

## Week 1

**I. Direction Fields** Use the first part of the attached note by Yonatan to explain how to plot out the direction field of a 1D ODE using MATLAB.

## II. MATLAB ODE Solver

Solve the following "Lorenz" system using MATLAB ODE solver "ode45"

$$\begin{aligned}\dot{x}_1 &= \sigma(x_2 - x_1) \\ \dot{x}_2 &= rx_1 - x_2 - x_1x_3 \\ \dot{x}_3 &= x_1x_2 - bx_3\end{aligned}$$

where  $\sigma = 10$ ,  $b = 8/3$  and  $r = 28$ . Randomly chose some initial conditions around

$$x = [\sqrt{b(r-1)}, \sqrt{b(r-1)}, r-1]^T$$

Plot out the solution in 3D. The solution should demonstrate chaotic behavior (you don't need to explain chaos. This is a topic we will cover later). The MATLAB codes for this simulation are in LorenzAnimation.m and LorenzDynamics.m.