

UNIT 1: Linear population models

Outline

Example populations

Dandelions

Gypsy moths

Bacteria

Exponential growth

Log and linear scales

Time scales

Constructing models

Dynamical models

Examples

A simple discrete-time model

A simple continuous-time model

Units and scaling

Key parameters

Discrete-time model

Continuous-time model

Links

Growth and regulation

Subsection 1

Dandelions

Dandelions

- ▶ Start with one dandelion; it produces 100 seeds, of which only 4% survive to reproduce the next year.



Dandelions

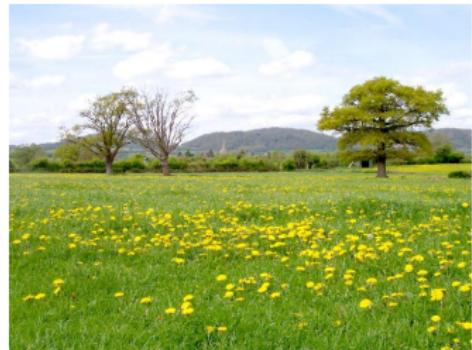
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- ▶ The spreadsheet is an implementation of a dynamical model!



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Subsection 2

Gypsy moths

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- ▶ A pest species that feeds on deciduous trees



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- ▶ Introduced to N. America from Europe 150 years ago



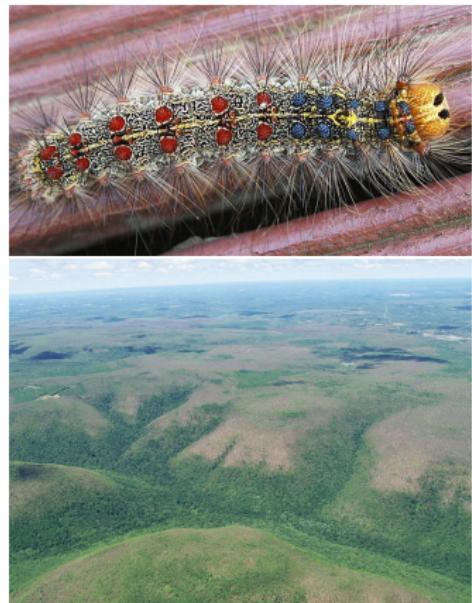
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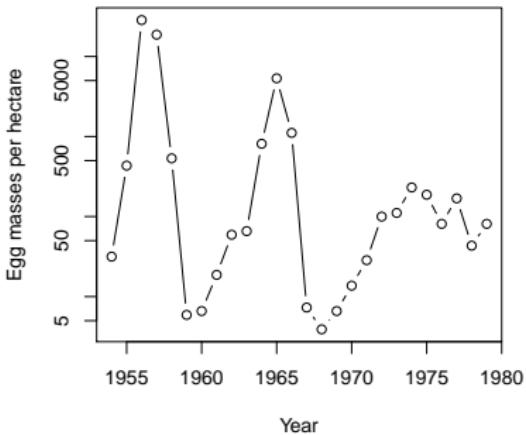
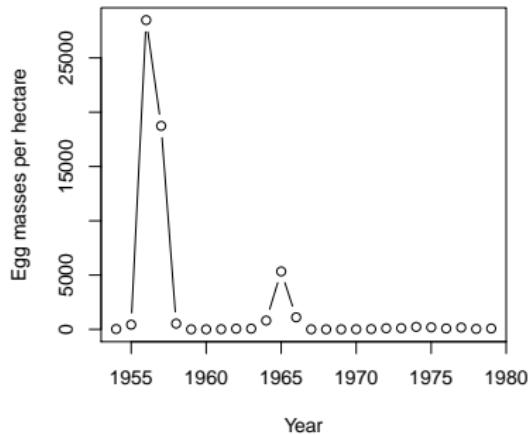


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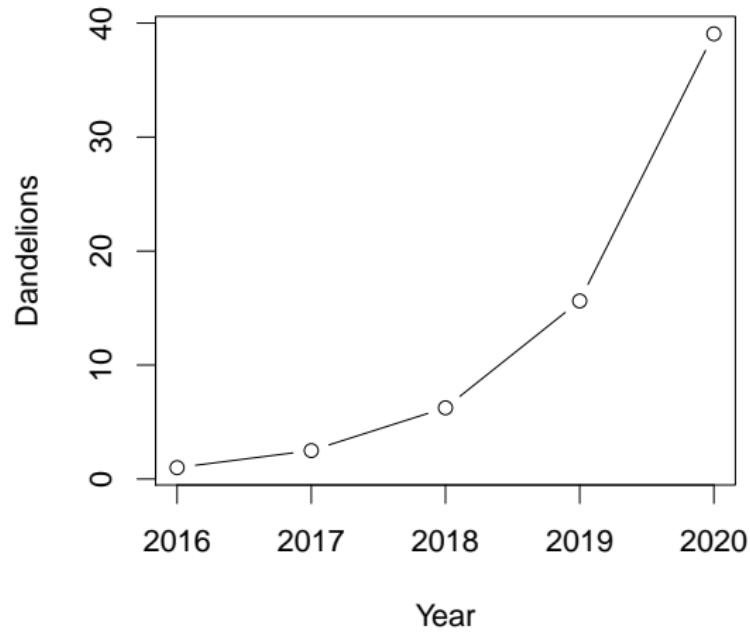
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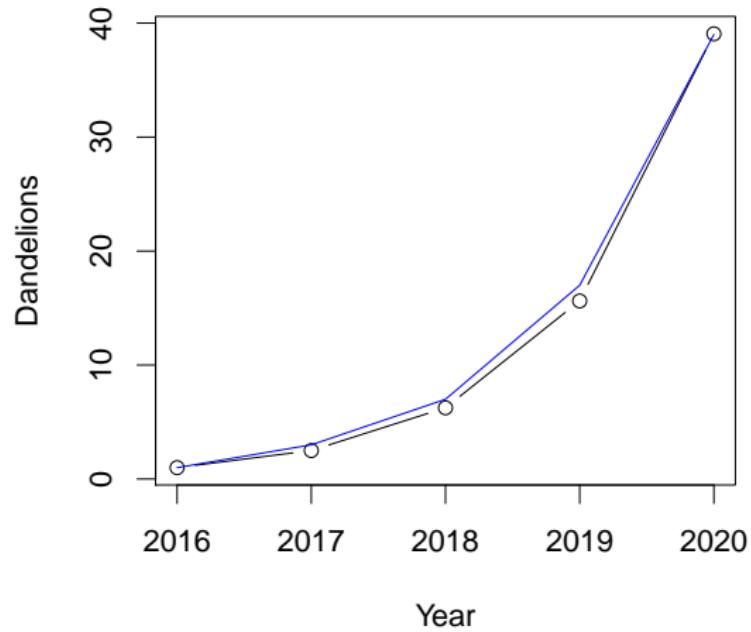
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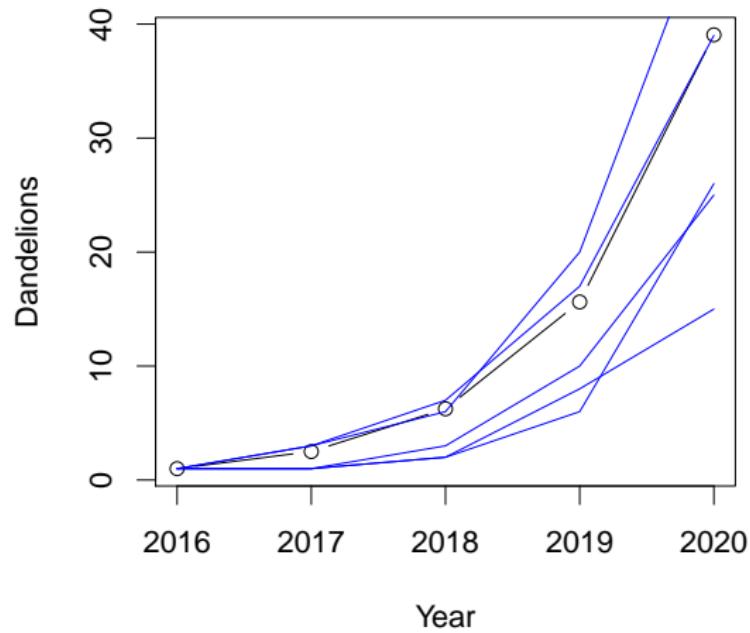
Stochastic model



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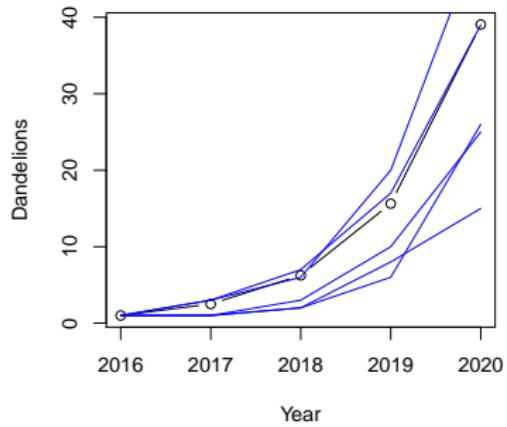


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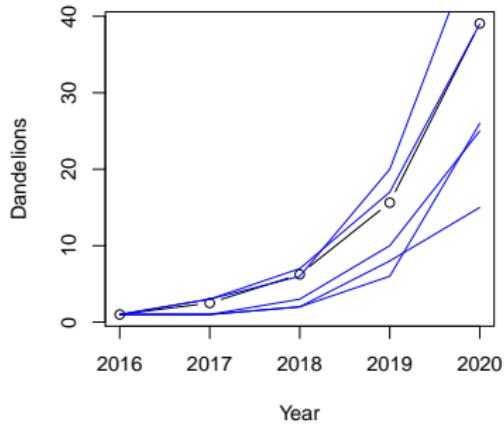
Stochastic model

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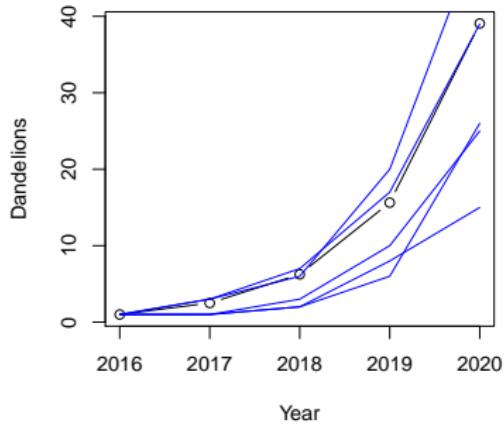
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Subsection 3

Bacteria

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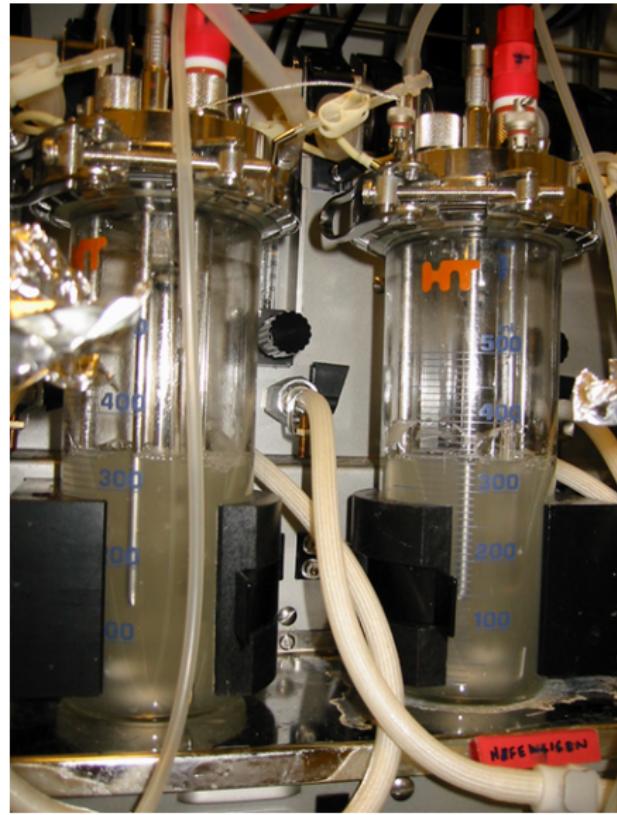
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Bacteria in a tank



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 - ▶ **They die at a rate of 0.24/day**

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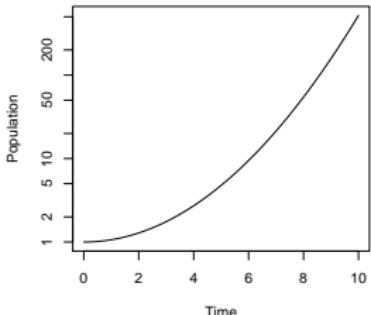
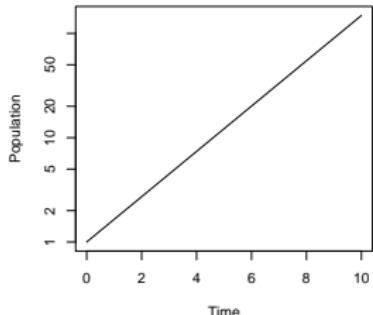
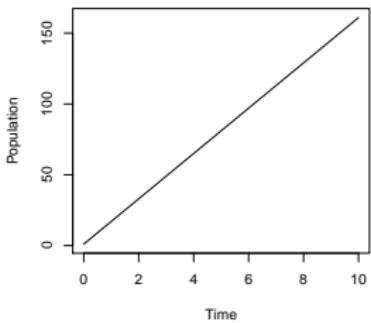
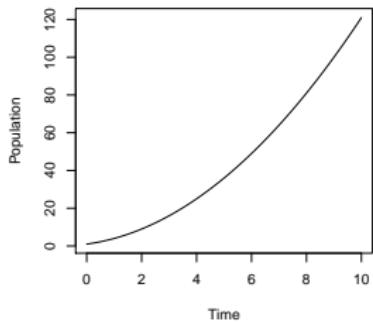
Continuous-time model

Links

Growth and regulation

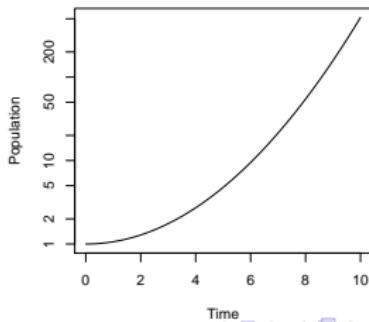
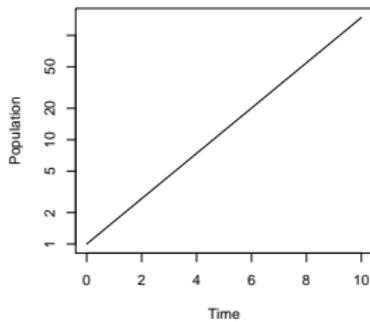
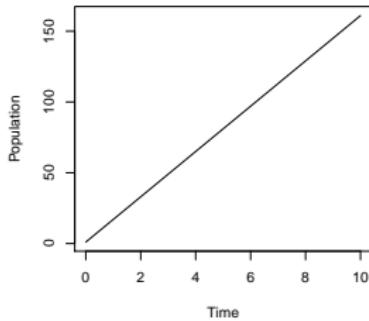
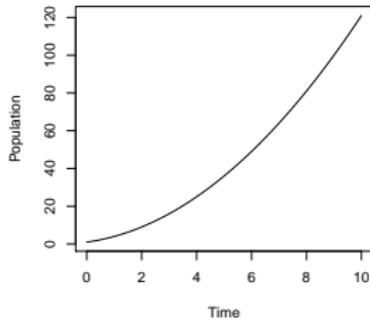
Exponential growth

► What is exponential growth?



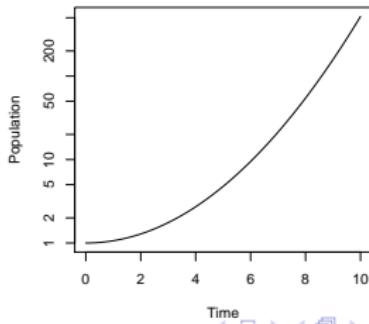
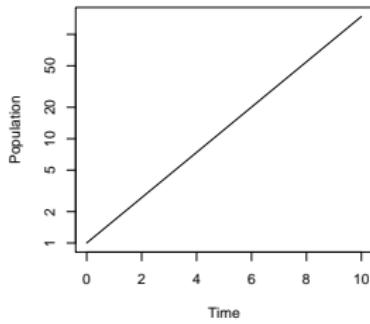
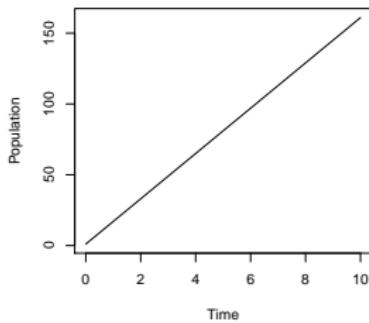
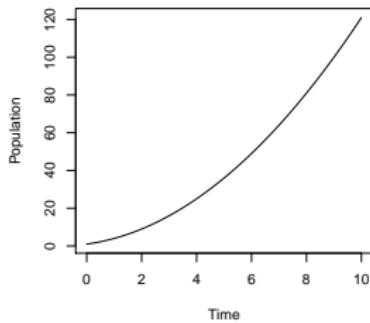
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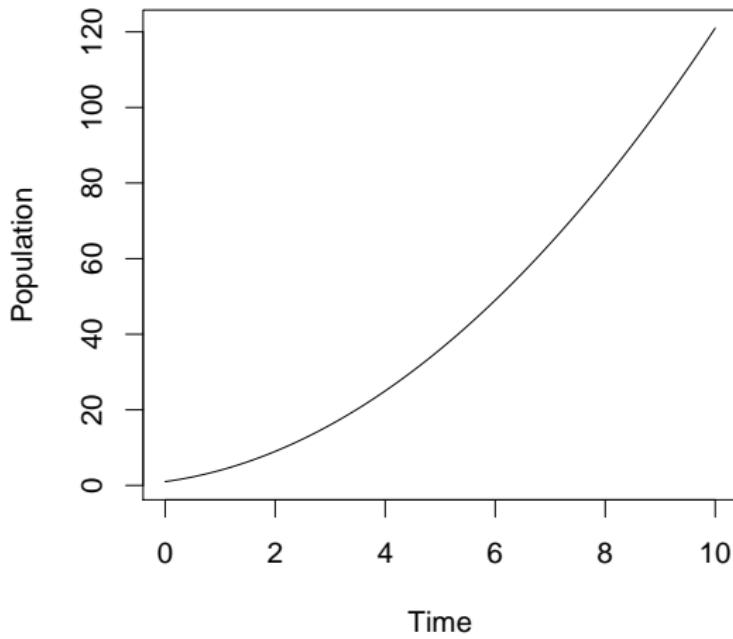


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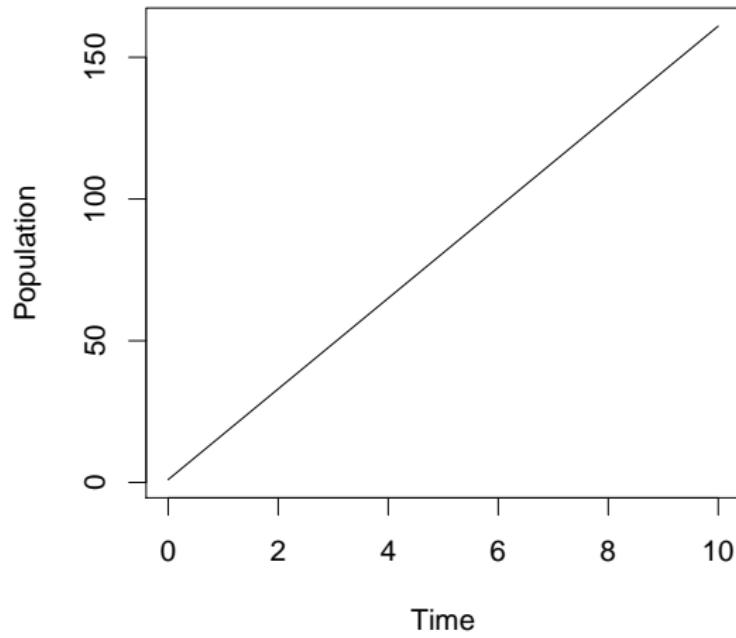
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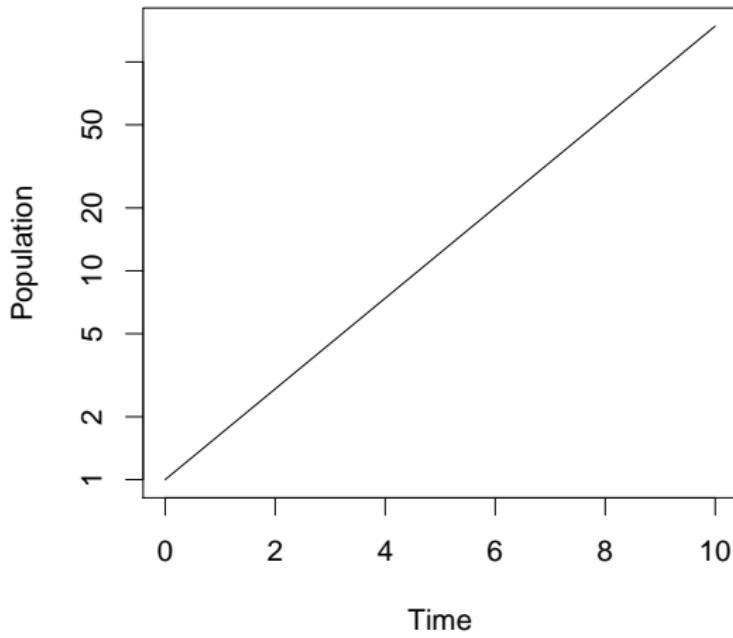
A



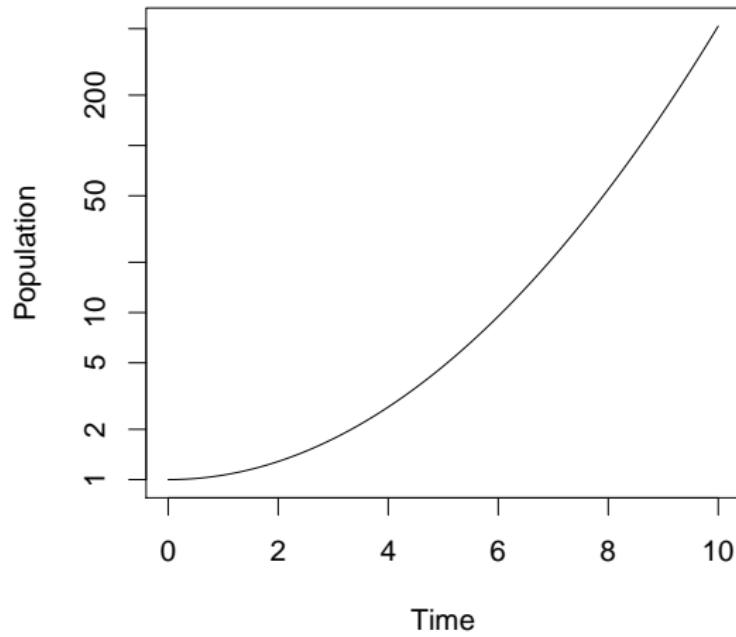
B



C

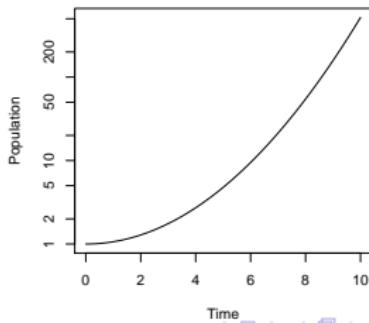
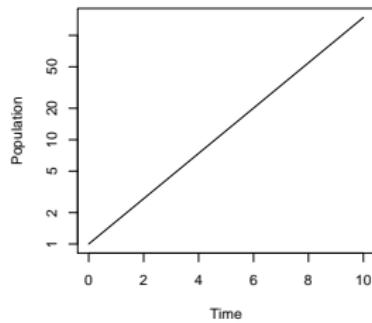
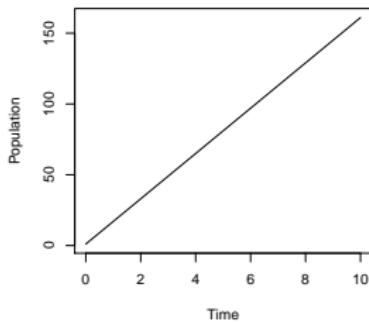
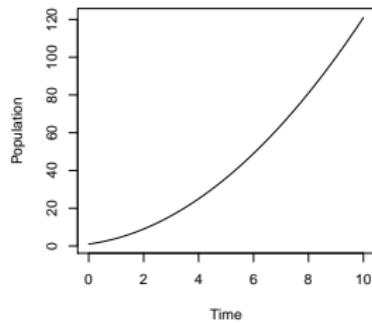


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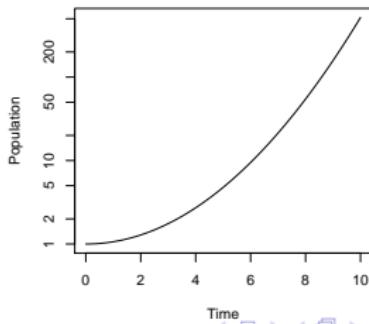
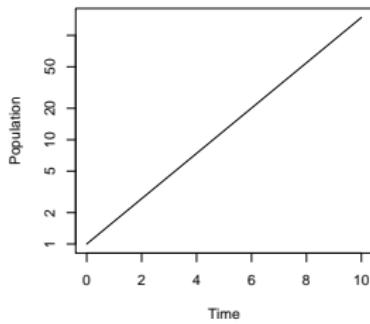
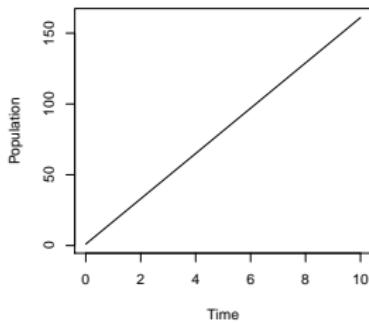
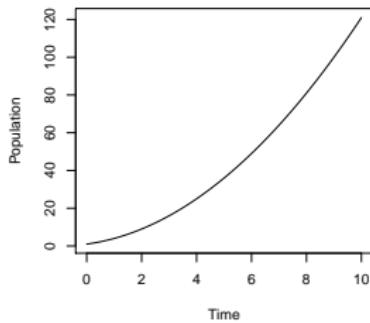
Exponential growth

► Poll: What is exponential growth?



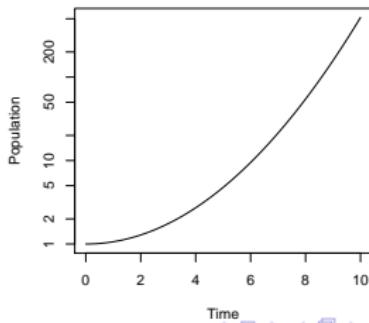
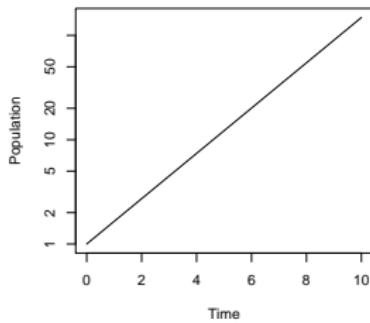
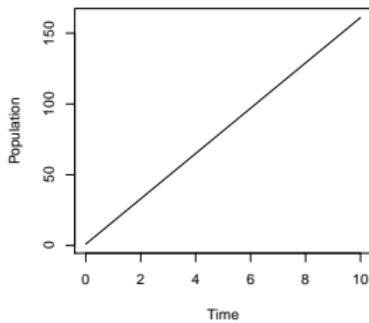
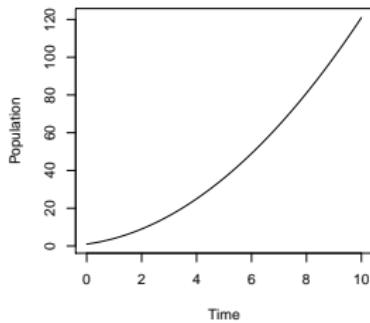
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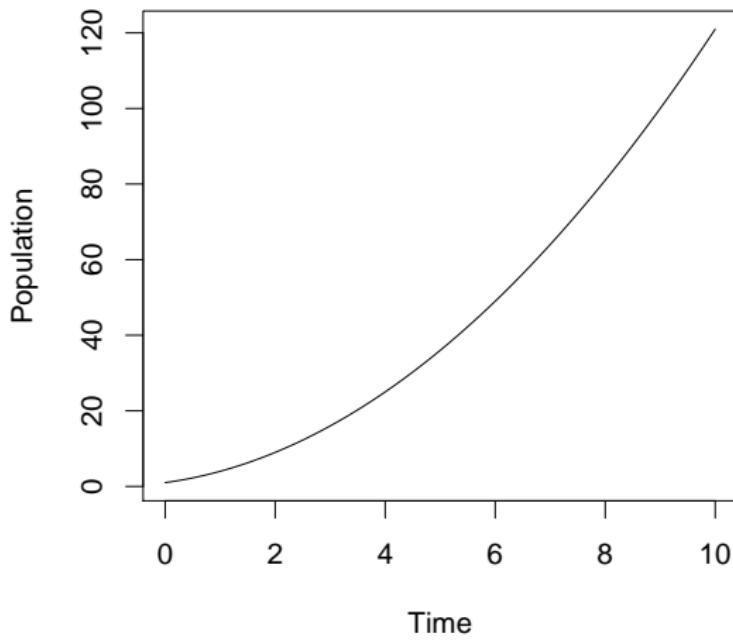


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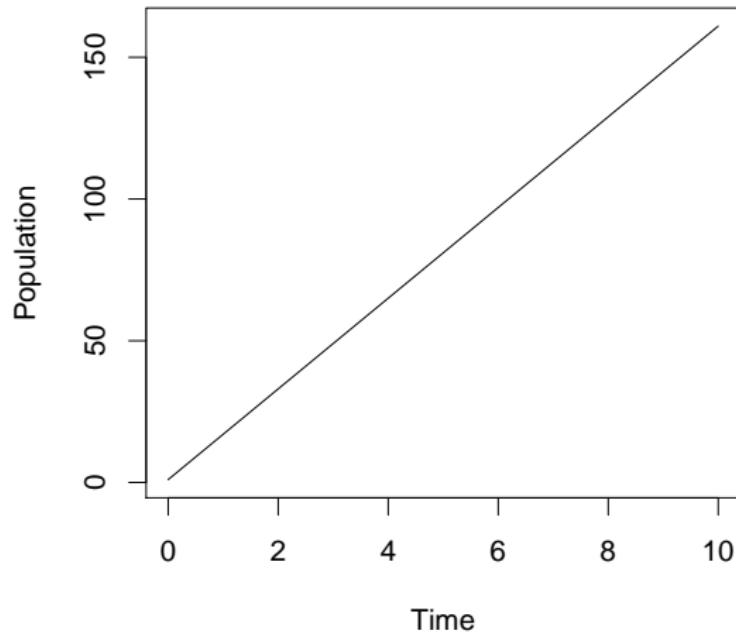
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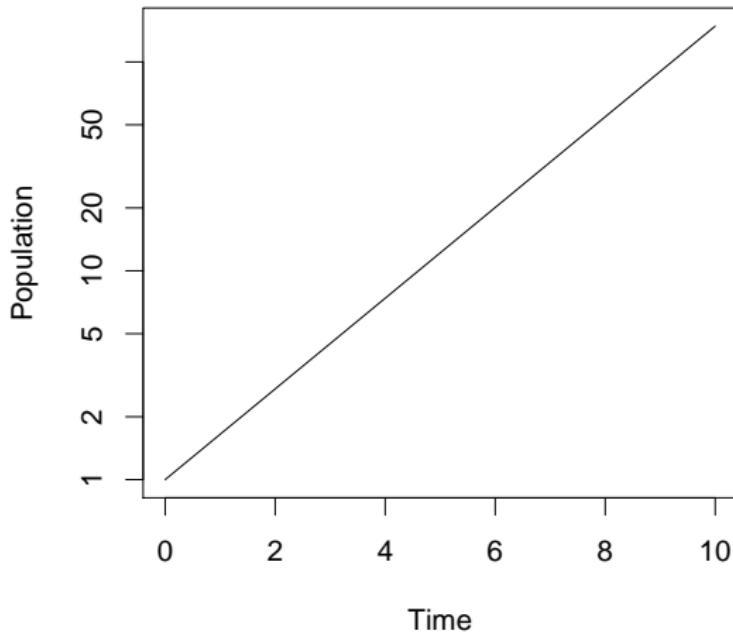
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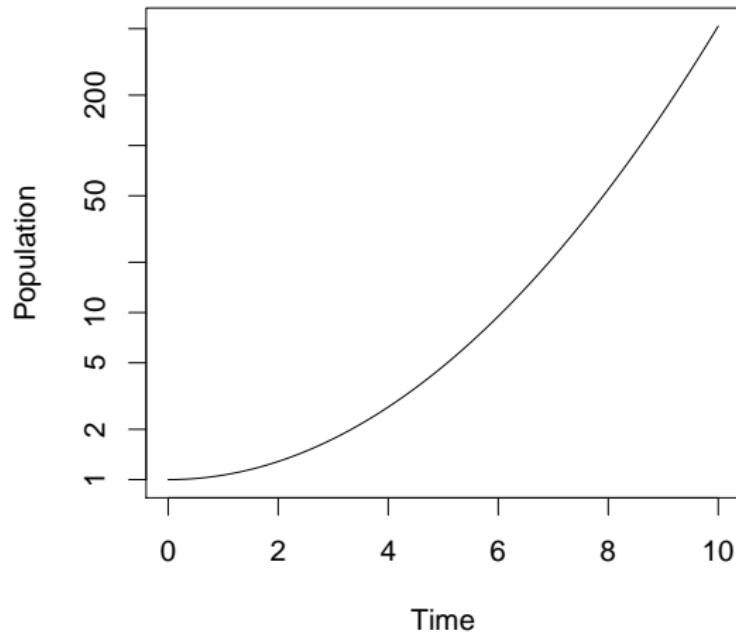
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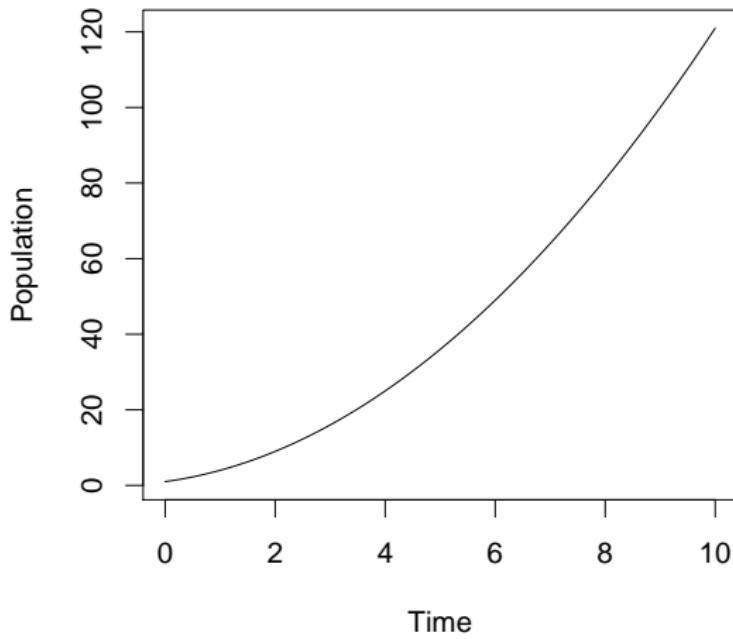
C



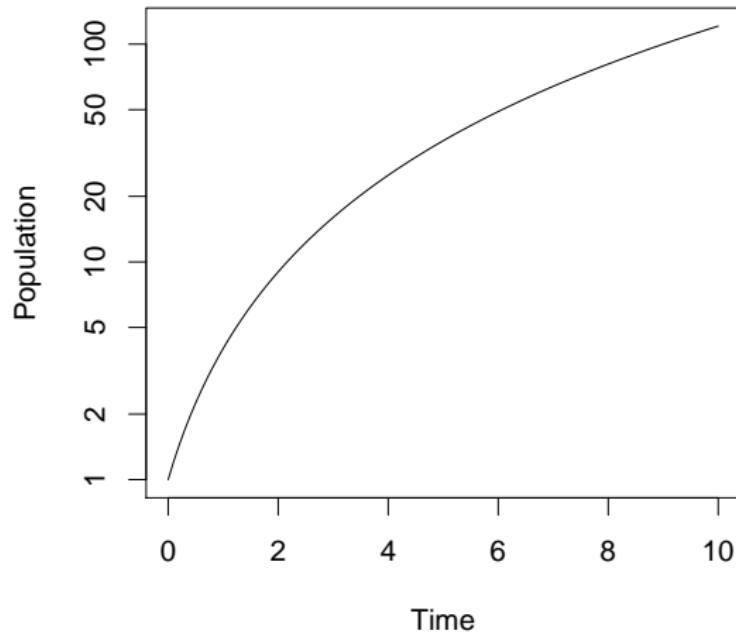
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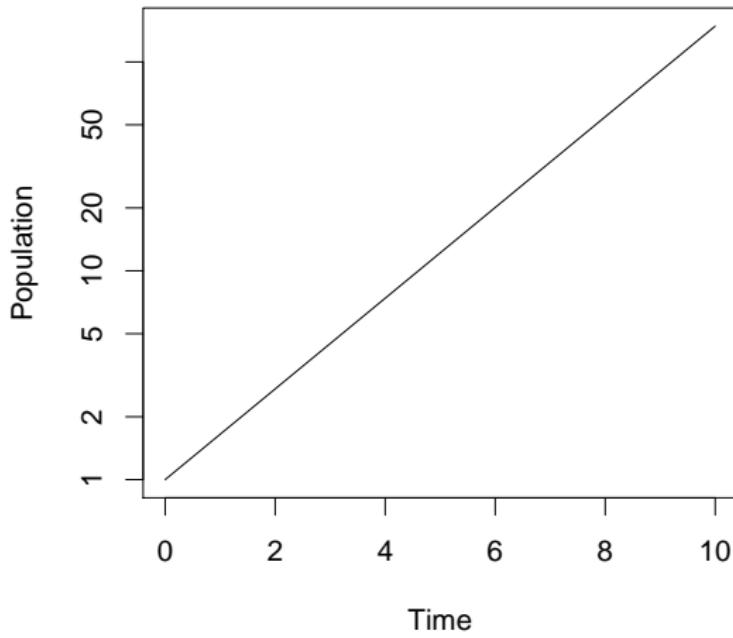
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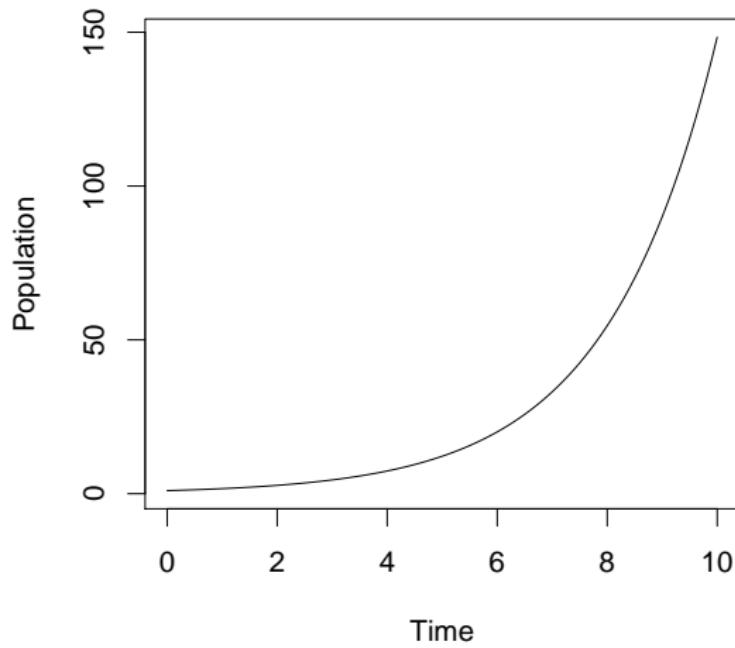
A on the log scale



C



C on the linear scale



Types of growth

- arithmetic/linear:

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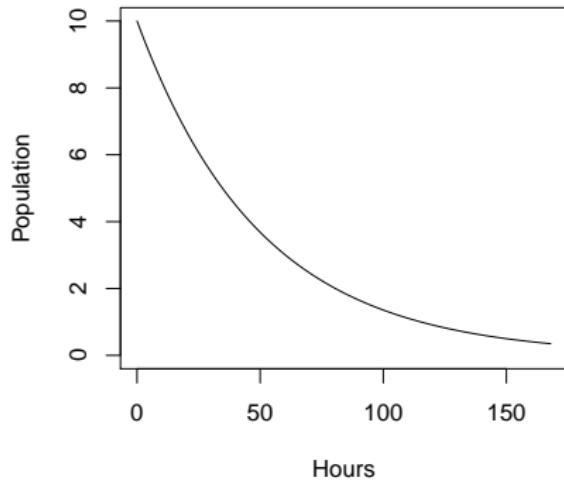
Exponential decline?

- ▶ Poll: What does exponential decline look like?
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 - ▶ * Declines more and more *slowly* (on linear scale)

Exponential decline?

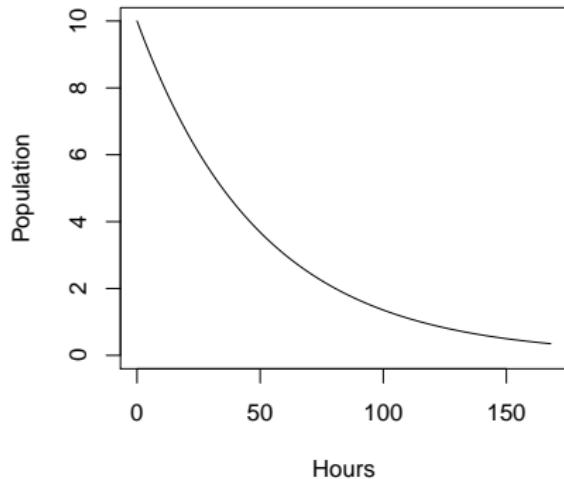
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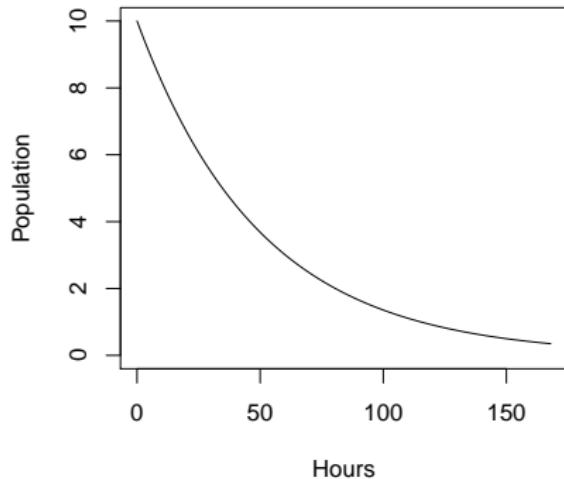
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Subsection 1

Log and linear scales

Scales of comparison

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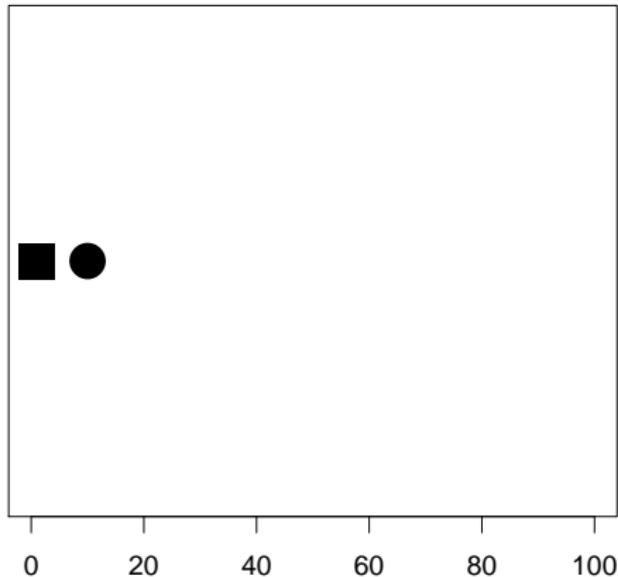
Scales of comparison

- ▶ Poll: 1 is to 10 as 10 is to what?
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 - ▶ * If you said 19, you are thinking additively

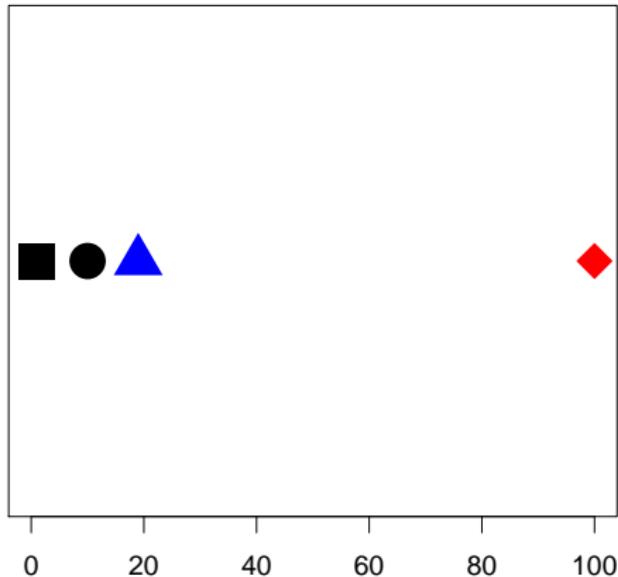
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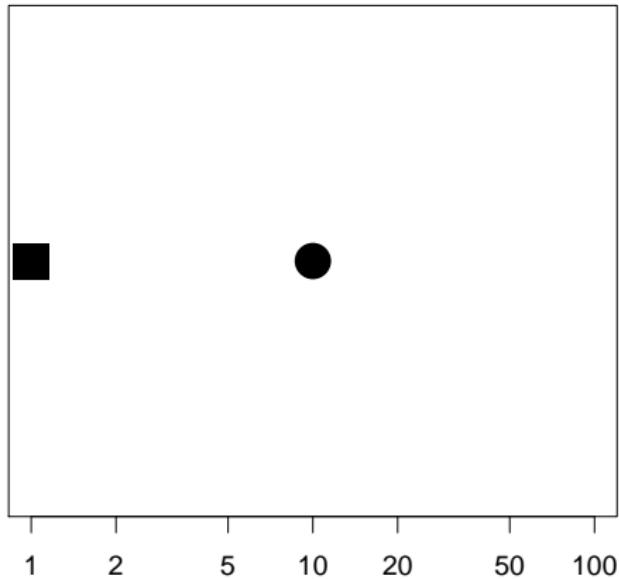
Scales of display



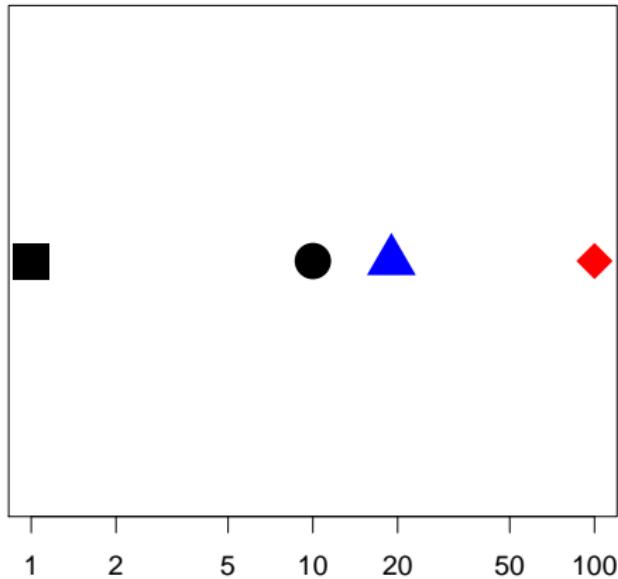
Scales of display



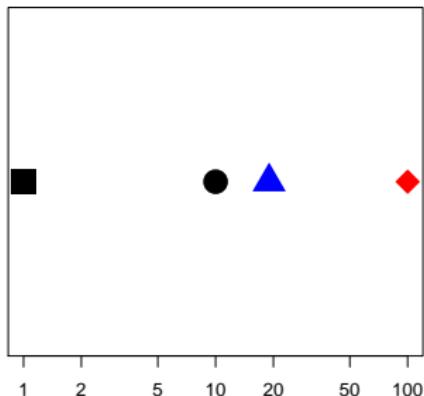
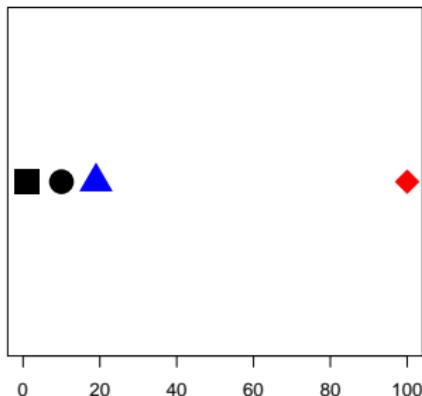
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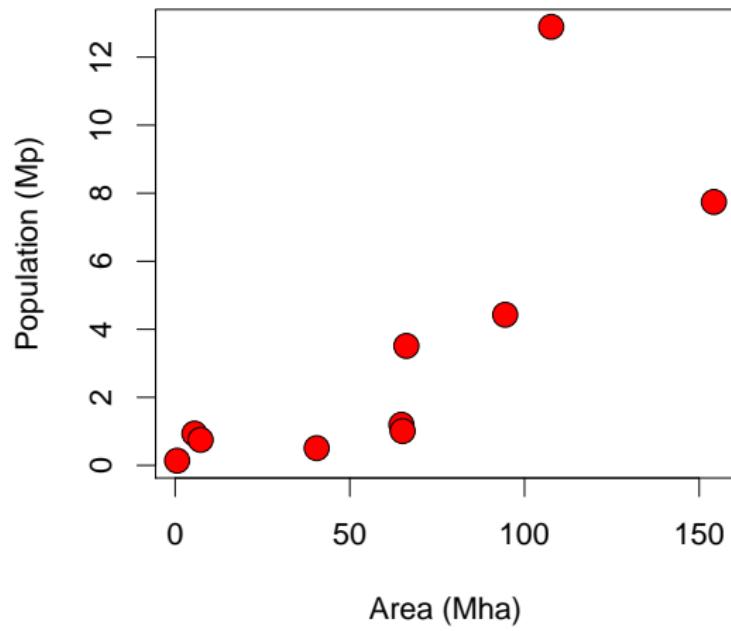


Scales of display

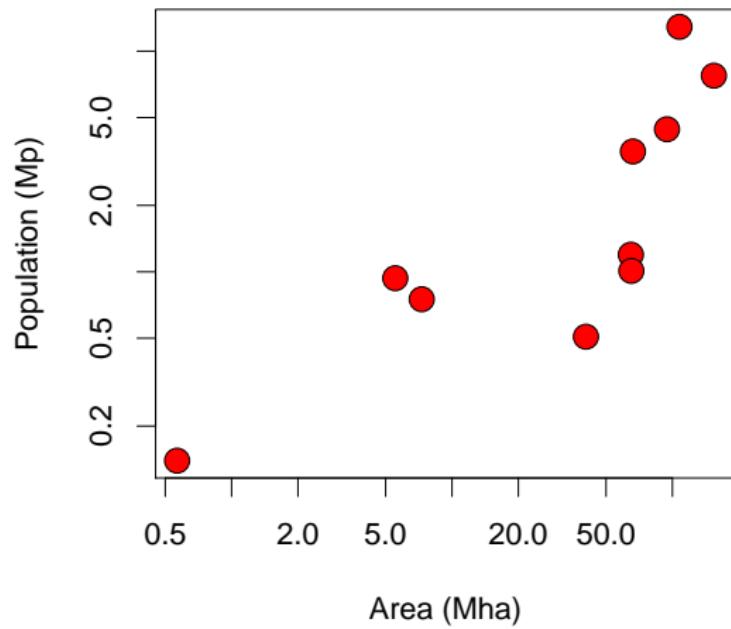


There is only one log scale; it doesn't matter which base you use!

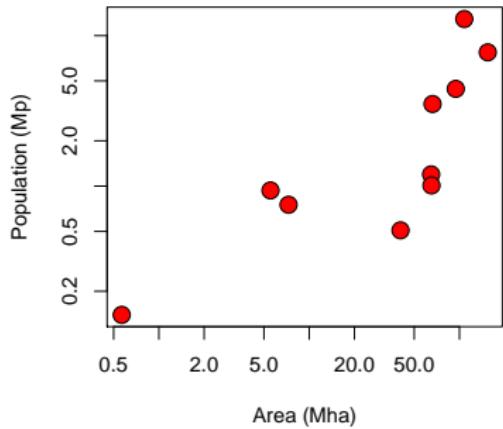
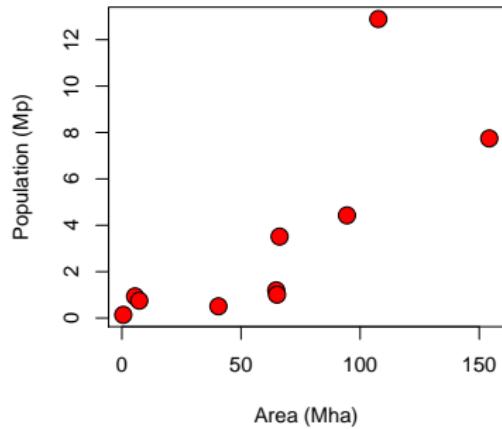
Canadian provinces



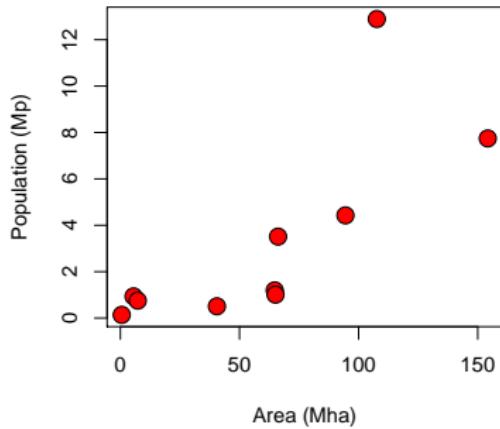
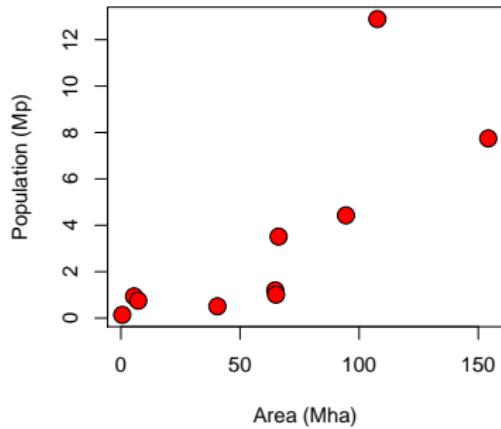
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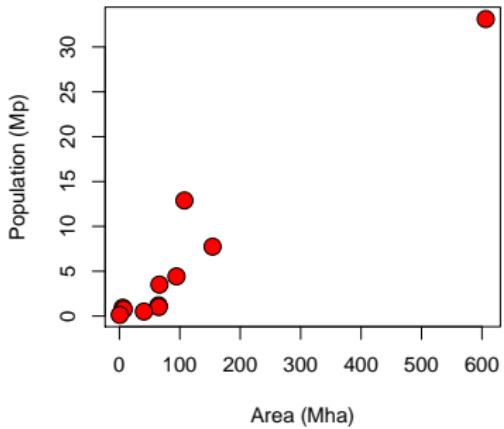
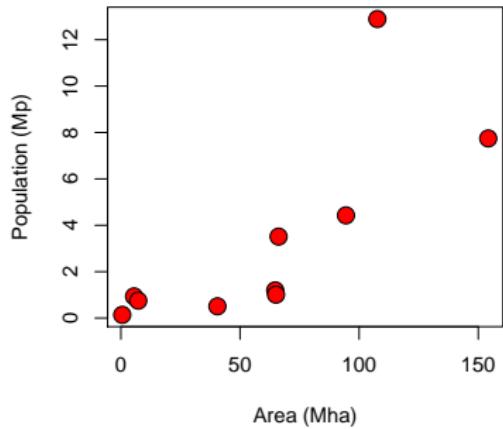
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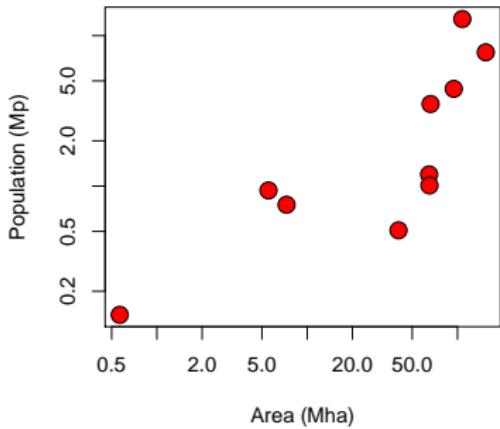
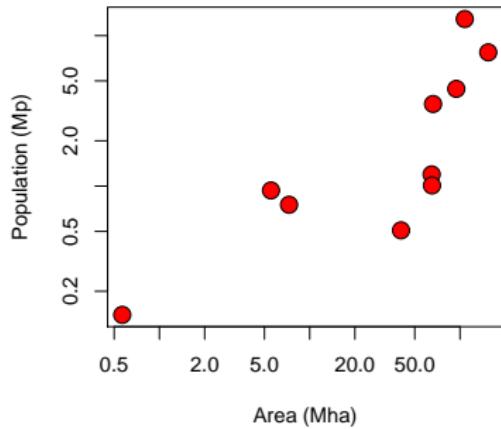
Canadian provinces plus Canada?



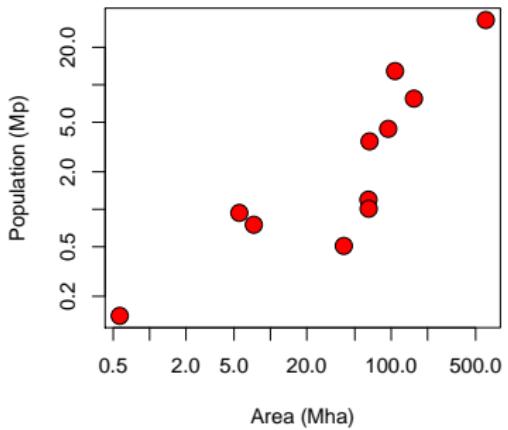
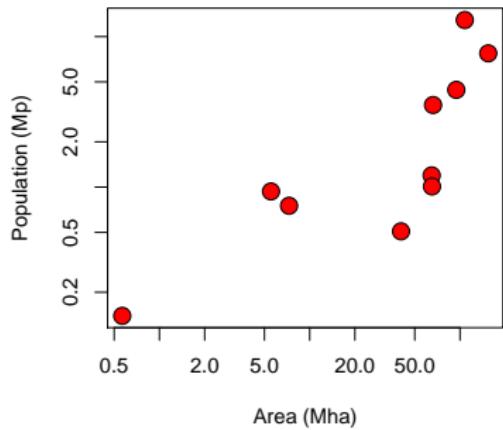
Canadian provinces plus Canada



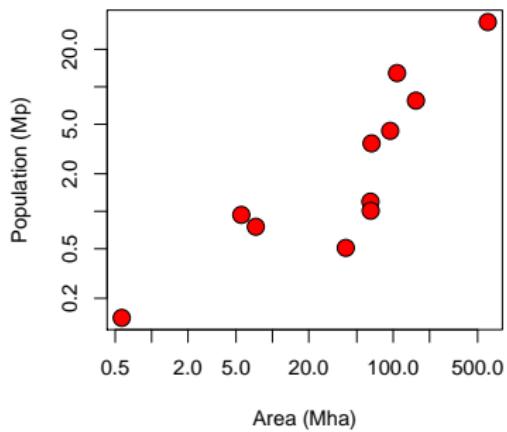
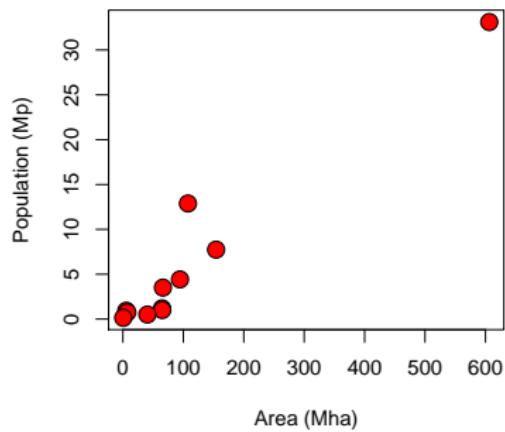
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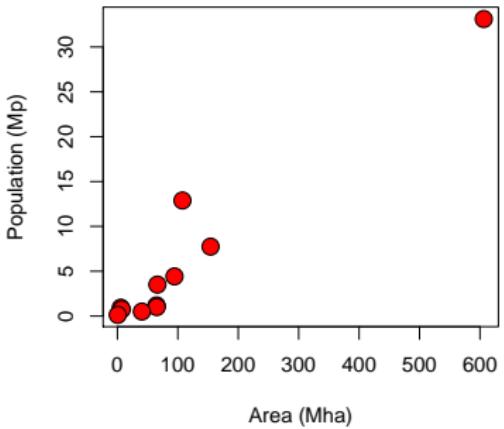
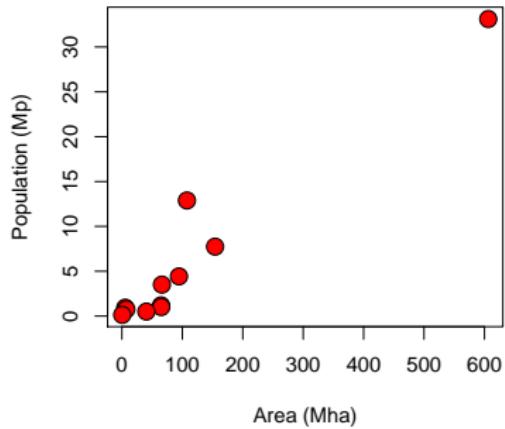
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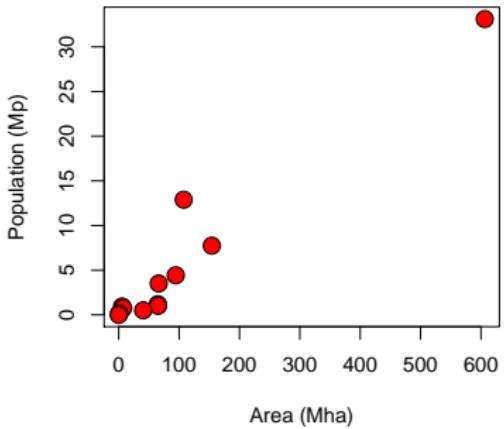
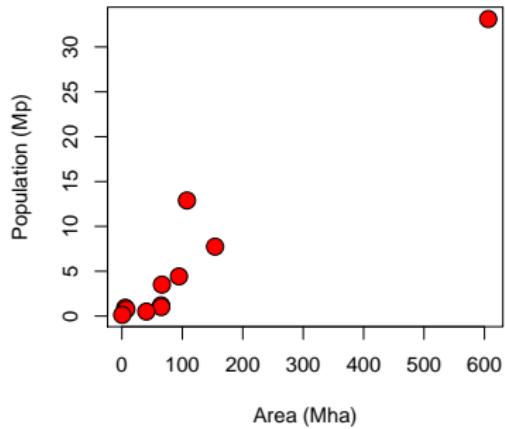
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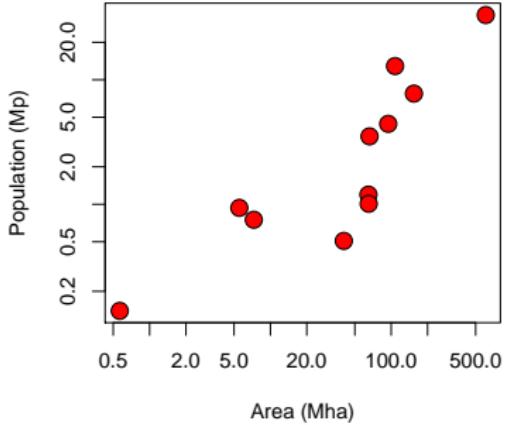
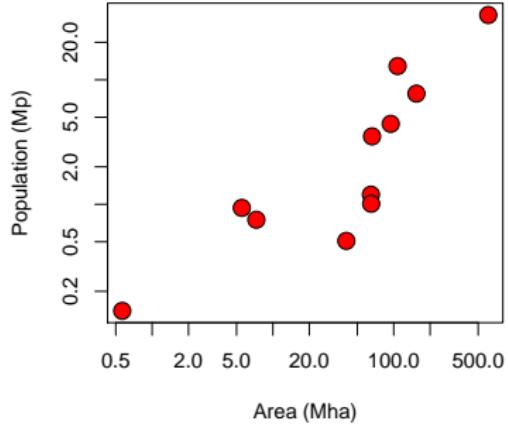
Canada plus room 1105?



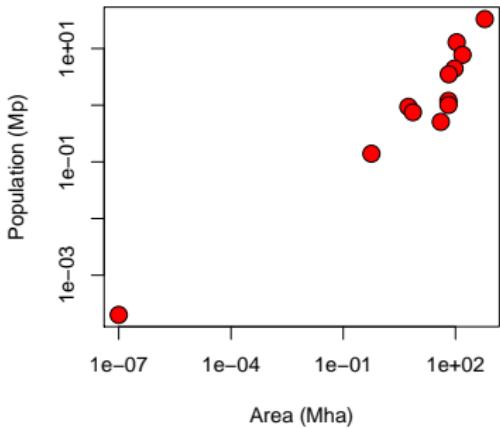
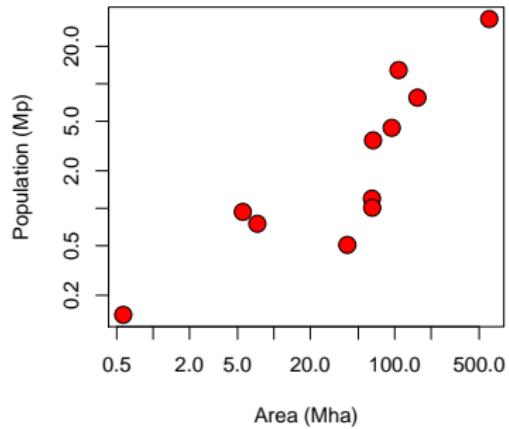
Canada plus room 1105



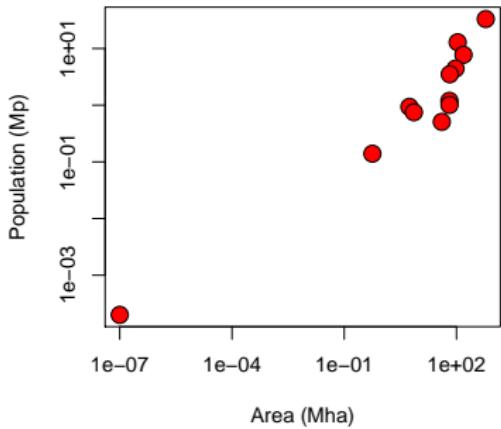
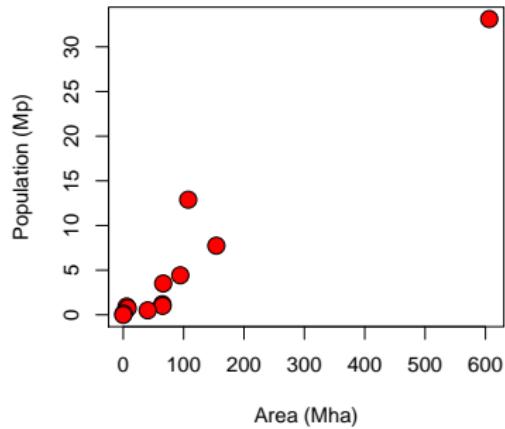
Canada plus room 1105?



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Canada plus room 1105



Predation comparison



Predation comparison

- ▶ A 500 lb lion is attacking a 1000 lb buffalo!



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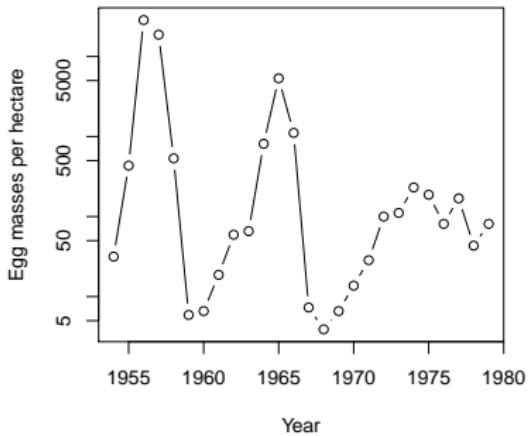
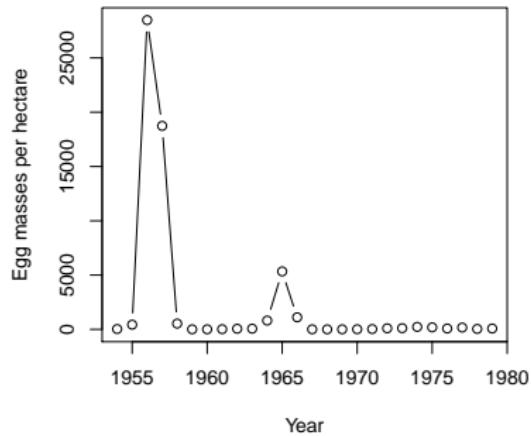
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Gypsy-moth example



Scales in population biology

- The linear scale looks at differences at the population scale

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- ▶ The log scale looks at differences at the individual scale (per capita)

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Subsection 2

Time scales

Speeding in Taiwan

- A life experience



Speeding in Taiwan

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Outline

Example populations

Dandelions

Gypsy moths

Bacteria

Exponential growth

Log and linear scales

Time scales

Constructing models

Dynamical models

Examples

A simple discrete-time model

A simple continuous-time model

Units and scaling

Key parameters

Discrete-time model

Continuous-time model

Links

Growth and regulation

Subsection 1

Dynamical models

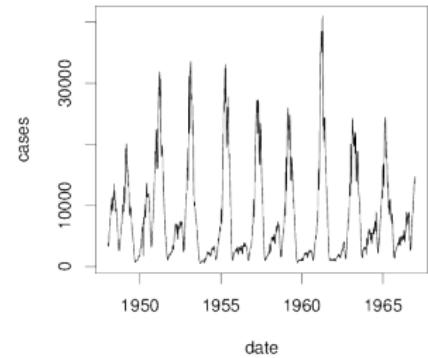
Dynamical models

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Measles reports from England and Wales

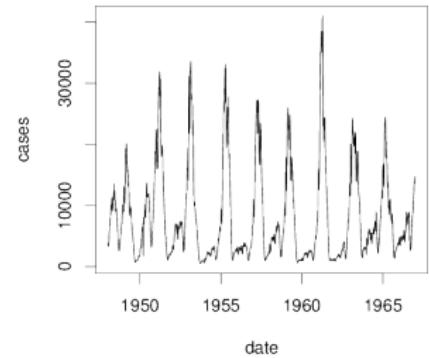


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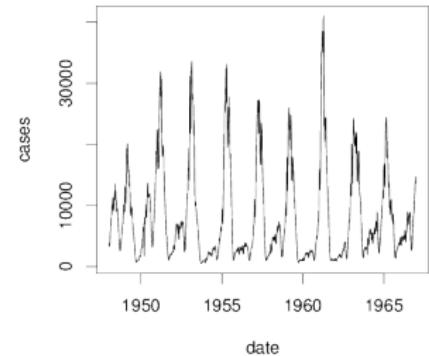


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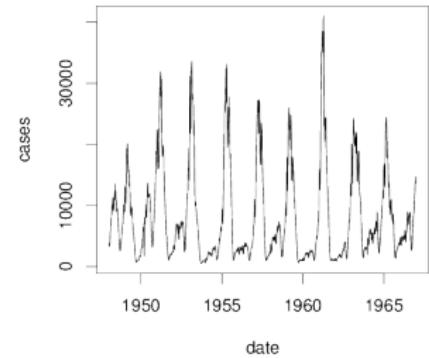


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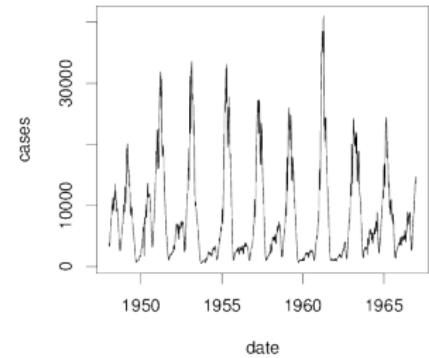


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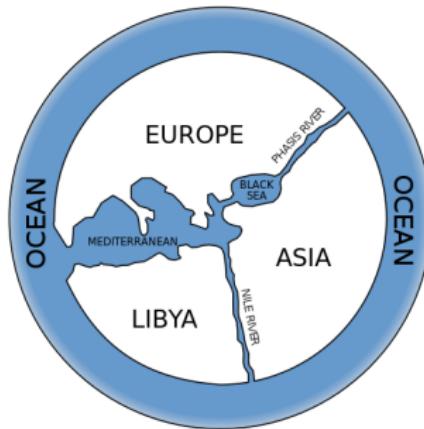


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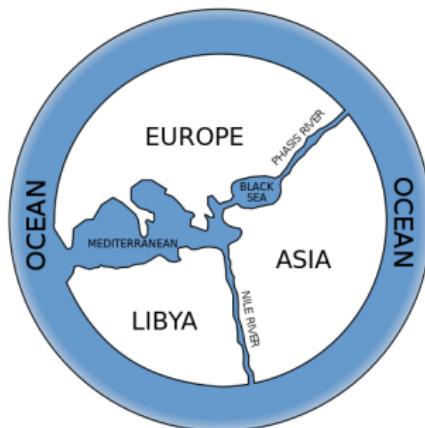
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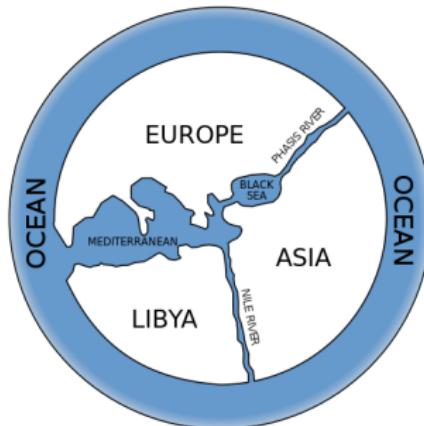
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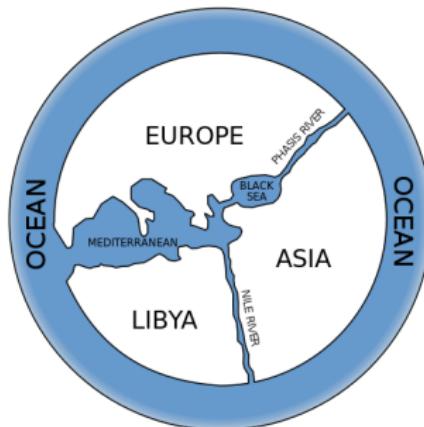
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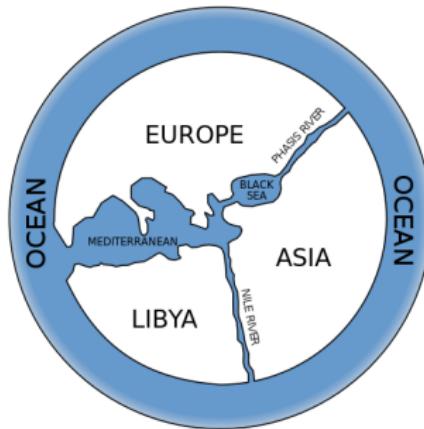
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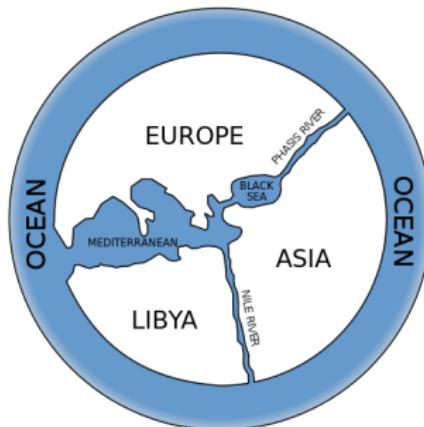
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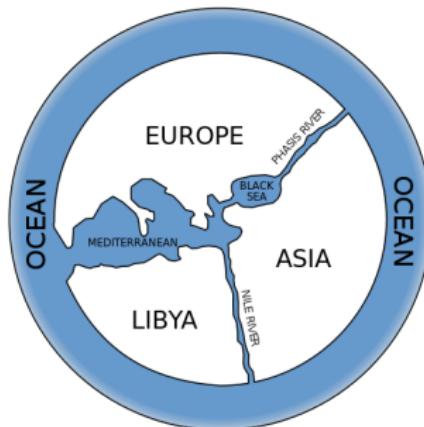
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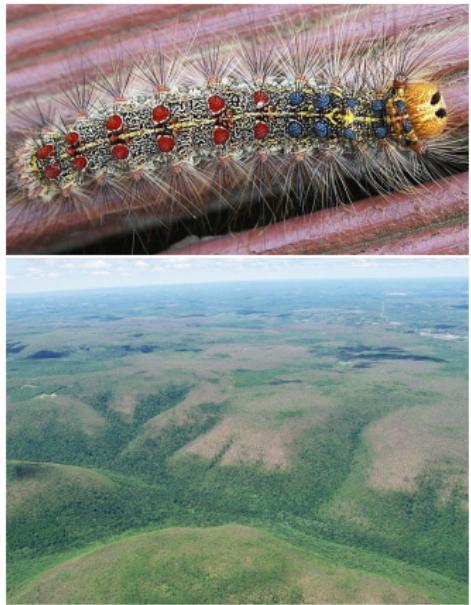
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Subsection 2

Examples

Gypsy moths

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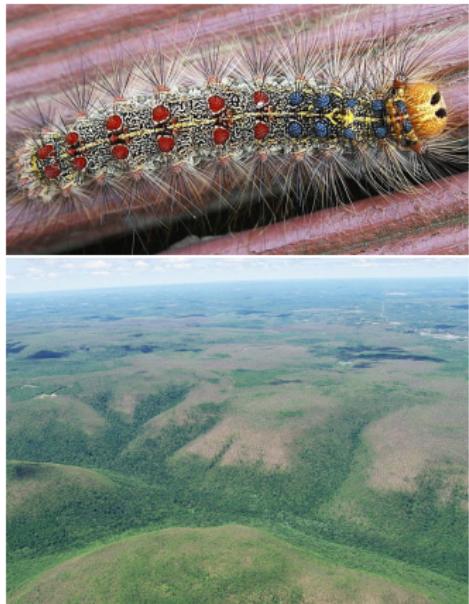
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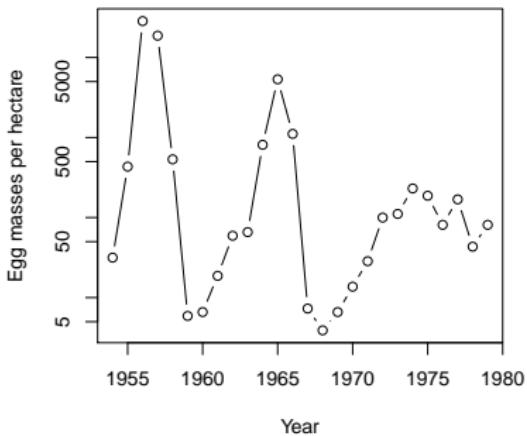
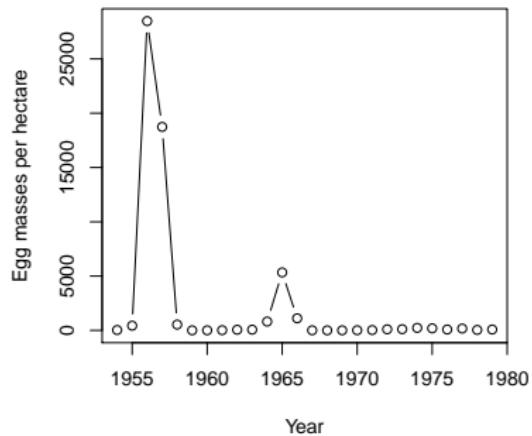


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Moth example

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Moth example

- ▶ State variables
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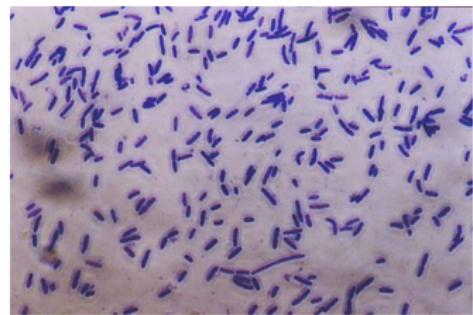
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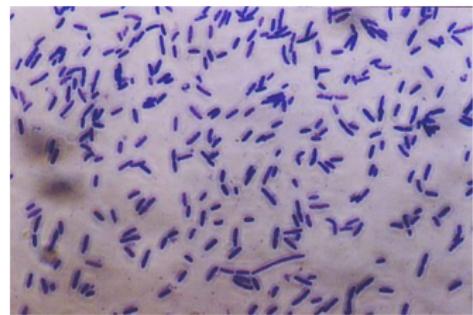
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Subsection 3

A simple discrete-time model

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Subsection 4

A simple continuous-time model

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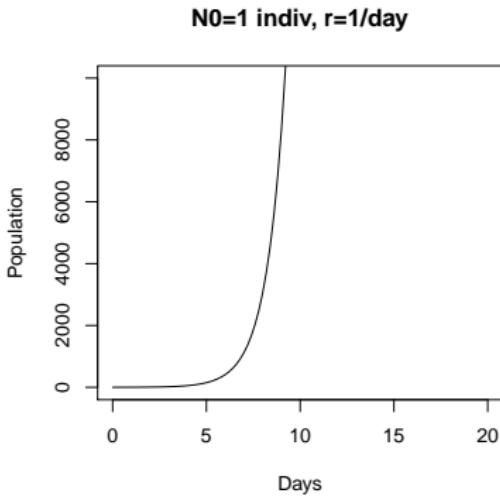
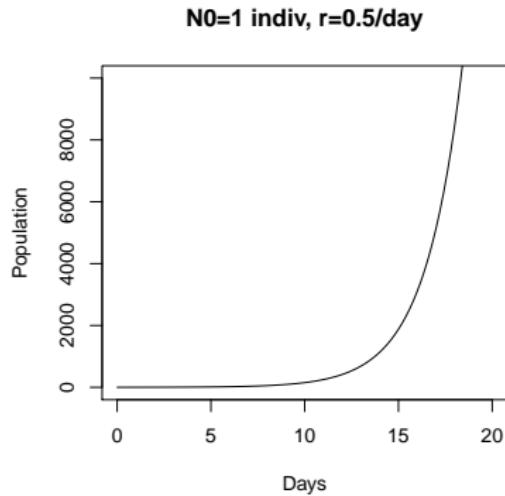
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Dandelions

Gypsy moths

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Exponential growth

Log and linear scales

Time scales

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Dynamical models

Examples

A simple discrete-time model

A simple continuous-time model

Units and scaling

Key parameters

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Links

Growth and regulation

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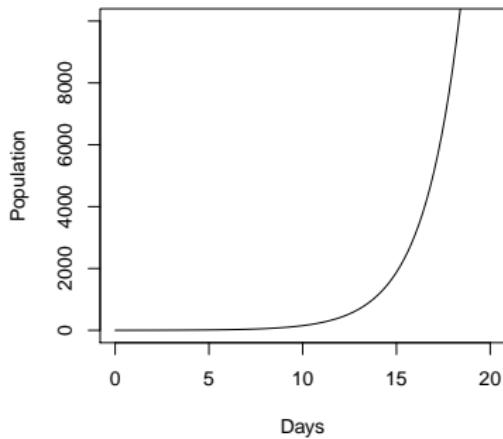
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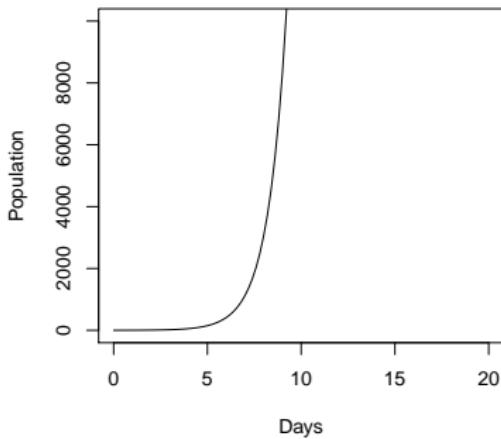
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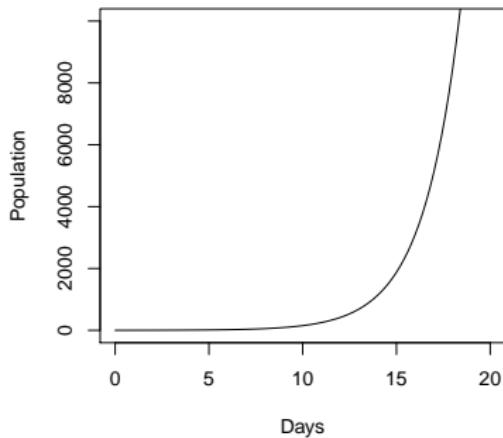


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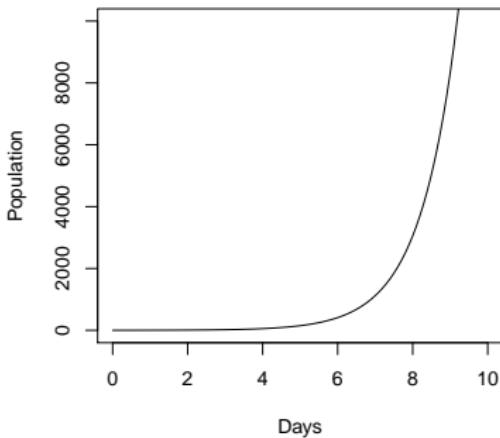


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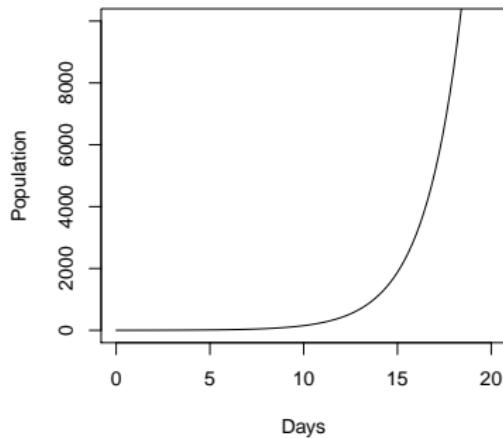


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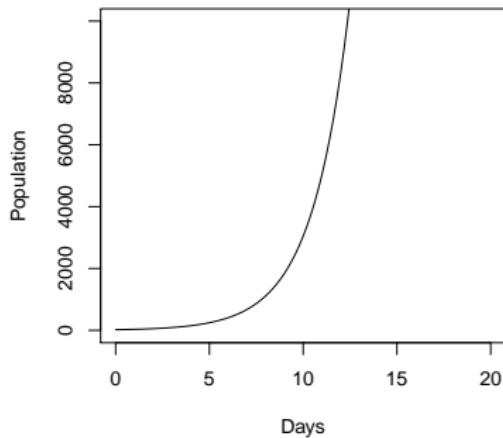


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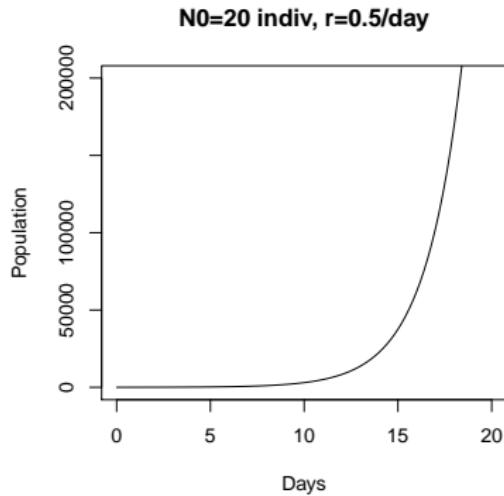
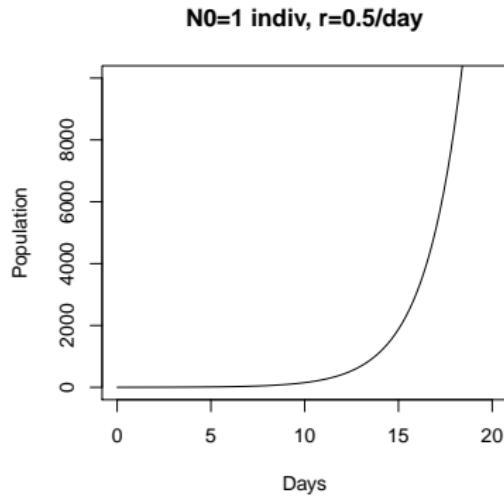
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Subsection 2

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Outline

Example populations

Dandelions

Gypsy moths

Bacteria

Exponential growth

Log and linear scales

Time scales

Constructing models

Dynamical models

Examples

A simple discrete-time model

A simple continuous-time model

Units and scaling

Key parameters

Discrete-time model

Continuous-time model

Links

Growth and regulation

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