R course # 1

INTRODUCTION TO R AND RSTUDIO (SEE SECTIONS 1 TO 5 OF THE HANDOUT)
Introduction

1. INTRODUCTION
The dataset

An experimental maize field
The dataset

100 maize stems randomly selected
The dataset

- 100 maize stems randomly selected

maize.txt
## The dataset

**maize.txt**

<table>
<thead>
<tr>
<th>stem</th>
<th>Measurement 1</th>
<th>Measurement 2</th>
<th>Etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Corn" /></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image2.png" alt="Corn" /></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image3.png" alt="Corn" /></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image4.png" alt="Corn" /></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Install R and RStudio

2. HOW TO GET RSTUDIO AND DOCUMENTATIONS
2.1 Presentation

Created by Ross Ihaka and Robert Gentleman, known as R & R
Auckland university, 1996

Core team
+ contributors from around the world
2.1 Presentation

- Free
- Compatible with most used OS (Windows, Mac, Linux)
- Documentation available online
- Very powerful
2.1 Presentation

Download at: http://www.r-project.org/
2.1 Presentation

Choose the closest mirror to your location
Here: France, Paris1

France
- https://pbil.unic-lyon1.fr/CRAN/
- https://mirror.ibcp.fr/pub/CRAN/
- http://mirror.ibcp.fr/pub/CRAN/
- https://cran.biostools.fr/
- http://cran.biostools.fr/
- https://ftp.igh.cnrs.fr/pub/CRAN/
- http://cran.irsn.fr/
- https://cran.univ-paris1.fr/
- http://cran.univ-paris1.fr/

Download R for your OS (Linux, Windows, Mac OS X)
2.2 RStudio installation for Windows, Mac OS and Linux

Download at: https://www.rstudio.com/

Choose:

- RStudio Desktop
  - Open Source License
  - FREE

And the installer for your OS
2.3 Helpful online documentations

http://www.r-project.org/

https://support.rstudio.com/hc/en-us

RStudio

3. RAPID PRESENTATION OF RSTUDIO
Among others:

- Files
- Plots
- Packages
- Help
3.1. Console

This is the main pane.
The 3 others are not essential for R computation and running, but will make life easier.

Write or copy/paste code.
Press return key to run the code.
3.2. Editor

**Write** your code, **run** it, **correct** it if errors are signaled, and **save** it for later.

- **Run current line or selection**
- **Run all script**
- **Select the kind of code to have color visualization, formatting and help:** *R Script*
3.3. Environment & History

**History:** see the commands you ran
3.3. **Environment & History**

**Environment:** information about objects created

Click to display data on the Editor pane
3.4. Tools

Show all plots drawn, save them as images.

Display information about a function:
> ?function

Browse in the computer files, choose your working directory.

View local web content.
3.4. **Tools**

Install a new package from the web

Package loaded: can be used in RStudio

Package installed but not active: cannot be used in RStudio

List of all packages installed on the computer
3.4. Tools

Install a new package:

> install.packages("coin")

From console pane

Specify the desired package name

From tools pane
3.4. Tools

Load an installed package:

> library(coin)

From console pane

Click on the desired package check box

From tools pane
4. DESCRIPTION OF THE MAIN FEATURES OF R
4. Description of the main features of R

- **Data objects**
  - Data to be analyzed

- **Other features**
  - Used to create, manipulate and analyze data objects.
    - *Ex: functions, operators, special features*
4.1. Instructions

**Instruction**: any succession of characters, numbers, symbols typed in the console

\[ \text{Instruction} = \text{command line} = \text{expression} = \text{line of code} \]

**Execute an instruction:**

- In the **console** pane, write your instruction and press ‘Enter’

- In the **Editor** pane, write your instruction and hit \[\rightarrow\text{Run}\]
4.1. Instructions

**Prompt**: Symbol that appears in the R console, invitation to write instructions:

```
> | R is awaiting for an R command
> 5*2
[1] 10
> |
```
4.1. Instructions

**Prompt**: Symbol that appears in the R console, invitation to write instructions:

> | R is awaiting for an R command

> 5*2

[1] 10

> | R is awaiting for the end of the current command

> 5*

+ |
4.1. Instructions

**Prompt**: Symbol that appears in the R console, invitation to write instructions:

> | R is awaiting for an R command

```
> 5*2
[1] 10
> |
```

+ | R is awaiting for the end of the current command

```
> 5*
+ 2
[1] 10
> |
```
4.1. Instructions

**Prompt**: Symbol that appears in the R console, invitation to write instructions:

```
> | R is awaiting for an R command

> 5*2
[1] 10
> |
```

```
> 5*
> + 2
[1] 10
> |
```

```
> Sys.sleep(20)
```

A blank prompt means that R is computing something. **STOP** icon appears in the top of the console pane. Click on it or press « **Escape** » to kill a run if necessary.
4.1. Instructions

Comments:

Everything written between the "#" symbol and the end of the line is not recognized by R.
Use it to provide explanations on your code.

Succession of instructions:

use « ; » instead of ‘enter’ key to put 2 complete instructions on a same line

```r
r = 3
# Calculate the perimeter of a circle with radius equal to ‘r’
p = 2 * pi * r
# Do both instructions on the same line
r = 3 ; p = 2*pi*r
```

Ignored by R
2 instructions on same line
4.2. The objects
4.2. The objects: 4.2.1. Data objects

- Data file
- Import into R
- or
- Create your own data
4.2. The objects: 4.2.1. Data objects

- Anglo-saxon letters, numbers, dot
- Starting with letter
- Case sensitive

<table>
<thead>
<tr>
<th>Examples:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masse.grains</td>
</tr>
<tr>
<td>grandmere24</td>
</tr>
<tr>
<td>star.slash.exclamationmark</td>
</tr>
</tbody>
</table>

Not:
- Masse/grains
- Masse grains
- Grandmère24
- 2masse
- *./.!
4.2. The objects: 4.2.1. Data objects

- **Name**: Height
- **Length**: 3
- **Mode**: Numeric

**Creation / Import**

- 130
- 300
- 170

**Description** (Number of elements)

- 3

**Modification** (name changed, 300 removed)

- Name: Weak.height
- Length: 2
- Mode: Numeric

- 130
- 170

**Use** (mean)

- 200
4.2. The objects: 4.2.2. Functions

<table>
<thead>
<tr>
<th>name</th>
<th>arguments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

`> sum(1:5)`

[1] 15

**Execution** of the function = Perform a **procedure**:  
- modification of an object  
- statistical computation  
- graphical display  
- etc.

`> sum`  
function (... , na.rm = FALSE) .Primitive("sum")

View the content of a function
4.2. The objects: 4.2.2. Functions

**Help function**
* Ask for help:
  > help(function)
Or
  > ?function

* View help in tools pane. Almost always contains:
  - **Description**: indicates the nature of the function
  - **Usage**: shows how we must write the function
  - **Arguments**: explains the terms used between the brackets of the function
  - **Details**: provides more information on how the function operates
  - **Value**: details the output data when the function is executed
  - **References**: indicates the origin of the function
  - **See Also**: shows related functions (very useful)
  - **Examples**: provides examples that you can copy and paste into the console
Help function: Example with `sum`

```r
> help(sum)

Or

> ?sum
```
4.3. Operators

**Arithmetic operators** are used for simple **calculations**.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>addition</td>
</tr>
<tr>
<td>-</td>
<td>subtraction</td>
</tr>
<tr>
<td>*</td>
<td>multiplication</td>
</tr>
<tr>
<td>/</td>
<td>division</td>
</tr>
</tbody>
</table>

**Logical operators** are **comparison** tools.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>and</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comparison operators** compare data objects or data object elements.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;</td>
<td>less than</td>
</tr>
<tr>
<td>&lt;=</td>
<td>less than or equal to</td>
</tr>
<tr>
<td>&gt;</td>
<td>greater than</td>
</tr>
<tr>
<td>&gt;=</td>
<td>greater than or equal to</td>
</tr>
<tr>
<td>==</td>
<td>equal to (do not confuse with =, see after)</td>
</tr>
<tr>
<td>!=</td>
<td>different</td>
</tr>
</tbody>
</table>

**Extraction operators** allow to extract some elements of a data object.

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ and ]</td>
<td></td>
</tr>
<tr>
<td>[[ and ]]</td>
<td></td>
</tr>
<tr>
<td>$</td>
<td></td>
</tr>
</tbody>
</table>

**Specific operator**

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>~</td>
<td>explained by</td>
</tr>
<tr>
<td>y~x</td>
<td>means data object y explained by data object x</td>
</tr>
</tbody>
</table>

*Used primarily in the linear analysis, but also in some graphics and test functions.*
4.3. Operators

**Assignment operator:** *creates objects*

- `<-` Assignment of the right to the left
- `->` Assignment from left to right
- `=` similar to `<-

**Examples:**

```r
# Create an empty object
X <- NULL

# Assign number 4 to object named X
X <- 4
X <- 4
X <- 4
X = 4
X = 4
X = 4

> ls()
[1] "X"
```

# ls: list all objects created
4.3. Operators

**Assignment** operator: overwrites object if existing

```r
# Put 4 to object X
> X <- 4
> X
[1] 4
```

_Beware_
4.3. Operators

**Assignment operator:** overwrites object if existing

```r
> X <- 4
> X
[1] 4

# assign other data to same object name
> X <- 5
> X
[1] 5
```

**BEWARE**
4.4. Special features

Example of words reserved for specific use:
- **NA**: Missing value (*Not Available*)
- **NaN**: Result of impossible arithmetic computation, like 0 divided by 0 (*Not a Number*)
- **Inf**: Infinity (*-Inf* for minus infinity)
- **NULL**: Empty object
- **TRUE**: Logical argument "True"
- **FALSE**: Logical argument "False"

Example of R **constants**:
- **letters**: The 26 letters of the alphabet in lower case
- **pi**: \(\pi = 3.141593\)

Warning: the name of a reserved word cannot be used to create an object.
First step: R is a calculator

5. First step: R is a calculator
5. R is a calculator

# Division:
> 10/3
[1] 3.333333

# Square root:
> 25^0.5 # or sqrt(25)
[1] 5

# Decreasing series of numbers:
> 5:2
[1] 5 4 3 2

# Standard calculation using \( \pi = 3.141593 \)
> 8*(4+2^2)/3-pi
[1] 18.19174
Set your working directory
Working directory (dumbest definition)

This is the folder in your file system in which R is going to look for files.
E.g., let’s assume you want to read a file called `table.txt` with the function `read.table`.
If your working directory is “C:/users/Gael/Documents” and your command is

```
read.table("table.txt")
```

, R is going to assume you are looking for the file called

```
"C:/users/Gael/Documents/table.txt"
```

To change your working directory, use `setwd("C:/RCourse")`
To know your current working directory, use `getwd()`
Or... use R Studio’s functionalities!
Exercise – Set a working directory

1) Create a new folder « Rcourse » in your computer

→ This folder will contain the material of the course (slides, data, R file... whatever you want)

2) Go to the course website and download the maize.txt file: this is the dataset we are going to work on in the next session

3) Put this file into your folder « Rcourse »

4) In R, create a new R script

5) Set the folder « Rcourse » as your working directory

→ You are now ready to import the maize.txt file into R: see the next session for this step!