BIOL 3295 Fall 2019

Assignment 2 due Friday Oct 11, 1pm

Geometric and exponential growth

Note that in class, I refer to exponential growth in discrete time as 'geometric growth', while the Vandermeer and Goldberg textbook refers to this as exponential growth.

1.1 Exercise 1.1 in [Vandermeer and Goldberg, 2013]. Calculate the population size for $t = 1, 2, 3, 4$ and 5. The questions states that you should assume $N_0 = 1$.

1.2 Exercise 1.2 in [Vandermeer and Goldberg, 2013], but only for $\lambda = 2$.

1.3 Exercise 1.3 in [Vandermeer and Goldberg, 2013]. Do this question only for tripling time. Here, 'exponentially growing' refers to a discrete time geometric growth equation (equation 3 in Vandermeer and Goldberg, 2013). Note that the population has tripled when $N_t/N_0 = 3$. Use the general solution: $N_t = \lambda^t N_0$, and take the natural logarithm of both sides of an equation to isolate t in your formula. Come see myself or a TA if you need help.

1.4 Exercise 1.4 in [Vandermeer and Goldberg, 2013]. Note that your plot will consist of 12 points; the four points: (N_1, N_2), (N_2, N_3), (N_3, N_4), and (N_4, N_5) where (x, y) are the x- and y- coordinates of the point; for each of the three λ values. Use different symbols to represent the 3 different λ values.

1.5 Assume a population is growing exponentially (continuous time). Let $r = 1.5$ and $N(0) = 1$. Calculate the population size at time, $t = 5$.

1.6 Assume a population is growing exponentially (continuous time). Let $r = 1.5$ and $N(0) = 1$. What is the rate of change in population size, $\frac{dN(t)}{dt}$?

Logistic growth

2.1 The continuous time logistic growth equation is equation 17 in [Vandermeer and Goldberg, 2013]. For this equation, for what values of N, is $\frac{dN(t)}{dt} = 0$?

2.2 Sketch a graph of the solution to a continuous time logistic growth model (i.e. such that $\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$) with population size, N, on the y-axis and time, t on the x-axis. Plot the following scenarios:

(a) $r > 0$ and $0 < N(0) < K$, where $N(0)$ denotes the population size at time, $t = 0$,

(b) $r > 0$ and $N(0) > K$, and

(c) $r < 0$ and $0 < N(0) < K$.

Please make sure your answer clearly indicates which lines correspond to (a),(b), and (c).

2.3 Define the per capita growth rate as $\frac{dN}{dt}\frac{1}{N}$. Sketch a graph of the per capita growth rate for a continuous time logistic model (y-axis) versus population size, N (x-axis). Assume $r > 0$ and make sure your graph clearly indicates:

- The value of the per capita growth rate when $N = 0$ (i.e., the y-intercept).
- The value of N when the per capita growth rate is 0 (i.e., the x-intercept)
- The slope of the line.

2.4 Name a significant limitation of May's discrete time logistic map potentially limiting it's applicability to biological populations.

References

[Vandermeer and Goldberg, 2013] Vandermeer, J. H. and D. E. Goldberg, 2013. Population ecology: first principles. Princeton University Press. Available as an ebook from the MUN library. https://ebookcentral.proquest.com/lib/mun/detail.action?docID=1205619