Get Parametrical - Automatic Generation of Parameter Data

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1 - (un)conditional probability — Weight tables and Markov chains

Markov chains are a common process in various generative computer programs, especially when it comes to algorithmic composition. And they're a part of a larger group of algorithms that deal with conditional probability, which means that past events are taken into account when generating a new event. Suiting mainly, but not exclusively, applications where state-transition probabilities become a must.
The number of past events taken into account is reflected in the algorithm's order, where a 2nd-order Markov chain checks the probability of a certain outcome, given two past events. Alternatively, a zeroth-order Markov chain, sometimes referred to as weight table, is more of an unconditional probability problem, which disregards all previous events, but is nonetheless a very simple and useful technique for generative processes in the digital art domain.

Some references:

• Aschauer, D. (2008). "Algorithmic Composition." Retrieved from wp1120301.msdata.at/algocomp/AlgorithmicComposition.pdf

• Nierhaus, G. (2009). "Algorithmic Composition - Paradigms of Automated Music Generation." Springer.

2 - Logistic Function

Classic algorithm for chaotic generation that Curtis Roads introduces in the "Computer Music Tutorial" (1996).The logistic function, formulated by R.May (1976) can be defined as:

$$x_{n+1} = \lambda \times x_n \times (1 - x_n)$$

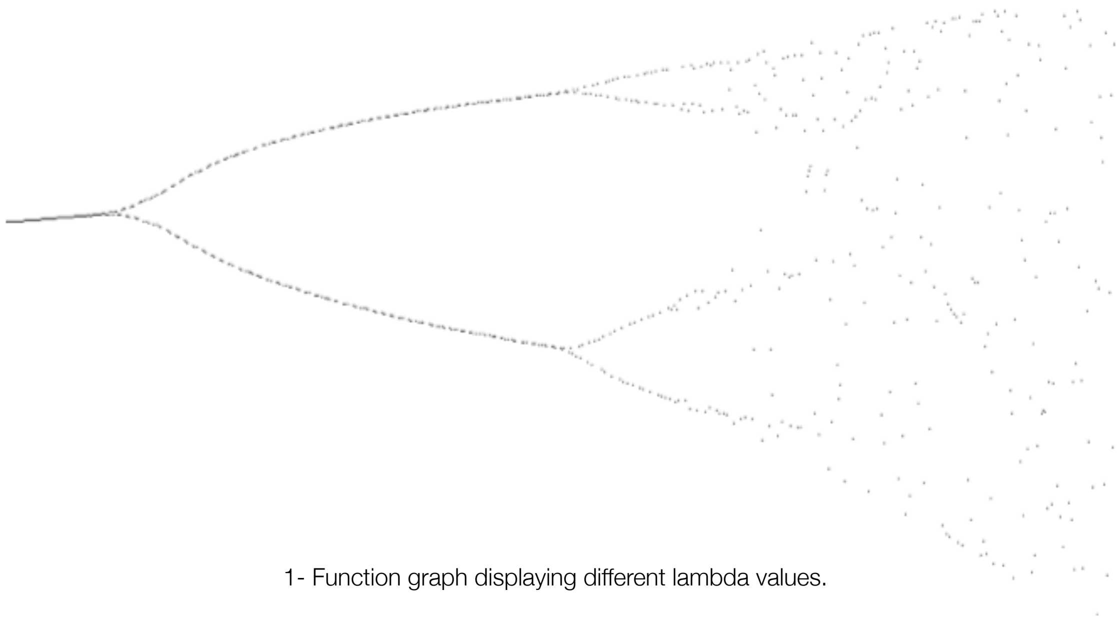
Where $0 < \lambda \leq 4$.

According to Roads, the function behaves such as:

λ = 3.449499, the 2 members cycle forks into a 4 member cycle.
λ = 3.54409 to 3.569946 the 4 member cycle forks into a 8 member and so on, thus creating an harmonic cascade.

Curiosity: In a workshop hosted at the "International Computer Music Conference" (Copenhagen, 2007) Heinrich Taube showed this function as an interesting example for the chaotic generation of melodies.

Some references:
• Taube, H. K. (2007). *Common Music* (software, v 2.10).



1- Function graph displaying different lambda values.

3 - Probability Distributions

Probability distributions lie in the core of stochastic algorithms, where the resulting quantity of elements follows a given statistical form or function. These distributions are often categorized according to the given function, such as linear, exponential, bell-shaped or Poisson's distribution. Although many generative applications use a graphical function editor instead of a pure mathematical function, since, in the art domain, it is often more important to achieve a "good result" than to implement a mathematical model in a strict manner.

Some references:

• Aschauer, D. (2008). “Algorithmic Composition.” Retrieved from wp1120301.msdata.at/algocomp/AlgorithmicComposition.pdf

• Roads, C. (1996). Computer Music Tutorial.

4 - Tendency Masks

Tendency masks are a common procedure in stochastic parameter generation, which enables the limiting of the lower and upper boundaries of generated parameters. These boundaries can change over time according to a given shape, becoming an essential tool in these types of processes by allowing for macro control of the algorithm.

Curiosity: composers such as James Tenney, Gottfried Michael Koenig, Iannis Xenakis and Barry Truax have used this technique to shape stochastically generated material, such as musical or sound synthesis parameters.

Some references:

• Aschauer, D. (2008). *Algorithmic Composition*. Retrieved from wp1120301.msdata.at/algocomp/AlgorithmicComposition.pdf

• Tsirikoglou, I. (2012). *Multidimensional Data-Sets for Sound Applications I*. Retrieved from http://www.sonology.org/NL/thesis-pdf/Ioannis%20Tsirikoglou.pdf

• Roads, C. (1996). *Computer Music Tutorial*.

5 - Genetic Algorithms

Inspired by evolutionary biological processes, genetic algorithms (GA) have the power of bringing a conception of life to computer programs. Initially implemented for search and optimization tasks, in order to find an optimal solution to a given problem, GAs have been increasingly used within the digital art domain. These algorithms carry characteristics found in nature's evolutionary processes like selection (fitness function), reproduction (crossover) and mutation.

Unlike stochastic techniques, evolutionary algorithms, especially GA's, are extremely useful to generate data capable of bearing some resemblances to previous iterations (generations), by generating a stream of data that evolves over time from an initial population.

Some references:

- Aschauer, D. (2008). *Algorithmic Composition*. (accessed from wp1120301.msdata.at/algocomp/AlgorithmicComposition.pdf)

- Burton, Anthony and Vladimirova, Tanya. *Generation of Musical Sequences with Genetic Techniques*.

- Nierhaus, G. (2010). *Algorithmic Composition: Paradigms of Automated Music Generation*.

6 - MnM.matmap

The [mnm.matmap] object maps an input of *N* values (the input vector) to an output of *M* values (the output vector). *N* and *M* can have different sizes which allows few-to-many or many-to-few mappings.

By providing a set of examples (learn process), each example containing one input (of dimension *N*) and one output (of dimension *M*), [mnm.matmap] performs a linear interpolation between the learnt examples in the playing process (after learning a set of examples).

Note: The fidelity of the restitution depends on the number of examples and their distribution.

Quite useful to simplify the interaction with complex mapping strategies, as well as to develop transition structures between different states of some sort of parameters group.

Some references:

- Bevilacqua, F., Müller, R., Schnell, N., Bevilacqua, F., & Muller, R. (2005). *MnM : a Max / MSP mapping toolbox*. New Interfaces for Musical Expression (NIME05), Vancouver, BC, Canada (pp. 85–88). Retrieved from http://recherche.ircam.fr/equipes/temps-reel/articles/mnm.nime05.pdf

- Hunt, A., and R. Kirk. *Mapping strategies for musical performance*. In Wanderley and Battier (eds.) Trends in Gestural Control of Music. Paris: IRCAM, Centre Pompidou, 2000.