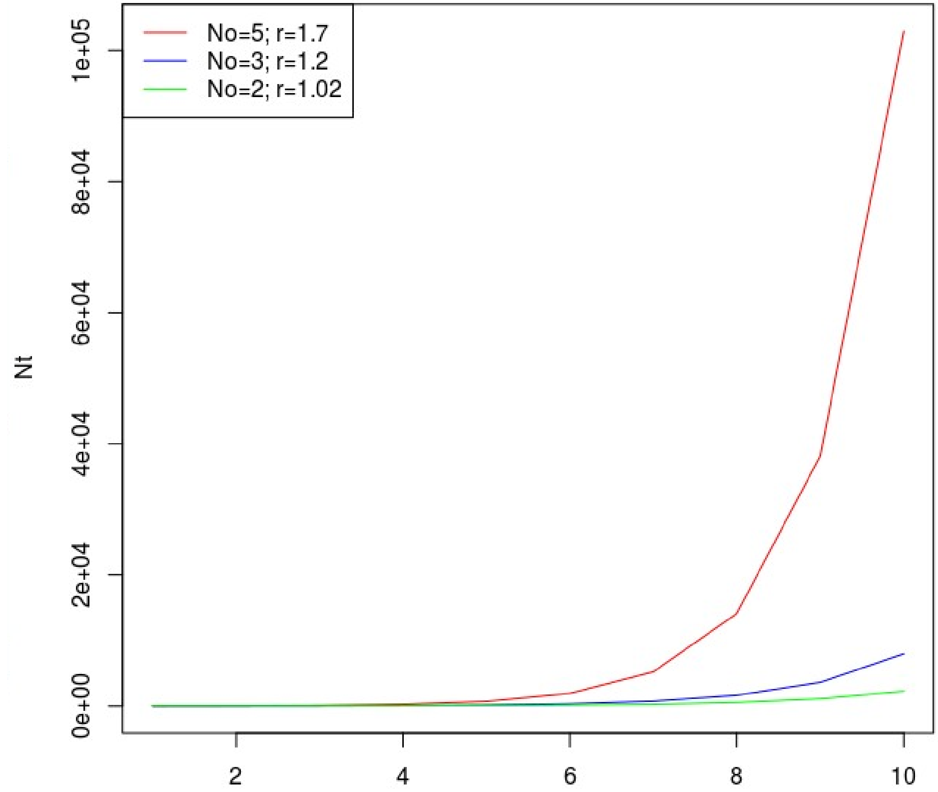
Follow the next steps to model population growth according to the Malthus' exponential growth:

$$Nt=No(1+r)^t$$

Where Nt and No are population sizes at times t and 0 and r is the growth rate.



1) Use the **Malthus model** to obtain the population size after 100 generations, using No=33 and r=0.3

[solution: 8.181806e+12]

2) Now estimate population size for generations 1 to 100 in the example before. You should get a two columns matrix with t and Nt values. Keep in mind that population sizes with decimals does not make sense...

t	0	1	2	3	…	100
Nt	33	43	56	73	…	8.2E+12

3) Transform the script into a function (called “Malthus”), allowing the user to set No, r, and t. Provide default values to r=2 and t=100.
Remember how to define functions:

```
Function.name<-function(arguments=default.values){
    Code
}
```

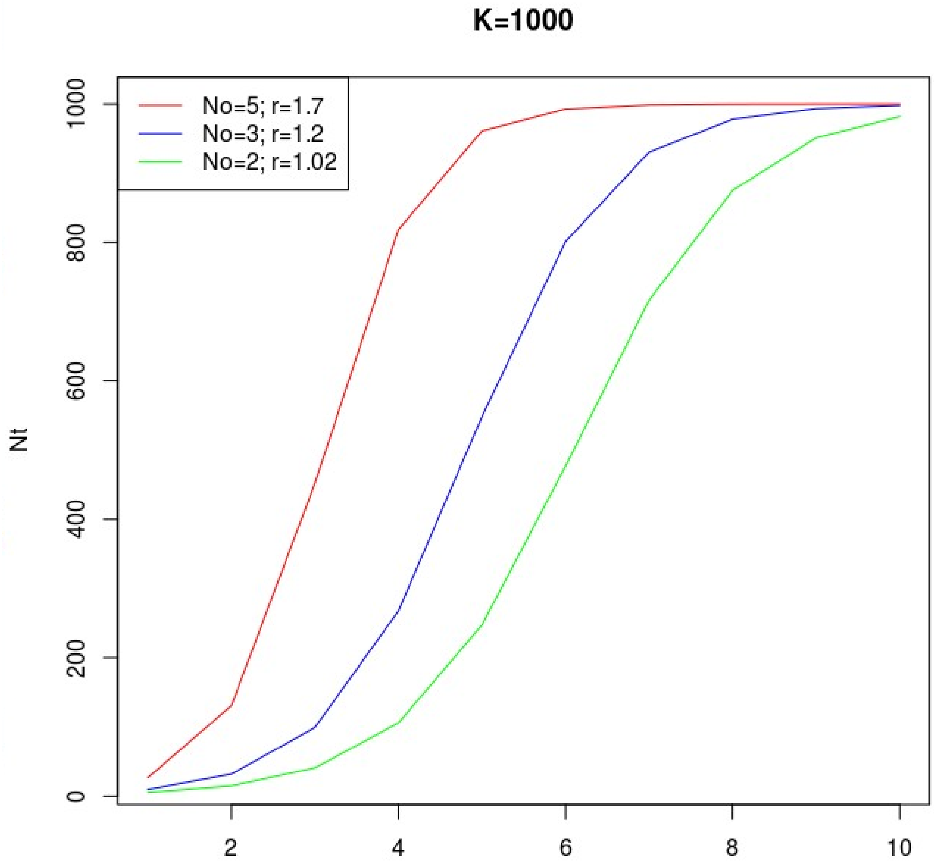
4) Because No and t can not be negative, add a line within your function to print an error if the user provides negative values for these parameters.

5) Add an option “plot” to allow the user to plot population size through time (that is, Nt as Y and t as X). The plot option must be a logical, FALSE by default. Feel free to add more options (color line, line with,...)

Follow the next steps to model population growth according to the Verhulst's logistic growth:

Nt=(K*No*e^(r*t))/(K+No*(e^(r*t)-1))

Where K is the carrying capacity: the maximum population size of the species that the environment can sustain indefinitely. As before, Nt and No are population sizes at times t and 0 and r is the growth rate.



1) Use the **Verhulst's model** to obtain the population size after 10 generations, using No=33, r=0.3 and K = 1000

[solution: 407]

2) Now estimate population size for generations 1 to 100 in the example before. You should get a two columns matrix with t and Nt values. Keep in mind that population sizes with decimals does not make sense...

t	0	1	2	3	…	100
Nt	44	58	77	102	…	1000

3) Transform the script into a function (called “Verhulst”), allowing the user to set No, r, K, and t. Provide default values to r=2 and t=100.
Remember how to define functions:

```
Function.name<-function(arguments=default.values){
    Code
}
```

4) Because No, K, and t can not be negative, add a line within your function to print an error if the user provides negative values for these parameters.

5) Add an option “plot” to allow the user to plot population size through time (that is, Nt as Y and t as X). The plot option must be a logical, FALSE by default. Feel free to add more options (color line, line with,...)

Now, build a function combining the two previous function you did, allowing the user to select the method to estimate Nt. For that:

1) Create a new function (called “pop.growth”) with the following options and values by default: No=10, r=0.3, t=100, K=1000, get.plot=FALSE.

2) Add a new option (method) to allow the user selecting the model. Possible values for method must be “Malthus”, “Verlhust” and “both".

3) Within the pop.growth function, define the Malthus and Verlhust functions. Remember that parameters defined by user in “pop.growth” must be passed to Malthus and Verlhust functions.