Math 354, Class Exercise 1
Exponential Growth
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1. A certain colony of bacteria is observed to double in 4 hours time. What is the growth rate? If it doubles in 8 hours time, what is the growth rate? Can you write down a general equation depending on N, for a population that doubles in N hours? What if it quadruples in N hours?

2. A population of bacteria is initially N_0 and grows at a constant rate of R_0. Suppose τ hours later, the bacteria is put into a different culture where it now grows at a constant rate R_1. Determine the population of bacteria for all time. Is the function that yields the population for all time continuous at $t = \tau$? Is it differentiable there as well? Why or why not? Plot your result for your assumption on R_1 and R_0.

3. The growth rate of a certain strain of bacteria is unknown, but assumed to be constant. When an experiment is started, it is estimated that there were 1500 bacteria present, and an hour later, 2000. How many bacteria would you predict there are 4 hours later? Using matlab, plot the bacteria population for the first 100 hours after the initial estimation of the population. When is the population 10 times the initial? Find this time by examining the data generated in your matlab code and show that this agrees with the time you estimated by the explicit model.

4. **(Variable Growth Rate)** Suppose the growth rate of a certain species is not constant but depends in a known way on the temperature of its environment. If the temperature is known as a function of time, derive an expression for the future population (which is initially N_0). Show that the population grows or decays with an exponential growth coefficient that is equal to the average of the time dependent growth rate.