Two dimensional real discrete chaotic attractors

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1 Introduction

Showcase of a selection of two dimensional real discrete chaotic attractors.

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2 Attractors

2.1 Clifford attractor

$$x_{n+1} = \sin(ay_n) + c\cos(ax_n)$$
$$y_{n+1} = \sin(by_n) + d\cos(bx_n)$$

Image parameters:

$$a = 2, b = -2, c = 1, d = -1$$

2.2 Peter de Jong attractor

$$x_{n+1} = \sin(ay_n) - \cos(bx_n)$$
$$y_{n+1} = \sin(cx_n) - \cos(dy_n)$$

Image parameters:

$$a = 0.97, b = -1.899, c = 1.381, d = -1.506$$

2.3 Tinkerbell attractor

$$x_{n+1} = x_n^2 - y_n^2 + ax_n + by_n$$
$$y_{n+1} = 2x_n y_n + cx_n + dy_n$$

Image parameters:

$$a = 0.9, b = -0.6013, c = 2, d = 0.5$$

2.4 Johnny Svensson attractor

$$x_{n+1} = d\sin(ax_n) - \sin(by_n)$$
$$y_{n+1} = c\cos(ax_n) + \cos(by_n)$$

Image parameters:

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

2.5 Gumowski-Mira attractor

$$f(x) = ax + \frac{2(1-a)x^2}{(1+x^2)^2}$$
$$x_{n+1} = by_n + f(x_n)$$
$$y_{n+1} = f(x_{n+1}) - x_n$$

Image parameters:

$$a = -0.192, b = 0.982$$

2.6 Fractal Dreams (SSSS) attractor

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

Image parameters:

$$a = 1.468, b = 2.407, c = 0.194, d = 1.438$$

2.7 Quadratic Strange attractor

$$x_{n+1} = a_0 + a_1 x_n + a_2 x_n^2 + a_3 x_n y_n + a_4 y_n + a_5 y_n^2$$
$$y_{n+1} = a_6 + a_7 x_n + a_8 x_n^2 + a_9 x_n y_n + a_{10} y_n + a_{11} y_n^2$$

Image parameters:

$$CVQKGHQTPHTE$$

2.8 Bogdanov attractor

$$x_{n+1} = x_n + y_{n+1}$$
$$y_{n+1} = y_n + \epsilon y_n + k x_n(x_n - 1) + \mu x_n y_n$$

Image parameters:

$$\epsilon = 0, k = 1.2, \mu = 0$$

2.9 Gingerbread attractor

$$x_{n+1} = 1 - y_n + |x_n|$$
$$y_{n+1} = x_n$$

2.10 Duffing attractor

$$x_{n+1} = y_n$$
$$y_{n+1} = -b x_n + a y_n - y_n^3$$

Image parameters:

$$a = 2.5, b = 1$$

2.11 Hénon attractor

$$x_{n+1} = 1 - ax_n^2 + y_n$$
$$y_{n+1} = bx_n$$

Image parameters:

$$a = 1.2, b = 0.5$$

2.12 Ikeda attractor

$$t_n = 0.4 - \frac{6}{1 + x_n^2 + y_n^2}$$
$$x_{n+1} = 1 + u(x_n \cos t_n - y_n \sin t_n)$$
$$y_{n+1} = u(x_n \sin t_n + y_n \cos t_n)$$

Image parameters:

$$u = 0.918$$

2.13 Standard attractor

Values of p and θ were replaced by x and y respectively.

$$p_{n+1} = [p_n + K \sin(\theta_n)] \mod 2\pi$$
$$\theta_{n+1} = [\theta_n + p_{n+1}] \mod 2\pi$$

Image parameters:

$$u = 0.918$$

2.14 Zaslavskii attractor

$$\mu = \frac{1 - e^{-r}}{r}$$
$$x_{n+1} = [x_n + \nu(1 + \mu y_n) + \epsilon\nu\mu \cos(2\pi x_n)] \mod 1$$
$$y_{n+1} = e^{-r}(y_n + \epsilon \cos(2\pi x_n))$$

Image parameters:

$$\epsilon = 1.5, \nu = 0.8, r = 1.2$$

3 References

- https://sequelaencollection.home.blog/2d-chaotic-attractors/
- https://blbadger.github.io/
- https://en.wikipedia.org/wiki/List_of_chaotic_maps

Clifford Attractor

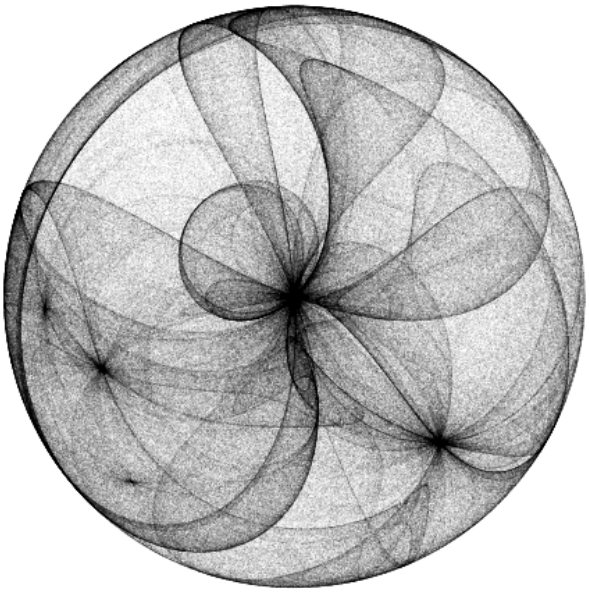

Figure 1: Clifford attractor

Peter de Jong Attractor

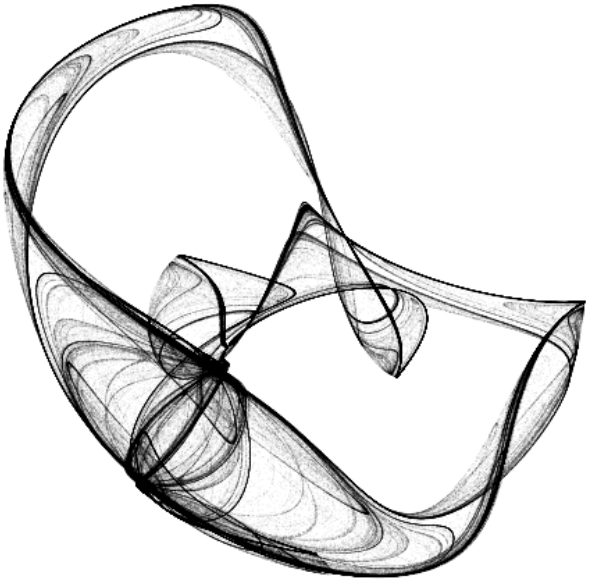

Figure 2: Peter de Jong attractor

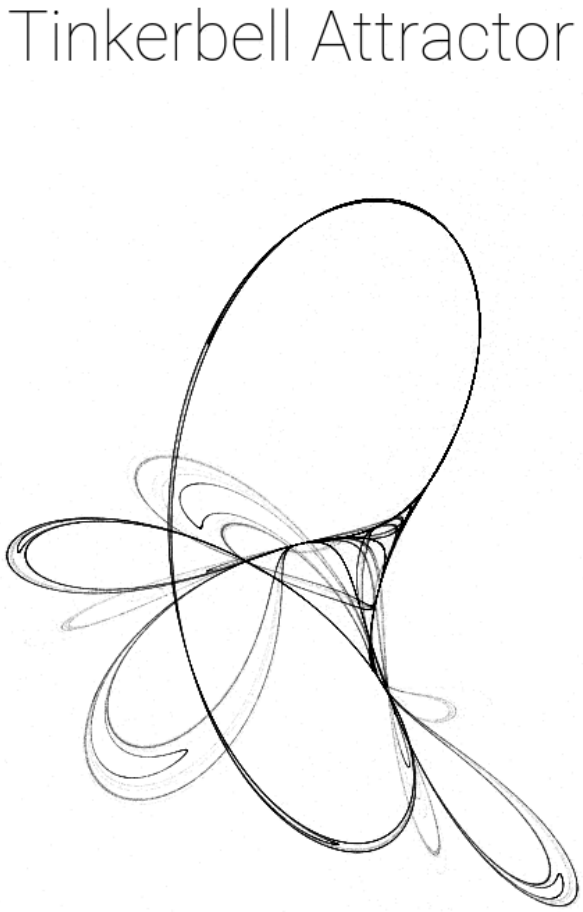

Figure 3: Tinkerbell attractor

Johnny Svensson Attractor

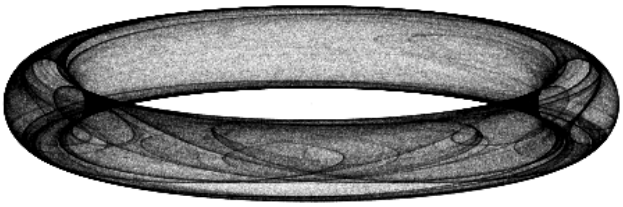

Figure 4: Johnny Svensson attractor

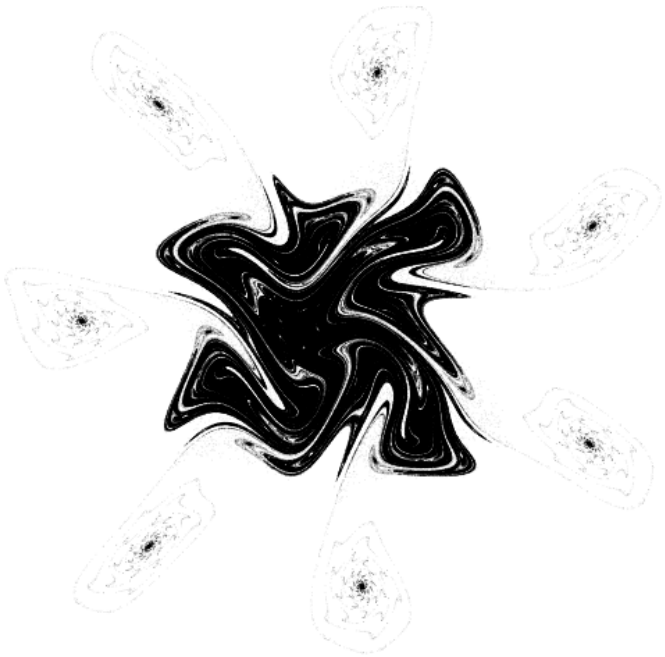

Figure 5: Gumowski-Mira attractor

Figure 6: Fractal Dreams (SSSS) attractor

Quadratic Strange Attractor

Figure 7: Quadratic Strange attractor

Figure 8: Bogdanov attractor

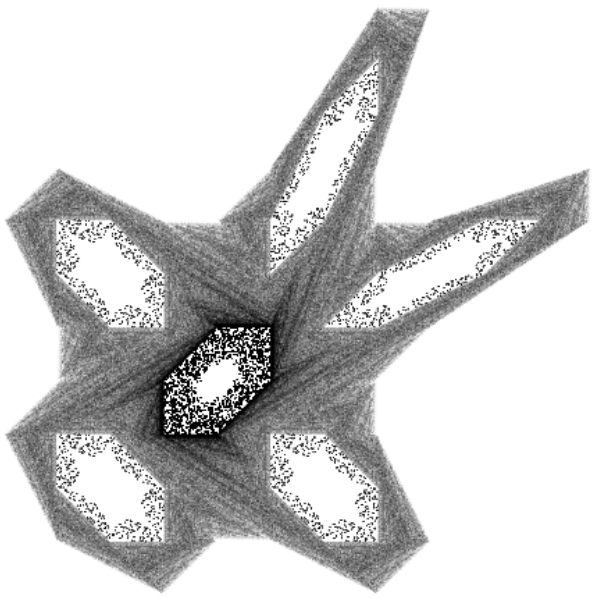

Figure 9: Gingerbreadman attractor

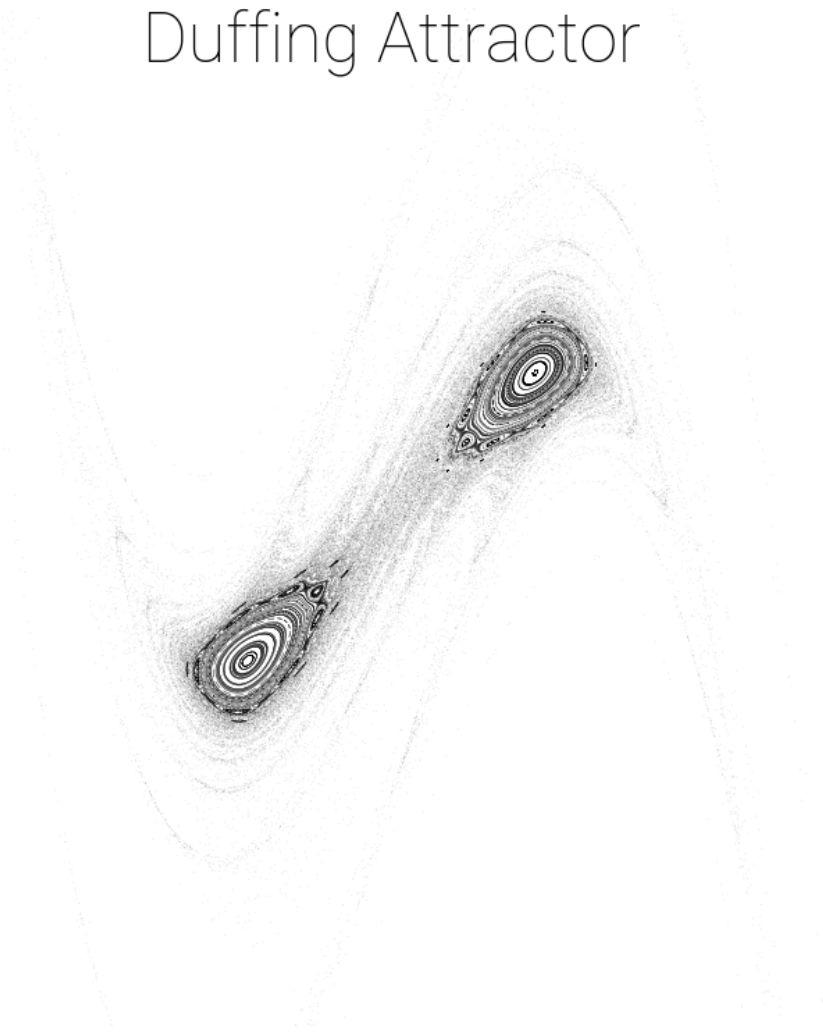

Figure 10: Duffing attractor

Figure 11: Hénon attractor

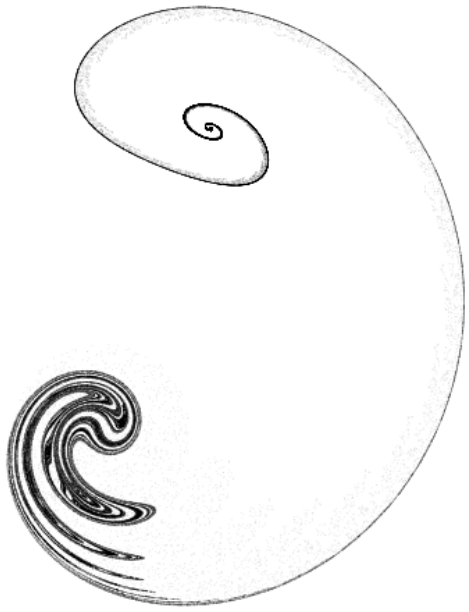

Figure 12: Ikeda attractor

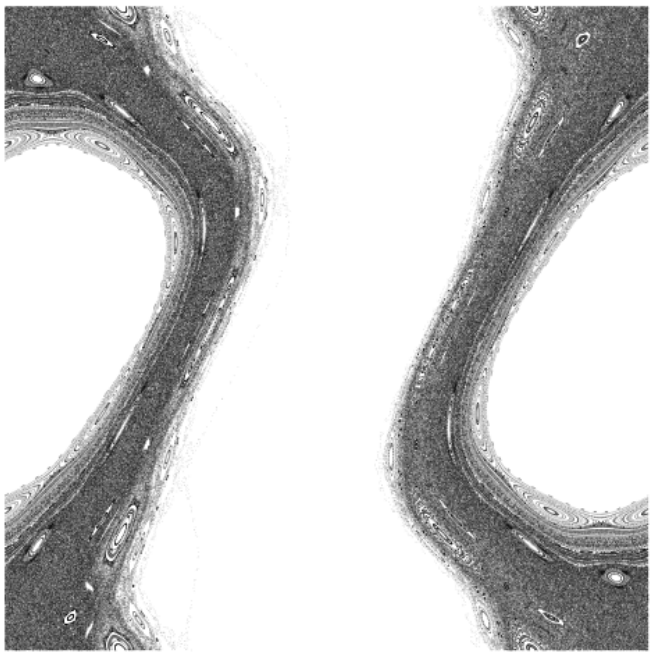

Figure 13: Standard attractor

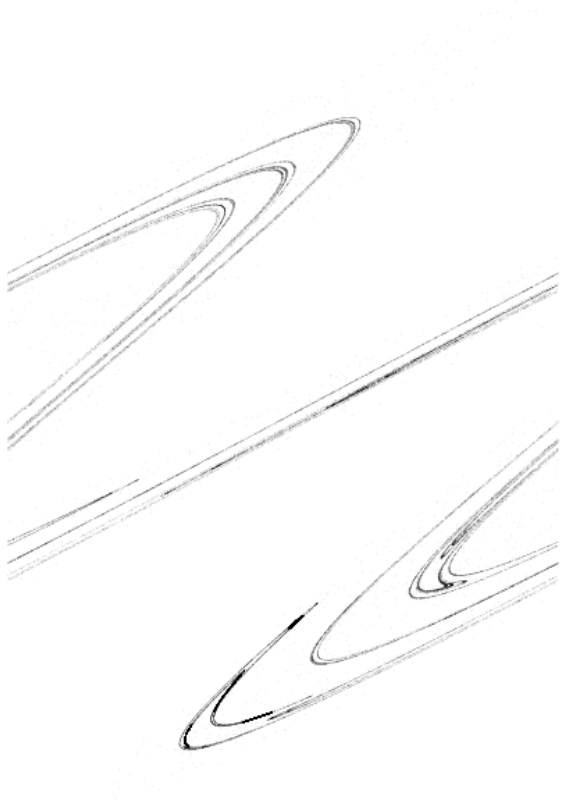

Figure 14: Zaslavskii attractor