# Strange Attractors - Documentation

Simon Chen

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# 1 The Lorenz Attractor

The Lorenz attractor is a set of chaotic solutions to the Lorenz system, which is a set of three ordinary differential equations given by [1]:

$$\frac{dx}{dt} = \sigma(y - x) \tag{1.1}$$
$$\frac{dy}{dt} = x(\rho - z) - y \tag{1.2}$$
$$\frac{dz}{dt} = xy - \beta z \tag{1.3}$$

where $x$, $y$, and $z$ are the state variables and $\sigma$, $\rho$, and $\beta$ are system parameters.

# 2 The Aizawa Attractor

The Aizawa attractor is governed by the following set of three ordinary differential equations[1]:

$$\frac{dx}{dt} = (z - \beta)x - \delta y \tag{2.1}$$
$$\frac{dy}{dt} = \delta x + (z - \beta)y \tag{2.2}$$
$$\frac{dz}{dt} = \gamma + \alpha z - \frac{z^3}{3} - (x^2 + y^2)(1 + \epsilon z) + \zeta z x^3 \tag{2.3}$$

where $x$, $y$, and $z$ are the state variables and $\alpha$, $\beta$, $\gamma$, $\delta$, $\epsilon$, and $\zeta$ are system parameters.

# 3 Usage

NumPy and Matplotlib are required to use the script yourself. You will be prompted to choose an attractor, specify the number of trajectories you wish to see, and input the initial conditions for each trajectory.

You may choose between viewing static plots of the finished trajectories or viewing their real-time animation.

# References

[1] Edward N. Lorenz. "Deterministic Nonperiodic Flow". In: *Journal of Atmospheric Sciences* 20.2 (1963), pp. 130–141. DOI: https://doi.org/10.1175/1520-0469(1963)020<0130:DNF>2.0.CO;2.

[1] Sadly, I could not find the original paper by Aizawa, if it even exists.