**Computer Lab #1 – Exponential population growth**

The goal of this computer lab is to calculate the geometric mean growth rate of a population of muskoxen and to project the size of the population in the future using a stochastic exponential growth model.

If you don’t know the syntax of a function in Rstudio, use help. Either by typing **?function\_of\_interest()** in the console. Alternatively, you can use the Help tab in Rstudio. You can also google the function. In general, and I am sure you have heard it a lot, google is your best friend while working with R. If you run into an unknown error: google; if you know what you want to do but don’t know how to do it: google.

1. Import muskox dataset (excel file) into Rstudio

* **Possible function:** **read.xlsx(…)**,

**Note:** this is not a built-in function of base R.

1. Plot population size through time.

* **Possible function:** **plot()**,

**Note:** the **ggplot2** package is widely used and I highly recommend learning it. It is mainly used in most built-in plot functions of other packages and it makes the base function **plot** almost entirely irrelevant once you learn it.

1. Calculate the growth rate between each year, from 1947 to 1968

* First create a subset of the muskox data (e.g. muskox47\_68) that only includes the years 1947 to 1968
* Second calculate the population growth rate for each consecutive year

**Possible functions:** **subset(…), for(…)**

**Note:** This is maybe the first tricky part, since **for loops** can be a little confusing, but learning them is worth it as they are incredibly useful. However, there are other more skillful methods that avoid **for loops.** For example, **apply** could replace a **for loop**.

**Remember:** If I have a growth rate and multiply it with the population size of a year I get the population size of the following year. You can use that knowledge to calculate the growth rate if you have the population size of any two consecutive years.

1. Call the minimum and maximum growth rate

* **Possible functions: min(…), max(…)**

**Note:** As any mathematical function in r (**mean**, **var**, **sum**…) if you have any NA’s in your data (only the column you calling in the function) **min** or **max** will return NA.

1. Calculate the geometric mean growth rate, and store it (e.g. R <- geometric mean growth rate)

* **Possible function: prod(…)**
* **Remember:** The geometric mean is
* **Note:** in R (and really any program language I believe) = x^(1/2)

1. Make a histogram of your growth rate values.

* **Possible function: hist(…)**

1. Project the number of muskox 5 years in to the future by using a stochastic exponential growth model.

* **Assumption:** The next five years will be similar to the past, so we can choose randomly growth rates that we have observed. The starting population size is 714 (Number of muskox in 1968)
* **Possible functions: sample(…), for(…)**
* **Note:** You want to store the results. Therefore, you need to create something you can store the values in (e.g. a vector). You want a new growth rate every iteration.

1. Plot your future population size trough time.
2. You just completed one simulation for the future population size. Now do that a 1000 times. I will give you one hint: this time you maybe want to use a nested for loop. If you need help, ask your colleagues or me. That is an important step as a scientist, nobody is perfect and nobody knows how to do everything. Science is collaborative, and it is okay to ask others for help. It is important that you do not let others do the work for you, so that you understand what to do. Produce a Histogram of the population size in the 5th year.

**Questions:**

1. **What is the mean value for population size 5 years into the future, of the 1000 calculations?**
2. **What are the 95% confidence intervals?**

**Credit for this computer lab:**

1. **Turn in the histogram of 6.) and 9.)**
2. **Your answers to the questions.**
3. **Optional Create a plot with the expected population (based on the exponential growth model) and the real population (e.g. next page). Here you would start with the year 1936, when the population size was 31 muskoxen.**

