ReadME

- This is a group project and results are produced by my partner (Laura Hu).
- The following results are the dynamics of a SIR Two-Strain Viral model.
- Parameters are chosen arbitrarily to express dyanamics of chaos

Parameters:

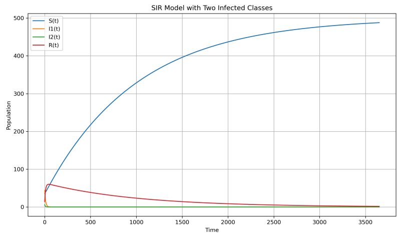
- $\Lambda \equiv$ Susceptible recruitment rate of individuals per day
- $d \equiv$ natural death rate
- $\beta_1 \equiv$ transmission rates for a *mildly* infected individual
- $\beta_2 \equiv$ transmission rates for a *severely* infected individual
- $\gamma_1 \equiv$ recovery rate of viral strain 1
- $\gamma_2 \equiv$ recovery rate of viral strain 2
- $\alpha \equiv$ mutation rate
- $d_1 \equiv$ disease death rate of viral strain 1
- $d_2 \equiv$ disease death rate of viral strain 2

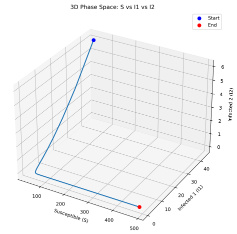
Mathematical Model

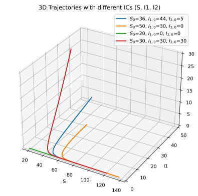
$$\frac{dS}{dt} = \Lambda - \beta_1 S I_1 - \beta_2 S I_2 - dS \tag{1}$$
$$\frac{dI_1}{dt} = (1-\alpha)\beta_1 S I_1 - \gamma_1 I_1 - d_1 I_1 \tag{2}$$
$$\frac{dI_2}{dt} = \beta_2 S I_2 + \alpha\beta_1 S I_1 - \gamma_2 I_2 - d_2 I_2 \tag{3}$$
$$\frac{dR}{dt} = \gamma_1 I_1 + \gamma_2 I_2 - dR \tag{4}$$

Case 1: Disease-Free Equilibrium

$\Lambda = 0.5, d = 0.001, \beta_1 = 0.0001, \beta_2 = 0.00005, \gamma_1 = \gamma_2 = 0.1, \alpha = 0.1, d_1 = 0.002, d_2 = 0$



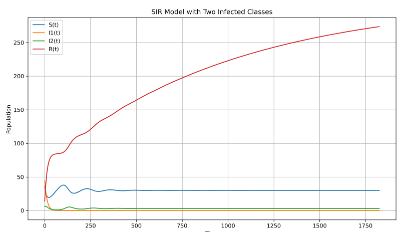


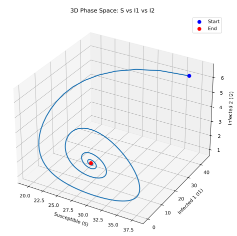


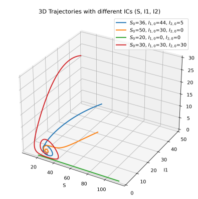
Case 2: Endemic Equilibriums

- Damped Oscillation and Mono-existent

$$\Lambda = 0.5, d = 0.001, \beta_1 = 0.001, \beta_2 = 0.005, \gamma_1 = \gamma_2 = 0.1, \alpha = 0.1, d_1 = 0.1, d_2 = 0.5$$



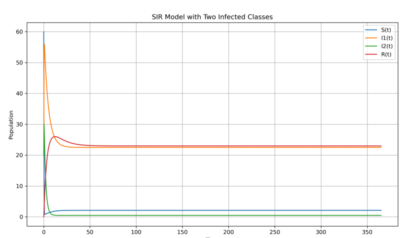


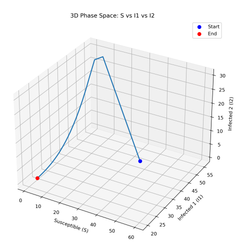


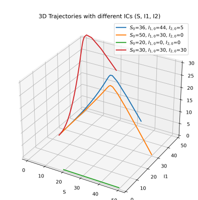
Case 3: Co-existent for Virus 1 and 2

- Scenario 1

$$\Lambda = 5, d = 0.1, \beta_1 = 0.1, \beta_2 = 0.05, \gamma_1 = \gamma_2 = 0.1, \alpha = 0.1, d_1 = 0.1, d_2 = 0.5$$







- Scenario 2

Shifting $d_2 = 0.16$ to be closer to $d_1 = 0.1$.