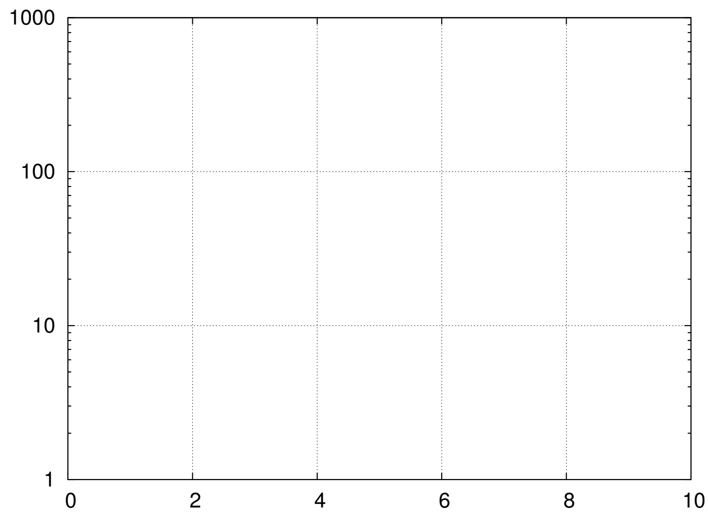
5.4 Logarithmic axes

In the various case studies we have seen in the last 2 weeks, we came across logarithmic axes and their peculiar properties when it comes to graphing power laws and exponential functions. Let's see this once again through two examples.

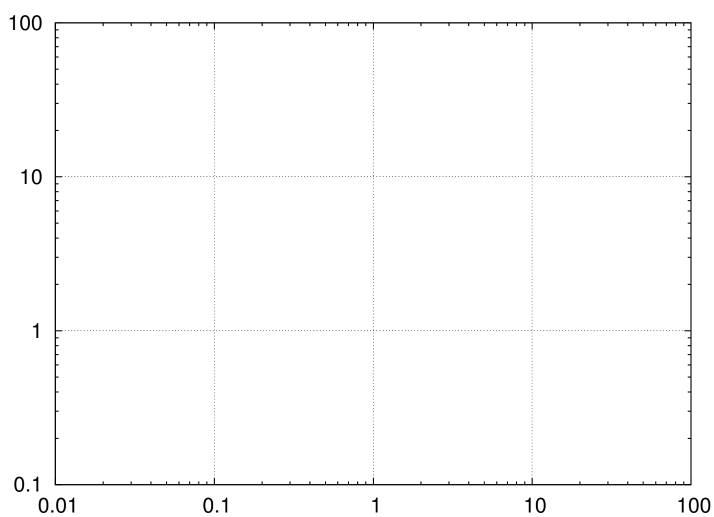
Example 1: Graphing an exponential function on log-linear axes.

Let's draw the function $N(x) = 2 \times 4^x$ (the rabbit population growth model) on a graph with a logarithmic y-axis, and a linear $x-$axis (called a Log-Linear graph).



Example 2: Graphing a power law on log-log axes.

Let's draw the function $N(x) = \frac{2}{x}$ on a graph with a logarithmic $x-$ and y-axes, (called a Log-Log graph).



These findings confirm what we found in earlier lectures, namely that

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This is in fact generally true, and it is relatively easy to understand why this is the case.

Let us first look at the case of exponential functions.

Similarly, for power law functions, we have:

Knowing that a logarithmic axis actually records the logarithm of a quantity (rather than the quantity itself) also explains why the numbers 0.1, 1, 10, 100, 1000 etc are equidistant on that axis. Indeed,

To summarize, we have the following results:

- The logarithmic axis actually plots the logarithm of a quantity $\log x$ (or $\log y$), though often labels it as x (or y).
- The graph of an exponential function $f(x) = be^{\pm rx}$ appears as a straight line on a log-linear plot. The slope of the line is equal to $\pm r$.
- The graph of a power function $f(x) = bx^a$ appears as a straight line on a log-log plot. The slope of the line is the exponent a, and is positive if $a > 0$, and negative if $a < 0$.

Graphing on log-linear or log-log plots is used in a vast range of scientific papers. to *establish* that a given dataset is best modeled by a power law or an exponential. For instance: