Lorenz Attractor (Deterministic Chaos)

Worksheet 16
20 March 2023

In 1963, MIT meteorologist Edward Lorenz developed a simplified mathematical model for atmospheric convection. The model is a system of three ordinary differential equations now known as the Lorenz equations. They are given by

$$\frac{dx}{dt} = a\,(y - x)\,, \tag{1}$$

$$\frac{dy}{dt} = x\,(b - z) - y\,, \tag{2}$$

$$\frac{dz}{dt} = x\,y - c\,z\,, \tag{3}$$

where a, b, c are constant parameters and t denotes time.

Task

Write a structured Fortran code which solves the Lorenz equations for $0 \leq t \leq 100$ seconds, $\Delta t = 10^{-3}$ seconds, and $a = 10$, $b = 28$, $c = 8/3$. You do **not** need to include a preamble. The initial conditions are $x_0 = 10$, $y_0 = 10$, and $z_0 = -5$.

Code Design

- Use the `advance='NO'` option to input the values of x_0, y_0, and z_0 from keyboard. Here is an example for x_0:

```
write(*,'(A)', advance='NO') ' Input value for x_0: '
read(*,*) x_0
```

- The values assigned to x_0, y_0, and z_0 are to be written back to screen. The data must be presented in formatted form as shown below:

```
x_0 = 10.0
y_0 = 10.0
z_0 = -5.0
```

- The program must write y as a function of x to an output file named `LoreanzAttractor.dat`. Create a plot which shows $y(x)$.

Submission Instructions. Create an archive which contains your Fortran source code and the `pdf` file of your plot. Email the archive to `ewhart317@gmail.com`. Put `LastFirst PHYS 317 WS 16` in the subject line.