The global COVID-19 pandemic has impacted everyone, showing the importance of studying the spread of disease and how to mitigate the effects of a disease. The study below examines influenza, another respiratory disease, using a very basic model. This study should help you appreciate how mathematical models can provide some predictive tools, such as lives saved by vaccination and what the models mean by flattening the curve. Influenza or flu is a viral infection that is readily transmitted through the air and causes respiratory problems in humans and other animals. It occurs seasonally and results in an average of 30,000 deaths in the U. S. annually primarily among the young and old. There have been some epidemics, such as the pandemic of 1918, which resulted in 17-50 million and possibly as high as 100M deaths around the world.

This study has you examine CDC data from one season of flu in the early 2000s. **WeBWorK** gives students different flu strains from different years, but they all follow the recognizable rapid rise and fall over the course of a year. (Not a group project!) We introduce the epidemiological SIR model to allow you to see that some basic mathematical models can provide valuable information about the spread of a disease and how to approach treatment. Though this is a discrete dynamical model, it is effectively using an Euler's method for a 2D ODE, so connects our study of Numerical DEs and the current study of Systems of ODEs. The basic discrete SIR model satisfies the following:

$$\begin{aligned} s_{n+1} &= s_n - \frac{\beta}{N} s_n i_n, \\ i_{n+1} &= i_n(1-\gamma) + \frac{\beta}{N} s_n i_n, \\ r_{n+1} &= r_n + \gamma i_n, \end{aligned}$$

where s_n, i_n, and r_n are the susceptibles, infectives, and recovered individuals in the population, respectively. You will simulate a reduced model, fit parameters, test different actions for control, graph results, and write short discussions.

b. (4 pts) This part has you create graphs of the SIR model, fitting it to data, and has you write a brief discussion about what you observe. Your graphs need to be computer generated, preferably in MatLab, including a title and appropriately labeled axes.

f and g. (6 pts) This part has you create a composite graph overlaying the one above to observe how different control actions affect the spread of flu. You also write a brief discussion about what you observe with the different controls and has you connect to the current COVID-19 pandemic.