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A Brief Introduction to R

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A Brief Introduction to R:

1. What is R ?
2. Software and documentation.
3. First steps, from R to q()
4. R objects and objects types.
    - 4.1 Vectors.
    - 4.2 Arrays and Matrices.
    - 4.3 Lists and Data frames.
5. Functions.
    - 5.1 Basic objects functions.
    - 5.2 General use of functions
    - 5.3 More information, using help
6. Packages.

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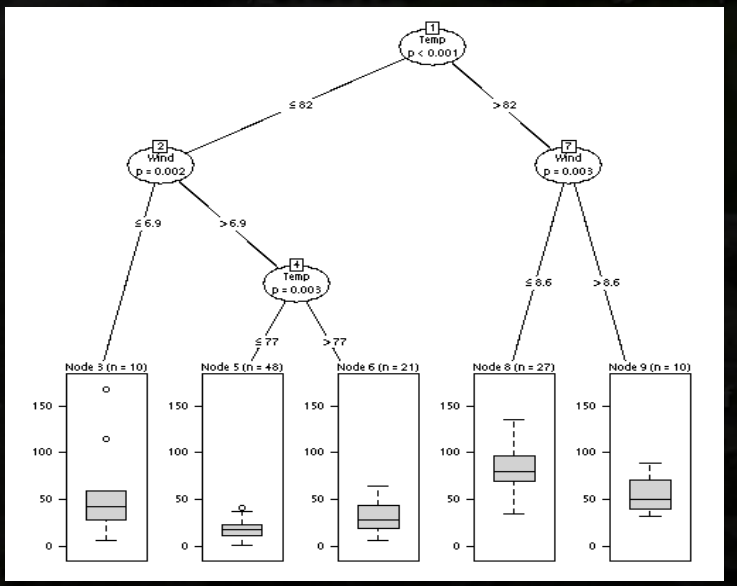
1. What is R ?

R is a language and environment for statistical computing and graphics..

```
> x <- c(1:10)
> y <- c(11:20)
> x * y
 [1]  11  24  39  56  75  96 119 144 171 200
> mtx <- matrix(c(1:25), ncol=5, nrow=5, byrow=TRUE, dimnames=list(c('A','B','C'
,'D','E'), c('v', 'w', 'x', 'y', 'z')))
> mtx
   v  w  x  y  z
A  1  2  3  4  5
B  6  7  8  9 10
C 11 12 13 14 15
D 16 17 18 19 20
E 21 22 23 24 25
> t(mtx)
   A  B  C  D  E
v  1  6 11 16 21
w  2  7 12 17 22
x  3  8 13 18 23
y  4  9 14 19 24
z  5 10 15 20 25
>
```



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2. Software and documentation.

WEB:

OFICIAL WEB: http://www.r-project.org/index.html

QUICK-R:
http://www.statmethods.net/index.html

BOOKS:

Introductory Statistics with R (Statistics and Computing), P. Dalgaard
[available as manual at R project web]

The R Book, MJ. Crawley

R itself: help() and example()

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3. First steps, from R to q().

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Two ways to run R:

1) Interactively: q()

```
$ R
>                    "any R command, as functions, objects ..."
> q()                "to exit"
```

2) Command line

```
$ R [options] [< infile] [> outfile]
   or: R CMD command [arguments]

$ R –vanilla < myRcommands.txt > myRresults.txt
```

3. First steps, from R to q().

Basic Grammar with R console:

7 Rules

1- Object names

2- Assigments

3- Case sensitive

4- Commands

5- Grouping

6- Comment

7- Arguments

3. First steps, from R to q().

Basic Grammar with R console:

1) Objects are defined with names.

   This names can be composed by alphanumeric characters, [a-z,0-9], dots '.' and underlines '-'.

   Names should start with [a-z] or '.' plus [a-z]

```
> x
> x_23.test
```

2) '=' or '<-' signs are used to assign a value to an object

```
> x <- 100
> y <- 25
```

3. First steps, from R to q().

Basic Grammar with R console:

3) Case sensitive: 'x' is different than 'X'.

```
> x <- 100
> X <- 5
```

4) Commands are separated by ';' or new line.

```
> x <- 100;    y <- 25;        x * y;
```

5) Commands can be group using '{' to '}'.

```
> x * y + 2;                  ## it will be 2502 (* higher prcedence )
> x * { y + 2 }               ## it will be 2700
```

3. First steps, from R to q().

Basic Grammar with R console:

6) Comments will be preceded by '#'

```
> ## This is a comment
```

7) Functions arguments will be placed between '(' ')', separated by commas ',' with equal signs '=' to define arguments.

```
> help()
> sqrt(4)
> log(2, base = 10)
```

3. First steps, from R to q().

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Features of R environment:

1) Keep the history and objects: history()

```
$ R
> history()                    ## It will print the last 25 commands
```

2) Load commands from a file: source()

```
> source("myfile")             ## It will execute command from myfile
```

3) Check objects stored in the session: objects()

```
> objects()                    ## It will print a list of objects
```

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4. R objects and objects types.

General object commands in R

1) To assign a value to an object '=' or '<-'

```
> obj1 <- “My First Object”        ## Character
> obj2 <- 23                       ## Numeric
> obj3 <- TRUE                     ## Logical
```

Different types of values or data types:

I- Characters (always between double quotes “”).

II- Numeric (normal or scientific notation).

III- Logical (TRUE, FALSE, NA and NULL)

4. R objects and objects types.

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General object commands in R

2) To know the object type. class()

```
> obj1 <- “My First Object”
> class(obj1)                    ## It should return character
```

3) To list the object defined objects()

4) To delete an object rm()

```
> rm(obj1)                       ## It will delete obj1
> rm(list = objects() )          ## It will delete ALL the objects
```

4. R objects and objects types.

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General object commands in R

5) To print an object print()

```
> obj1 <- “test that”
> print(obj1)
```

A Brief Introduction to R:

4.1 Vectors.

Vectors: Most simple 'data structure' in R.

Ordered collection of data values.

Command used: c()

```
> obj1 <- c(1, 2, 3, 4, 5, 6, 7, 8, 9, 10)      ## Numeric
> obj2 <- c(1:10)                                ## Numeric sequence
> obj3 <- c("blue", "green", "red")              ## Characters
> obj4 <- c(1, 2, "blue", TRUE)                  ## Mixed
> obj5 <- c(obj1, obj2)                          ## Use other vectors
```

4.1 Vectors.

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Numeric Vectors can be used with binary operators and functions

```
x + y          ## addition
x – y          ## substraction
x * y          ## multiplication
x / y          ## division
x ^ y          ## exponentation
```

```
sqrt(x)        ## square root
abs(x)         ## absolute value
log(x)         ## logarithmic
median(x)      ## median
mean(x)        ## mean
```

EXERCISE 1:

Is TRUE or FALSE the following expressions:

a) Median of square root of a vector sequence from 1 to 100 is the same than square root of a median of a vector from 1 to 100.

b) For a serie of 1 to 100, there are 51 numbers where is true that square root of x is equal to x divided by square root of x

A Brief Introduction to R:

4.2 Arrays and Matrices.

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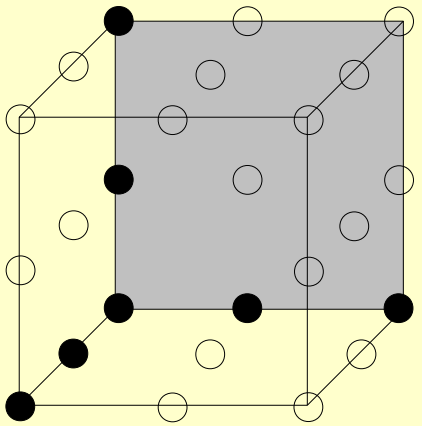
Array: Is a vector with a dimension vector with positive values.

array(vector, dimension)

```
> xyz <- array(c(1:27), dim=c(3, 3, 3))
```



4.2 Arrays and Matrices.

Array: Arrays are indexed

```
> xyz <- array(c(1:27), dim=c(3, 3, 3))
> xyz
, , 1

     [,1] [,2] [,3]
[1,]    1    4    7
[2,]    2    5    8
[3,]    3    6    9

, , 2

     [,1] [,2] [,3]
[1,]   10   13   16
[2,]   11   14   17
[3,]   12   15   18

, , 3

     [,1] [,2] [,3]
[1,]   19   22   25
[2,]   20   23   26
[3,]   21   24   27
```

First dimension

Second dimension

Third dimension

4.2 Arrays and Matrices.

Array: Arrays are indexed, so each element is accessible throught these indexes

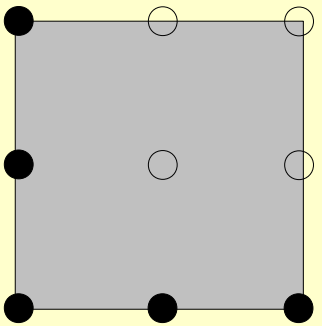
```
> xyz <- array(c(1:27), dim=c(3, 3, 3))
> xyz
> xyz[2,2,2]                    ## a single numeric element

> xyz[2,2, ]                    ## a vector (1 dimension array)

> xyz[2, , ]                    ## a 2 dimension array
```

4.2 Arrays and Matrices.

Matrix: Is a vector with a 2 dimension vector with positive values.

matrix(vector, 2dimension)

```
> xy <- matrix(c(1:9), ncol=3, nrow=3)
```



4.2 Arrays and Matrices.

Matrix: It has indexes too

```
> xy <- matrix(c(1:9), ncol=3, nrow=3)
> xy
> xy[2,2]                    ## a single numeric element

> xy[2, ]                    ## a vector (1 dimension array)
```

Matrix: Indexes can be replaced by names

```
> xy <- matrix(c(1:9), ncol=3, nrow=3,
                dimnames=list(c("A","B","C"), c("x", "y", "z")))
  x y z
A 1 4 7
B 2 5 8
C 3 6 9
```

4.2 Arrays and Matrices.

Matrix: There are many way to create a matrix.

1) matrix(vector, ncol=x, nrow=y, dimnames=list())

```
> xy <- matrix(c(1:9), ncol=3, nrow=3,
                    dimnames=list(c("A","B","C"), c("x", "y", "z"))
```

2) Binding columns (cbind) or rows (rbind)

```
> x <- c(1,2,3);      y <- c(4,5,6);
> col_xy  <- cbind(x, y);
> row_xy <- rbind(x, y);
```

4.2 Arrays and Matrices.

Matrix: Operations

I) Multiplication

```
> X * Y          ## Matrix multiplication
> X %*% Y        ## By element
```

II) Inversion

```
> X ^ {-1}       ## Inversion
```

III) Transposition

```
> t(X)           ## Transposition
```

Matrix: Operations

IV) Eigenvectors and eigenvalues:

"The eigenvectors of a square matrix are the non-zero vectors which, after being multiplied by the matrix, remain proportional to the original vector, For each eigenvector, the corresponding eigenvalue is the factor by which the eigenvector changes when multiplied by the matrix."

```
> X ← matrix(c(1:16), ncol=4, nrow=4)          ## Simetric matrix

> eigX ← eigen(X)

> eigX_vectors ← eigen(X)$vectors
> eigX_values ← eigen(X)$values
```

4.2 Arrays and Matrices.

EXERCISE 2:

- Create a simetric array of 4 dimensions (t,x,y,z) with 10000 elements and extract the value for the central point.

- Create two matrices for t=1 and z=1 and t=10 and z=1.

- Multiply them and calculate the transpose matrix

- Calculate the median of the eigenvalues for this matrix.

- What type of result have you obtained ?

A Brief Introduction to R:

4.3 Lists and Data frames.

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List: An object consisting of an ordered collection of objects known as its components. list()

```
> c ← c(“M82”, “Alisa Craig”, “Microtom”);
> y ← c(2006, 2008)
> l  ← c('CA', 'FL')
> s ← array(c(2, 1, 3,  4, 6, 2,  5, 7, 5, 6, 3, 2, 2), dim=c(3, 2, 2))

> phenom ← list(cultivars=c, years=y, localizations=l, size=s)
```

4.3 Lists and Data frames.

List: Objects in the list are indexed and also can be accessible using their names

```
> phenom ← list(cultivars=c, years=y, localizations=l, size=s)

>phenom[ [ 1 ] ]
>phenom$cultivars
```

4.3 Lists and Data frames.

Data frames: Is a list with class "data.frame" with the following features:

- The components must be **vectors** (numeric, character, or logical), **factors**, **numeric matrices**, **lists**, or **other data frames**.
- Matrices, lists, and data frames provide as many **variables** to the new data frame **as** they have **columns, elements**, or **variables**, respectively.
- Numeric vectors, logicals and factors are included as is, and character vectors are coerced to be factors, whose levels are the unique values appearing in the vector.
- **Vector structures** appearing as variables of the data frame must all have the **same length,** and **matrix structures** must all have the **same row size**.

4.3 Lists and Data frames.

Dataframe: Made with: data.frame()

```
> accessions ← c("Alisa Craig", "Black Cherry", "Comete", "Gnom");

> fruit_size    ← matrix(c(7, 8, 5, 7, 6, 8, 9, 8), ncol=2, nrow=4, byrow=TRUE,
                         dimnames=list(accessions, c(2006, 2007))

> sugar_content ← matrix(c(2.1, 3.2, 3, 2.1, 4.1, 2.3, 2.8, 3.1), ncol=1, nrow=4,
                         byrow=TRUE, dimnames=list(accessions, c(2008)))



> phenome ← data.frame(fruit_size, sugar_content);
```

4.3 Lists and Data frames.

Dataframe: Accessing to the data

attach()/detach()

summary()

```
> phenome ← data.frame(fruit_size, sugar_content);

## As a matrix:
> phenome[1,]                    ## for a row
> phenome[,1]                    ## for a column
> phenome[1,1]                   ## for a single data

## Based in the column names
> phenome$X2007

## To divide/join the data.frame in its columns use attach/detach function
>attach(phenome)
> X2007

>summary(phenome)               ## To know some stats about this dataframe
```

4.3 Lists and Data frames.

Dataframe: Importing/expoting data

read.table()/write.table()

```
> phenome ← read.table(“tomato_phenome.data”);
```

read.table() arguments:

header=FALSE/TRUE,

sep=””,

quote=”\””

4.3 Lists and Data frames.

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Dataframe: Importing/expoting data

read.table()/write.table()

```
> phenome ← read.table("tomato_phenome.data");
```

Derived read.table() functions:

- read.csv(), separated with "," and decimal as "."
- read.csv2(), separated with ";" and decimal as ","
- read.delim(), separated with "\t" and decimal as "."
- read.delim2(), separated with "\t" and decimal as ","

4.3 Lists and Data frames.

EXERCISE 3:

- Load the file: “tomato_weight.tab” into R session
- Create a vector with the accession names.
- Calculate the weight media of each accession.
- Calculate the weight media of each year.
- Create a new matrix with two extra columns with the means and the standard desviation.

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5. Functions.

Functions: They are objects with a set of instructions to process some data object.

name(arguments)

```
read.table("tomato_phenome.data");
```

A Brief Introduction to R:

5.1 Basic objects functions.

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Basic functions:

http://www.statmethods.net/management/functions.html

NUMERIC FUNCTIONS

Function	**Description**
abs(x)	absolute value
sqrt(x)	square root
ceiling(x)	ceiling(3.475) is 4
floor(x)	floor(3.475) is 3
trunc(x)	trunc(5.99) is 5
round(x, digits=n)	round(3.475, digits=2) is 3.48
signif(x, digits=n)	signif(3.475, digits=2) is 3.5
cos(x), sin(x), tan(x)	also acos(x), cosh(x), acosh(x), etc.
log(x)	natural logarithm
log10(x)	common logarithm
exp(x)	e^x

5.1 Basic objects functions.

CHARACTER FUNCTIONS

Function	Description
substr(x, start=n1, stop=n2)	Extract or replace substrings in a character vector. x <- "abcdef" substr(x, 2, 4) is "bcd"
grep(pattern, x , fixed=FALSE)	Search for pattern in x.
sub(pattern, replacement, x)	Find pattern in x and replace with replacement text.
strsplit(x, split)	Split the elements of character vector x at split.
paste(..., sep="")	Concatenate strings.
toupper(x)	Uppercase
tolower(x)	Lowercase

SIMPLE STATS FUNCTIONS

Function	Description
mean(x, trim=0, na.rm=FALSE)	mean of object x
sd(x), var(x)	standard deviation, variance of object(x).
median(x)	median
quantile(x, probs)	quantiles where x is the numeric vector
range(x)	range
sum(x), diff(x)	sum and lagged differences
min(x), max(x)	minimum, maximum
scale(x, center=TRUE)	column center or standardize a matrix.

5.1 Basic objects functions.

SIMPLE GRAPH FUNCTIONS

Function	Description
bmp(), tiff(), jpeg(), png() pdf(), postscript()	Initiation of the graphical device defining format and size jpeg(filename=”mygraph.jpeg”, width=200, height=300)
par()	graphical parameter for the device
plot(), pairs(), dotchart(), hist() boxplot(), barplot(), pie()	high-level plotting commands
axis(), points(), line(), legend()	low-level plotting commands

A Brief Introduction to R:

5.2 General use of functions

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function_name(function_arguments sep with ',')

```
> fruit_sizes ← read.delim(“tomato_weight.tab”)
> accessions ← row.names(fruit_sizes)
>

## Init. the graphical device (to print the graph into a file)
>bmp(filename=“tomato_weight.bmp”, width=600, height=600)

## Plot all the years
>barplot(t(as.matrix(fruit_sizes)), beside=TRUE, las=2, col=c(“blue”,”green”,”red”))
```

A Brief Introduction to R:

5.3 More information, using help

To know more about a function:

```
help(myfunction)
```

```
??myfunction
```

4.3 Lists and Data frames.

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EXERCISE 4:

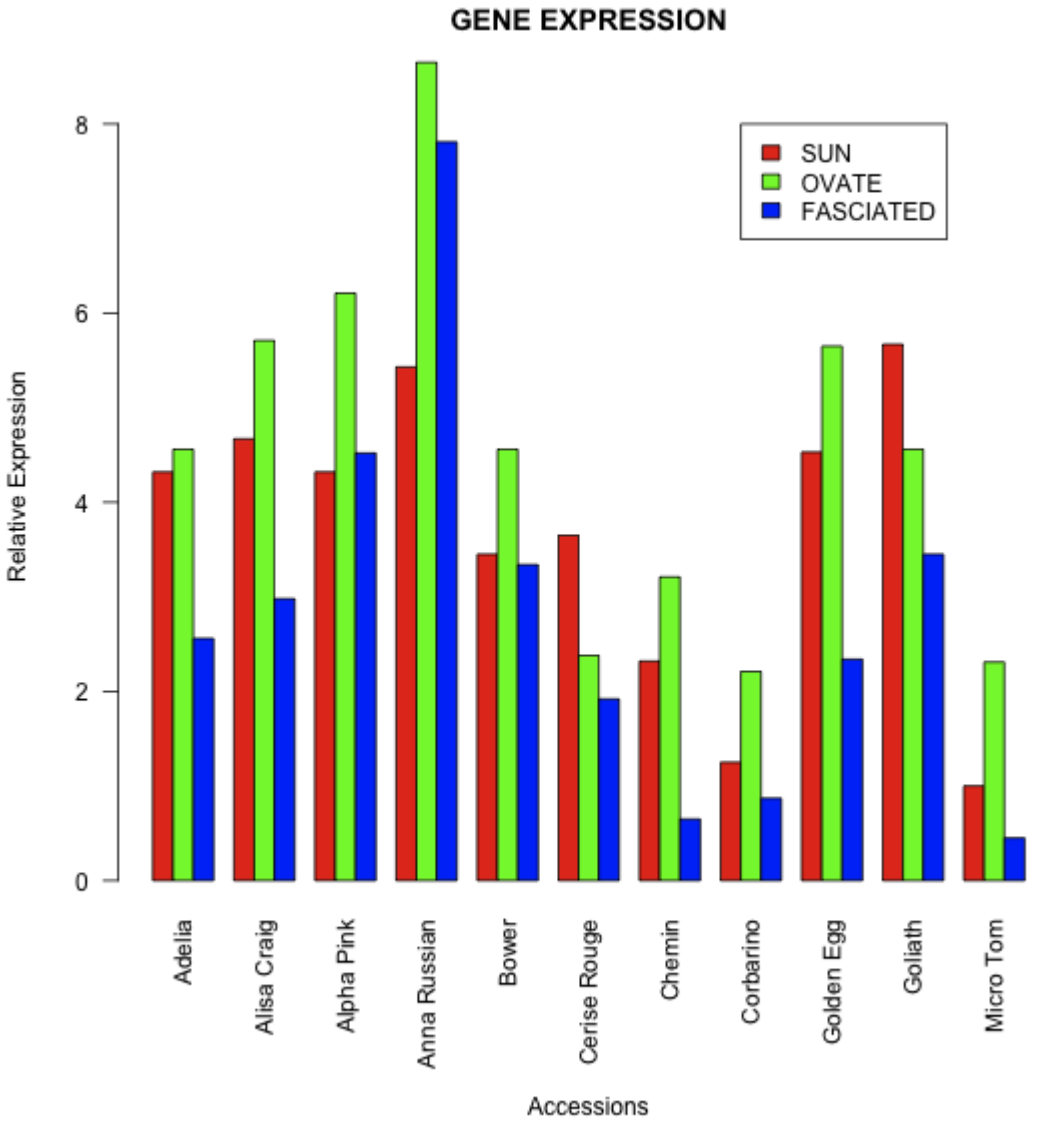
- Loading the files:

"tomato_weight.tab"

and

"tomato_gene.tab"

- Produce this graph.



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6. Packages.

Packages: Set of functions and data that can be downloaded and installed from R repository CRAN.

Example: 'ade4', is a package of analysis of ecological Data.

Important Commands: > install.packages("ade4")

> library("ade4")

> packageDescription("ade4")