Chaotic Systems

I. THE RÖSSLER SYSTEM

Today we’ll use MATLAB’s ode45 to study a couple chaotic systems. First we’ll look at a system called the Rössler system. This is a three-dimensional system defined as following:

\[
\begin{align*}
\dot{x} &= -y - z \quad (1) \\
\dot{y} &= x + 0.1y \quad (2) \\
\dot{z} &= 0.1 + z(x - 14) \quad (3)
\end{align*}
\]

Use ode45 to solve this system with the initial condition \(x = 15, \ y = 1, \) and \(z = 0.1\) (remember, you’ll need to write a function that defines the ODEs above). Now, to plot the solution in 3-D, we’ll use the function plot3. Our solution is contained in the vector \(x\), so to plot the solution, write something like

\[\text{plot3}(x(:,1),x(:,2),x(:,3),'r-');\]

which will give a plot like:

![Plot3 Diagram]

II. THE LORENZ SYSTEM

Now you’ll study the Lorenz system. This system was developed in 1963 by a meteorologist named Edward Lorenz and is considered the first chaotic system ever studied. The equations are as follows:

\[
\begin{align*}
\dot{x} &= 10(y - x) \quad (4) \\
\dot{y} &= x(28 - z) - y \quad (5) \\
\dot{z} &= xy - \frac{8}{3}z \quad (6)
\end{align*}
\]

III. HW

This week your homework is to use ode45 to numerically solve the Lorenz system defined above. Use an initial condition of \(x = 2, \ y = 3, \) and \(z = 17\) and simulate it for about 40 units of time. You’ll have to write a function that defines the equation, as well as a script that uses ode45 to solve the system and plot the solution in 3-D. Send your TA the function and script.