LOGISTIC EQUATION RESPRESENTATION

Master in Computational Biology
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1. Introduction

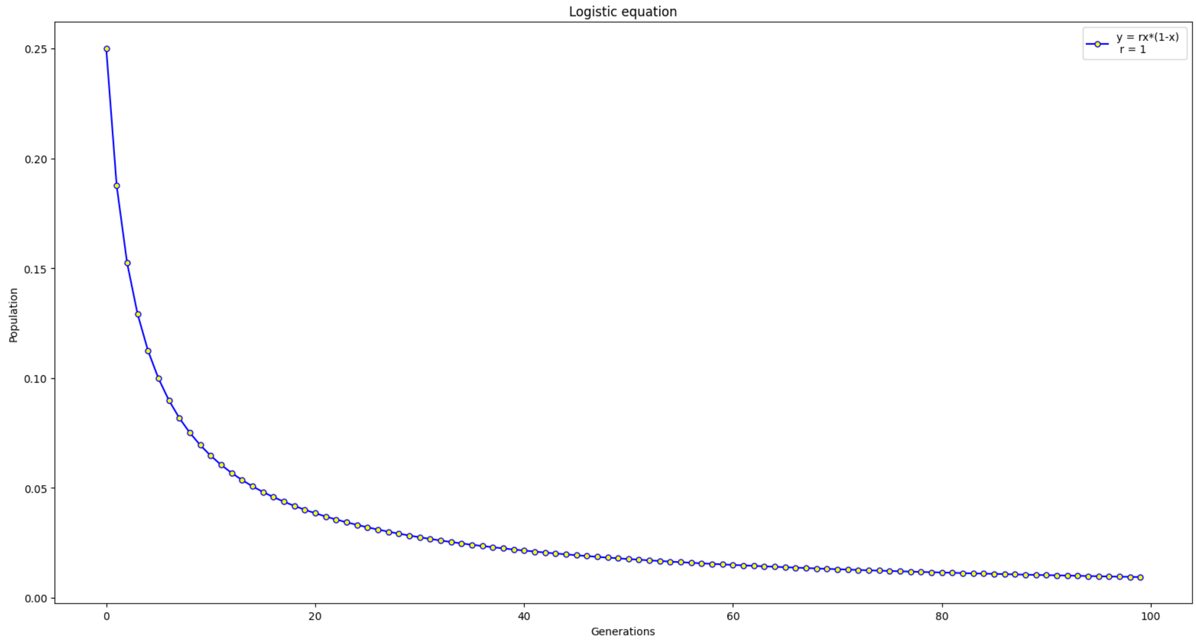
The logistic function or logistic curve is a mathematical function used in several fields including biology, biomathematics, demography, etc. Focusing on biology it is a commonly way to represent the population growth or diseases spread.

This function could be represented by a differential equation: $\frac{dx}{dt} = rx(1-x)$ where x is the population size and y is a period of time. Finally, r represents the rate between reproduction and mortality in the given population.

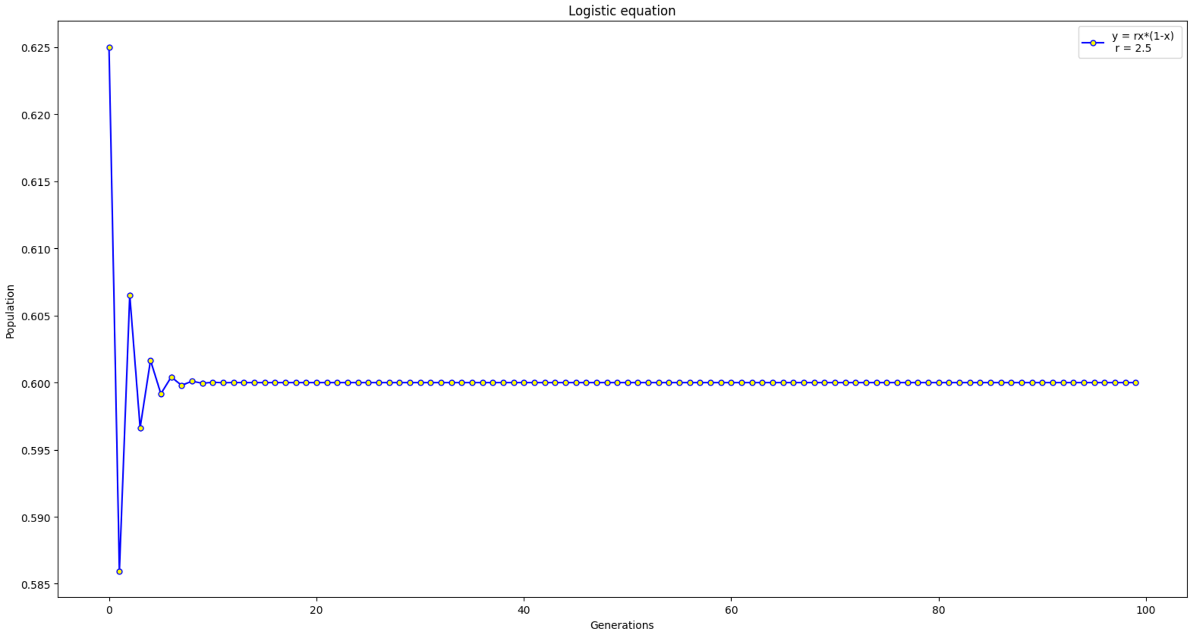
2. Test cases

Twelve test cases are represented below to see the differences when we vary the values of x and r.

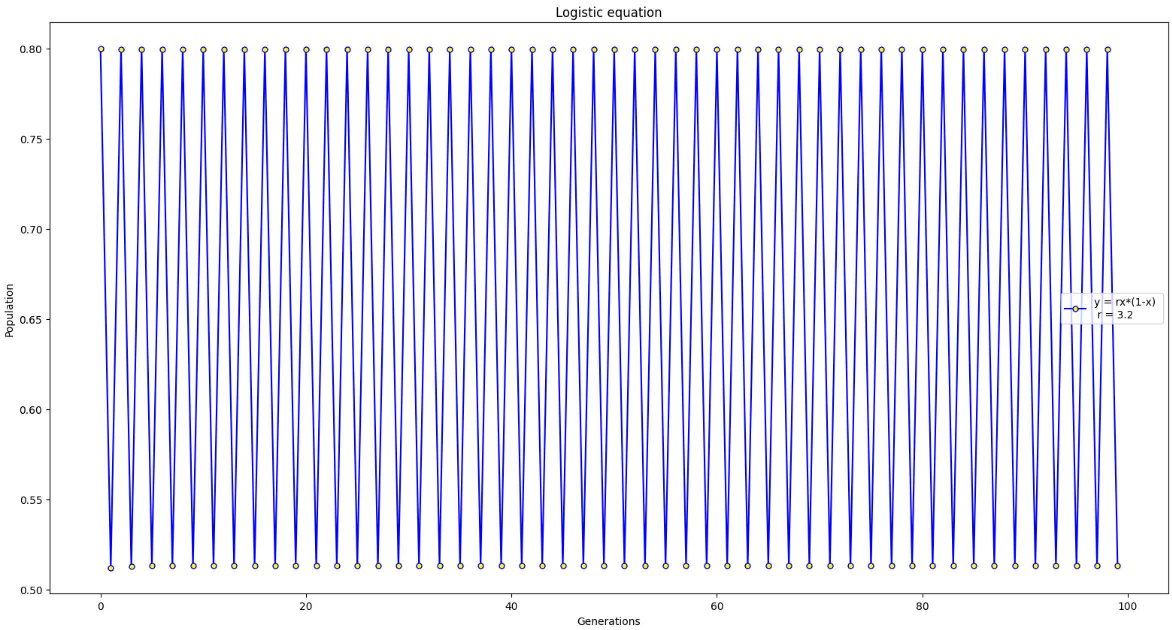
a. $x = 0.5, r = 1$



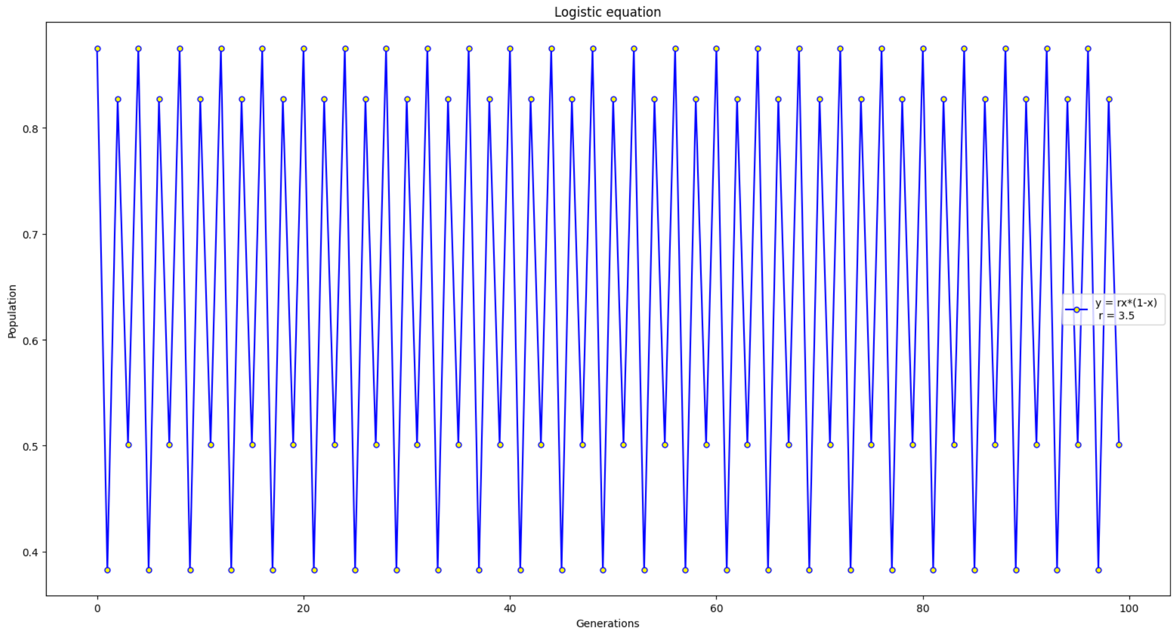
b. $x = 0.5, r = 2.5$



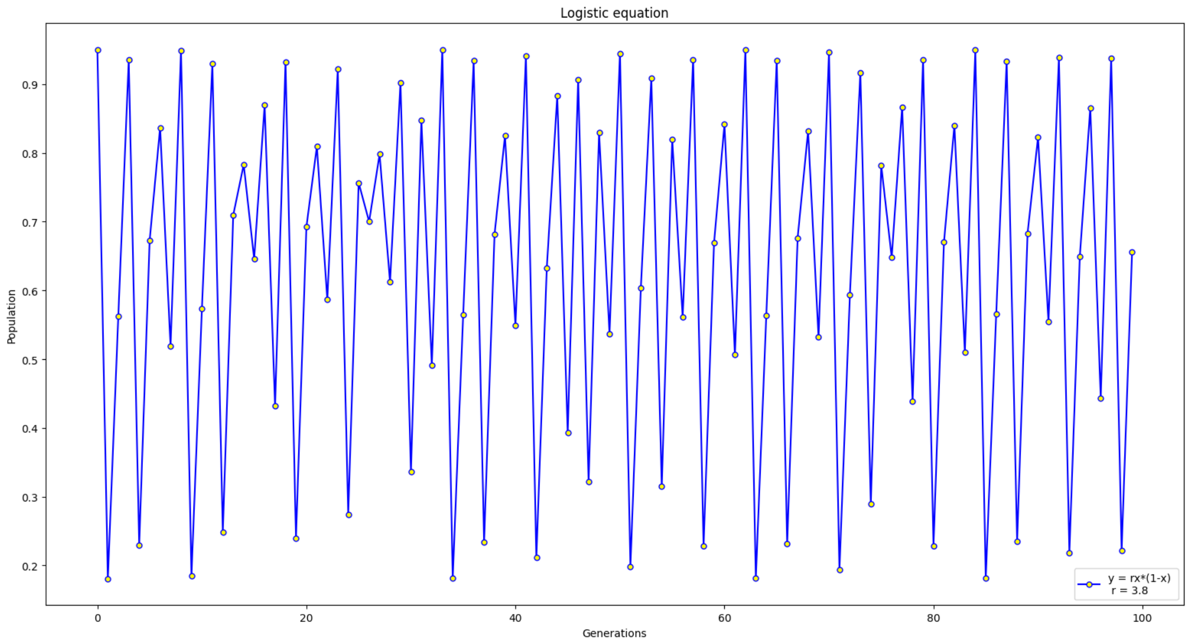
c. $x = 0.5, r = 3.2$



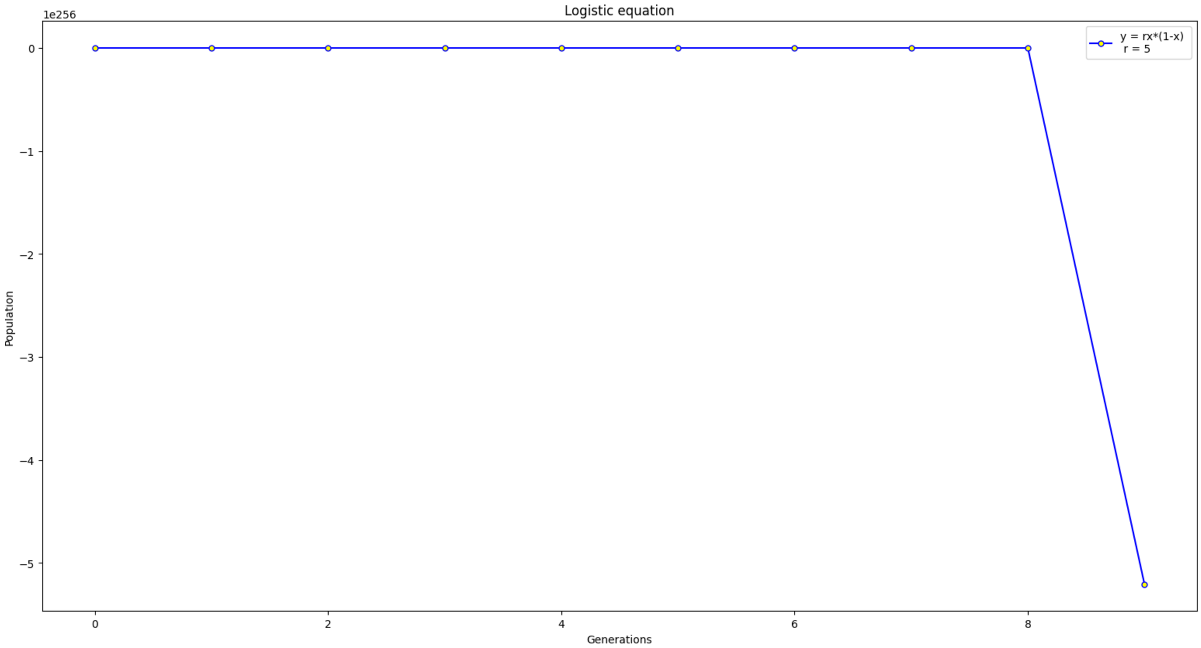
d. $x = 0.5, r = 3.5$



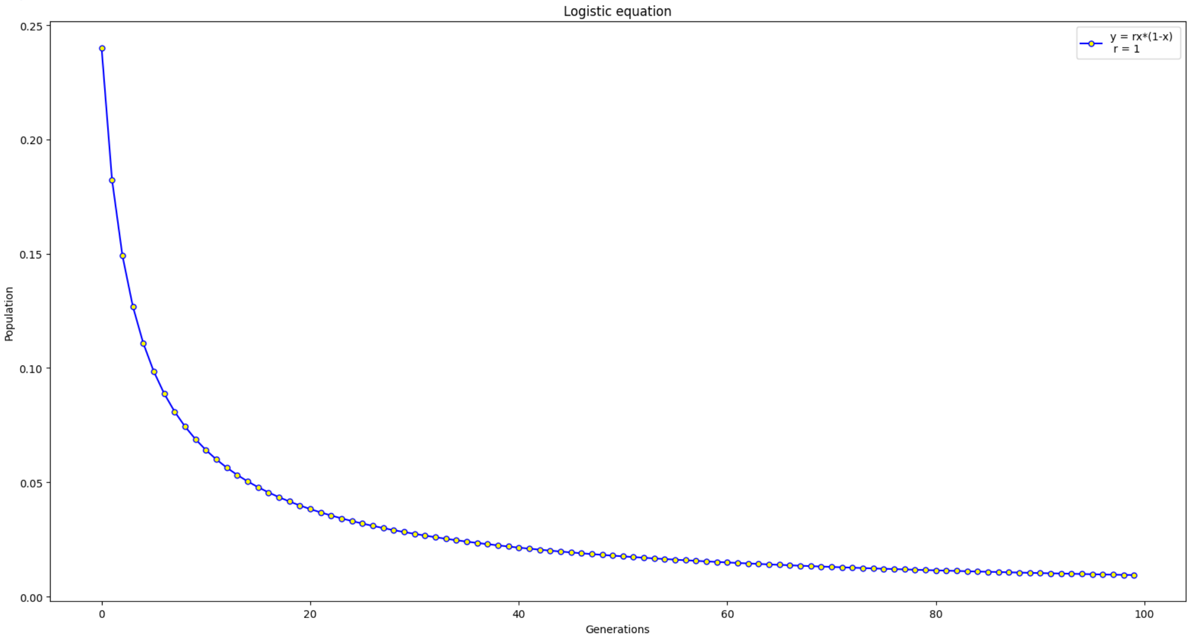
e. $x = 0.5, r = 3.8$



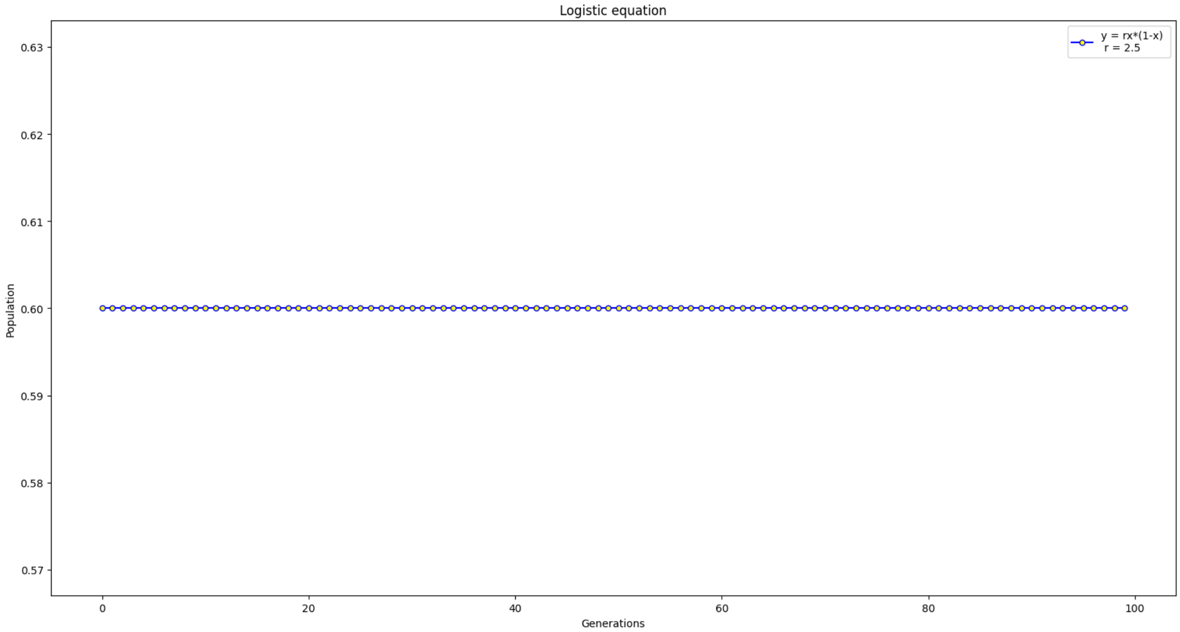
f. $x = 0.5, r = 5$



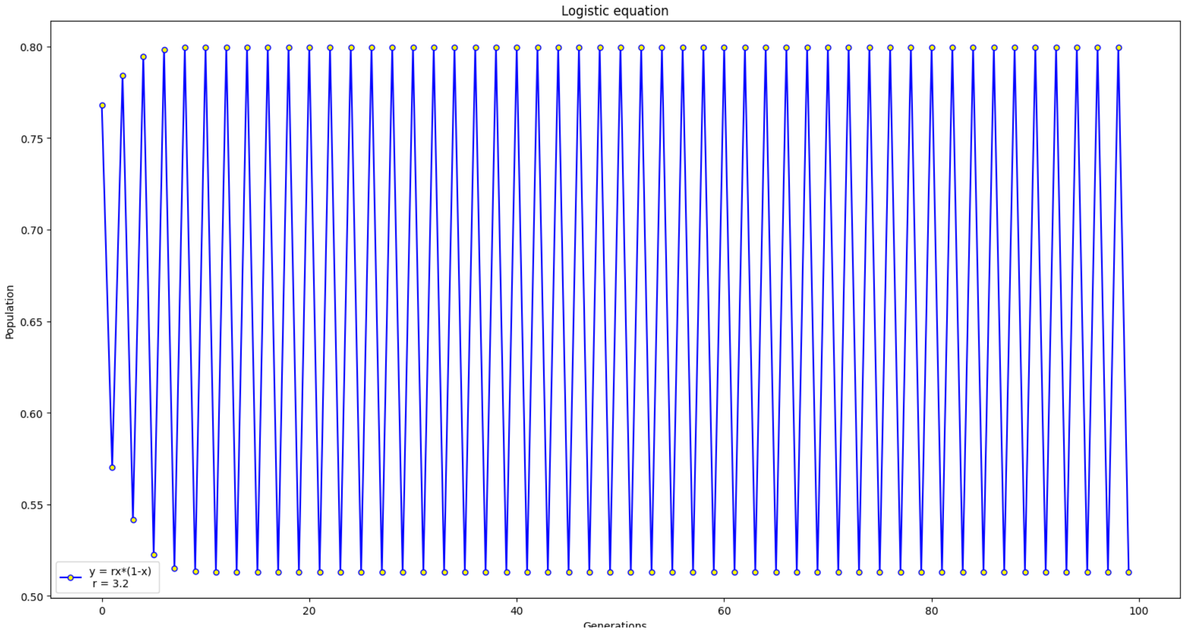
g. $x = 0.4, r = 1$



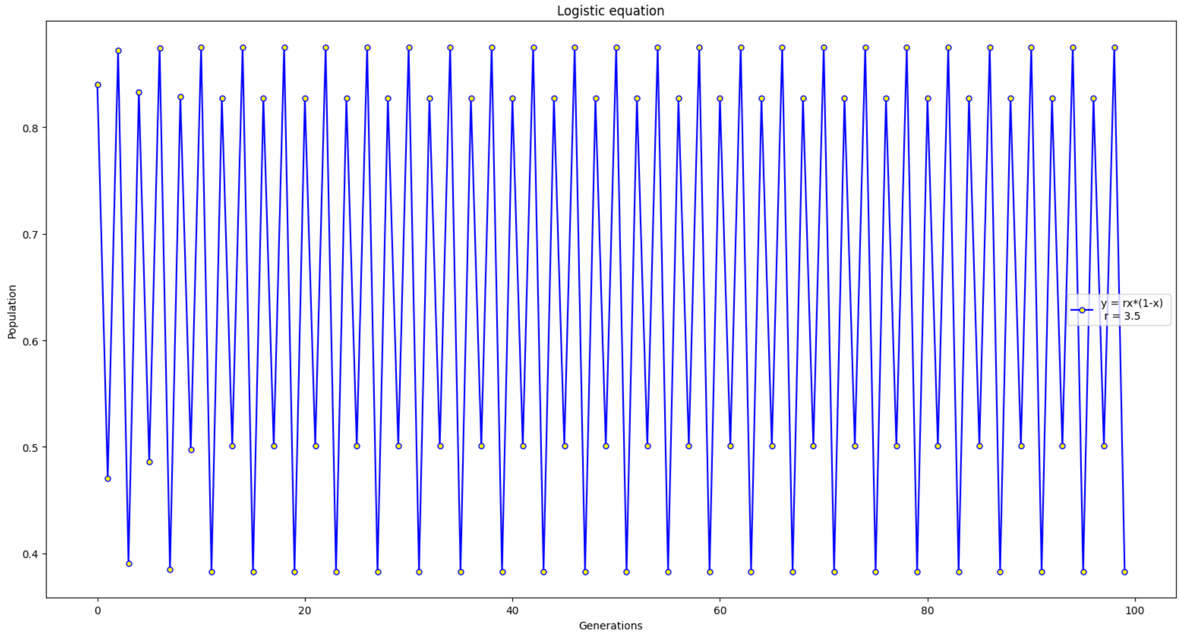
h. $x = 0.4, r = 2.5$



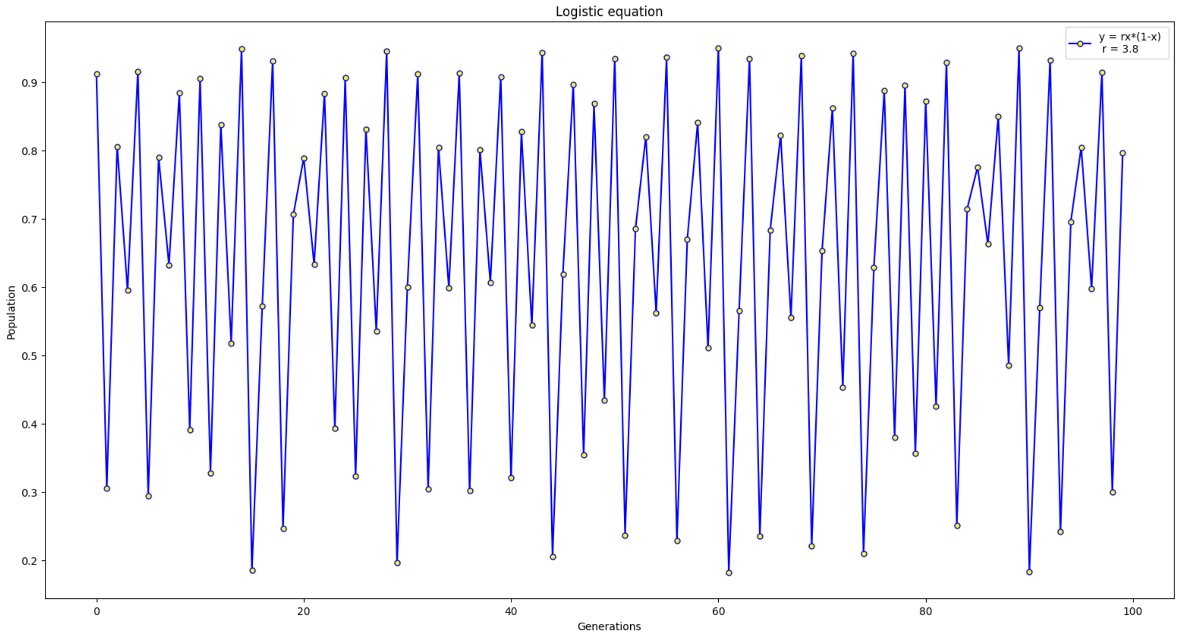
i. $x = 0.4, r = 3.2$



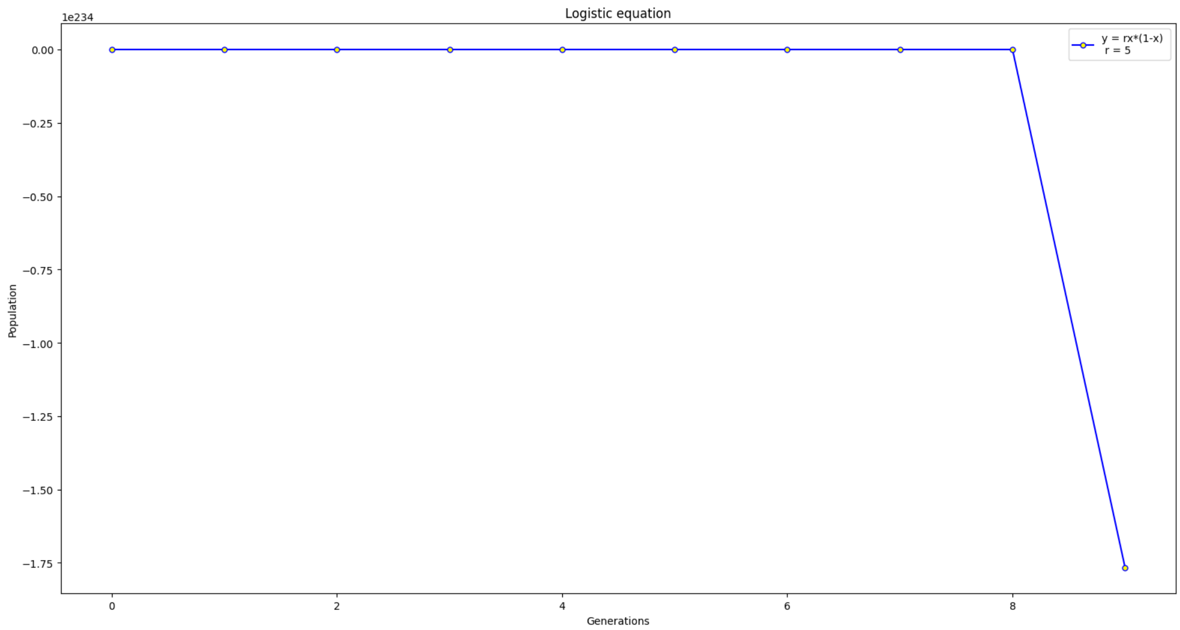
j. $x = 0.4, r = 3.5$



k. $x = 0.4, r = 3.8$



I. $x = 0.4, r = 5$

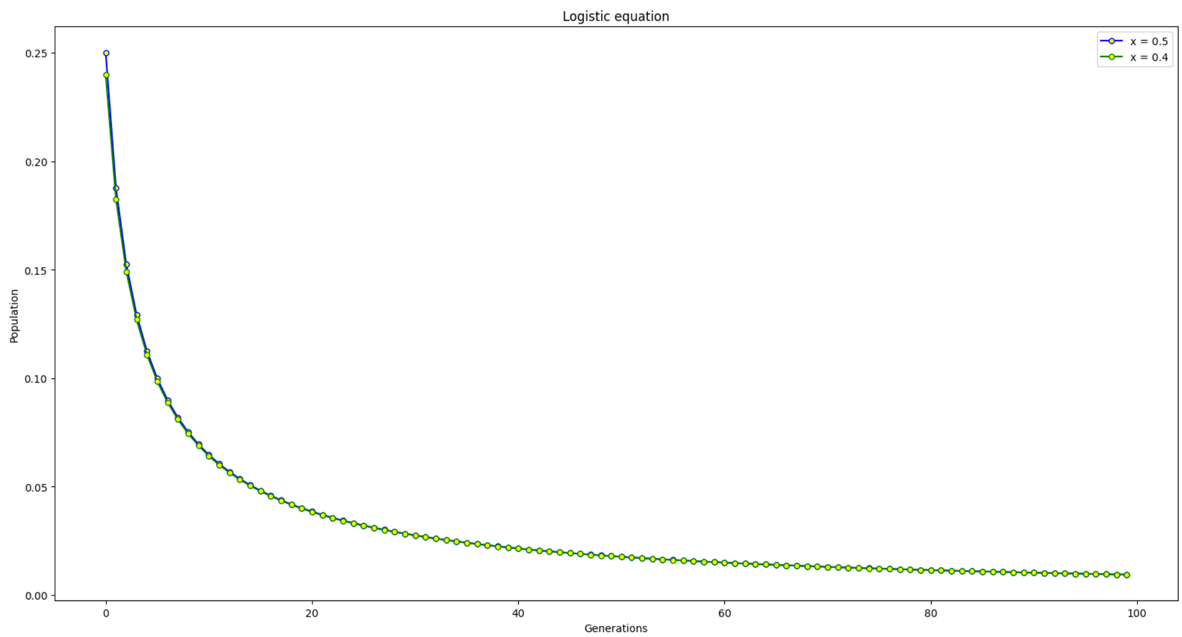


3. Conclusions

For answering the question: *"What happens if you start from a slightly different x_0 (e.g., 0.4)?"* I made another plot for comparing the graphs above. I found that the principal value which we must observe was not x_0, but r. So, if we vary so slightly the value of x_0 there is no a huge difference at the final result on the plots (only the time it takes to stablish the final value).

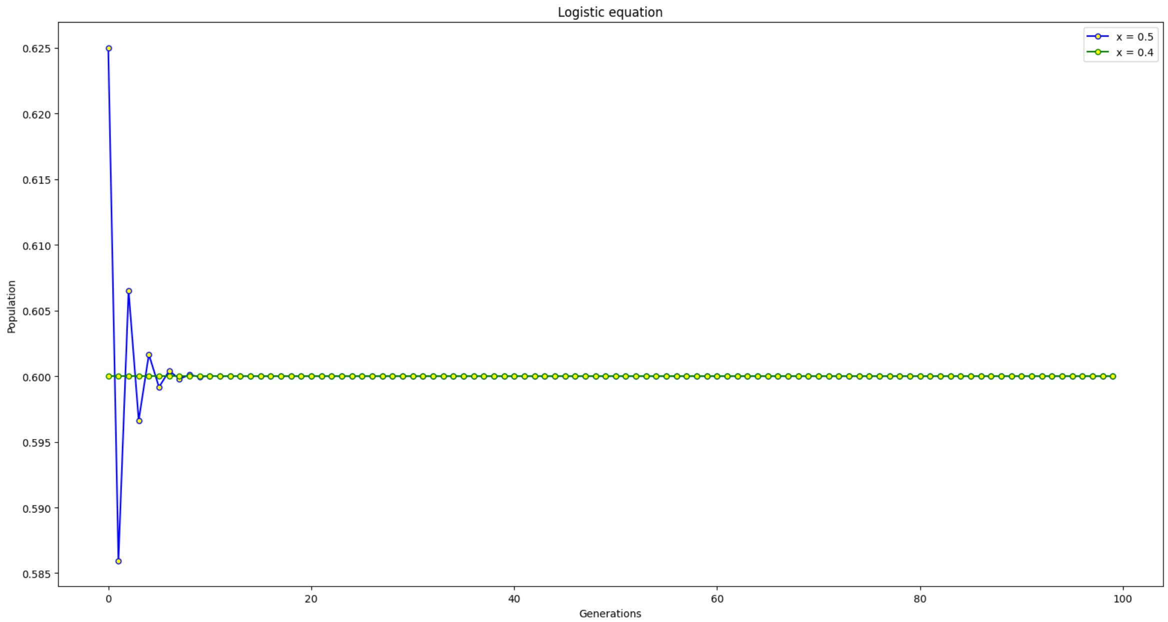
a. $r = 1$

For $r \leq 1$ the studied population will disappear regardless de initial number of organisms.



b. $r = 2.5$

For $r = 2.5$ we can observe that at some point the population will stabilize at some value. In contrast to last example ($r = 1$), we can affirm that higher number of initial populations, the longer it will take for the graph to stabilize.



c. $r = 5$

Due to the size of the equation results, it is impossible for Python to represent them. Therefore, after some investigation I found that for $r > 4$, values left the common interval [0,1] and the graph diverge for all values.