractor" value, but also on the previous oscillator state. You might find when using the oscillator that it doesn't always return to the same attractor when you set the knob to the same value. This is why.
- The ability to change oscillator frequency is unique to the digital model.
- Chaotic systems are often visualized in phase-space, which plots the system variables against one another rather than through time. The first and second derivative outputs are given so that the oscillator phase portrait can be plotted on a scope. They also have distinct spectral profiles.