(Brief) Introduction to R

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R Language

- Script based Programming language
- Focus of statistical data analysis
- Open source
- Contributing packages
  - Bioconductor (bioinformatics tools)
  - ggplot (plotting functions)
  - …

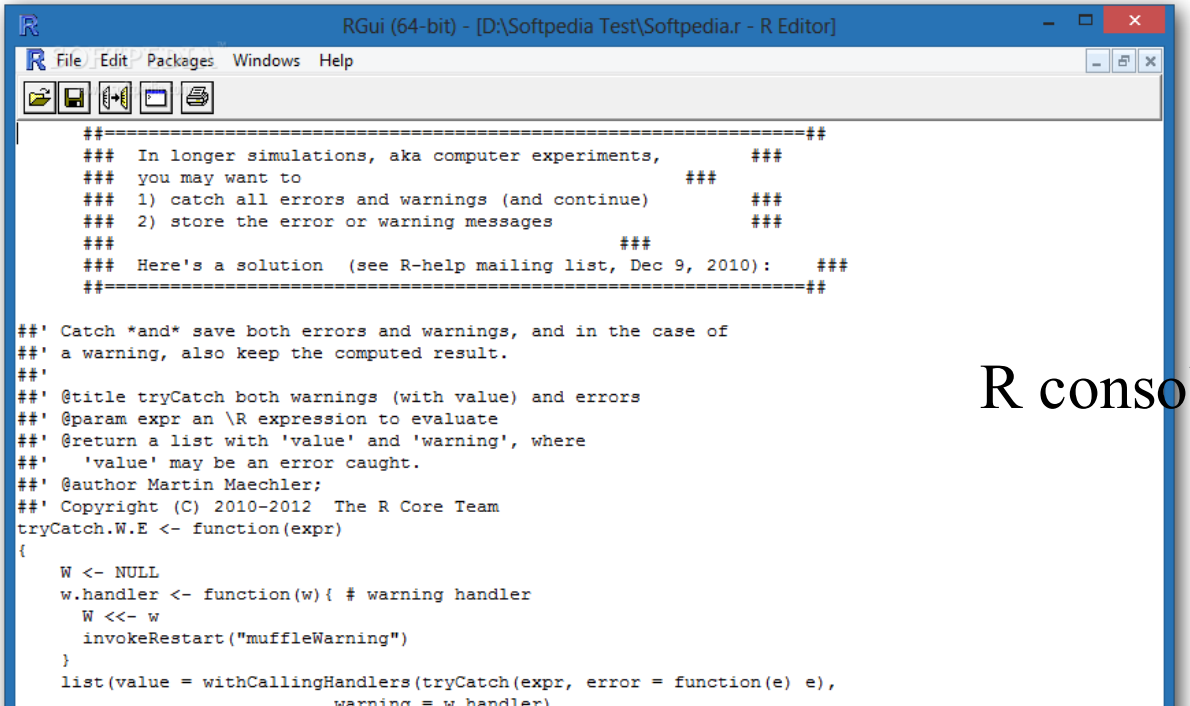
http://www.r-project.org/

Getting Started

- Install R

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

- Run R



R console in windows

Variables and Data Types

Single data can be stored in variables

- Data Types: “numeric”, ”character”, “logical”, …

R console

```
>x = 3;
>x;
[1] 3
>class(z);
“numeric”
>y = “Bioinformatics”
>y;
“Bioinformatics”
```

```
>class(y);
“character”
>z= TRUE;
>z;
TRUE
>class(z);
“logical”
```

Operations

We can apply arithmetic/logical functions to variables

+ (addition), - (subtraction) , / (division), * (multiplication)

R console

```
> x = 3;
> y = 4;
> x+y;
[1] 8
> x*y;
[1] 12
> x/y
[1] 1
```

```
> x>y;
[1] FALSE
> z=TRUE;
> z & (x>y) # logical and
[1] FALSE
> Z | (x>y) # logical or
[1] TRUE
```

Complex Data Structures

- Vector – variable containing a array of items of the same type
- Matrix – two dimensional vector with items of the same type
- Data Frame – complex data structure for two dimensional data where columns can be of distinct type (as an excell sheet).
- …

Vector

- Creating, accessing and updating vector

```
> v=c(3.2,4.1,1.9)
> v
[1] 3.2 4.1 1.9
> v[2]              # access 2nd position of vector
[1] 4.1
> v[3] = 10.4   #update 3rd position of vector
> v
3.2  4.1 10.4
> u=c(1,2,3)
> u+v
>v
[1]  4.2  6.1 13.4
```

Vector

- Operations, functions and access

```
> z = u+v              # arithmetic operation in vector
> z
[1]  4.2  6.1 13.4
> length(z)           # function indicating size of vector
[1] 3
> z[c(1,3)]           #subsetting vector (1st and 3rd pos.)
[1] 4.2 13.4
> z>6                 #logical operator
[1] FALSE  TRUE  TRUE
>z[z>6]                # return all values greater than 6
[1]  6.1 13.4
```

Matrix

- Matrix – two dimensional vector / same type

```
> m = matrix(1:12, 4, 3) # 4 by 3 matrix
>dim(m)    # size of matrix
4  3
>m[1,]      # show first row of matrix
[1] 1  5  9
>m[3,1]     #show element at 3rd row / 1st collumn
[1]
>m
 [,1] [,2] [,3]
[1,]    1    5    9
[2,]    2    6   10
[3,]    3    7   11
[4,]    4    8   12
```

Matrix

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```
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>dim(m)    # size of matrix
4  3
>m[1,]      # show first row of matrix
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>m[3,1]     #show element at 3rd row / 1st collumn
[1]
>m
 [,1] [,2] [,3]
[1,]    1    5    9
[2,]    2    6   10
[3,]    3    7   11
[4,]    4    8   12
```
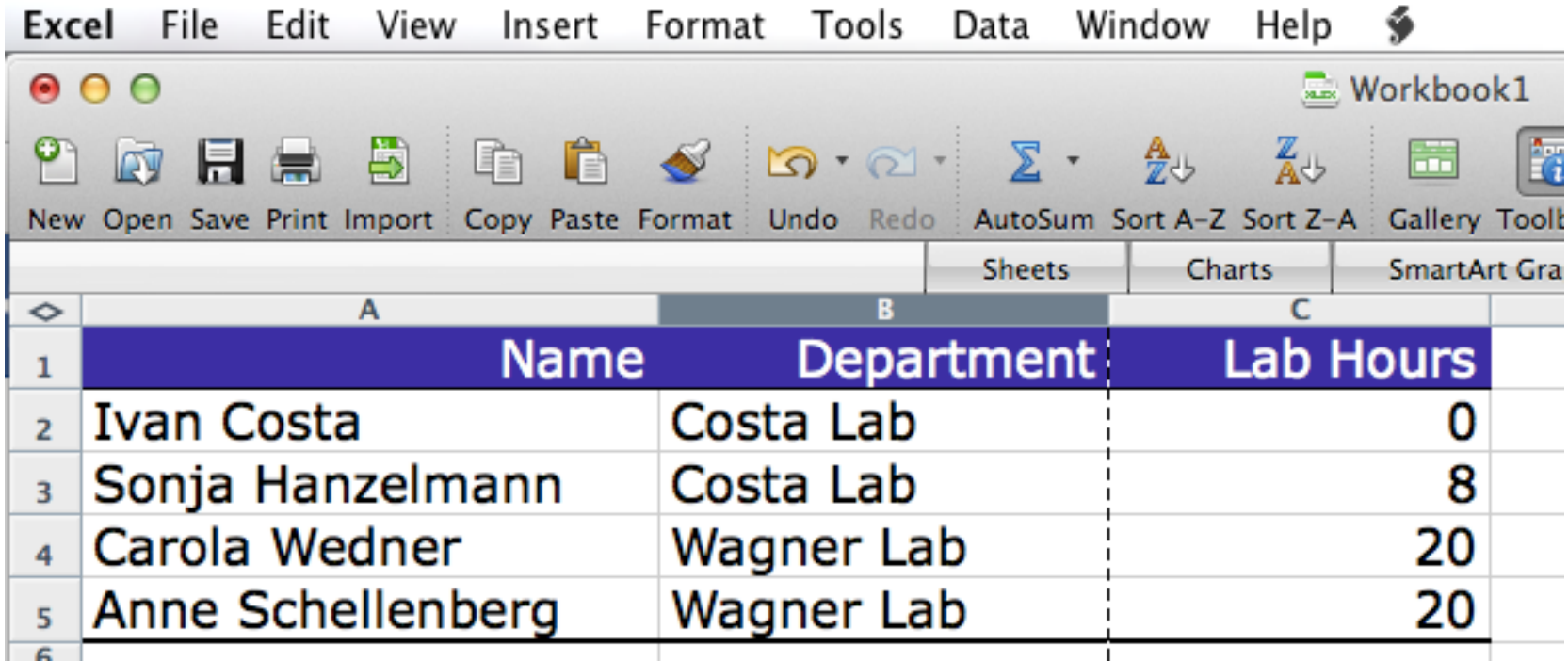

Data Frames

- Data frames are hold a spreadsheet like table. The observations are the rows and the covariates are the columns. Columns share the same type.
- Data frames can be operated as matrices and be indexed with two subscripts.



	A	B	C
1	Name	Department	Lab Hours
2	Ivan Costa	Costa Lab	0
3	Sonja Hanzelmann	Costa Lab	8
4	Carola Wedner	Wagner Lab	20
5	Anne Schellenberg	Wagner Lab	20

Data Frames

- Creation and manipulation

```
>data =data.frame(name=c("Ivan","Sonja","Carola","Anne"),
+ department=c("Costa","Costa","Wagner","Wagner"),
+ labhour=c(0,8,20,20))
> data
    name department labhour
1   Ivan      Costa       0
2  Sonja      Costa       8
3 Carola     Wagner      20
4    Anne     Wagner      20
> data$department
[1] Costa  Costa  Wagner Wagner
Levels: Costa Wagner
```

Data Frames

- Creation and manipulation

```
>data[1,]
 name department labhour
1 Ivan      Costa       0
> data$labhour >8          # lab hours exceeding 8
[1] FALSE FALSE  TRUE  TRUE
> data[data$labhour >8,]  # data from members with more than 8 hours
    name department labhour
3 Carola     Wagner      20
4    Anne     Wagner      20
> data[data$department=="Costa",] # data from members of Costa dept.
 name department labhour
1  Ivan      Costa       0
2 Sonja      Costa       8
```

Functions

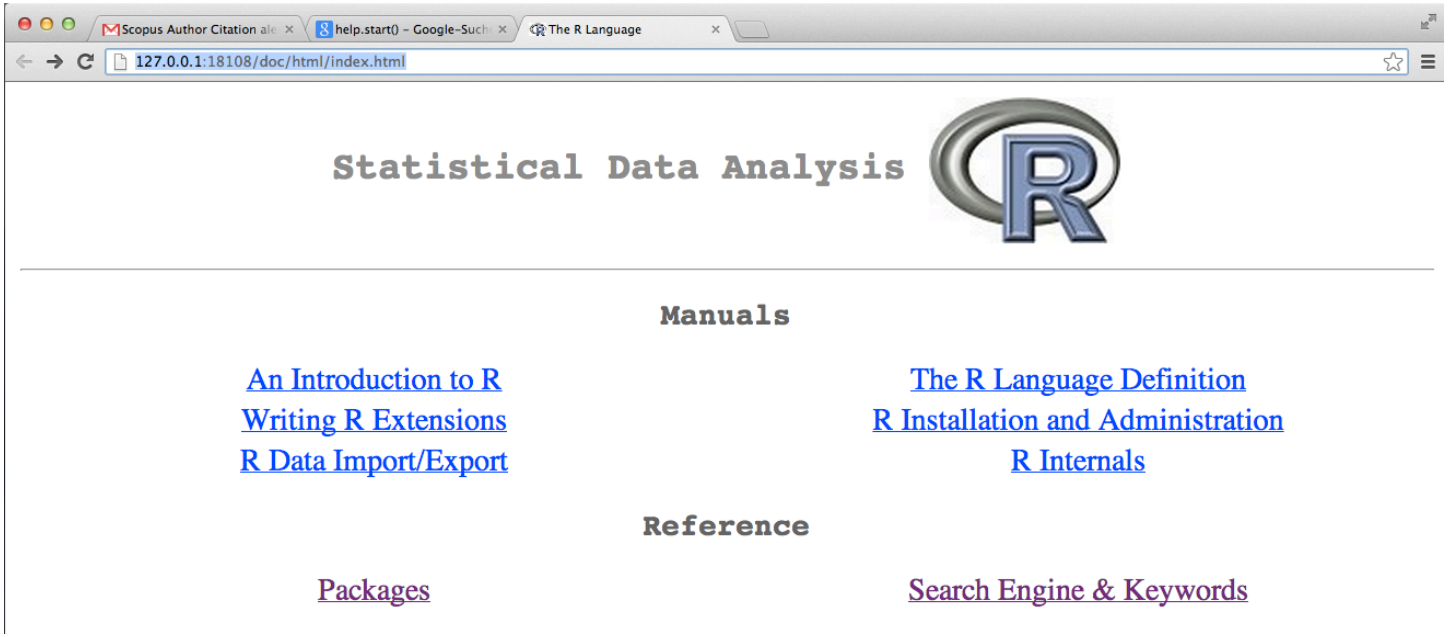
- A section of a program that perform a specific task
  - Takes values as input parameter and returns some new value (or perform a operation)
- R and defines several types of functions
  - math: log, exp, abs, sqrt,…
  - array/matrix manipulation: length, dim, array, repmat,…
  - Read/write files: read.table, write.table, …
- Can be created by user (not seen here) or defined in contributing packages

Example of Functions

```
>log2(4)
[1] 2
>dim(data)                          # size of the data frame
[1] 4 3
>summary(data)                      # statistics of a data frame columns
name    department    labhour
 Anne  :1   Costa :2   Min.   : 0
 Carola:1   Wagner:2   1st Qu.: 6
 Ivan  :1              Median :14
 Sonja :1              Mean   :12
                       3rd Qu.:20
                       Max.   :20
>write.data("mydata.txt",data)   # write data in a .txt file
```

General Commands & Links

>quit() # end R session
>ls() #show all variables currently defined
[1] “x”, “y”, “data”
>help(matrix) #shows help function for the function passed as param.
>help.start() #opens a page with manual, tutorials and help search



Packages

- In R the primary mechanism for distributing software is via packages
- CRAN is the major repository for packages.
- You should use install.packages or update.packages to install and update packages.

```
>install.packages("packagename")   # install a new package
```

- In addition, on Windows and other GUIs, there are menu items that facilitate package downloading and updating.
- Bioconductor packages are installed with biocLite command.

```
>source("http://bioconductor.org/biocLite.R")
>biocLite("packagename")
```

Exercise 1

Create a vector representing the radius of three circles with lengths 5, 10, and 20. Use * and the built-in constant pi to compute the areas of t.

Exercise 1 - Solution

```
> circles <- c(5, 10, 20)
> # areas are:
> pi * circles * circles
[1] 78.53982 314.15927 1256.63706
> # you could also use ^
> pi * circles^2
[1] 78.53982 314.15927 1256.63706
> # reduce radii by 2.1
> pi * (circles - 2.1)^2
[1] 26.42079 196.06680 1006.59770
```

Exercise 2

Creating regular numeric sequences is a common task in statistical computing. You can use the seq function to create sequences.

1. Read the help page for seq by entering help(seq).
2. Generate a decreasing sequence from 50 to 1, then another sequence from 1 to 50.
3. Use seq to generate a sequence of the even integers between one and ten.

Exercise 2 - Solution

```
> seq(50, 1)  #sequences 50 to 1
[1] 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33
[19] 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15
[37] 14 13 12 11 10 9 8 7 6 5 4 3 2 1
> seq(1, 50) # sequences 1 to 50
[1] 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
[19] 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
[37] 37 38 39 40 41 42 43 44 45 46 47 48 49 50
> seq(2, 10, 2) #even integers
[1] 2 4 6 8 10
```

Exercise 3

- Create an integer vector i that can be used to subset v such that it will output the elements of v in decreasing order. For the general case, read the help pages for order and sort.

```
> v = c(1.1, 2, 100, 50, 60)
```

Exercise 3 - Solution

```
> i = c(3, 5, 4, 2, 1)                    #create a vector with right order
> i = order(v, decreasing = TRUE)  # or use sort function to get order
> i;
[1]  3 5 4 2 1
> v[i]                                    # reorder elements from v
[1] 100.0  60.0  50.0   2.0   1.1
```

- More exercises at …

http://www.bioconductor.org/help/course-materials/2010/BioC2010/First_Steps_With_R_SOLUTIONS.pdf