IB 120/201 - Lab 2

Numerical Solutions to Single ODEs

Due Date: February 5, 2021

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Background

Yeast Model

In this example you will model the logistic growth of yeast. Below is data from an experiment in which brewer's yeast (*S. cerevisiae*) was grown over a 47 hour period. The population of yeast for this study was measured as a volume.

Time	0	1.5	9	10	18	23	25.5	27	34	38	42	45.5	47
Population	0.37	1.63	6.2	8.87	10.66	12.5	12.6	12.9	13.27	12.77	12.87	12.9	12.7

Also, recall from class that the general equation for logistic growth (in discrete time) is:

$$n(t+1) = n(t) + rn(t)\left(1 - \frac{n(t)}{K}\right)$$

Assignment

1. Plot the yeast data given in the table.
2. What is the approximate carrying capacity of yeast?
3. Through trial and error, fit a logistic model of growth to the data presented in the table. To do this use the carrying capacity you approximated from part 1b, the initial condition from the data and try the following reproductive factors ($r = 1:5, r = 2:0, r = 0:4, r = 0:7$). Which reproductive factor fits the data best? (Hint: use Python to iteratively solve the recursive logistic equation. This can be done with a single loop).
4. Suppose you have decided to go into the yeast selling business. Modify the logistic growth equation to include a constant daily harvest amount, denote this amount h.
5. Mathematically find the new equilibrium points for this new model. (Hint: You will likely have to use the quadratic equation, $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$, to find the equilibrium points.)
6. Set $h = 1$. Starting at the carrying capacity you found in part 2. (i.e. set the initial population size to K) simulate 100 days of yeast growth. Is this a sustainable harvest amount? Make sure to plot your results to help visualize what is happening.
7. If you found $h = 1$ to be unsustainable in the long term, change the harvest amount so that it becomes sustainable. Plug your values for h, r and K into the equilibrium points you found in part 5. and see if your answer matches the simulation result.