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INTRODUCTION TO R

UEB – VHIR

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1. Why R
2. First steps in R and RStudio
3. Install packages in R
4. Data manipulation with R
5. Plots with R
6. Help!!

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1.Why R

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Intro to R

What is R?

- R is a FREE *language and environment* for statistical computing and graphics.
- R provides a wide variety of statistical and graphical techniques, and is highly extensible.
- It can be used fro simple tasks to highly complex reproducible projects.
- It compiles and runs on a wide variety of UNIX platforms and similar systems Windows and MacOS.

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Pros

The system is

- Free
- It's platform independent
- It is constantly improving (2 new versions/year)

It is a statistical tool

- Implements almost every statistical method that exists
- Great graphics
- Simple reporting tools
- Also state-of-the-art in Bioinformatics through the Bioconductor Project.

Programming language

- Easy to automate repetitive tasks Possibility to create user friendly web interfaces with a moderate effort.

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Cons

- R is mainly used issuing commands from a console
  - less user friendly than almost any other statistical tool you may know.
- Constantly having new versions may affect our projects
- Not necessarily the best language nor suitable for every existing task

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2. First steps in R and RStudio

Install R and RStudio

Get to know R.

- Visit the R-project page and see what can be found there.
- If you haven't done it before, download and install R and Rstudio in your computer
  - https://cran.r-project.org/
  - https://posit.co/products/open-source/rstudio/

- Open R studio. Look at the panels and figure out what can we do at each window.

2.First steps in R and RStudio

- Data managed in R ...
  is stored as *variables (objects)*
- Variables can be of distinct *types*
  - Numerical
    - numeric (13.7)
    - int (3)
  - Character
    - "R is cute"
  - Factors
    - A,B,C,D
    - WT, Mut
- Variables can be contained in distinct *structures*
  - vectors
  - matrices
  - data.frames
  - lists
  - tibble

Vectors: a collection of numbers or characters:

```
myvec <- c(10,20,30,40,50)
myvec
## [1] 10 20 30 40 50

myvec + 1
## [1] 11 21 31 41 51

myvec + myvec
## [1]  20  40  60  80 100

food <- c("eggs", "beans", "bacon", "sausage")
```

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Dataframe: is a table or a two-dimensional array-like structure in which each column contains values of one variable and each row contains one set of values from each column :

```
iris
      Species Sepal.Length Sepal.Width Petal.Length Petal.Width
       setosa          5.1         3.5          1.4         0.2
       setosa          4.9         3.0          1.4         0.2
       setosa          4.7         3.2          1.3         0.2
   versicolor          7.0         3.2          4.7         1.4
   versicolor          6.4         3.2          4.5         1.5
   versicolor          6.9         3.1          4.9         1.5
   versicolor          5.5         2.3          4.0         1.3
    virginica          6.3         3.3          6.0         2.5
    virginica          5.8         2.7          5.1         1.9
    virginica          7.1         3.0          5.9         2.1
    virginica          6.3         2.9          5.6         1.8
    virginica          6.5         3.0          5.8         2.2
```

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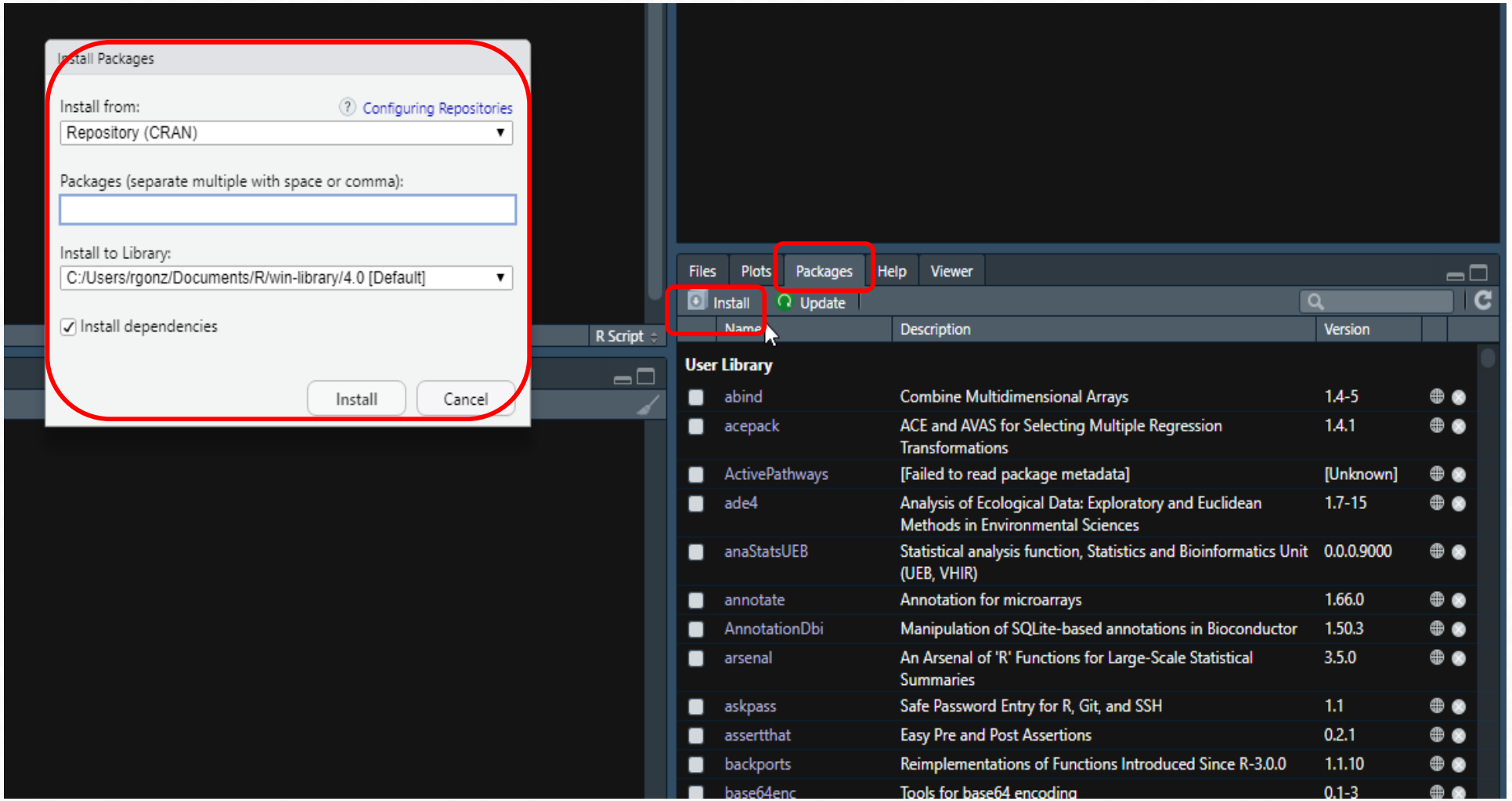
3. Install packages in R

3. Install packages in R

- Packages are extensions of the basic R functions
- It is necessary to install once in each computer when needed
- Call it each time you want to use it
- Two ways to install the packages:

install.packages("*name of the package*")

3. Install packages in R



3. Install packages in R

- If package are hosted in Bioconductor repository:

```
if (!requireNamespace("BiocManager", quietly = TRUE))
    install.packages("BiocManager")

BiocManager::install("airway")
```

3. Install packages in R

Cran R

magrittr
dplyr
ggplot2
pheatmap
RColorBrewer
ggbeeswarm

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4. Data manipulation with R

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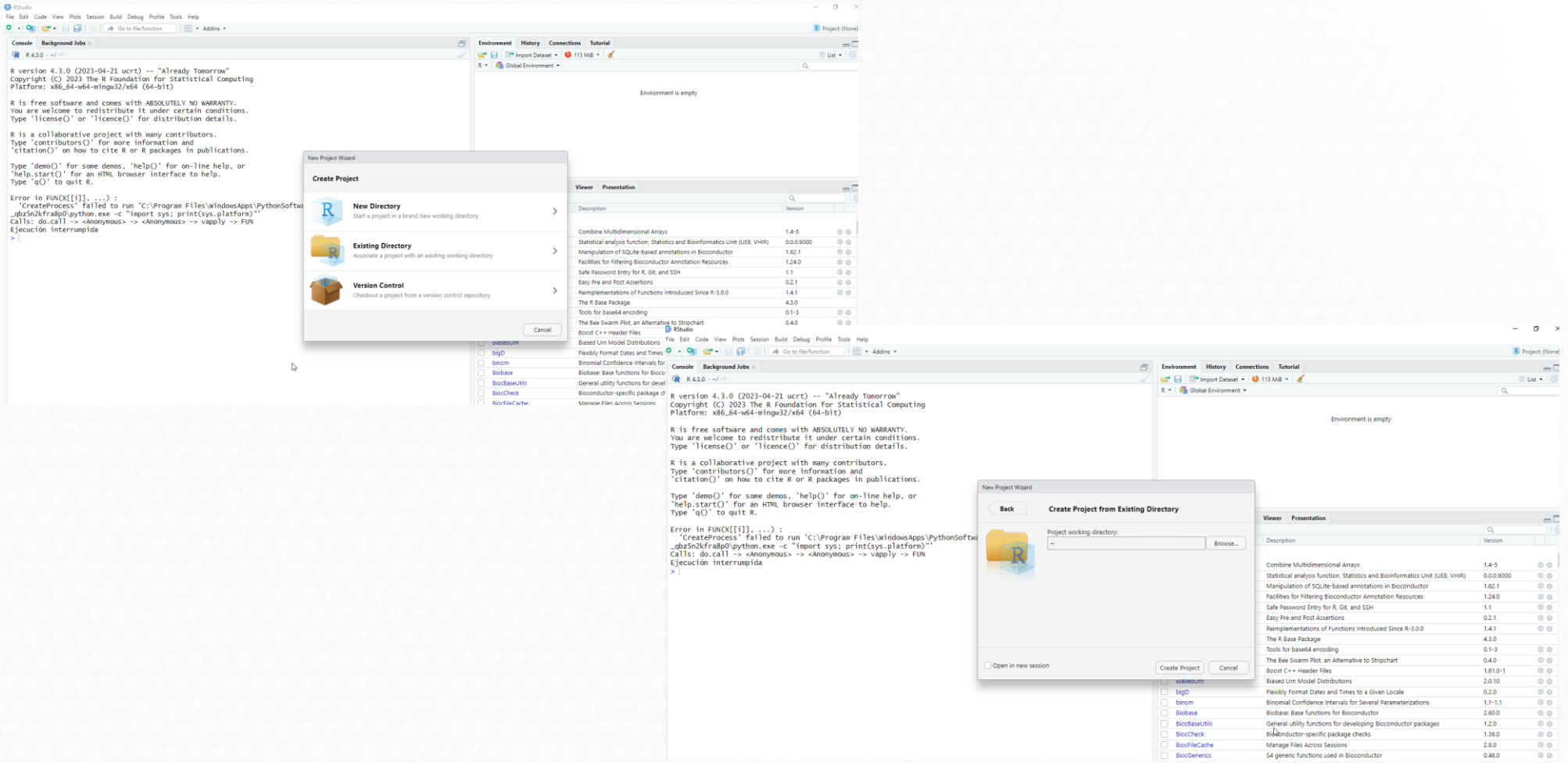
Create a project

- Files can be read from any location, let it be a physical support or a web site.
- The simplest and best way to control file location and modularity of your analyses is to create an Rstudio project for each new analysis.
  - Easy way to keep together your data, code and results.
  - Increases portability (avoids forgetting a file in an external folder).
  - I opens the door to infinite possibilities when you learn to *clone* github projects.

4. Data manipulation with R

Create a project

- Menu File > New Project



2. Data manipulation with R

1. Open a markdown document
   a. Menu File > R Markdown…

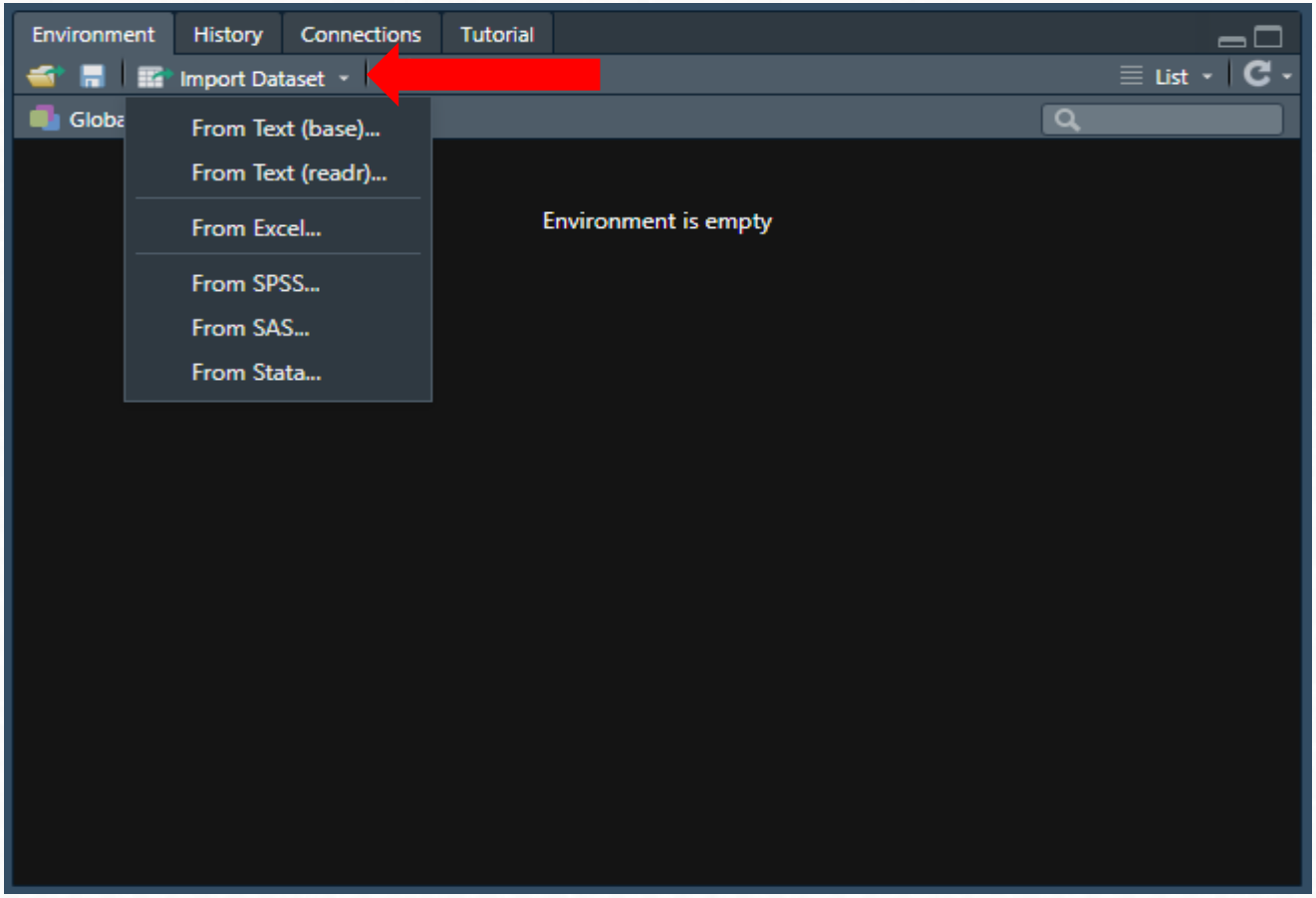
2. Open a csv file or an excel file (2 ways):
   a. With R command line instructions:

```
osteoporosis2 <- read.csv2("osteoporosis.csv", sep = "\t", dec = ",", header = TRUE)
```

check the folder you are working on!

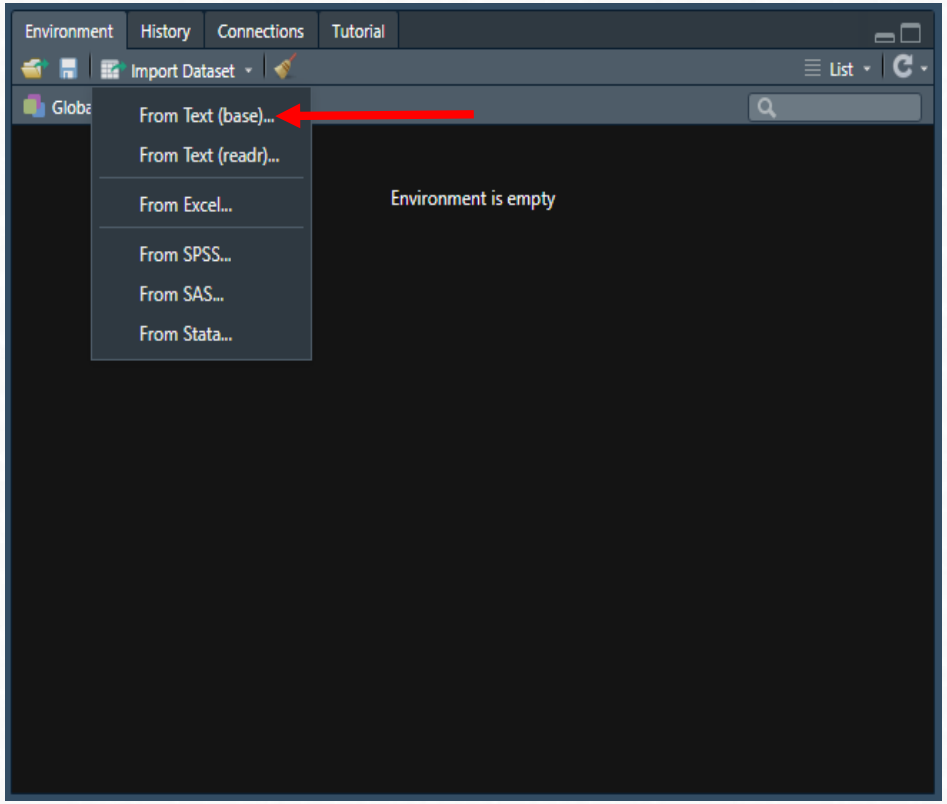
4. Data manipulation with R

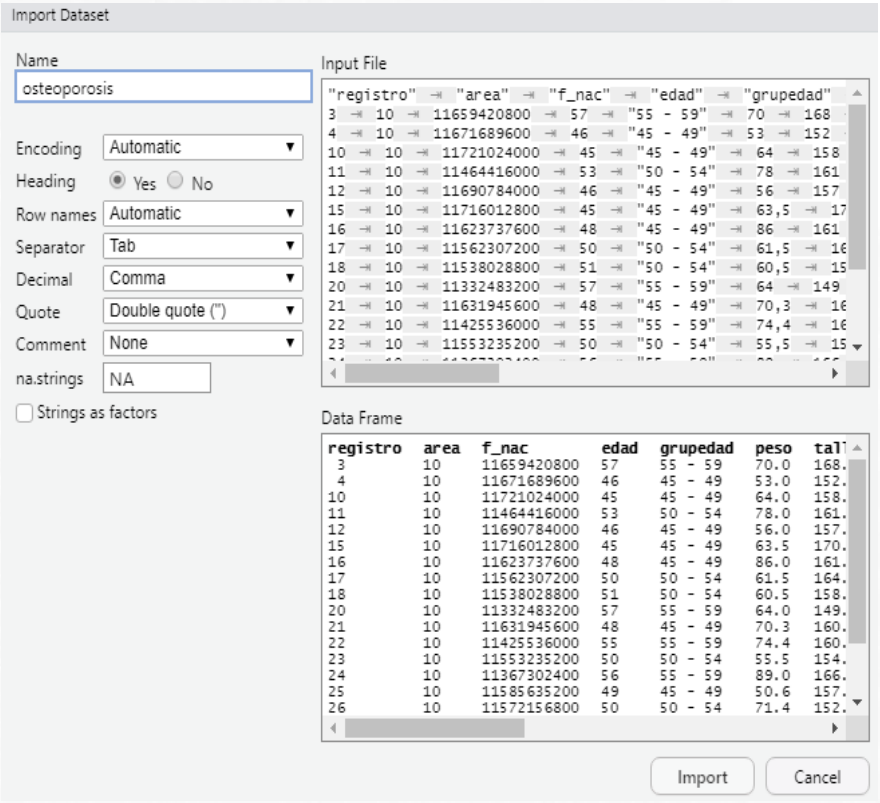
b. The easiest way to get data into R is to click on the “Import Datasets” button.



4. Data manipulation with R

- The easiest way to get data into R is to click on the “Import Datasets” button.





4. Data manipulation with R

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	registro	area	f_nac	edad	grupedad	peso	talla	imc	bua	clasific	menarqui	edad_men	menop	tipo_men	nivel_ed
1	3	10	11659420800	57	55 - 59	70.0	168.0	24.80	69	OSTEOPENIA	12	99	NO	NO MENOPAUSIA/NO CONSTA	SECUNDARIOS
2	4	10	11671689600	46	45 - 49	53.0	152.0	22.94	73	OSTEOPENIA	13	99	NO	NO MENOPAUSIA/NO CONSTA	SECUNDARIOS
3	10	10	11721024000	45	45 - 49	64.0	158.0	25.64	81	NORMAL	14	99	NO	NO MENOPAUSIA/NO CONSTA	PRIMARIOS
4	11	10	11464416000	53	50 - 54	78.0	161.0	30.09	58	OSTEOPENIA	10	50	SI	NATURAL	PRIMARIOS
5	12	10	11690784000	46	45 - 49	56.0	157.0	22.72	89	NORMAL	13	99	NO	NO MENOPAUSIA/NO CONSTA	PRIMARIOS
6	15	10	11716012800	45	45 - 49	63.5	170.0	21.97	76	NORMAL	14	99	NO	NO MENOPAUSIA/NO CONSTA	SECUNDARIOS
7	16	10	11623737600	48	45 - 49	86.0	161.0	33.18	87	NORMAL	11	99	NO	NO MENOPAUSIA/NO CONSTA	PRIMARIOS
8	17	10	11562307200	50	50 - 54	61.5	164.0	22.87	74	NORMAL	10	99	NO	NO MENOPAUSIA/NO CONSTA	PRIMARIOS
9	18	10	11538028800	51	50 - 54	60.5	158.0	24.23	58	OSTEOPENIA	14	99	NO	NO MENOPAUSIA/NO CONSTA	SECUNDARIOS
10	20	10	11332483200	57	55 - 59	64.0	149.0	28.83	61	OSTEOPENIA	13	50	SI	AMBAS	PRIMARIOS
11	21	10	11631945600	48	45 - 49	70.3	160.0	27.46	67	OSTEOPENIA	12	48	SI	OVARIECTOMIA	SECUNDARIOS
12	22	10	11425536000	55	55 - 59	74.4	160.0	29.06	68	OSTEOPENIA	14	50	SI	NATURAL	PRIMARIOS
13	23	10	11553235200	50	50 - 54	55.5	154.5	23.25	73	OSTEOPENIA	11	48	SI	NATURAL	PRIMARIOS
14	24	10	11367302400	56	55 - 59	89.0	166.0	32.30	61	OSTEOPENIA	14	47	SI	NATURAL	PRIMARIOS
15	25	10	11585635200	49	45 - 49	50.6	157.0	20.53	68	OSTEOPENIA	14	40	SI	NATURAL	PRIMARIOS
16	26	10	11572156800	50	50 - 54	71.4	152.0	30.90	74	NORMAL	14	48	SI	AMBAS	PRIMARIOS
17	27	10	11590992000	49	45 - 49	78.0	157.0	31.64	62	OSTEOPENIA	12	46	SI	NATURAL	PRIMARIOS
18	28	10	11293516800	58	55 - 59	72.0	162.0	27.43	65	OSTEOPENIA	11	54	SI	NATURAL	PRIMARIOS
19	29	10	11215238400	61	60 - 64	68.0	155.5	28.12	65	OSTEOPENIA	14	50	SI	NATURAL	PRIMARIOS

What type of data is this?

4. Data manipulation with R

- Once you have loaded the data, it is necessary to check it
- Different ways to do it:

  - head(*name of dataframe*): to see the first rows of a dataframe
  - tail(*name of dataframe*): to see the last rows of a dataframe
  - str(name of dataframe): to check the structure of the dataframe and their variables
  - summary(name of dataframe): Descriptive summary of the variables of the dataframe

4. Data manipulation with R

```
 head(osteoporosis)
  registro area       f_nac edad grupedad peso talla   imc bua   clasific menarqui edad_men menop               tipo_men    nivel_ed
1        3   10 11659420800   57  55 - 59 70.0   168 24.80  69 OSTEOPENIA       12       99    NO NO MENOPAUSIA/NO CONSTA SECUNDARIOS
2        4   10 11671689600   46  45 - 49 53.0   152 22.94  73 OSTEOPENIA       13       99    NO NO MENOPAUSIA/NO CONSTA SECUNDARIOS
3       10   10 11721024000   45  45 - 49 64.0   158 25.64  81     NORMAL       14       99    NO NO MENOPAUSIA/NO CONSTA   PRIMARIOS
4       11   10 11464416000   53  50 - 54 78.0   161 30.09  58 OSTEOPENIA       10       50    SI                 NATURAL   PRIMARIOS
5       12   10 11690784000   46  45 - 49 56.0   157 22.72  89     NORMAL       13       99    NO NO MENOPAUSIA/NO CONSTA   PRIMARIOS
6       15   10 11716012800   45  45 - 49 63.5   170 21.97  76     NORMAL       14       99    NO NO MENOPAUSIA/NO CONSTA SECUNDARIOS
```

```
 tail(osteoporosis)
     registro area       f_nac edad grupedad peso talla   imc bua   clasific menarqui edad_men menop tipo_men               nivel_ed
995      1028   11 11190182400   63  60 - 64   71   161 27.39  57 OSTEOPENIA       14       48    SI  NATURAL              PRIMARIOS
996      1029   11 11287036800   60  60 - 64   64   158 25.64  69 OSTEOPENIA       10       40    SI    AMBAS             SUPERIORES
997      1030   11 11066371200   67  65 - 69   68   157 27.59  75     NORMAL       11       55    SI  NATURAL PRIMARIOS SIN FINALIZAR
998      1031   11 11289196800   59  55 - 59   72   153 30.76  67 OSTEOPENIA       12       56    SI  NATURAL              PRIMARIOS
999      1032   11 11137219200   64  60 - 64   80   152 34.63  55 OSTEOPENIA       14       50    SI  NATURAL              PRIMARIOS
1000     1033   11 11213164800   62  60 - 64   67   161 25.85  65 OSTEOPENIA       13       54    SI  NATURAL            SECUNDARIOS
```

4. Data manipulation with R

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```
str(osteoporosis)
'data.frame':      1000 obs. of  15 variables:
 $ registro: int  3 4 10 11 12 15 16 17 18 20 ...
 $ area    : int  10 10 10 10 10 10 10 10 10 10 ...
 $ f_nac   : chr  "11659420800" "11671689600" "11721024000" "11464416000" ...
 $ edad    : int  57 46 45 53 46 45 48 50 51 57 ...
 $ grupedad: chr  "55 - 59" "45 - 49" "45 - 49" "50 - 54" ...
 $ peso    : num  70 53 64 78 56 63.5 86 61.5 60.5 64 ...
 $ talla   : num  168 152 158 161 157 170 161 164 158 149 ...
 $ imc     : num  24.8 22.9 25.6 30.1 22.7 ...
 $ bua     : int  69 73 81 58 89 76 87 74 58 61 ...
 $ clasific: chr  "OSTEOPENIA" "OSTEOPENIA" "NORMAL" "OSTEOPENIA" ...
 $ menarqui: int  12 13 14 10 13 14 11 10 14 13 ...
 $ edad_men: int  99 99 99 50 99 99 99 99 99 50 ...
 $ menop   : chr  "NO" "NO" "NO" "SI" ...
 $ tipo_men: chr  "NO MENOPAUSIA/NO CONSTA" "NO MENOPAUSIA/NO CONSTA" "NO MENOPAUSIA/NO
CONSTA" "NATURAL" ...
 $ nivel_ed: chr  "SECUNDARIOS" "SECUNDARIOS" "PRIMARIOS" "PRIMARIOS" ...
```

4. Data manipulation with R

```
summary(osteoporosis)
    registro          area          f_nac               edad         grupedad             peso           talla           imc      
 Min.   :   3.0   Min.   :10.00   Length:1000        Min.   :45.00   Length:1000        Min.   : 44.00   Min.   :138.0   Min.   :17.21  
 1st Qu.: 280.8   1st Qu.:10.00   Class :character   1st Qu.:48.00   Class :character   1st Qu.: 60.50   1st Qu.:153.0   1st Qu.:24.80  
 Median : 531.5   Median :11.00   Mode  :character   Median :52.00   Mode  :character   Median : 68.00   Median :157.0   Median :27.51  
 Mean   : 529.9   Mean   :11.58                      Mean   :53.42                      Mean   : 69.12   Mean   :156.9   Mean   :28.11  
 3rd Qu.: 781.2   3rd Qu.:13.00                      3rd Qu.:58.00                      3rd Qu.: 75.00   3rd Qu.:161.0   3rd Qu.:30.82  
 Max.   :1033.0   Max.   :13.00                      Max.   :69.00                      Max.   :123.50   Max.   :180.0   Max.   :48.39  
      bua          clasific           menarqui        edad_men        menop             tipo_men           nivel_ed      
 Min.   : 11.0   Length:1000        Min.   : 8.00   Min.   :24.00   Length:1000        Length:1000        Length:1000    
 1st Qu.: 62.0   Class :character   1st Qu.:12.00   1st Qu.:46.00   Class :character   Class :character   Class :character  
 Median : 72.0   Mode  :character   Median :13.00   Median :51.00   Mode  :character   Mode  :character   Mode  :character  
 Mean   : 73.3                      Mean   :12.71   Mean   :63.04                                                                
 3rd Qu.: 84.0                      3rd Qu.:14.00   3rd Qu.:99.00                                                                
 Max.   :136.0                      Max.   :17.00   Max.   :99.00                                                                
```

4. Data manipulation with R

```
nrow(osteoporosis)
[1] 1000

ncol(osteoporosis)
[1] 15

colnames(osteoporosis)
 [1] "registro" "area"     "f_nac"    "edad"     "grupedad" "peso"     "talla"    "imc"
"bua"      "clasific" "menarqui" "edad_men" "menop"
[14] "tipo_men" "nivel_ed“
```

4. Data manipulation with R

- Sometimes we do not need to work with all the variables of cases of the dataset
- There are different ways to select them:

```
#select the first 3 rows and columns
osteoporosis[1:3, 1:3]
```

```
  registro area       f_nac
1        3   10 11659420800
2        4   10 11671689600
3       10   10 11721024000
```

4. Data manipulation with R

```
#select the different rows and columns
osteoporosis[c(31:36, 115, 950), c(2, 4:6,13:15)]
```

```
    area edad grupedad peso menop                tipo_men     nivel_ed
31    10   67  65 - 69 60.0    SI                  NATURAL    PRIMARIOS
32    10   50  50 - 54 70.0    SI                  NATURAL    PRIMARIOS
33    10   56  55 - 59 68.0    SI                  NATURAL    PRIMARIOS
34    10   67  65 - 69 63.0    SI                  NATURAL    PRIMARIOS
35    10   58  55 - 59 64.0    SI                  NATURAL    PRIMARIOS
36    10   57  55 - 59 75.0    SI                  NATURAL SIN ESTUDIOS
115   10   45  45 - 49 57.0    NO NO MENOPAUSIA/NO CONSTA  SECUNDARIOS
950   11   62  60 - 64 75.5    SI                  NATURAL    PRIMARIOS
```

```
#select all the rows and by variable name and save the dataset with another name
osteoporosis2 <- osteoporosis[, c("edad", "grupedad", "tipo_men", "nivel_ed")]
head(osteoporosis2)
```

```
     edad grupedad                tipo_men    nivel_ed
 1   57  55 - 59 NO MENOPAUSIA/NO CONSTA SECUNDARIOS
 2   46  45 - 49 NO MENOPAUSIA/NO CONSTA SECUNDARIOS
 3   45  45 - 49 NO MENOPAUSIA/NO CONSTA   PRIMARIOS
 4   53  50 - 54                NATURAL   PRIMARIOS
 5   46  45 - 49 NO MENOPAUSIA/NO CONSTA   PRIMARIOS
 6   45  45 - 49 NO MENOPAUSIA/NO CONSTA SECUNDARIOS
```

4. Data manipulation with R

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- It is also possible to select some rows depending on logic expressions:

```
#select pacients older than 60 years
osteoporosis3 <- osteoporosis[which(osteoporosis$edad > 60), ]
head(osteoporosis3)
```

```
   registro area       f_nac edad grupedad peso talla   imc bua     clasific menarqui edad_men menop tipo_men                nivel_ed
19       29   10 11215238400   61  60 - 64 68.0 155.5 28.12  65   OSTEOPENIA       14       50    SI  NATURAL               PRIMARIOS
23       34   10 10992758400   68  65 - 69 66.5 145.0 31.63  57   OSTEOPENIA       13       50    SI  NATURAL PRIMARIOS SIN FINALIZAR
24       35   10 10909382400   69  65 - 69 70.0 168.0 24.80  48 OSTEOPOROSIS       13       45    SI  NATURAL               PRIMARIOS
27       38   10 11043907200   66  65 - 69 67.0 144.0 32.31  79       NORMAL       12       56    SI  NATURAL               PRIMARIOS
28       39   10 10948089600   69  65 - 69 70.5 148.5 31.97  40 OSTEOPOROSIS       11       43    SI  NATURAL            SIN ESTUDIOS
29       40   10 11051251200   66  65 - 69 66.5 147.0 30.77  48 OSTEOPOROSIS       13       40    SI  NATURAL               PRIMARIOS
```

```
osteoporosis4 <- subset(osteoporosis, edad > 60)
head(osteoporosis4)
```

```
   registro area       f_nac edad grupedad peso talla   imc bua     clasific menarqui edad_men menop tipo_men                nivel_ed
19       29   10 11215238400   61  60 - 64 68.0 155.5 28.12  65   OSTEOPENIA       14       50    SI  NATURAL               PRIMARIOS
23       34   10 10992758400   68  65 - 69 66.5 145.0 31.63  57   OSTEOPENIA       13       50    SI  NATURAL PRIMARIOS SIN FINALIZAR
24       35   10 10909382400   69  65 - 69 70.0 168.0 24.80  48 OSTEOPOROSIS       13       45    SI  NATURAL               PRIMARIOS
27       38   10 11043907200   66  65 - 69 67.0 144.0 32.31  79       NORMAL       12       56    SI  NATURAL               PRIMARIOS
28       39   10 10948089600   69  65 - 69 70.5 148.5 31.97  40 OSTEOPOROSIS       11       43    SI  NATURAL            SIN ESTUDIOS
29       40   10 11051251200   66  65 - 69 66.5 147.0 30.77  48 OSTEOPOROSIS       13       40    SI  NATURAL               PRIMARIOS
```

4. Data manipulation with R

- We can combine different logic expressions

```
osteoporosis4 <- subset(osteoporosis, edad > 60 & nivel_ed == "PRIMARIOS")
head(osteoporosis4)
```

	registro	area	f_nac	edad	grupedad	peso	talla	imc	bua	clasific	menarqui	edad_men	menop	tipo_men	nivel_ed
19	29	10	11215238400	61	60 - 64	68.0	155.5	28.12	65	OSTEOPENIA	14	50	SI	NATURAL	PRIMARIOS
24	35	10	10909382400	69	65 - 69	70.0	168.0	24.80	48	OSTEOPOROSIS	13	45	SI	NATURAL	PRIMARIOS
27	38	10	11043907200	66	65 - 69	67.0	144.0	32.31	79	NORMAL	12	56	SI	NATURAL	PRIMARIOS
29	40	10	11051251200	66	65 - 69	66.5	147.0	30.77	48	OSTEOPOROSIS	13	40	SI	NATURAL	PRIMARIOS
31	45	10	11029651200	67	65 - 69	60.0	147.0	27.77	49	OSTEOPENIA	13	53	SI	NATURAL	PRIMARIOS
34	48	10	11034489600	67	65 - 69	63.0	157.0	25.56	66	OSTEOPENIA	13	50	SI	NATURAL	PRIMARIOS

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5.Plots with R

5. Plots with R

- R is a powerful tool to plot your data
- Hadley Wickam (2009) introduced a modern (and perhaps easier) way to plot your data
- Extensions to ggplot2
  - GGally, ggrepel, …

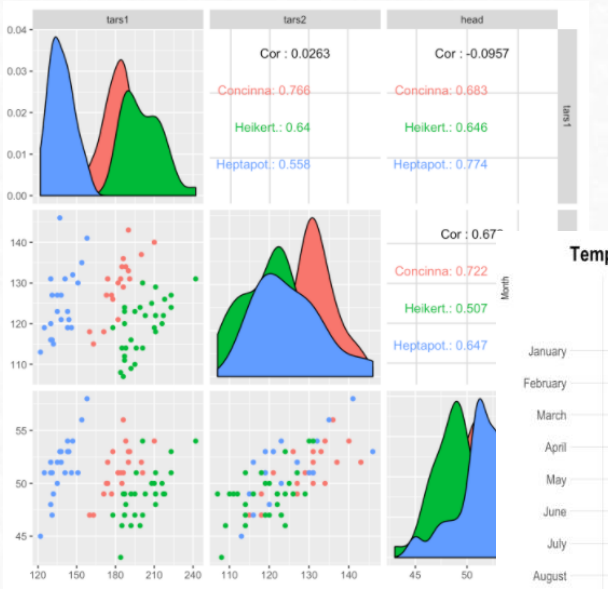
Hadley Wickam book
http://moderngraphics11.pbworks.com/f/ggplot2-Book09hWickham.pdf
https://ggplot2-book.org/

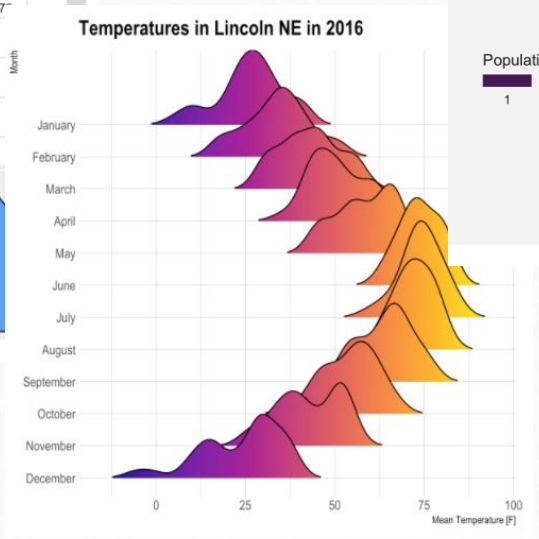
STHDA (Statistical tools for high-throughput data analysis)
http://www.sthda.com/english/wiki/ggplot2-essentials

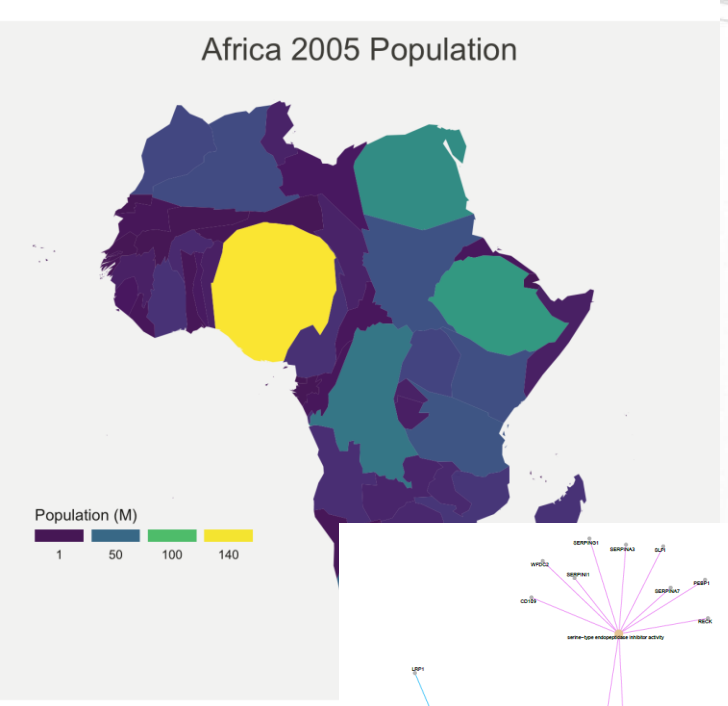
R Colors
http://www.stat.columbia.edu/~tzheng/files/Rcolor.pdf

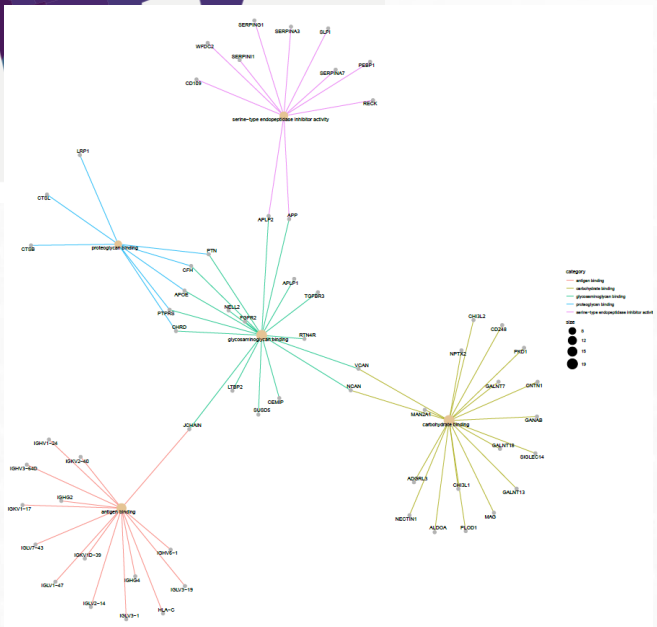
5. Plots with R

https://www.r-graph-gallery.com/









5. Plots with R

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library(ggplot2) #Remember to install the packages before call it

ggplot(osteoporosis, aes(x = peso, y = imc)) +
  geom_point()
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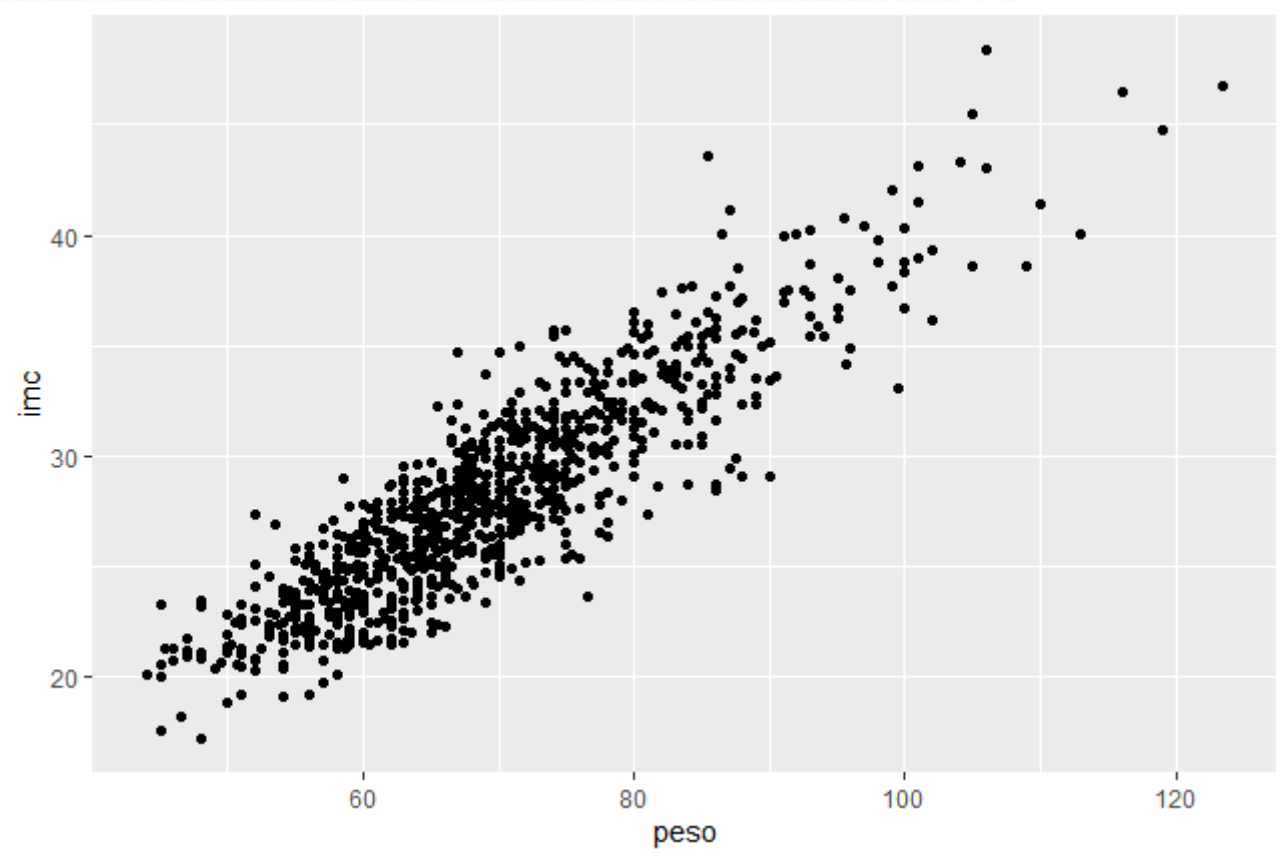
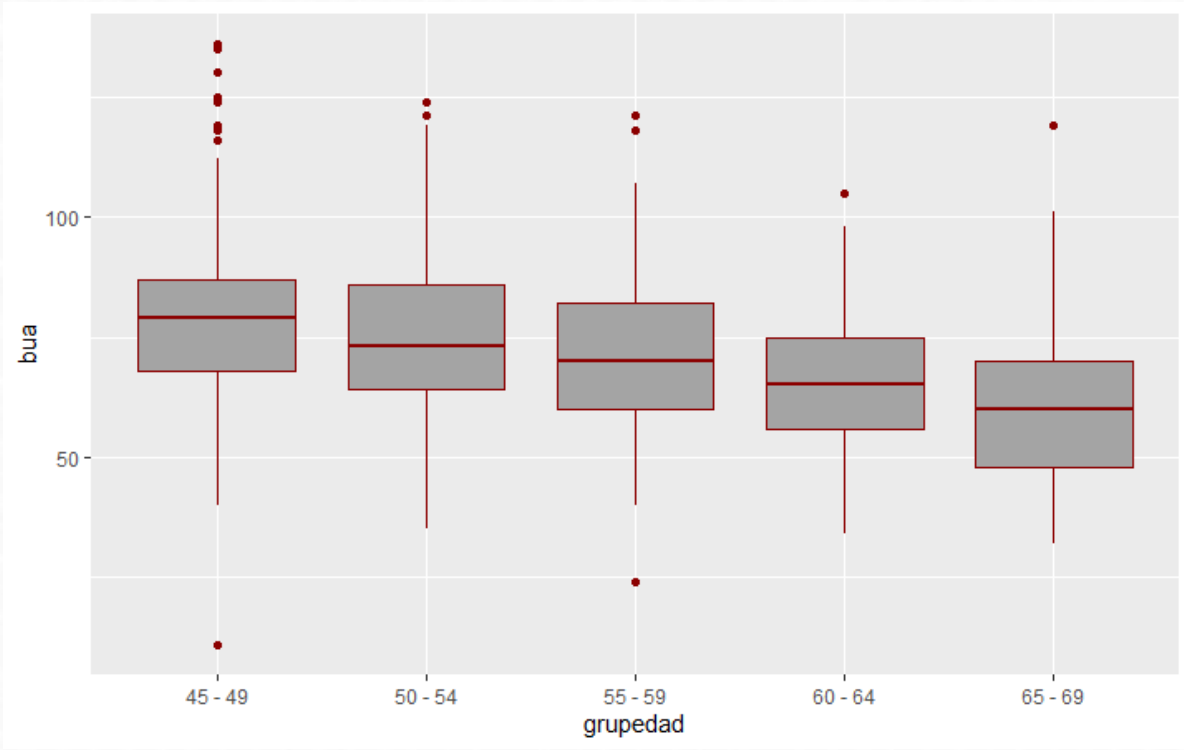


5. Plots with R

```
ggplot(osteoporosis, aes(x = peso, y = imc, color = grupedad)) +
  geom_point()
```

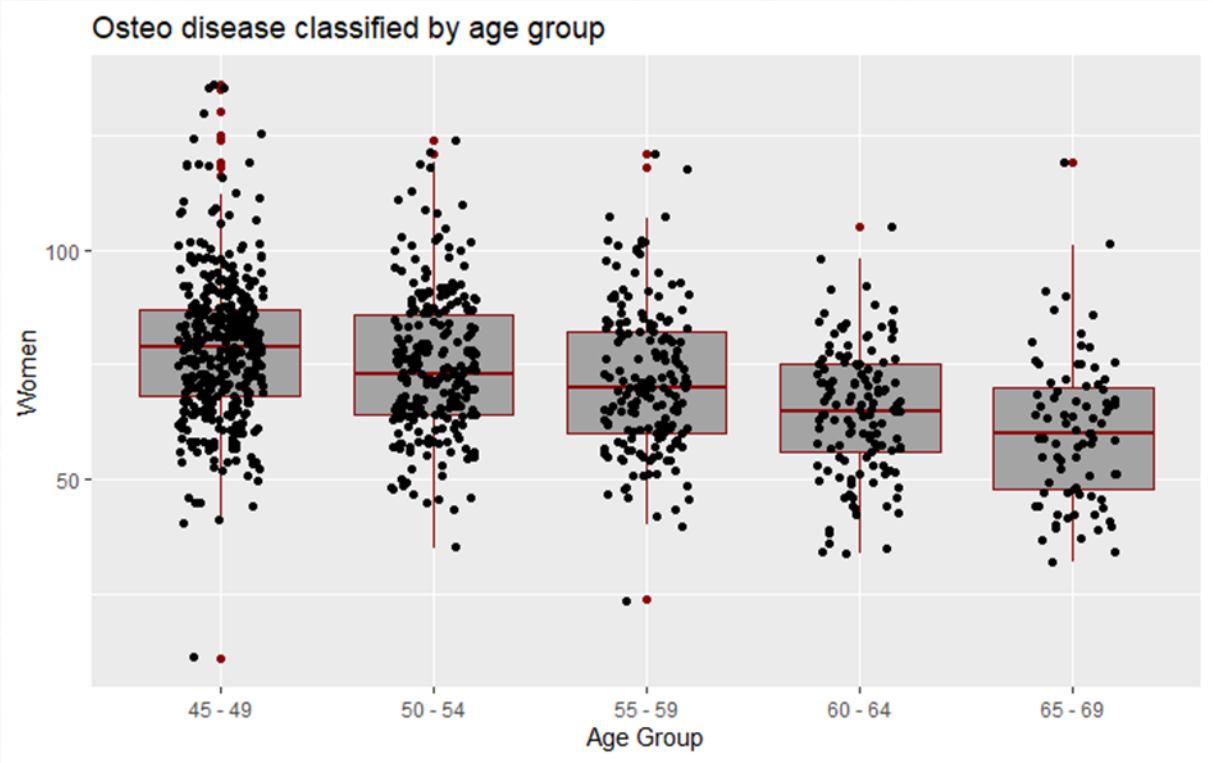
5. Plots with R

```
bp <- ggplot(osteoporosis, aes(x = grupedad, y = bua)) +
        geom_boxplot(fill='#A4A4A4', color="darkred")
```



5. Plots with R

```
bp + geom_jitter(shape = 16, position = position_jitter(0.2)) +
        labs(x = "Age Group", y = "Women", title = "Osteo disease classified by age group")
```



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Institut de Recerca

6. Help!!

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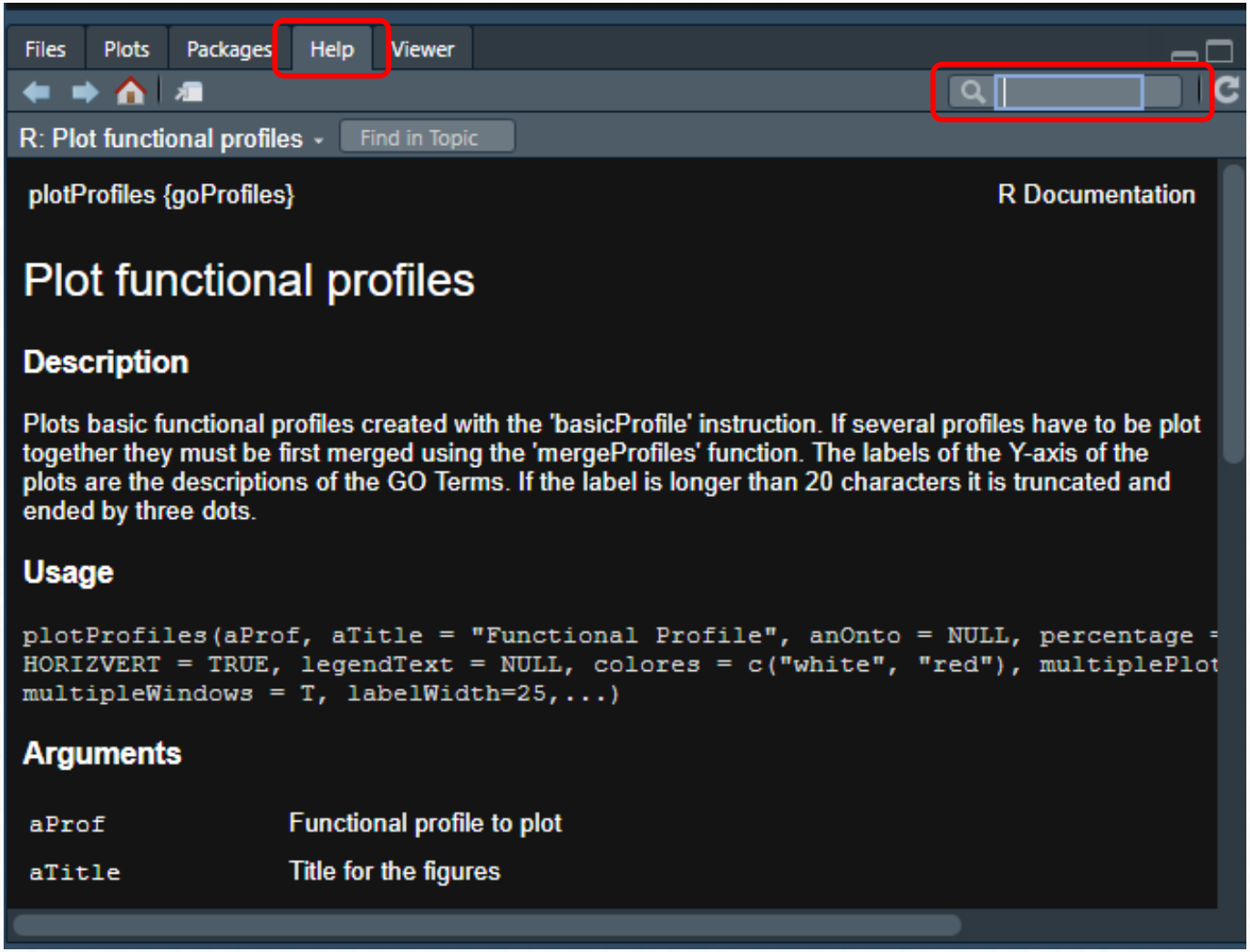
Files
Plots
Packages
Help
Viewer
R: Plot functional profiles
Find in Topic
plotProfiles {goProfiles}
R Documentation
Plot functional profiles
Description
Plots basic functional profiles created with the 'basicProfile' instruction. If several profiles have to be plot together they must be first merged using the 'mergeProfiles' function. The labels of the Y-axis of the plots are the descriptions of the GO Terms. If the label is longer than 20 characters it is truncated and ended by three dots.
Usage
plotProfiles(aProf, aTitle = "Functional Profile", anOnto = NULL, percentage =
HORIZVERT = TRUE, legendText = NULL, colores = c("white", "red"), multiplePlot
multipleWindows = T, labelWidth=25,...)
Arguments
aProf
Functional profile to plot
aTitle
Title for the figures