Exercise 5

These computational exercises should be completed by **January 15** at **11:59AM**. Solutions should be turned in through the course website.

1. **Advanced Plotting**

   Continue looking at the visualizations from the Wolfram webpage (or the gallery on the Matplotlib webpage) and thinking about your final project. Should you be happy with the Mathematica code, continue looking into how to implement the visualization in another language.

2. **Differential Equations:**

   Choose one (or more) of the following:

   - Use Mathematica to visualize the behavior of another ordinary differential equation. Here are some examples: Coupled population dynamics:

     $$\frac{dn_1}{dt} = -\gamma_{11} n_1 + \gamma_{12} n_2 \quad (1)$$
     $$\frac{dn_2}{dt} = -\gamma_{22} n_2 - \gamma_{12} n_2 \quad (2)$$

     The logistic equation:

     $$\frac{dx}{dt} = \lambda x(1-x) \quad (3)$$

     The forced, damped harmonic oscillator:

     $$\frac{d^2x}{dt^2} = -\gamma \frac{dx}{dt} - \omega_0^2 x + f_0 \cos \omega t \quad (4)$$

     The forced, damped pendulum:

     $$\frac{d^2\theta}{dt^2} = -\gamma \frac{d\theta}{dt} - \omega_0^2 \sin\theta + f_0 \cos \omega t \quad (5)$$

     Try using `Manipulate[]` to change the initial conditions or the equation parameters to get started. For the last of these equations, you may find very drastic behavior for certain parameters (e.g. $\omega = 2\pi$, $\omega_0 = 1.5\omega$, $\gamma = \omega_0/4$, and $f_0 > 1.1\omega_0^2$).
   - Do the same using Matlab, Python, or the computing language of your choice (e.g. using the Euler method).
   - Do the same using the fourth-order Runge-Kutta algorithm.