MA 137
Calculus 1 with Life Science Applications
Final Project

Your final project is due **on Canvas** on **Monday, April 18th**. Be sure to make it clear who all the members of your group are!

Project Description: Your project will focus on modeling the growth of COVID-19 using the various population models discussed in this class.

1. Choose a US state and a 6-month window sometime between March 2020 and today. Go online to find, for each day in your 6-month period, the total number of COVID cases to that day for your chosen state. For example, you can find such data on the CDC website here:

   `https://covid.cdc.gov/covid-data-tracker/#datatracker-home`

   There are many different statistics that could be interpreted as the "total number of cases". Be sure to explain why you made the choice you did.

2. Graph your data on *both* a standard xy-plot and a semi-log plot. What do you see? Why?

3. Model the total number of COVID cases N_t after t days using the following four population models discussed in class:

   (a) Exponential model:
   $$N_{t+1} = RN_t$$
   What value of R best fits your data? Why?

   (b) Beverton-Holt model:
   $$N_{t+1} = \frac{RN_t}{1 + \frac{R-1}{K}N_t}$$
   What values of R and K best fit your data? Why?

   (c) Discrete logistic model:
   $$N_{t+1} = N_t\Big[1 + R\Big(1 - \frac{N_t}{K}\Big)\Big]$$
   What values of R and K best fit your data? Why?

   (d) Ricker's model:
   $$N_{t+1} = N_t\exp\Big[R\Big(1 - \frac{N_t}{K}\Big)\Big]$$
   What values of R and K best fit your data? Why?

4. Which of the four models above best fits your data? What features of the COVID-19 pandemic do you think make this the most suitable model?

5. What notable discrepancies do you see between your data and your model? What do you think accounts for these discrepancies?

6. According to your model, what will be the limiting number of COVID cases? Why?

Assessment: While putting together your final project please make sure that it clearly conveys:

- your ability to explain information presented in mathematical forms through equations, graphs, diagrams, tables, words **(Interpretation)**;
- your ability to convert relevant information into various mathematical forms through equations, graphs, diagrams, tables, words **(Representation)**;

- your ability with calculations **(Calculation)**;
- your ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis **(Application/Analysis)**;
- your ability to make and evaluate important assumptions in estimation, modeling, and data analysis **(Assumptions)**;
- your ability in expressing quantitative evidence in support of the argument or purpose of the work **(Communication)**.

Requirements: Here are additional guidelines with which your paper must comply:

- You have to turn in a typed paper, at least four (4) pages long. It should be double spaced, it should use 12pt font (Times New Roman, Helvetica, or Arial).
- Your paper should not be in an itemized form but it should be written in a narrative/expository form. You can use sections and subsections. There must be an abstract, an introductory preamble and a final conclusion.
- You must quote, at the end of your paper, all the references that you used for your work.
- Your paper must provide historical and contextual facts and/or preliminary background material on the topic of your paper.
- Your paper must contain all the steps of your calculations (say, equation manipulations, derivatives, limits, and more). You must also indicate which properties you are using while doing your calculations (say, product rule, chain rule, etc...).
- Your paper must contain illustrative graphs and tables.
- Your paper can be written by yourself or by a group of at most three students. Be sure to make it clear who all the members of your group are!