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POPULATION ECOLOGY EXERCISES

FORMULAS

Exponential Growth

$N_{t+1} = N_t + r N_t$

$N_t = N_o (1+r)^t$

$r = b-d$

where r is the growing rate, Nt is the number of individuals in the present generation and N t+1 is the number of individuals in the next generation. No is the number of individuals of the population at generation 0 (the beggining). b identifies the rates for borning individuals in the population, and d is the mortality rate.

Logistic Growth

$N_{t+1} = N_t + rN_t [(K- N_t) / K]$

where r is the growing rate, Nt is the number of individuals in the present generation and N t+1 is the number of individuals in the next generation. K is the Carrying Capacity, the maximum number of individuals of this species that the environment can sustain.

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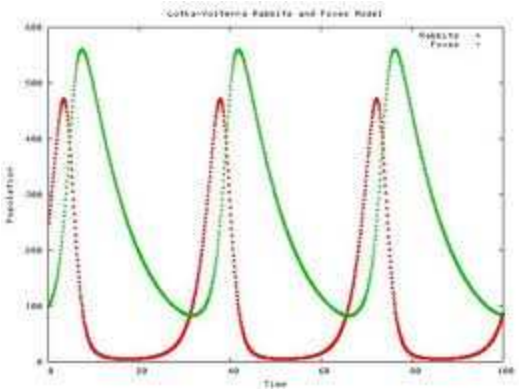
Lotka Volterra Predator- Prey models

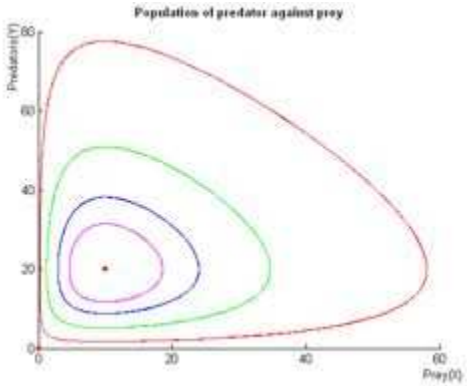
$X_{t+1} = X_t + rX_t - \delta X_t Y_t$

$Y_{t+1} = Y_t + \gamma X_t Y_t - c Y_t$

where Xt is the current number of individuals in the prey population
X t+1 is the number of individuals in the prey population in the next generation
Yt is the current number of individuals in the predator population
Y t+1 is the number of individuals in the predator population in the next generation

r is the growing rate of preys
d is the mortality rate of predators
δ is the negative effect for preys of meeting predators
γ is the positive effect for predators of meeting preys





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Exponential Growth and b and d rates.

1) The initial population of a group of rabbits is 40. Its borning rate is 0,8 and its mortality rate is 0,4. Calculate its growing rate (r), and the population in the next generation. (56 individuals)
2) Follow the population of exercise 1 during 10 generations and make a graph of it. Which is the population in the 10^{th} generation? (1156,8 individuals)
3) A population of birds has been growing for 6 generations and is composed by 200 individuals. In the 7^{th} generation, it is composed by 210 individuals. Calculate the value of r and which was the initial population No. (r=0,05; No=149,25 individuals)
4) A population of bacteria is growing with no ressource limits. If the initial population is 1000 individuals and it takes 20 minutes to get a new generation, calculate the time necessary to arrive to a population of 20.000 individuals, if r is 0,4. Make a graph of it. (3 hours)
5) A population of fishes increases its population from 20 to 45 individuals in one generation. Calculate the growing rate. (r=1,25)
6) The same as in the previous exercise, but consider that this increase is made in two generations (you will need to use the newton binomial or equations substitution. r=0.5)
7) Taking in account the data from exercise 5, calculate which is the mortality rate if b is 1,5. (d=0,25)
8) Fishermans want to exploit a population of fishes that have a rate of borning (b) of 0,5. Consider that the population have growth exponentially from an initial population of 30 individuals, and that in the generation 2, the population is composed by 36 individuals. The population grows during 10 generations, and at this moment, fishermans begin to capture fishes, so increasing the mortality rate to 0,8. Calculate the growing rate and the mortality rate under the two circumstances and determine if the population will resist this change during 10 more generations, or if, in the other hand, it will be extincted. Consider that below 8 individuals, the population is extinct. (before the fishermans, r= 0,2; d=0,3. After the fishermans, r= -0,3; d=0,8. After 10 generations, the population will be of 5,19 individuals, so extinct).
9) You are doing a yaourth and you know that you need a minimal amount of 500.000 individuals to get it. You want to do it in only one generation. If the growing rate is 0,7, which is the minimal initial amount of individuals? How many generations do you need to get it from 21800 individuals? (one generation: 29,4117,64 individuals; 6 generations)

10) You are following the development of a colony of rats in a city. You know from your work in the laboratory that the normal rates for rats are: a borning rate of 0,9, and a mortality rate of 0,3. The initial population of rats in the city was 100, and after 10 generations, it's 500. Which should be the normal population of rats? Do the rats have a predator in the city? (normal population: 10995 individuals).

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Logistic Growth

1) A population of flies is reproducing fastly at a growing rate of 0,8. If the initial population is 300 individuals and the the environment can sustain only 5000 individuals, calculate the population of flies during the next 8 generations, and make a graph of it. (N1=525,6; ….; N8=4938,70)

2) At its 3^{th} generation, the population of rabbits in a rural zone is 311,98 individuals, that increase to 393,89 in the next generation. If the growing rate is 0,3, calculate the capacity of charge of this ecosystem and which was the initial population. (K=2500; No= 150)

3) You are charged of the control of the population of ants in an ecosystem with a limited capcacity of charge K=8000. The normal growing rate for this species is 0,6 and the mortality rate is 0,3. To control it, you can increase or decrease the mortality rate by adding insecticides. Each 100 cL of insecticide corresponds to an increase of 0,1 in the mortality rate. Your goal is to bring a population from an initial population of 5000 to a population of 6000 in only one generation. Calculate the growing rate and the mortality rate necessary to get this results. Calculate the amount of insecticide required. (r=0,53; d=0,37; 70 cL).

4) At the present moment, the population of whales has been increasing during 4 generations at a growing rate of 0,5, with a K of 200. The initial population was 20 individuals. The maritime legal rules allow fishermans to fish whales when its population is over the 80% of its K. Whales takes 10 years to make a new generation. Fishermans consider that in twenty years, the population of whales will be about the 80% of its K, and so, they will have the right to fish. You are not sure about it. Determine if it's true, and if it's not, calculate how many years fishermans will have to wait. (It's not true, fishermans will have to wait for 40 years before fishing whales again).

5) A population of wild horses has been living in an island with limited ressources for 5 generations. The current population is 300 horses, which represents the 115% of the generation inmediately before. From populations of the same species of horses in other places, you know that the growing rate of this species is 0,2. A farmer proposes to bring to the island 200 more wild horses of the same species, to help growing the population. Decide if its correct or not, and, if not, stablish which is the maximum number of horses he can bring. (no, too much horses. Only 100 more horses can be sustained by this island).

6) In the asiatic region Ze-Dong, the current population is about 134400 individuals, after one generation of growing from a beggining population of 120000 individuals. The culture of this society implies a complete independence from the other regions. They don't do commerce and don't import ressources. Their growing rate is about 0,3 and the generation time is 18 years (they reproduce very young). The ONU is worried about their development, as they suppose there could be problems from the lack of ressources in few generations. They ask you to do an analysis including the several questions:
-Which is the maximum amount of individuals this region can sustain.
-If the population arrives to the critical point of the 80% of the capacity of charge, there will be problems of malnutrition in some parts of the region. Calculate in how many years will it happen.
-The ONU is trying to help this population, but the help programs will take 80 years. They are proposing to reduce the growing rate to 0,2 in order to make the critical point arrive only after 90 years. Determine if this strategy can work.
(maximum number of individuals=200000; in 72 years; the strategy will work, after 72 years, population will be 154994,17 individuals, under the critical point)

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Lotka Volterra Predator- Prey models

You are the ecologist charged of the supervision of the population of wolves and rabbits in a population. The initial population of rabbits is 5000, and the initial population of wolves is 80. The growing rate for rabbits (r) is 0,5

$X_{t+1} = X_t + rX_t - \delta X_t Y_t$

$Y_{t+1} = Y_t + \gamma X_t Y_t - c Y_t$