Tutorial 1 - Introduction to R and univariate statistics

I hope this tutorial will help you get started at R. Don't hesitate to ask me questions if you need more information. That's what I'm here for. I've given you everything you need to get to grips with R. I'll let you skip the steps you've mastered.

Note that this PDF is long because I've added all the necessary print screens.

Learning objectives :

- install packages
- load packages
- load a dataset
- get to grips with some first manipulations on R
- extract univariate statistics
- draw plots

I- R & RStudio presentation

Currently, R and Python are the main software tools used for statistical analysis. In these hands-on sessions, we'll be using R, a free statistical software package that can be downloaded from: http://cran.r-project.org

Installing R is simple; just follow the on-screen instructions. There may be some minor differences in the installation steps between Windows, Mac and Linux.

The use of R is facilitated by an integrated development environment (IDE), such as RStudio, which works not independently but in parallel with R. To use RStudio, you must first install R. You can download RStudio at https://www.rstudio.com .

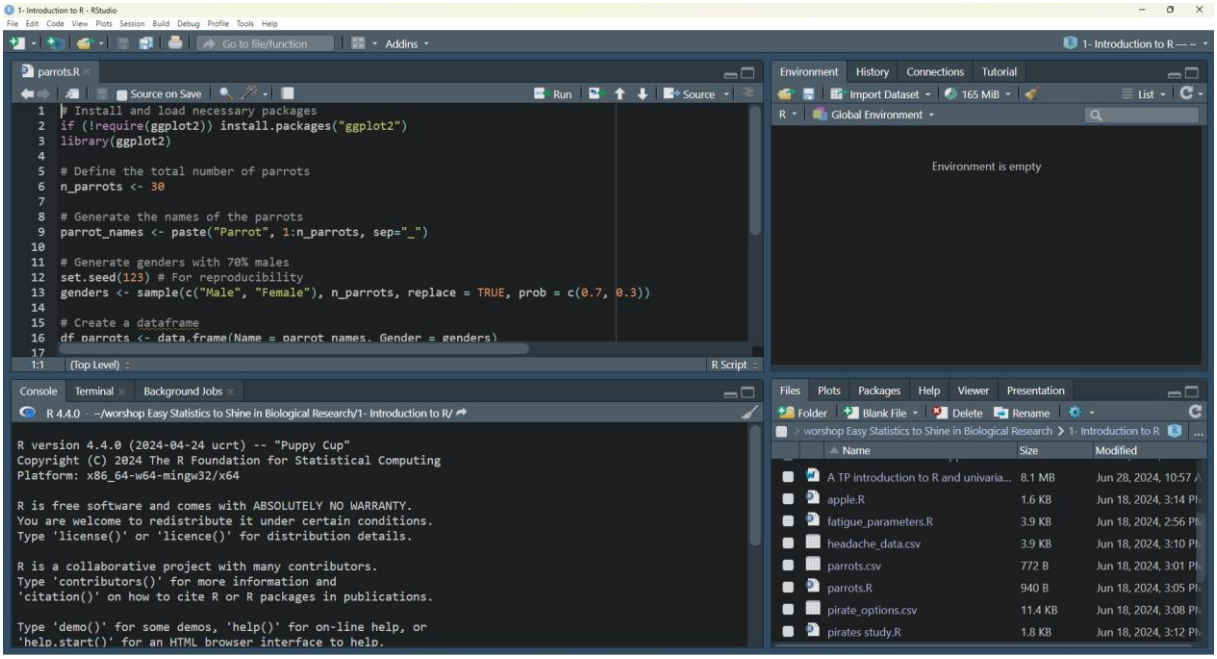
The RStudio workspace is organized into a main window divided into four panels:

- Script Editor, top left

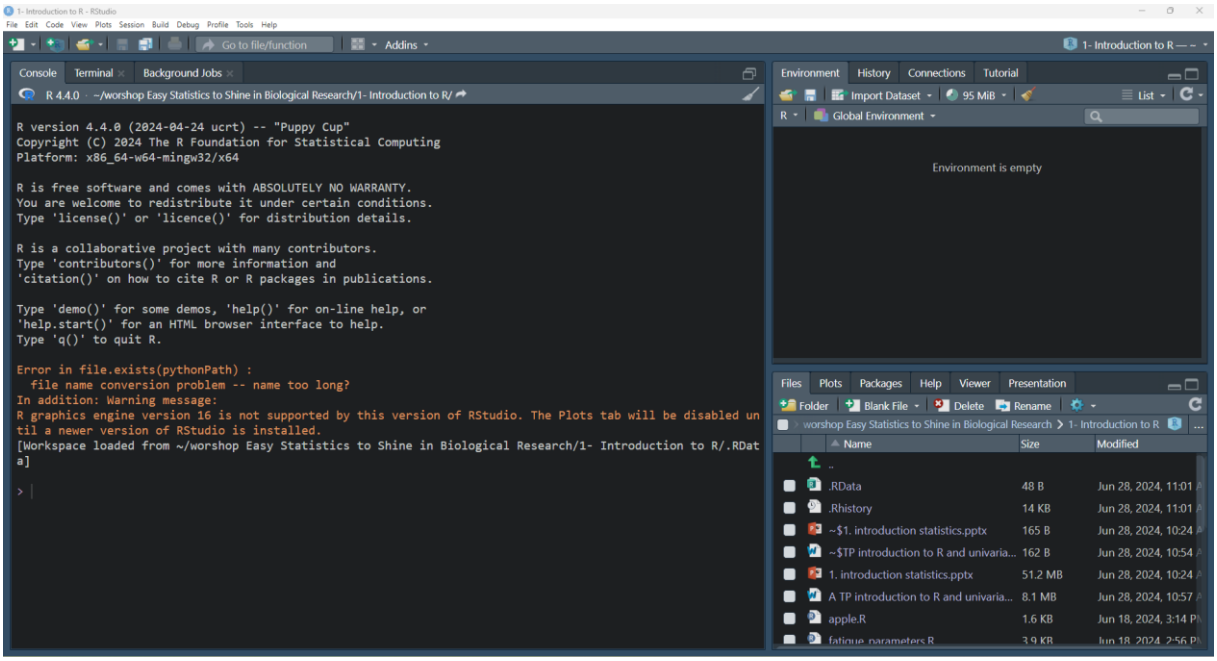
- Console, bottom left

- the environment and history panel at top right

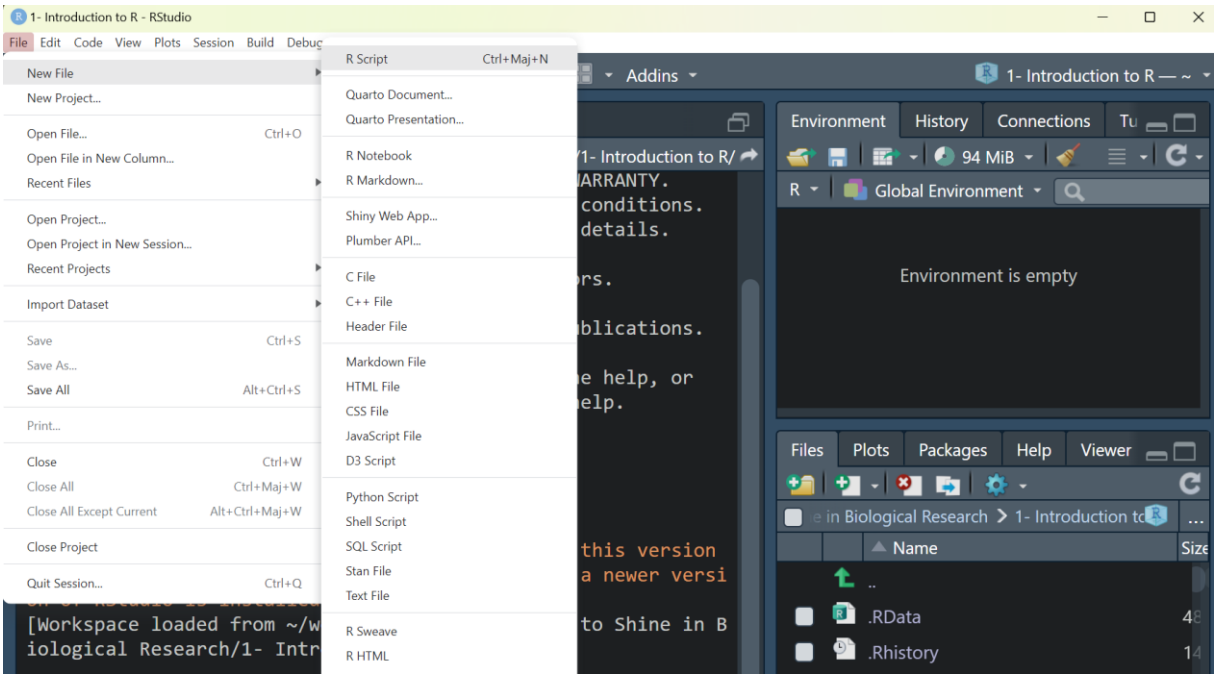
- the Files, Graves, Packages and Help window at bottom right



Note that a script might not be opened, as bellow :



You can access the script window as follows :

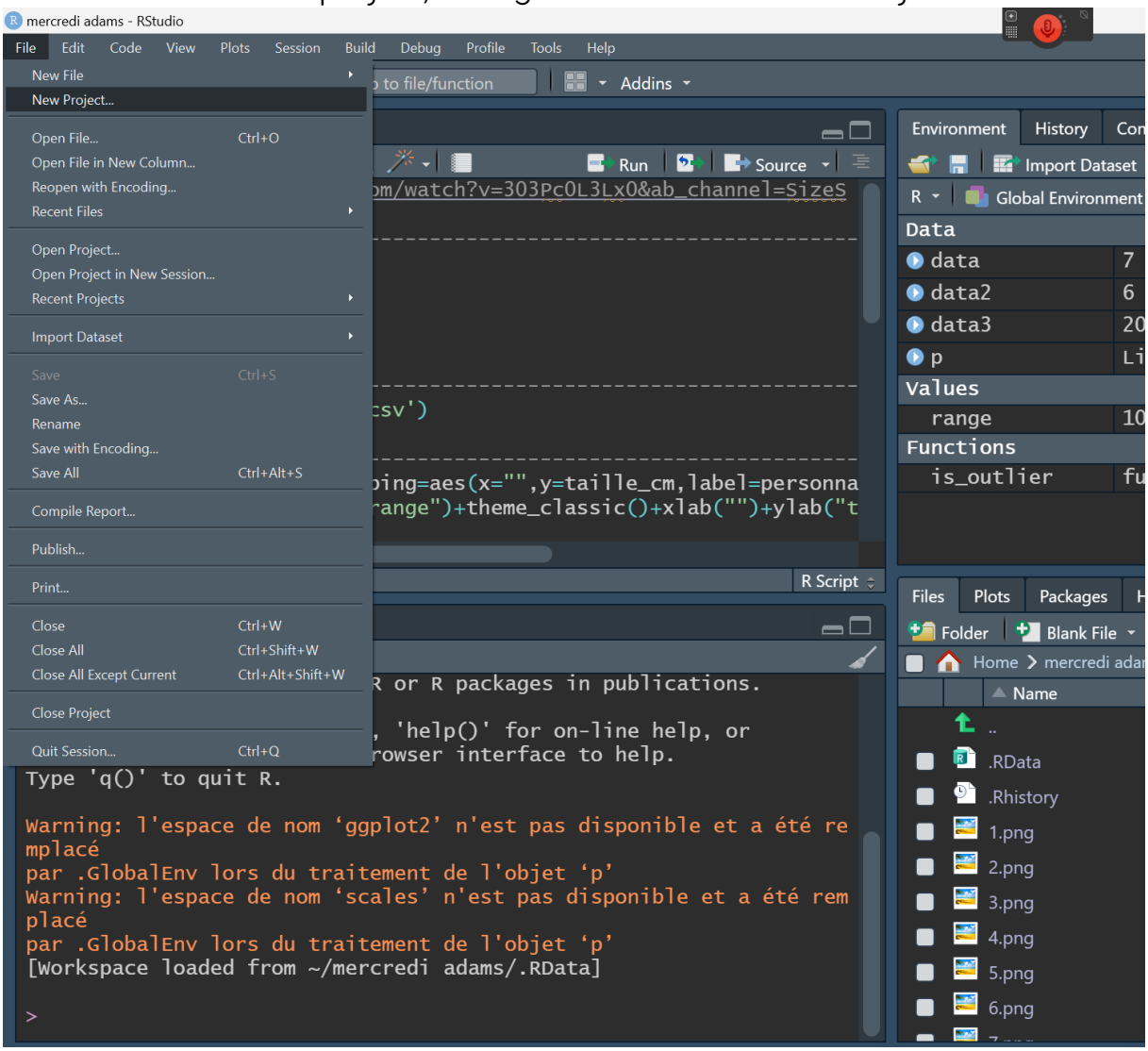


II- Creation of project

An RStudio project centralizes all context-specific elements like workspace, command history, environment variables, and R options into one folder.

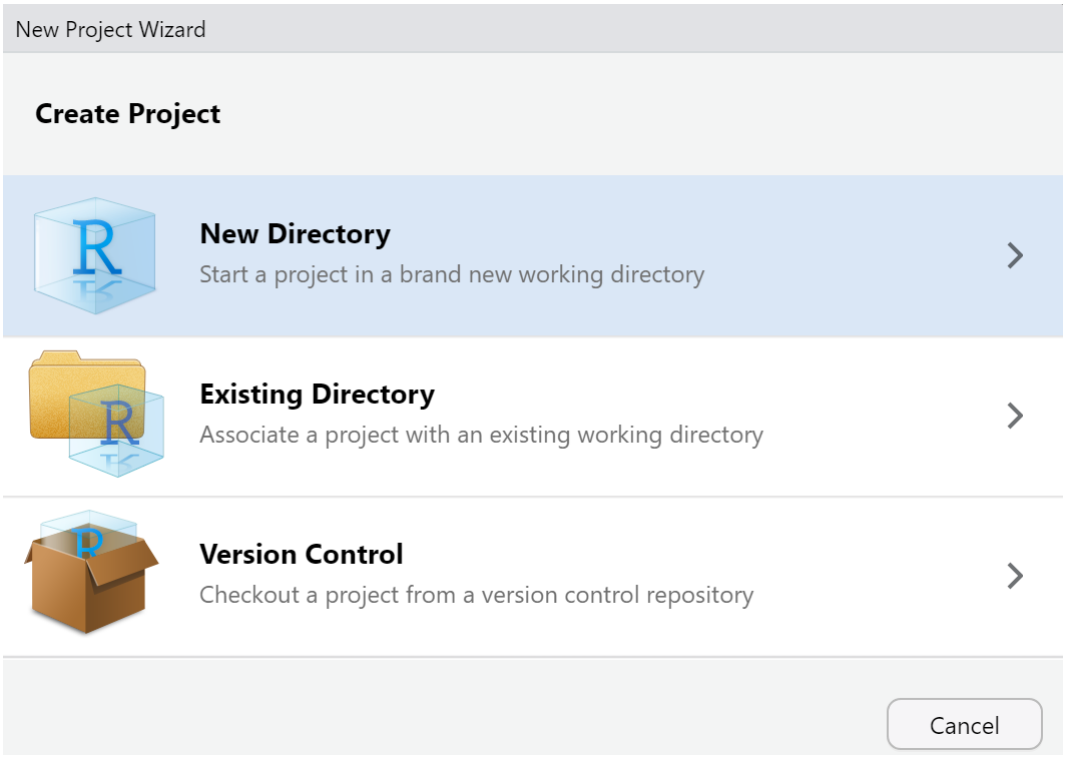
Creating an R project essentially means setting up a directory that R prioritizes for accessing components like scripts and data files.

To start a new R project, navigate to File > New Project in RStudio.

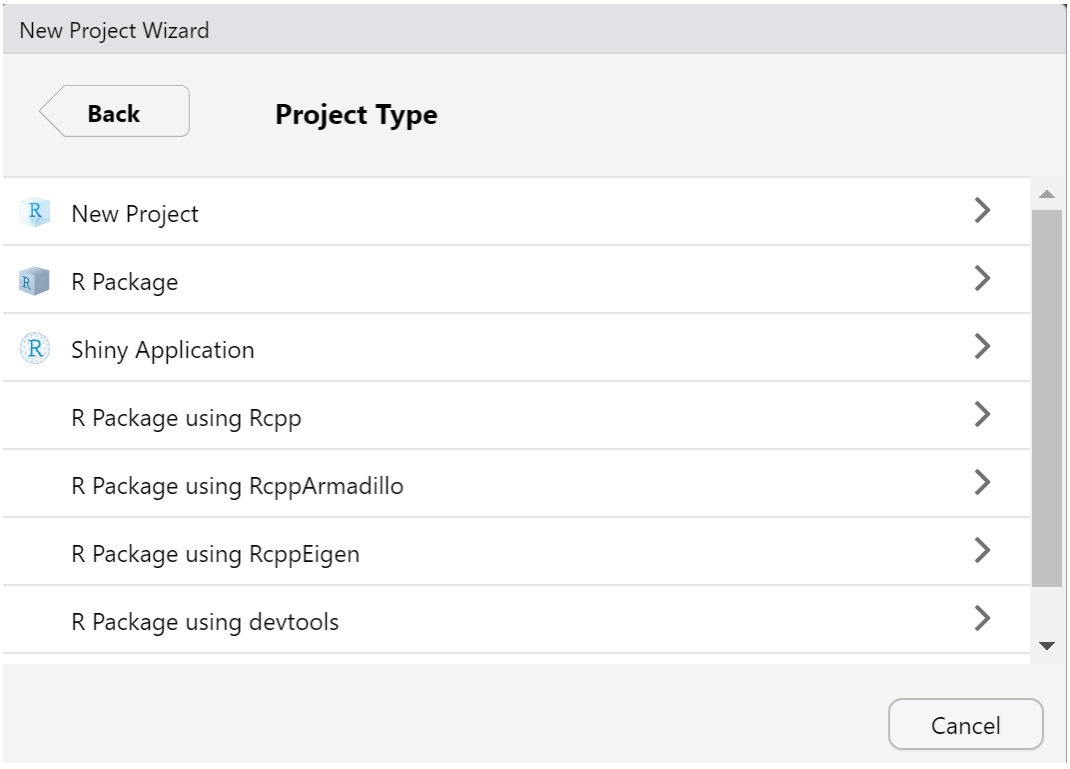


Then 'New Directory'.

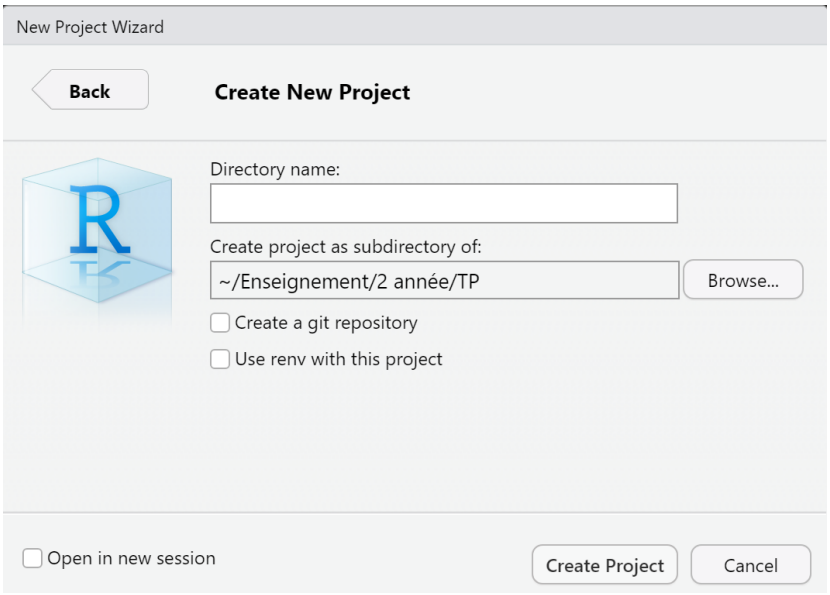
Note that you can create an R project directly in an existing folder. To do so, go to 'Existing Directory.



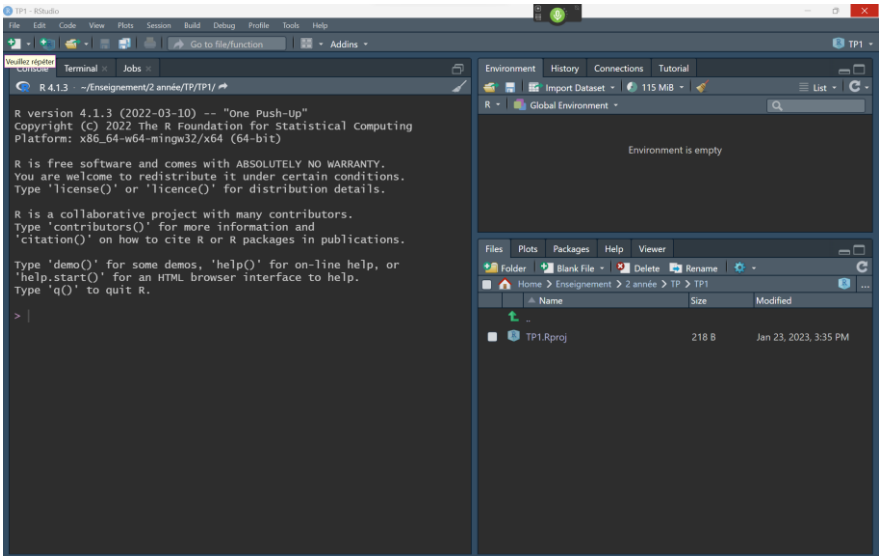
Then 'New Project'.



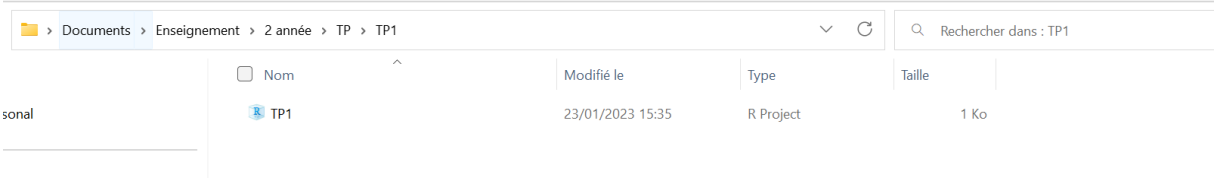
Then give your R project a name.



Your project is created.



A 3D-icon appears in your folder.



The main advantage of an R project is that R automatically searches for files in the right folder, eliminating the need to specify complex paths access. What's more, if you run into a problem and ask for help, sharing the entire project folder with someone can greatly speed up their understanding and troubleshooting, as they won't need to adjust your script to begin with.

Note: by default, your new scripts will also be saved in the R project or defined working environment.

III- Installing and loading packages

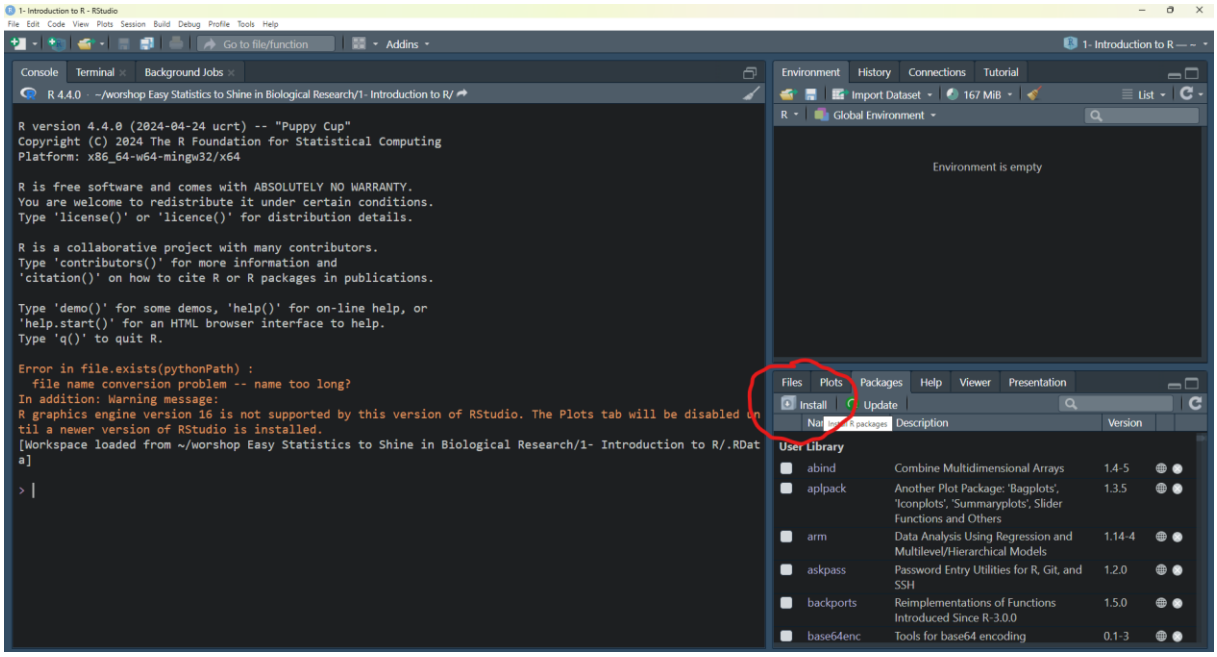
For this tutorial, we will need the R package called Rmcdr. But first, to understand the difference between downloading and loading a package, we will download and load the 'beepr' package as an example.

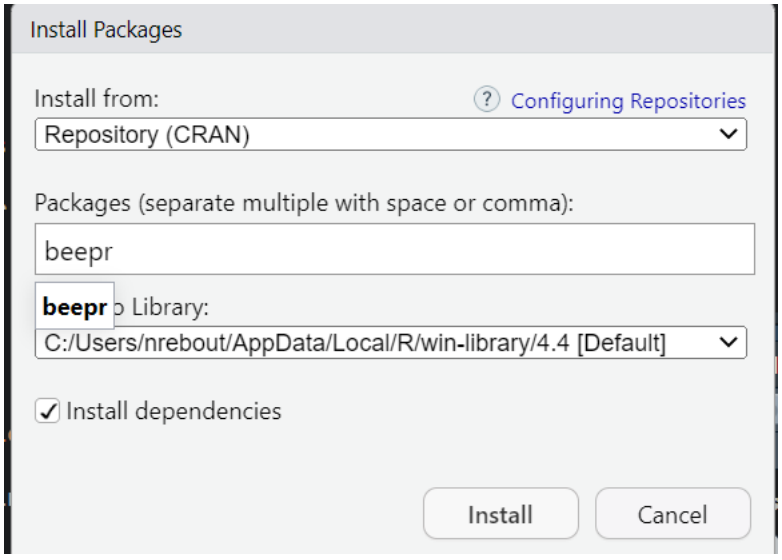
1) Installing packages

The goal is to install 'beepr' package. To install a package, we have two TEAMS:

CLICK BUTTON TEAM

by button-clicking in RStudio: in the bottom-right window, in the 'Packages' tab, click on 'install', then in the package space type in the package name and click on 'install'.





CODING TEAM

Directly in lines of code:

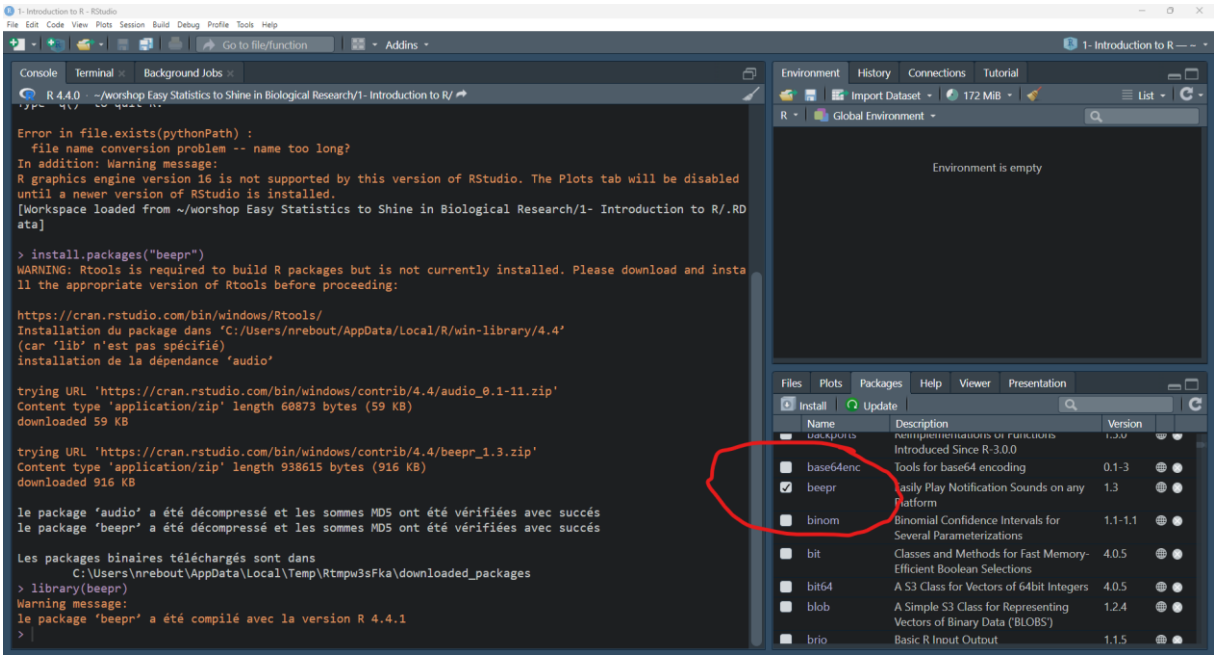
```
install.packages('beepr', dependencies=TRUE)
```

2) Packages loading

Once the packages have been downloaded, they need to be loaded (made active). To do this, we once again have two TEAMs:

CLICK BUTTON TEAM

on R studio: in the bottom right-hand panel, in the packages tab, tick the desired package.



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```
library(beepr)
```

Some additional points to consider when working with R packages:

Remark #1: si on n'a que quelques packages à télécharger, le clicRemark #1: Installing a few packages via the GUI is straightforward, but for frequently used packages, running a prepared script with command lines is more efficient.

Remark #2: When installing a package, enclose the package name in quotes in install.packages(). For loading it with library(), quotes are optional.

Remark #3: Packages need to be installed only once. Think of them like books in R's library: once a package is "ordered" and installed, you don't need to reinstall it to use it again, but you must "fetch" it from the library with library() each time you start a new session.

Now that beepr has been downloaded or loaded, we'll leave it aside for the moment.

I'll leave you to download and load the 'Rcmdr' package. The advantage of this package is that it gives you access to a drop-down menu, enabling you to click on a button.

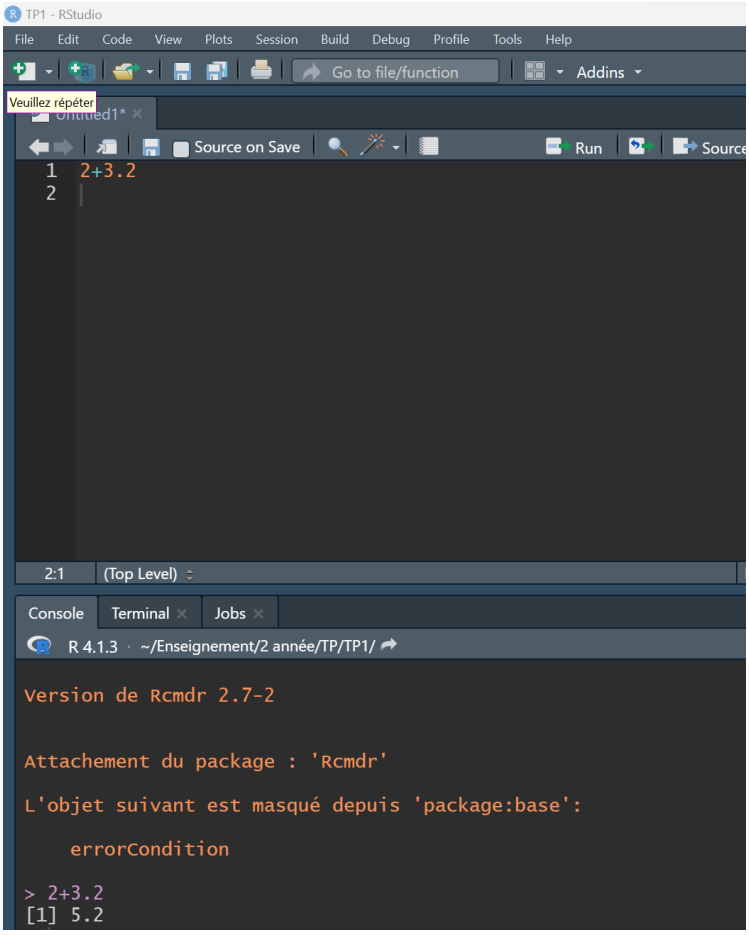
This window appears. It's a script window.

IV- Executing code

In RStudio, code is simply a segment of a computer program. For example, to perform an addition like 2 + 3.2, you can enter this directly into the RStudio console (bottom left window) and press 'Enter' to see the result.

Alternatively, you can write the code in a script window—typically the top left window of RStudio or the script window in Rcmdr. To execute code from the RStudio script window, position the cursor on the line (or select a block of code) and click 'Run' in the top right or use the keyboard shortcut Ctrl + Enter. In Rcmdr

(which is a script window itself), select the line and click 'Submit' to execute.



Once the line of code has been executed, you'll see the result in the console (bottom left).

What can go wrong?

Forgetting the next instruction. When R is waiting for the continuation of an instruction, they add +'s in the console.

```
> 1-
+
```

Example: 1-, it's waiting for the continuation of subtraction. If you press the 'enter' key several times without solving the problem, R will remain stuck and will only add +.

```
> 1-
+
+
+
+
+
+
+
+
```

You can add the continuation yourself, or if you've made a mistake, you can simply press the 'Esc' (escape) key.

V- R object

In R, data is managed through "objects" which can include various data types such as vectors (a sequence of data elements that can represent a column in a dataset) and matrices (2-dimensional arrays of data).

1) Creating Objects

To create an object in R, we use an assignment operation. This essentially involves assigning a value to a variable, which is then stored as an object. For instance:

```
b <- 41.3
```

This line of code means that we are assigning the value 41.3 to the object named b. In simpler terms, we are creating an object called b and setting its value to 41.3.

You can also perform the assignment using an equals sign, which works the same way:

```
b = 41.3
```

It's exactly the same.

2) Object behavior

Creation: Before these assignment statements, the object `b` does not exist. By executing either of these lines, we bring `b` into existence with the specified value.

Overwriting: If `b` was previously assigned a different value (say 10), executing the assignment again with a new value (41.3) will overwrite the original value. Now, `b` will no longer hold the value 10; instead, it will hold the new value 41.3.

Experiment with assignments: give a value to a, a value to b, then add a and b.

3) vectors

Vectors in R are fundamental data structures, composed of elements of the same data type. To do stats you need variables and usually these are the columns of your dataset.

a) Atomic Nature of Vectors

Vectors are described as "atomic" objects. This means that all elements in a vector must be of the same type, such as numeric (i.e. numbers), character (i.e. text), or logical. We don't care ? Not really... This uniformity is crucial because it dictates the operations you can perform with the vector.

b) Practical Implication of Atomic Nature

Suppose you have a dataset column that's primarily numeric but includes a text entry like "no data" in a cell. R will treat this entire column as a character vector because vectors can only hold one type of data. As a result, you won't be able to perform numerical calculations on this column until you address the mixed types—typically by cleaning or transforming the data.

c) Creating Numerical Vectors

There are various methods to create vectors in R, but one of the most common is using the c() function, which stands for "combine." Here's how you can use it to create a numerical vector:

```
> x<-c(5.6,-2,78,42.3)
> x
[1]  5.6 -2.0 78.0 42.3
```

I'll leave you to test another series.

You can also build vectors with sequences using the :

```
> x=1:6
> x
[1] 1 2 3 4 5 6
```

I'll leave you to test another series.

In the same way, you can create character vectors :

```
> x=c('A','B','C')
> x
[1] "A" "B" "C"
```

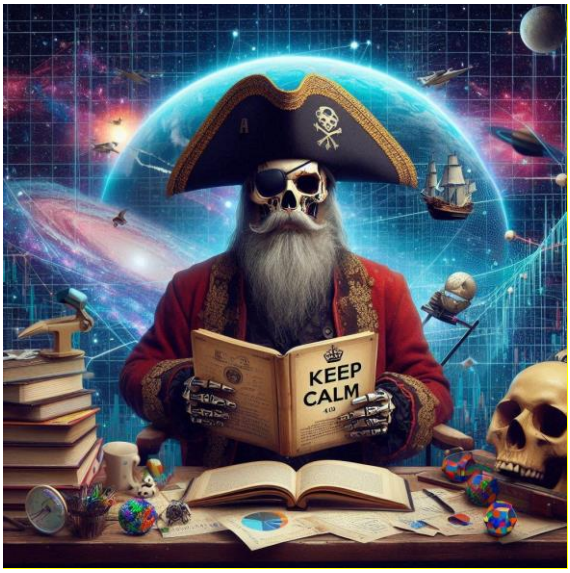
I'll leave you to test another series.

That's it, we've seen a few things about R. Now, what's important for you to understand is how to manage data tables, i.e. spreadsheets in most cases.

4) Import a dataset on R

We want to do statistics on our dataset so an import step is to download the dataset.

Download the tpfh.csv dataset (horror movie character size) and name it 'data' when importing using the procedure bellow.



Patience: the data download stage is sometimes the most complicated, the most limiting. It's normal for things not to go according to plan the first time.

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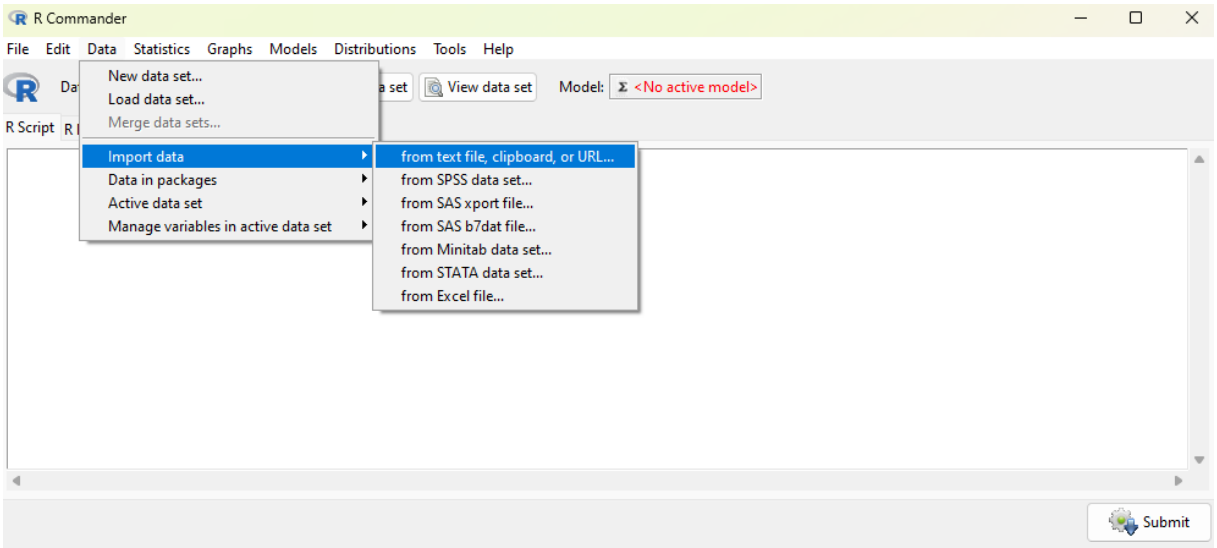
In the Data tab of Rcmdr.

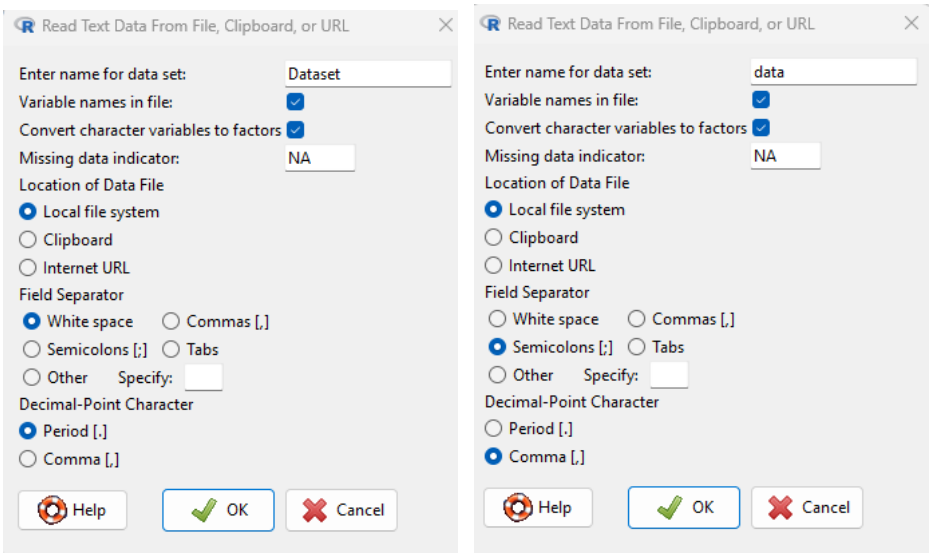
Click on 'Read data' from a file, clipboard or URL.



Change dataset name to data (instead of Dataset).

Change field separator: check Semicolons.

Leave top checked.



You might need to adjust the decimal notation for numbers. What character in your file separates the decimal part? For example, in French, we use commas. Make the necessary changes accordingly.

Go and find your file in the directory structure of your computer.

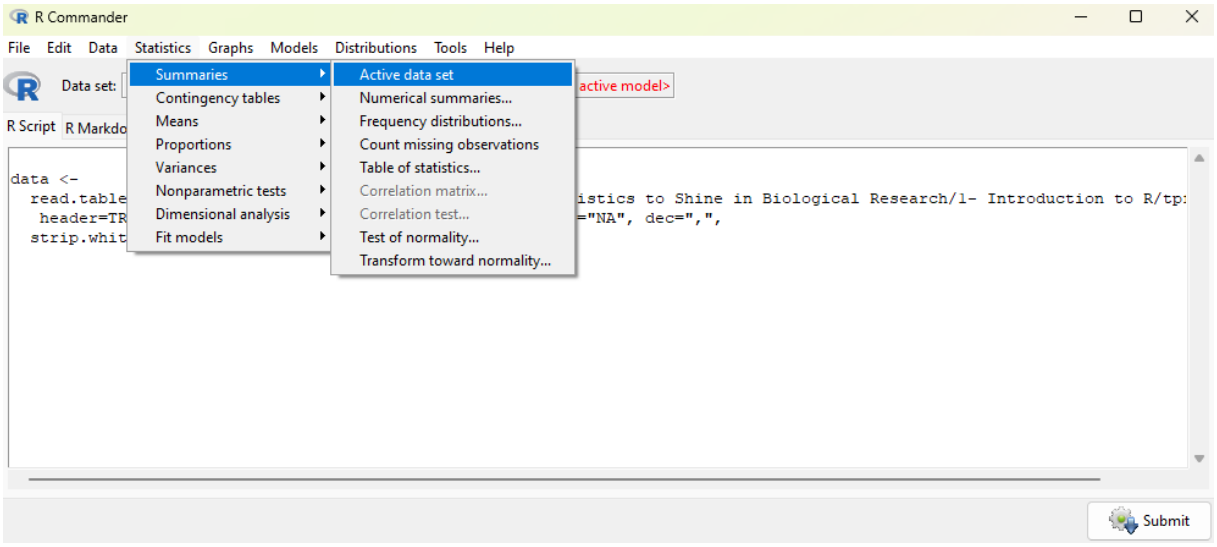
TEAM CODAGE

```
data=read.table('tpfh.csv',
                header=TRUE,
                sep=";",
                dec=",",
                stringsAsFactors=TRUE)
data
```

More precision on the code are given bellow.

I- Verification of data import

CLICK BUTTON TEAM



CODING TEAM

```
summary(data)
```

If everything has been imported correctly, you should have this rendering:

```
> summary(data)
          characters    size_cm                          film
 annabelle       : 1   Min.   :  40.0   a nightmare on elm street: 1
 billy the puppet: 1   1st Qu.: 123.0   alien                    : 1
 chucky          : 1   Median : 181.5   chucky                   : 1
 colver          : 1   Mean   : 544.3   cloverfilelds            : 1
 crites          : 1   3rd Qu.: 228.0   critters                 : 1
 freddy kruge    : 1   Max.   :7600.0   Friday the 13th          : 1
 (Other)         :16                    (Other)                  :16
```

If a problem has occurred, you should have something like this:

```
> summary(data)
                              personnage.taille_cm.film
 annabelle;100;the conjuring                 : 1
 billy the puppet;120;saw                    : 1
 chucky;74;chucky                            : 1
 colver;7600;cloverfilelds                   : 1
 crites;40;critters                          : 1
 freddy kruge;173;a nightmare on elm street: 1
 (Other)                                    :16
```

Or that :

```
> summary(data)
          v1          v2                          v3
 annabelle       : 1   100    : 1   a nightmare on elm street: 1
 billy the puppet: 1   120    : 1   alien                    : 1
 chucky          : 1   132    : 1   chucky                   : 1
 colver          : 1   173    : 1   cloverfilelds            : 1
 crites          : 1   174    : 1   critters                 : 1
 freddy kruge    : 1   176    : 1   film                     : 1
 (Other)         :17   (Other):17   (Other)                  :17
```

I'll let you change the code or procedure a little and see the differences.

Let's go back to the import elements (to be mastered):

- The header=TRUE/Variable names in file checkbox means that we specify to R that the column labels are on the first line of the spreadsheet.

- dec= ','/decimal separators specifies that the decimal separator on the spreadsheet is a comma.

- The sep=' ;'/field separator specifies that the column separator on the spreadsheet is a ;

Note:
Often, when you create your dataset, it will be on excel. Pure excel files don't import well into R. One trick is to save them 'under csv separator ; '. Basically, you'll have another 'excel' file which will have lost its colors if you had put any in. For csvs, the preferred field separator is ; or, if that doesn't work,

On R, you can also import datasets in txt format. In this case, the separator is often the tab '\t'. It's up to you to test when the time comes.

If you really want to download in excel (sometimes it iss better when dealing with special features in your dataset, here is the code :

```
library("readxl")
data <- read_xlsx("data.xlsx")
```

Here are three surefire ways to mess up data importation in R:

Ignore the Header Row: If you don't specify that the first line contains column names, R will default to naming them in its own way—V1, V2, etc., for "variable". This makes it tricky to refer to specific columns later.

Incorrectly Specify Field Separators: If you mess up the column separators, you'll end up with all your data crammed into a single column, rendering statistical analysis impossible.

Decimal Notation Errors: R is developed under British conventions, which use a period as the decimal separator. If your data uses commas (as is common in many European formats), failing to notify R to treat these commas as decimal points will lead R to treat numerical columns as text, thus blocking any numerical calculations.

5) Univariate statistics calculation

The good news is that if you've downloaded your dataset correctly, you'll already have some indicators in the dataset summary. The dataset summary looks like this: you have as many columns as you have variables. If the variable is quantitative, which is the case here for size, the dataset summary gives you the minimum value, the maximum value, the mean, the median and the first and third quartile. If, on the other hand, the variable is qualitative, as is the case here for film, you're given the number of characters presenting a given modality. This is of little interest here, as there are as many films as characters. But for example, if you had a gender variable: female characters versus male characters, the model summary would have given us the number of characters who belong to these two modalities. In some cases, this makes it possible to quickly assess the majority and minority modalities.

```
> summary(data)
           characters    size_cm                          film
 annabelle       : 1   Min.   :  40.0   a nightmare on elm street: 1
 billy the puppet: 1   1st Qu.: 123.0   alien                    : 1
 chucky          : 1   Median : 181.5   chucky                   : 1
 colver          : 1   Mean   : 544.3   cloverfilelds            : 1
 crites          : 1   3rd Qu.: 228.0   critters                 : 1
 freddy kruge    : 1   Max.   :7600.0   Friday the 13th          : 1
 (Other)         :16                    (Other)                  :16
```

Note that standard deviation and variance are not given. To retrieve them, use the following two lines of code:

```
sd(data$size_cm)
var(data$size_cm)
```

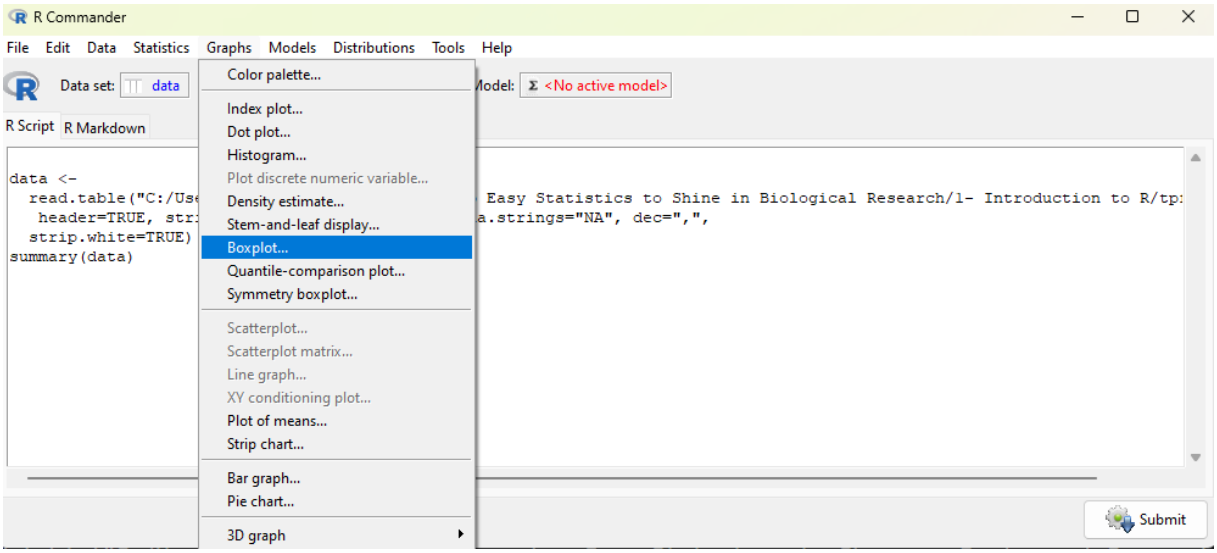
Var for variance, sd for standard deviation.

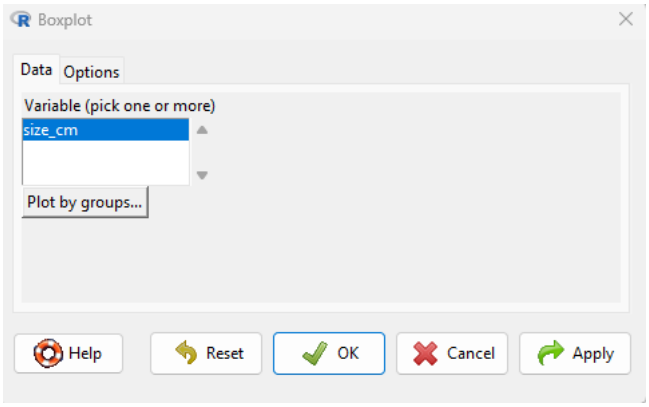
Writing "data$taille_cm" means "I select the taille_cm column in the data table".

II- Graphics creation

CLICK BUTTON TEAM

For a qualitative explanatory variable :





Then OK.

CODING TEAM

```
boxplot(data$taille_cm)
```

6) Exercices avec le jeu de données pirates

For these exercises, I'll give you the detailed procedure each time. Please note, however, that you will need to adapt the names of the files you import.

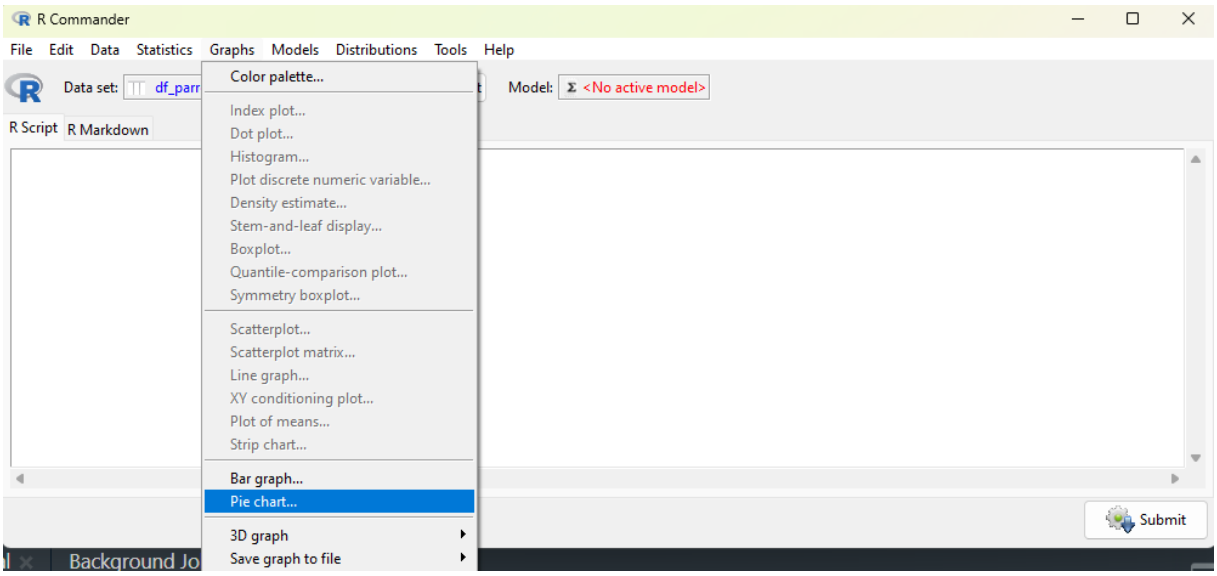
Using the "fatigue_parameters.csv" dataset, retrieve the mean, median and standard deviation for each column.

Hint: you've just done it before 😊

Using the "parrots.csv" dataset, create the bar graph and the pie chart.

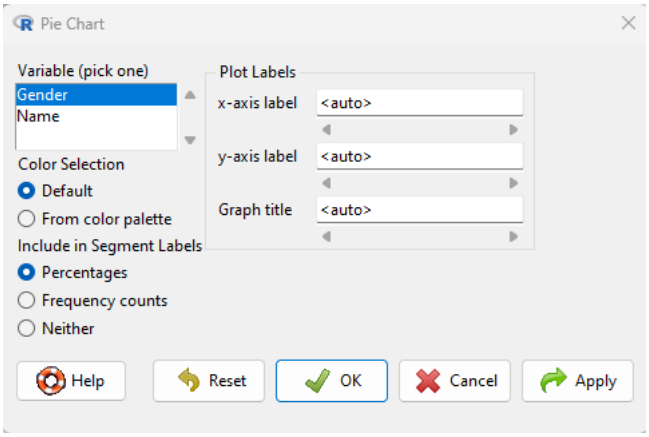
CLICK BUTTON TEAM

Go to the Graphs tab and select either Pie charts or Bar charts.



Then OK

Note: you can choose frequency or percentage



Then OK

CODING TEAM

In team coding, we have to do a little pirouette: recover the total of the columns as the first step.

```
# Create pie chart
genre_counts <- table(df_perroquets$Gender)
```

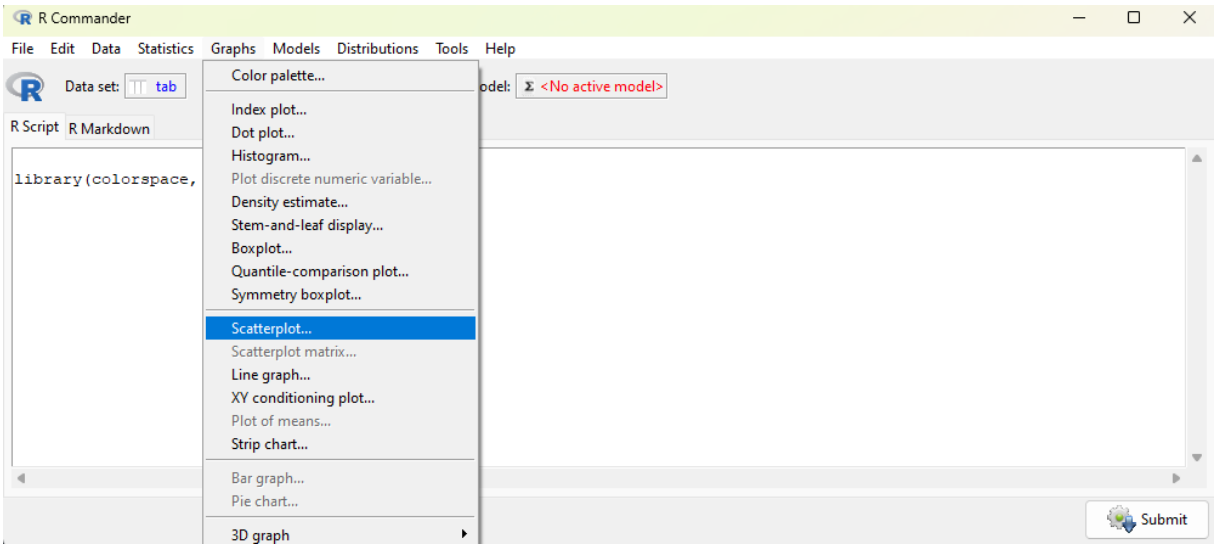
Here is the code for the other two graphs

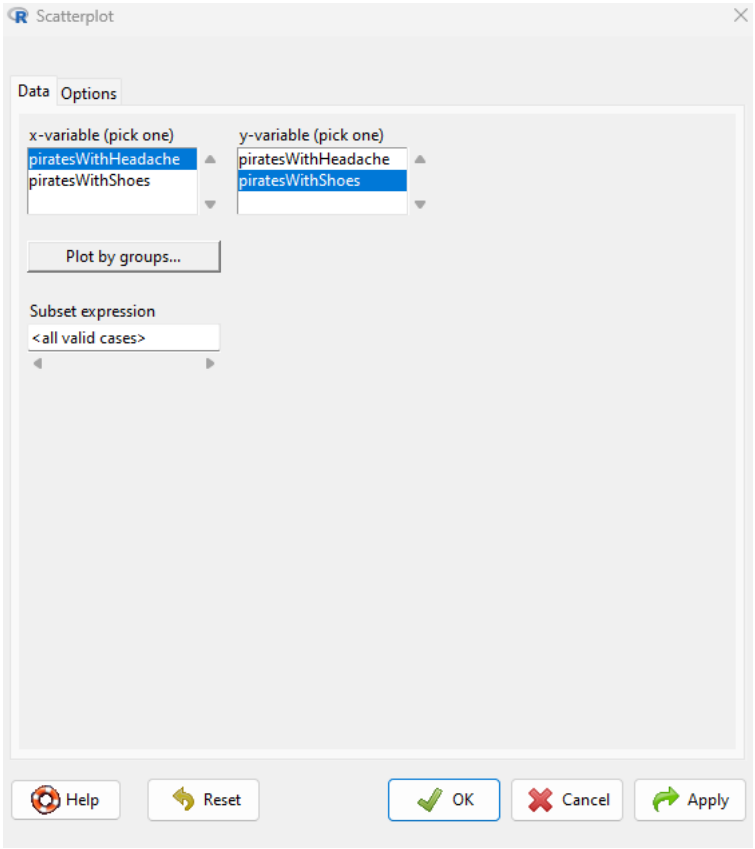
```
pie(genre_counts,col = c("yellow4", "darkturquoise"))

# Create bar chart
barplot(genre_counts, col = c("yellow4", "darkturquoise"), xlab = 'Gender')
```

Using the "headache_data.csv" dataset, create a scatter plot of the number of pirates with headaches as a function of the number of pirates sleeping in shoes. Also perform the Pearson test.

CLICK BUTTON TEAM





CODING TEAM

```
plot(tab$ piratesWithShoes, tab$ piratesWithHeadache)
```

Using the "pirate_option.csv" dataset, create bar and/or pie charts of the number of pirates who followed different options, separating managers and managed.

Also perform the chi² test.

CLICK BUTTON TEAM

We've already explained the procedure, so just click on the 'Graph by group' button.

For chi², go to CODING TEAM

TEAM CODAGE

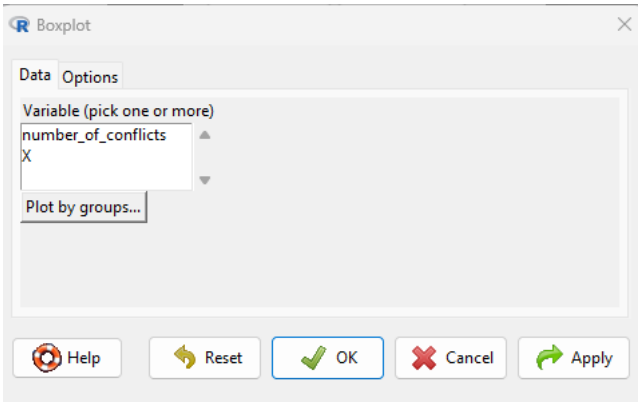
First, we need to make two sub-tables, managers and managed, here is the code:

```
df_managers <- subset(df_pirates, ManagerStatus== "Manager")
df_non_managers <- subset(df_pirates, ManagerStatus== "Non-Manager")
```

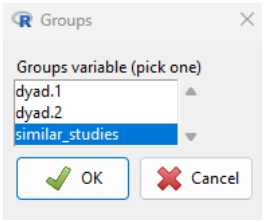
Then graph by status.

Using the "study_conflicts.csv" dataset, produce a boxplot and a Student's t test.

CLICK BUTTON TEAM



Then plot per group



Then OK, OK.

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For the graph :

```
boxplot(number_of_conflicts ~ similar_studies,data))
```

BONUS : I evaluate the normality of a distribution

Download the "fries.csv" dataset. We're interested in the size distribution of the fries, i.e. the size column.

1) With the histogramme

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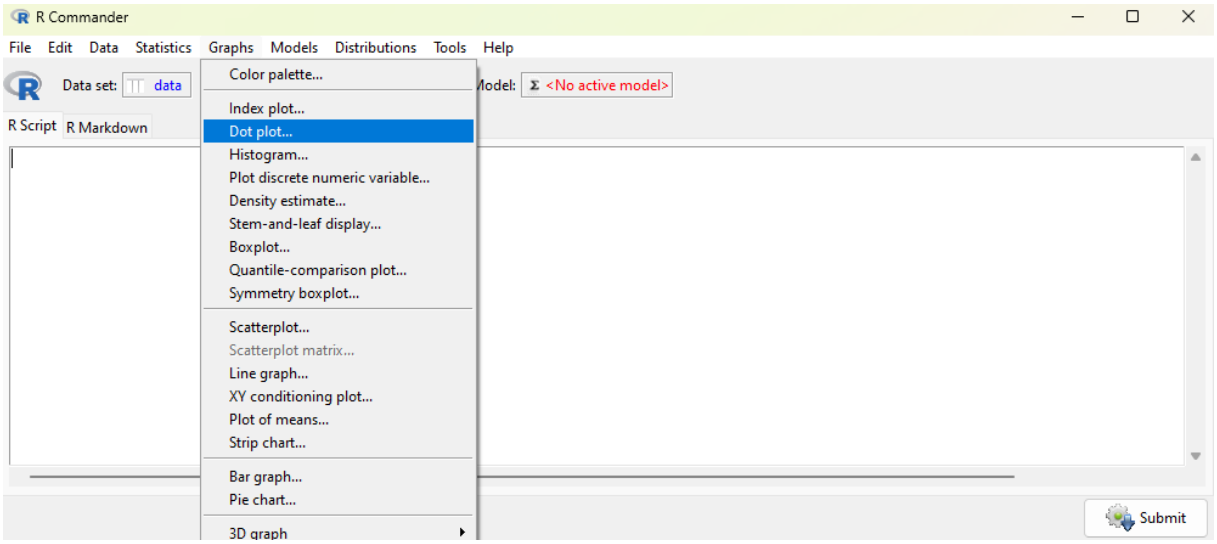

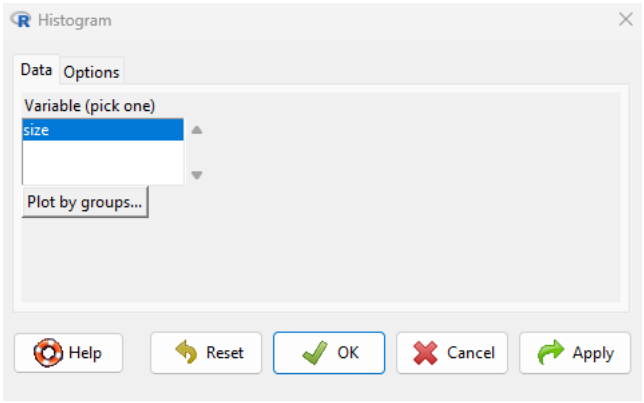

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```
hist(data$size)
```

2) Avec le qqplot

Rappel théorique : pour considérer qu'une distribution est normale, il faut qu'environ 80% des points soient alignés sur la droite.

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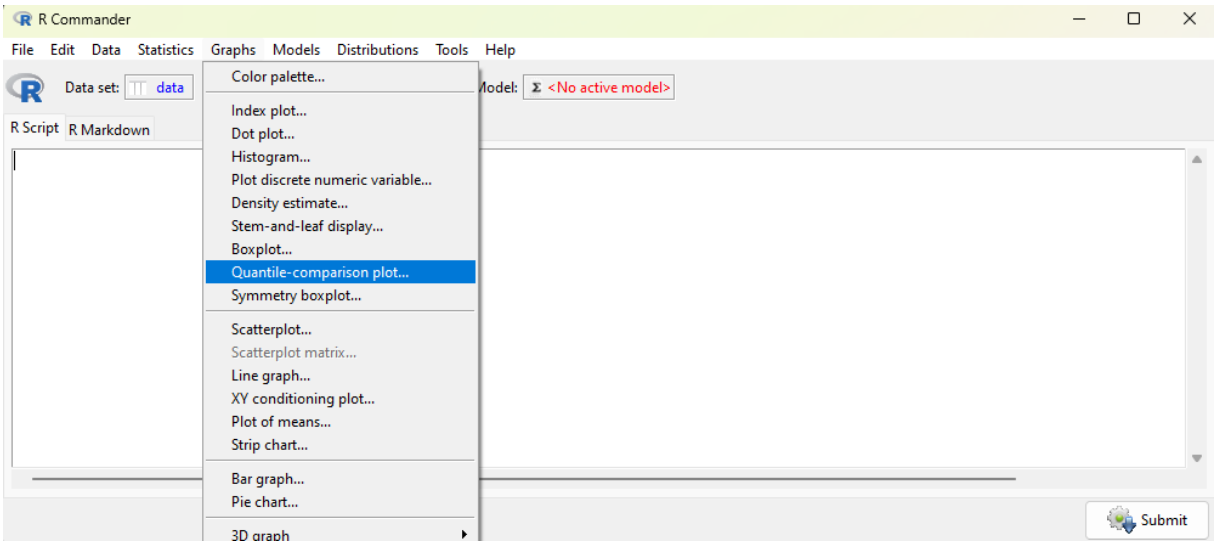

Then OK.

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```
qqnorm(data$size)
qqline(data$size, col = "red")
```

By calling the dataset "data" when importing.

3) Shapiro's test

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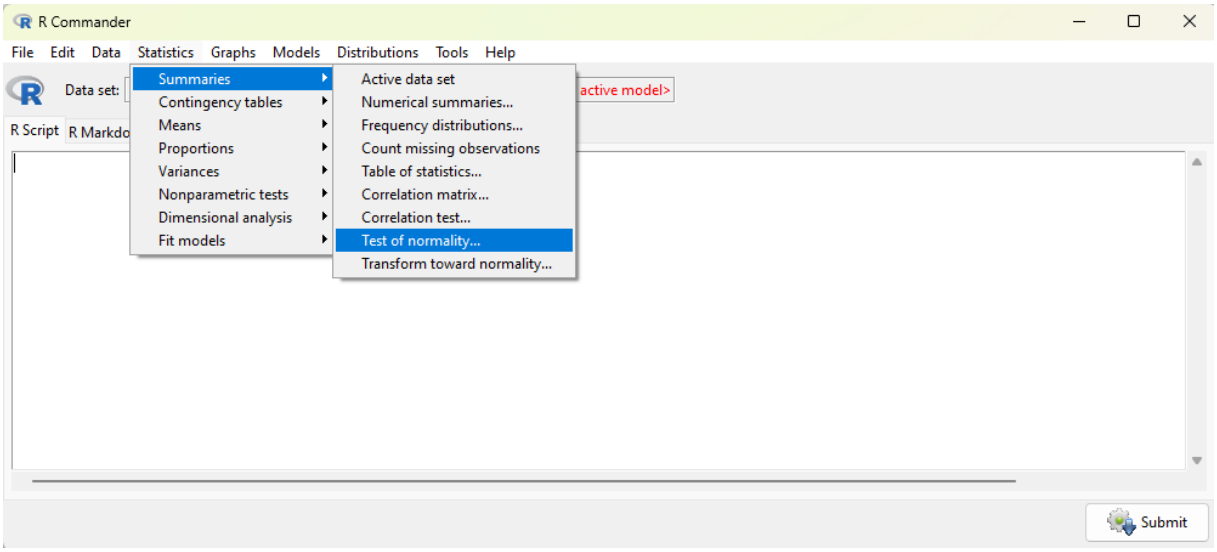

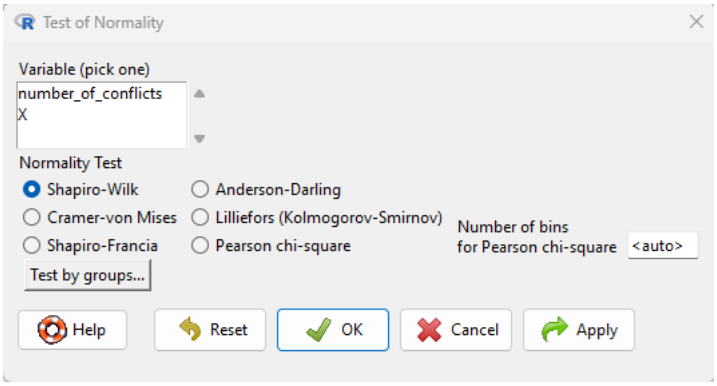

Then OK.

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```
shapiro.test(data$size)
```