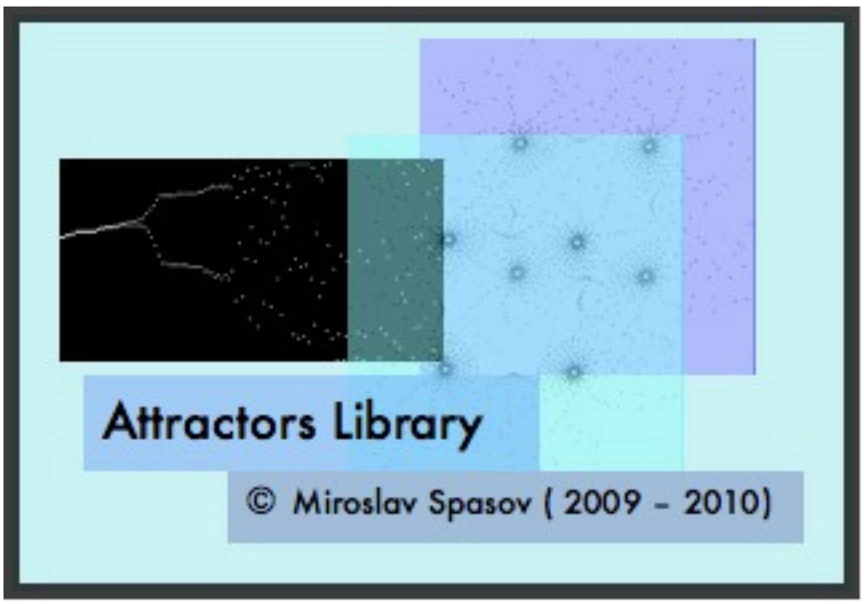
ATTRACTORS LIBRARY (v2.0)

and

Attractors – Mapping Examples



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For software updates and additional information:

http://www.keele.ac.uk/depts/mu/staff/miroslav.htm

Attractors Library (version 2.0) Date : 01/02/2010
& Attractors – Mapping Examples

Supported platforms: OSX (Apple Mac MacIntel) / Max 5/

Credits

I would like to thank IRCAM's imtr - team for developing the great MnM (IRCAM) library and making it available for further use free of charge. *fmat and mnm.matmap* objects/abstractions which are part of the FTM-based MnM Library were used with slight modification in conjunction with *Attractor's Library* and the *Mapping Examples*;

Installation

Place the Attractors Library folder somewhere on file search paths.

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Attractors Library is a collection of modules – MAX/MSP/Jitter and Max externals – based on iterative mathematical equations representing nonlinear dynamic systems whose evolution is unpredictable on a long run. It is accompanied by a collection of mapping examples (***Attractors–Mapping Examples***) showing how certain attractors-generating equations can be used for mapping one set of parameters into another.

The modules were originally developed as an integral part of the interactive multi-modal composing system ***ENACTIV***©, which allows composers, audiovisual artists and amateurs to express themselves by 'translating' their sonic (instruments, singing, speech), visual and bodily/kinetic patterns or 'narratives' into parameters controlling audiovisual synthesis and processing modules. The data coming from both video and sound capturing device(s) is first converted into streams of variables, and then routed to the 'mapping field' where ***Attractors Library***'s objects, mostly in combination with MnM's (©IRCAM) matrix-based many-to-many mapping objects, do a complex non-linear mapping, thus generating control parameters that will be routed to various audiovisual synthesis, processing and multi-channel spatialisation algorithms in real-time.

Structural Coupling

The idea to employ the non-linear field-of-attraction–generating systems embodied into ***Attractors Library's*** objects as potentially suitable for mapping, stems from the ground-braking *Santiago Theory* of cognition – the seminal work *Autopoiesis and Cognition* [Maturana and Varela, 1980] in particular. Briefly, the theory explains how the process of cognition arises through *structural coupling* – "a history of recurrent interactions leading to the structural congruence" between human and environment. This 'structural congruence'–generating process can be described or represented by non-linear pattern-generating systems with a potential to be used as mapping algorithms whenever one needs to 'translate' or map one type of data or variables onto another.

Strange Attractors

'Strange attractors' are systems associated with the Chaos Theory – a field of physics – that deals with irregularities and nonlinearities found in many natural phenomena such as the weather, population cycles of living beings, biological systems such as rates of heartbeat and blood pressure, human physical behavior and others. These systems are deterministic, however, their future behavior cannot be predicted in a long run.

These nonlinear dynamic systems are based on mathematical equations whose evolution can show both organized and random conditions depending on the values of initial parameters. They create self-similar patterns and are distinct from randomness resembling patterns of change found elsewhere in the nature.

It was this ‘pattern-generating’ feature of the ‘strange attractors’ in combination with pattern variations caused by the slight changes in the equation’s parameters that make them convenient to be used as non-linear mapping tools.

Iteration

The driving force of these formulas is *iteration*. There are systems in which as the chosen function is iterated, its values create a set of points toward which the value of the function tends after a number of iterations filling the delimited space with points. This space is referred to as ‘strange attractor’. It is particularly important to note that the nonlinear dynamic systems are extremely sensitive to initial conditions often producing very large qualitative differences in the output.

Application

The nonlinear dynamic systems iteratively to generate chaotic sequences of numbers that can be mapped to various sound synthesis or processing parameters. The other application of chaos is sound synthesis and timbre construction rather than on higher-level parameters such as note sequences and rhythms, etc.

Prospective Users:

- professional composers, audiovisual artists trying to transduce the every-day narratives across visual, verbal, spatial, and bodily-kinaesthetic modalities in live realtime creations.

- scientists’ further research leading toward investigations in order to understand and compare the behaviour of the dynamic systems and the natural phenomena

- general public

Attractors Library v2.0 consists of the following attractors:

The Logistic Map

It is also known as 'quadratic map' or 'Feingenbaum map', is a population growth model defined by the iterative equation x = kx (1-x) where k is a parameter that can be set to reflect the reproduction rate of the population.

Henon Attractor

The map is a discrete two-dimensional map defined by the equations x = a – x^2 + b and y = x, where a and b are constant parameters that determine whether the system is chaotic or not.

Lorenz Attractor

The attractor is a simplified model of convection flow found in the nature when the sun wars a layer of air closer the surface of the Earth, resulting in a similar circular flow. The system consists of three differential equations:

dx/dt = ay – ax
dy/dt = bx – y – zx
dz/dt = xy – cz

Poincare's Circle Map

Poincare circle map offers one route to the quasiperiodicity. It is based the Øn+1 = Øn + Δ + k sin Øn (mod 2π) equation which generates orbits with two frequencies w1 and w2. Δ is determined by the w1/w2 ratio and if their ratio is an irrational number then quasi-periodic dynamics appear.

Tinkerbell Map

Tinkerbell map is a discrete-time dynamical system given by:

Xn+1 = Xn^2 - Yn^2 + aXn + bXn;

Yn+1 = 2XnYn + cXn + dYn;

Some commonly quoted values of a, b, c, and d are

a=0.3, b=0.6, c=2, d=0.27.
a=0.9, b=-0.6013, c=2, d=0.5.

Kaplan-Yorke Map

The Kaplan–Yorke map is a discrete-time dynamical system that exhibits chaotic behavior. It takes a point (x_n, y_n) in the plane and maps it to a new point given by

Xn+1 = 2Xn (mod 1)
Yn+1 = åYn + cos (4 π Xn)
where *mod* is the modulo operator with real arguments. The map depends on only the one constant α.

Gingerbreadman Map

In dynamical systems theory, the Gingerbreadman map is a chaotic 2D map. It is given by the transformation:

$$\begin{cases} x' = 1 - y + |x| \\ y' = x \end{cases}$$

De Jong Attractor

De Jong Attractor is a chaotic 2D map. It is given by the transformation:

x_{n+1} = sin(a y_n) - cos(b x_n)
y_{n+1} = sin(c x_n) - cos(d y_n)

Some interesting results for a, b, c, d:

a = 1.4, b = -2.3, c = 2.4, d = -2.1

a = 1.4, b = 1.56, c = 1.4, d = -6.56

a = -2, b = -2, c = -1.2, d = 2

a = 2, b=2, c=2, d=2

Trigonometric Attractor

This Trigonometric Attractor (W. Koscielniak) is based on the following equations:

x = a * Math.sin (b * y) + c * Math.cos (d * x);
y = e * Math.sin (f * z) + g * Math.cos (h * t);

Some interesting results for a, b, c, d, e, f, g, h:

-1.47, 0.09, 1.95, 1.4, 0.79, -1.4, -0.52, 0.81;

0.98, 0.05, 1.4, 1.57, -0.82, -0.53, -0.59, 1.95;

1.39, -1.02, 1.61, 1.03, -1.81, -1.11, 0.17, 1;

1.91, 1.53, -1.99, 1.18, -1.69, -0.29, -0.81, 0.58;

-1, -0.71, -0.05, 0.41, 1.84, -0.82, 0.81, 0.7;

Bibliography

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MAPPING:

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CHAOS:

Good starting point for information about the strange attractors can be found at Wikipedia's Chaos theory website: http://en.wikipedia.org/wiki/Chaos_theory