The Beauty-Degree of Parameters in Generative Art

Prof. dr. em. Jan Paredaens
University of Antwerp, Belgium
www.JanParedaens.be
e-mail: jan.paredaens@uantwerpen.be

Abstract

In most of the generative videos the mathematical basis uses a number of parameters. The choice of the value of these parameters seems to be fundamental for the degree of beauty and/or of chaos of the resulting generative video. We call it the Beauty-Degree of the parameter value set. The higher the Beauty-Degree is the more beautiful and elegant we consider the resulting video.

We give three examples of mathematical constructions and illustrate each of them with parameter value sets with a low and a high Beauty-Degree. It is an open general problem to decide the Beauty-Degree of a parameter value sets. However, it is clear that in some cases, a lot of mathematical insight will be needed depending on the construction itself, to solve this open problem.

In this presentation we only hope to enjoy the wide range between low and high Beauty-Degrees.

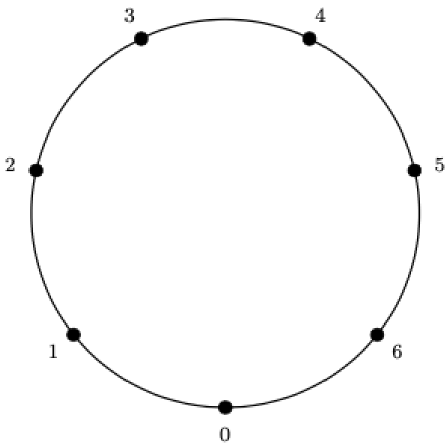
The video associated with this paper can be seen at https://vimeo.com/632726023

1. Introduction

In most of the generative pictures or videos the mathematical basis uses a number of parameters. The choice of the value of these parameters seems to be fundamental for the degree of beauty and/or of chaos of the resulting generative picture or video. We call it the Beauty-Degree of the parameter value set. The higher the Beauty-Degree is the more beautiful and elegant we consider the resulting video.

2. Circular Distances

The first construction that we present is called "Circular Distances". It is very simple and generates a continuity of remarkable and fascinating patterns [4,5].
Consider a circle *C* and *n* points uniformly distributed on the circumference of the circle *C*. For *n=7* we get



Consider now a real number *f* and connect each point *p* to the point *(p . f) modulo n*. We call the resulting figure *C(n,f)*.

The next figure shows *C(7,2)*. Here

• point *0* is connected to point *0*;

• point *1* is connected to point *2*;

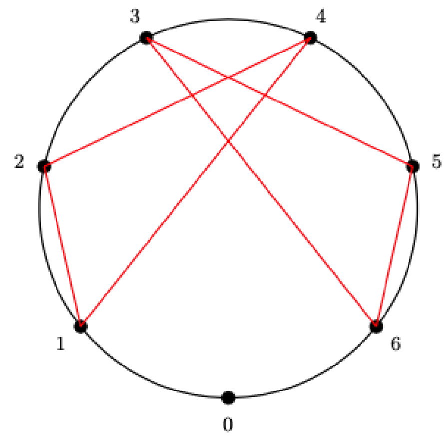
• point *2* is connected to point *4*;

• point *3* is connected to point *6*;

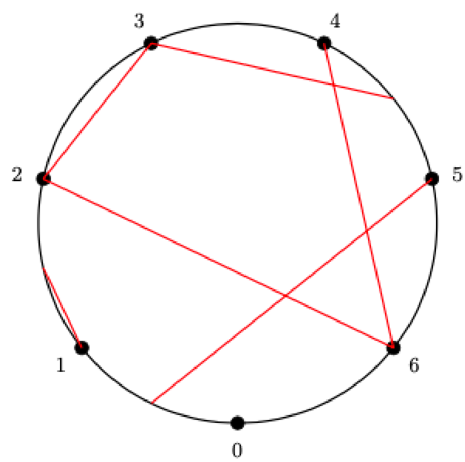
• point *4* is connected to point *1*;

• point *5* is connected to point *3*;

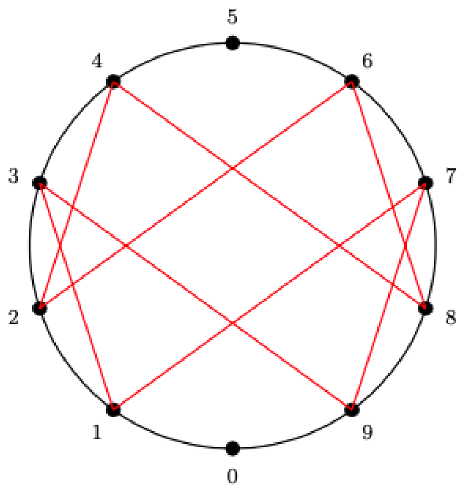
• point *6* is connected to point *5*;



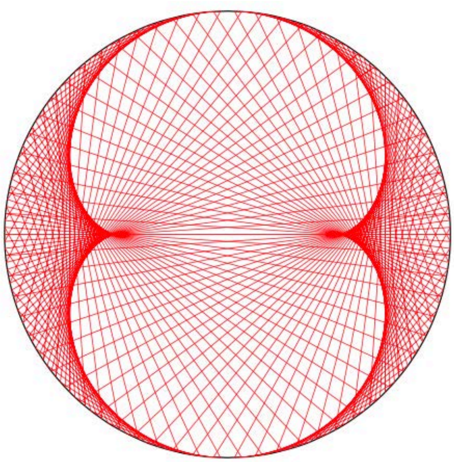
Next we show *C(7,1.5).*



Other examples are *C(10,7)*



and *C(200,3)*



We already see that *C(7,2)* and *C(10,7)* have a rather low Beauty-Degree while the Beauty-Degree of *C(200,3)* is higher.

We can also consider the Beauty-Degree of a movie. A movie is just a sequence of pictures. As such, we can consider a sequence *C(n,f)*, for *f* going from f_1 to f_2, f_1 and f_2 being two given real numbers.

The parameter value set of this movie is denoted by $(n,f_1 \text{ to } f_2)$.

The movies with *(6,0 to 2)*, *(20,0 to 2)*, *(200,0 to 2)* and *(200,40 to 52)* are shown in the video Part I-IV (2”, 22”, 42”, 1’02”).

Clearly for *(6, 0 to 2)* and *(20, 0 to 2)* the result is more chaotic and not elegant at all, and so they have a rather low Beauty-Degree, while the Beauty-Degree of *(200, 0 to 2)* and *(200, 40 to 52)* is higher and the result is fascinating especially in the beginning and at the end of *(200, 40 to 52)*.

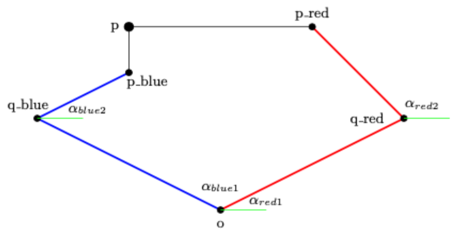
3 Double Folding Rule

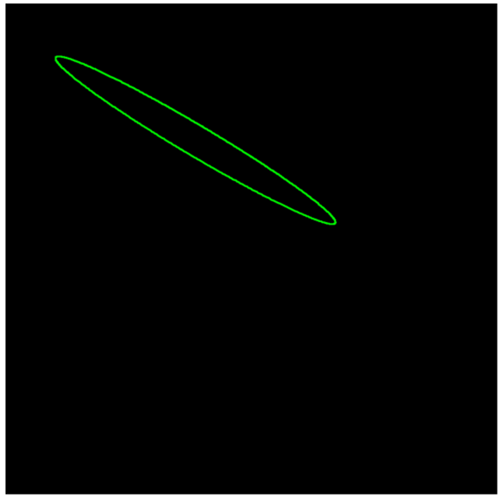
This section is based on [6].

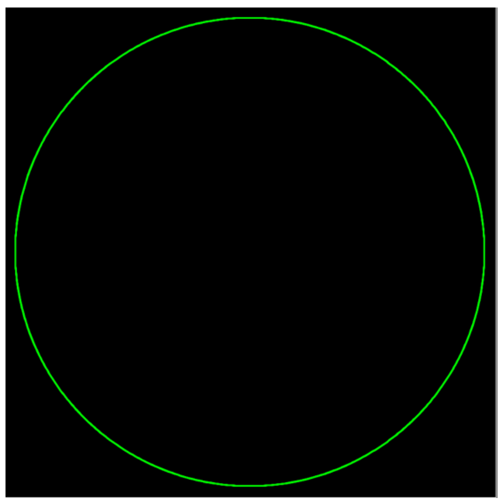
Consider a red folding rule with only two legs. We can rotate the first leg around its origine *o* and the second leg around the connection between the two legs *q_red*. Call *p_red* the endpoint of the second leg of this red folding rule.

Consider furthermore a blue folding rule also with only two legs and the same origine *o*. Again, we can rotate the first leg around its origine *o* and the second leg around the connection between the two legs *q_blue*. Call *p_blue* the endpoint of the second leg of this blue folding rule.

Take now the point *p* with the same *x*-coordinate as *p_blue* and the same *y*-coordinate as *p_red*.







αred1, αred2, αblue1 and αblue2, indicate the rotation of the legs. Clearly if the four legs of these two folding rules rotate then the point *p* follows a curve. This is the curve we are interested in.

The video Part V(3'02") shows an example of the generation of the curve by two folding rules.

There are 12 parameters: the length, the rotation velocity and the starting angle of each of the four legs. The rotation velocity is clockwise and the velocity is expressed in radians per minute.

The parameter value set for the example in Part V is *(((200,1,0),(100,2, 0)),((200,−1,π),(100,−2,0)))*.

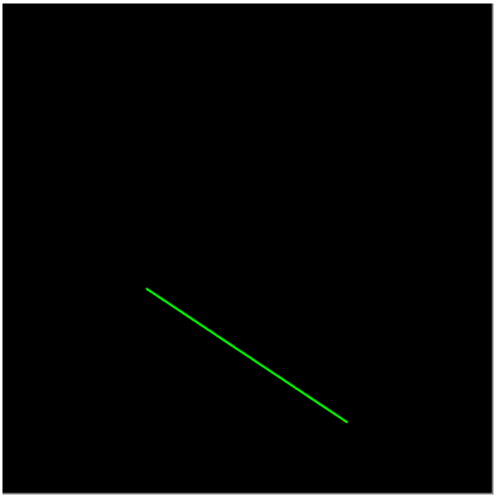
Here are four elementary curves that are obtained with the respective parameter valuesets

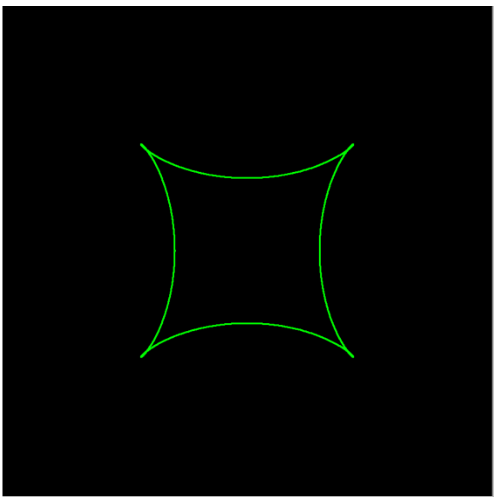
(a)(((230,0,−1),(150,2.5,4)),((100,0,3),(25 0,2.5,π−0.5)))

(b)(((200,3,0),(220,3,0)),((100,3,π),(320,3 ,π)))

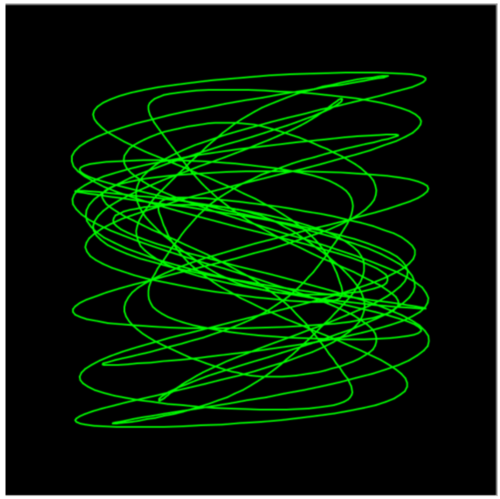
(c)(((200,0,1.3),(120,3,1.3)),((100,−3,π/2 −1.3),(80,−3,π/2−1.3)))

(d)(((200,1,0),(70,3,0)),((200,−1,π),(70,− 3,0)))

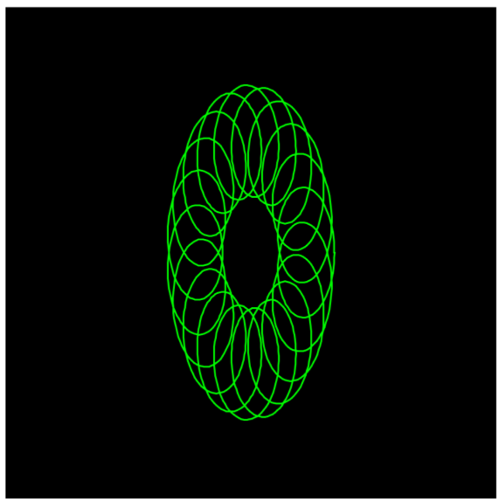




The possible parameter value sets are very rich in the sense that a good choice can generate elementary, complex, chaotic and beautiful curves. Here is a chaotic parameter value set *(((200,11,1),(120,−1,−2)),((80,−37,3),(240,23,0)))*.



and a beautiful one *(((200,1,0),(100,20,0)),((100,−1,0),(50,−20,0)))*.



The video Part VI (4’12”) and VII (5’22”) show the generation of the latter two curves.

4 The de Jong Attractor

Finally, we discuss the de Jong attractor [1][2]. The de Jong attractor is an iterative construction in a plane that starts with a point and iteratively calculates the next point. This calculation is very simple: if the coordinates of a point are (x,y) then the coordinates of the next point are

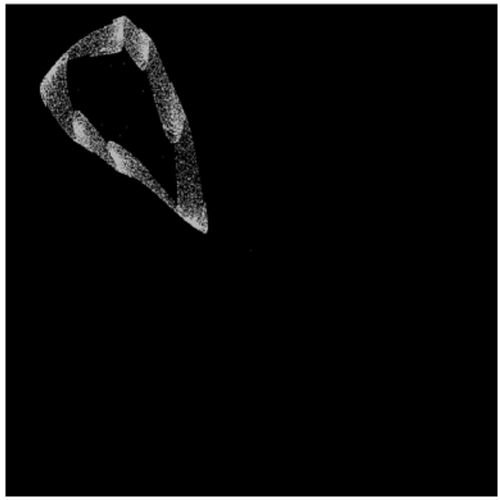
$$(\sin(a.y) - \cos(b.x), \sin(c.x) - \cos(d.y))$$

where $a, b, c, d \in [-\pi, \pi]$. The parameter value set is (p_0,n,a,b,c,d) where

p_0 is the first point and n is the number of points.

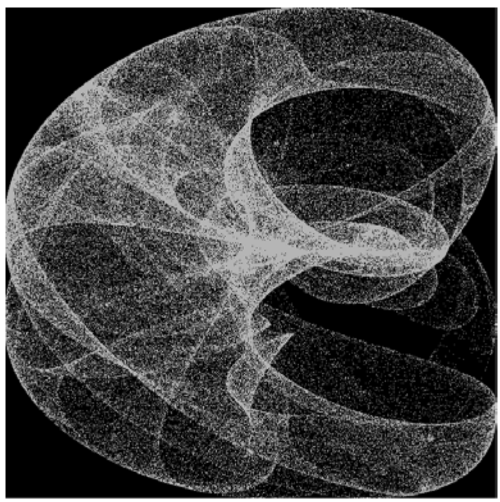
Again, the Beauty Degree depends on the parameter value set as illustrated below.
First we give two poor examples with their parameter value set:

((0,0),0.8634188,−1.1997708, 0.31690478,−2.4064186,300000)

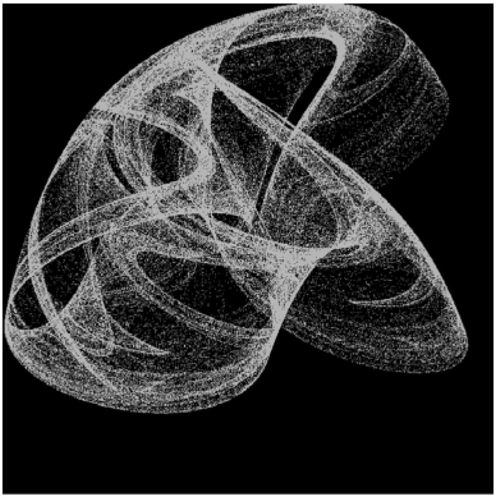


((0,0),1.1143491,−1.3373643,1.9125726, 0.98489785,20000)

Here are two more beautiful examples:

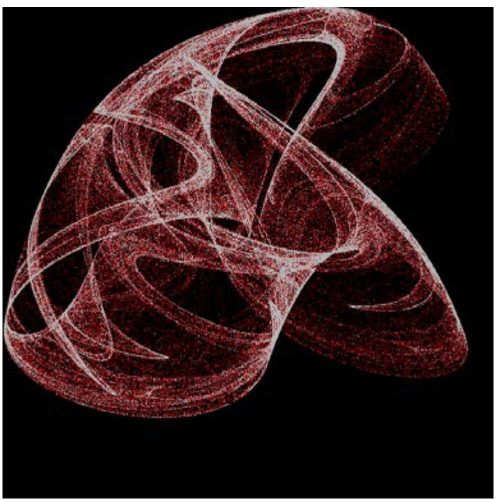


((0,0),2.9032648,−1.9439121,1.4092872 2.5404155,30000)



((0,0),0.70736766,−2.8591995,−2.01697, −1.185144,30000)

Taking into account the density of the resulting points we can get



Actually *(a,b,c,d)* are points in a 4-dimensional Euclidian space. Consider now a line *l* between two such points *p0* and *p1*. Consider furthermore *n* consecutive (4-dimensional) points on the line *l* from *p0* to *p1*. In such away we get a video of *n* frames.

The video Part VIII (6'32") illustrates this procedure.

5 References

[1] Paul Bourke, Peter de Jong Attractors, http://paulbourke.net/fractals/peterdejong/ , 1989.

[2] A.K. Dewdney, Computer Creations, Scientific American, Vol. 257,No, 1, 1987, pp. 108-111.

[3] GitHub, https://github.com/cjlarose/de-jong.

[4] Dan Lidral-Porter, https://youtu.be/vLIbEZt-3j0.

[5] Burkard Polster, Times Tables, Mandelbrot and the Heart of Mathematics, https://m.youtube.com/watch?v=qhbuKbxJsk8 .

[6] Guy Wyers, Private communication.