Logistic Population Growth

Learning objectives

The equation for logistic growth in discrete time

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The definition of density-dependent growth

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Basic properties of the model

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The equation for logistic growth in discrete time

The definition of density-dependent growth

Basic properties of the model

Strange behavior of the (discrete time) model, such as damped oscillations and chaos

Geometric growth

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

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Logistic growth

$$N_{t+1} = N_t + N_t r_{max} \left(1 - \frac{N_t}{K}\right)$$

where

- r_{max} is the growth rate when N_t is close to 0.
- K is the carrying capacity

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Definition: Population growth rate *is* affected by population size (N).

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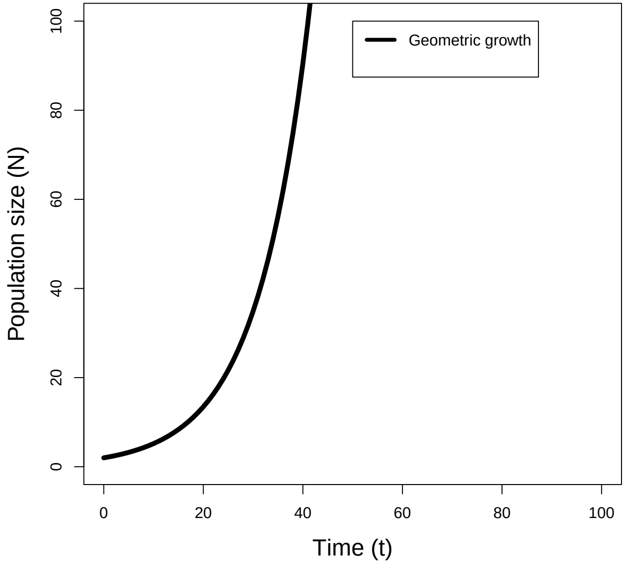
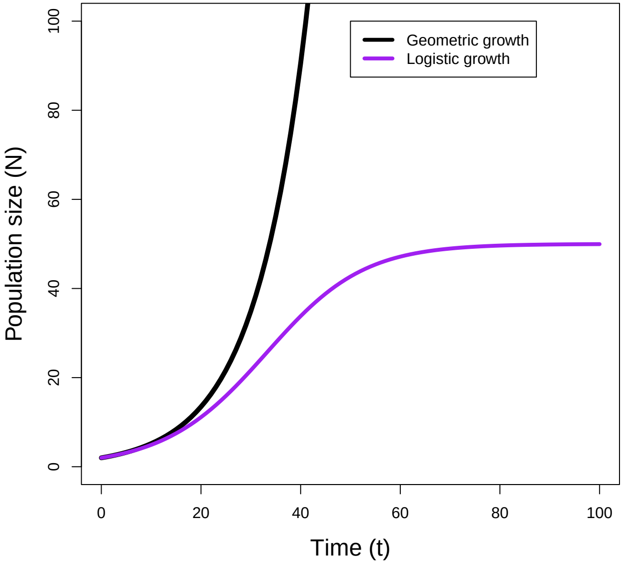
Implications: Resources are limited and there is a carrying capacity.

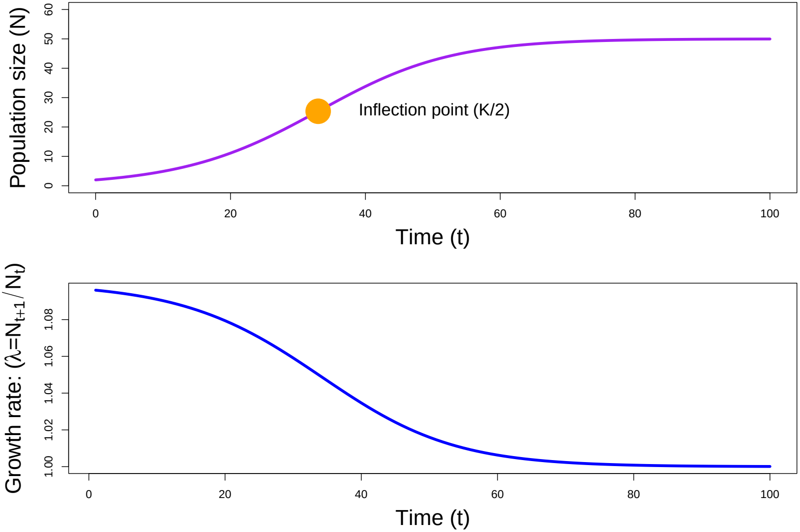
Graphical depiction



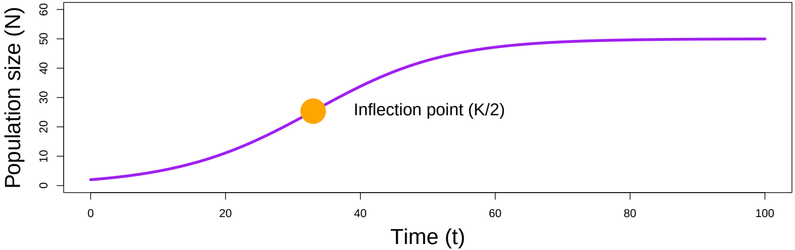
Graphical depiction

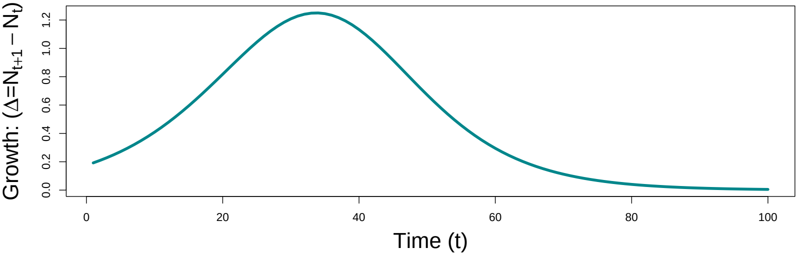


Growth rate ($\lambda_t = N_{t+1}/N_t$)

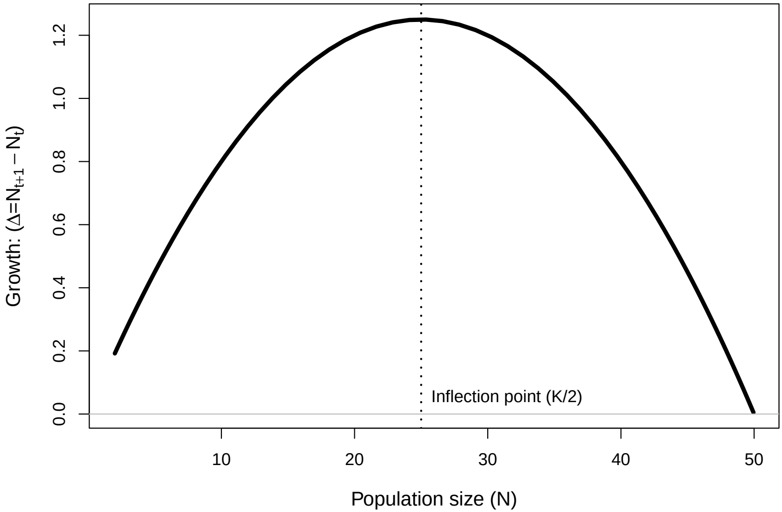


Growth ($\Delta_t = N_{t+1} - N_t$)

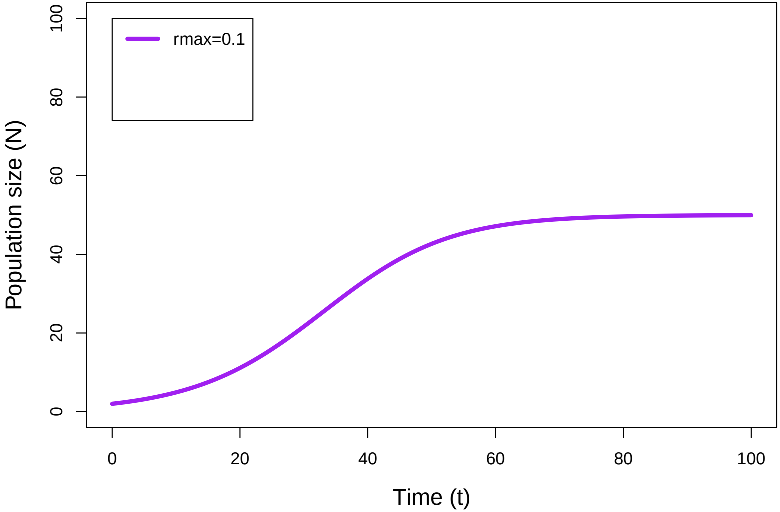




Growth ($\Delta_t = N_{t+1} - N_t$) as a function of N



What happens when we change r_{max}?



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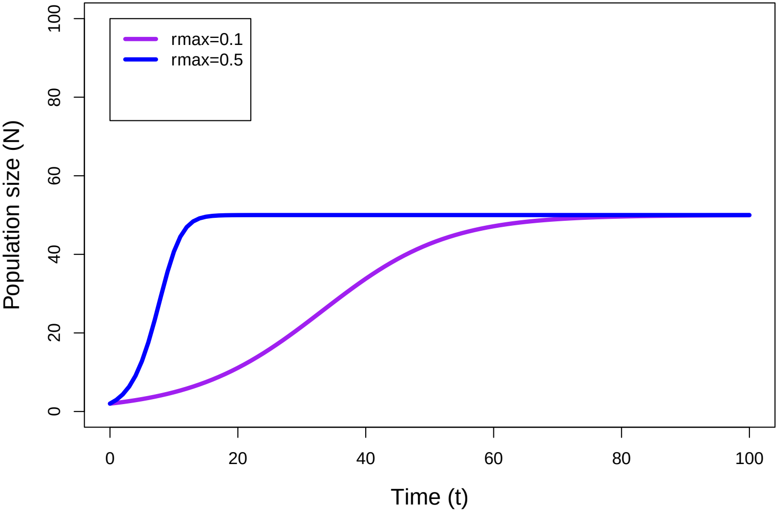
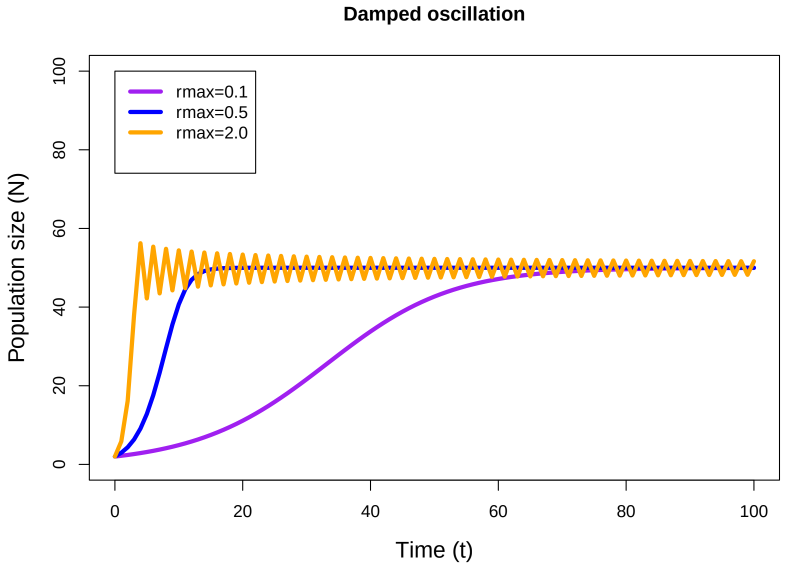
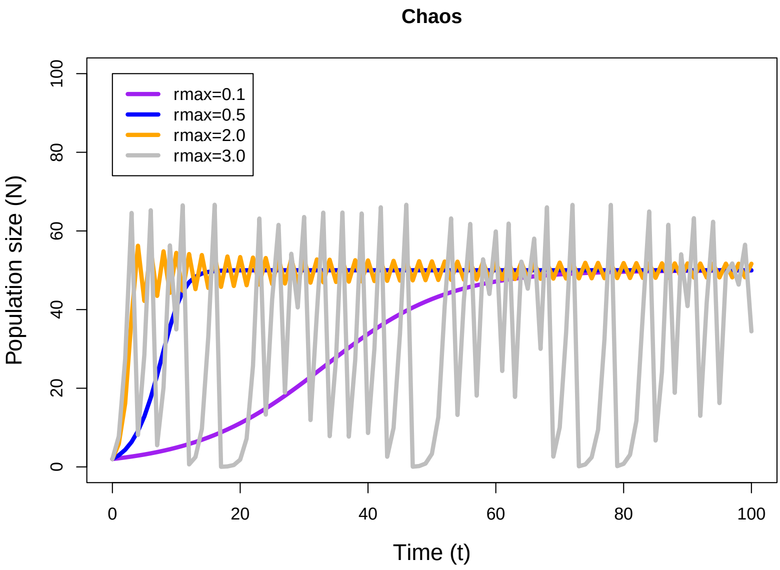



Damped oscillation
rmax=0.1
rmax=0.5
rmax=2.0
Population size (N)
0
20
40
60
80
100
Time (t)
0
20
40
60
80
100



Chaos
rmax=0.1
rmax=0.5
rmax=2.0
rmax=3.0
Population size (N)
0
20
40
60
80
100
Time (t)

Overcompensation

Density-dependent response in which populations over- or under-shoot carrying capacity rather than approach it gradually

Definitions

Overcompensation

Density-dependent response in which populations over- or under-shoot carrying capacity rather than approach it gradually

Chaos

Highly variable deterministic dynamics that are extremely sensitive to small changes in parameters

- K and r_{max} are constant
- No sex or age effects or other sources of individual heterogeneity
- No time lags
- No stochasticity

Summary

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Assignment

Read pages 32–36 in Conroy and Carroll