Swiss Paraplegic Research

Workshop – Introduction into R programming for health researchers

R Basics

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Welcome to the workshop!

Lecturers:

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Materials can be found at:

https://github.com/Swiss-Paraplegic-Research/Workshop/

Aims of the workshop

Workshop goals:

- Become familiar with the programming language **R**
- Use **R** (and **RStudio**) to …
  - manipulate
  - visualize
  - analyse

  … your data.

Workshop schedule

Day 1 (Tuesday 11.3)

Topic	Time
R Basics Lecture & Exercise	09:00 – 10:30
R Basics II (Functions) Lecture & Exercise	10:30 – 12:00
Lunch break	
Data Manipulation Lecture & Exercise	13:30 – 15:00

Day 2 (Tuesday 18.3)

Topic	Time
Data Visualisation Lecture & Exercise	09:00 – 10:30
Tidyverse Data Manipulation Lecture & Exercise	10:30 – 12:00
Lunch break	
Statistical Analysis Lecture & Exercise	13:30 – 15:00

R questionnaire

To get an impression of your experience with R, think about the following statements:

- “I have never used R before.”
- “I have used R occasionally but have rather little experience.”
- “I have used R repeatedly and know the basics.”
- “I am proficient in R but would like to get a formal introduction.”

R and RStudio

R is:

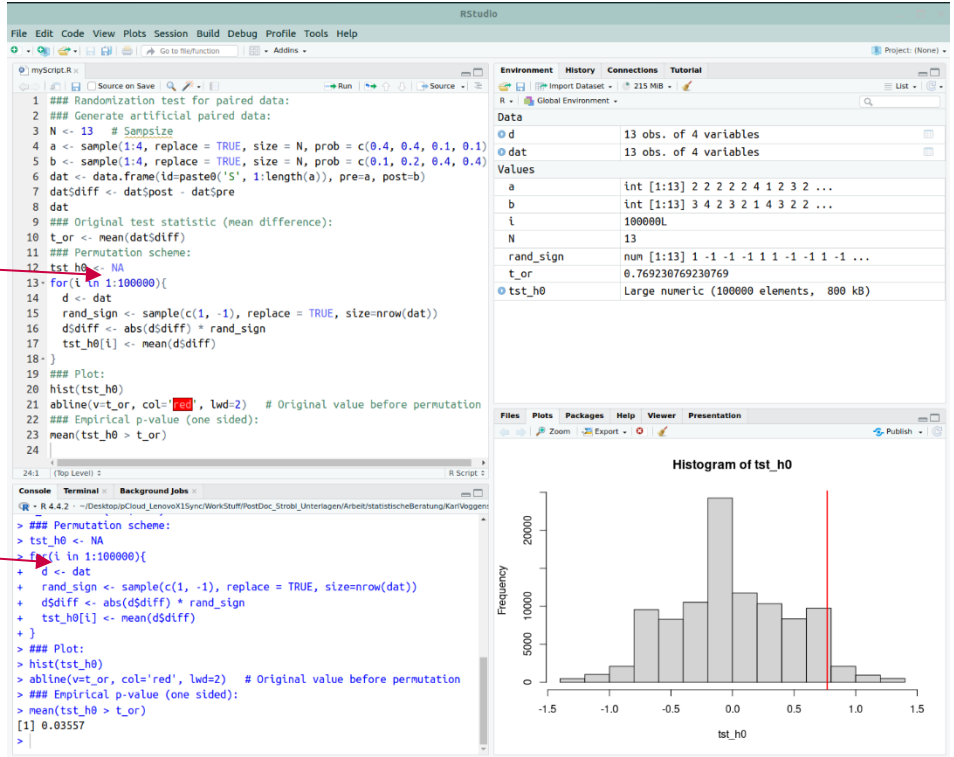
- A programming language for statistical analysis
- Free to use, open-source
- Very flexible (> 10’000 add-on packages)
- Widely used among statisticians

RStudio is:

- An “integrated development environment” (IDE) for R
- Supposed to make working with R more comfortable and efficient

First look at RStudio

- Classically we work in Rstudio in an **R-script**
  - Create new script under "*File > New File > R Script*"
- Execute the code from the script in the **R-console**
  - "Source" to execute the whole script
  - "Run" to execute current line of code (or selection of code)



First look at R code

- Using R as a calculator:

```
> 1 + 1
[1] 2
> 10 * 30
[1] 300
> 10 / 4
[1] 2.5
> 2^3
[1] 8
```

- …and to create objects:

```
> a <- 3
> b <- 24
> a + b
[1] 27
> longName <- 0.4
> b + longName
[1] 24.4
```

- We can use the # symbol to add comments (ignored when executing code)

Vectors (numerical and character)

- A vector in R is a combination of multiple elements and is created with **c()**:

```
> myvec <- c(20, 122, 39)
> myvec
[1] 20 122 39
```

- A vector containing the integers from x to y can be created with **x:y** :

```
> 1:10
[1] 1 2 3 4 5 6 7 8 9 10
```

- Not only numerical values are possible, here an example of a character-vector:

```
> texvec <- c("Random", "two words", "A small sentence")
> texvec
[1] "Random" "two words" "A small sentence"
```

(In a vector all elements must be of the same type)

Vectors (numerical and character)

- We can do calculations with numeric vectors:

```
> vec1 <- 1:3
> vec1
[1] 1 2 3

> vec1 + 10
[1] 11 12 13

> vec2 <- c(0, 100, -100)
> vec2
[1] 0 100 -100

> vec1 + vec2
[1] 1 102 -97
```

```
> vec3 <- vec1 + vec2
> vec3
[1] 1 102 -97
```

Selection of elements in a vector

- When processing data one is often interested in selecting specific elements. Such selections can be performed with the square brackets:

```
> vecA <- c(2, 6, 7, 9)
> vecA
[1] 2 6 7 9
> vecA[2]
[1] 6
```

- We can select multiple elements by passing the indices **as a vector**:

```
> vecA[ c(2, 4) ]
[1] 6 9
```

- Example of a nested call:

```
> s <- c(2, 4)
> vecA[s]
[1] 6 9
```

- We can also use the square brackets to assign new values to elements:

```
> vecA[2] <- 1000
> vecA
[1] 2 1000 7 9
```

Data frames

- Data frames are commonly used to represent tabular data in R. The columns of a data frame are vectors. Data frames can be created with the **data.frame** function:

```
> vecA <- c(2, 6, 7, 9)
> vecB <- c("gut", "schlecht", "mittel", "gut")
> vecC <- c(0.4, 0.2, 0.33, 0.9)
> dat <- data.frame(vecA, vecB, vecC)
> dat
  vecA     vecB vecC
1    2      gut 0.40
2    6 schlecht 0.20
3    7   mittel 0.33
4    9      gut 0.90
```

Selection of elements in data frames

- In a data frame, whole columns can be selected with the **$** sign:

```
> dat
 vecA      vecB vecC
1    2       gut 0.40
2    6 schlecht 0.20
3    7    mittel 0.33
4    9       gut 0.90

> dat$vecC
[1] 0.40 0.20 0.33 0.90

> dat$vecC[1]
[1] 0.40
```

- We can use the **$** sign to add a new column or remove a column:

```
> dat$newCol <- 1:2
> dat
 vecA      vecB vecC newCol
1    2       gut 0.40      1
2    6 schlecht 0.20      2
3    7    mittel 0.33      1
4    9       gut 0.90      2

> dat$vecB <- NULL
> dat
 vecA  vecC  newCol
1    2  0.40      1
2    6  0.20      2
3    7  0.33      1
4    9  0.90      2
```

Selection of elements in data frames

- The square brackets can also be used to directly select elements in a data frame. In that case, the wanted row and column indices are separated by a comma (**rows left, columns right**):

```
> dat
 vecA      vecB vecC
1    2       gut 0.40
2    6 schlecht 0.20
3    7    mittel 0.33
4    9       gut 0.90

> dat[2, 3]
[1] 0.20

> dat[3, 1]
[1] 7
```

- We can leave a side empty to select all rows/columns:

```
> dat[1, ]
  vecA  vecB  vecC
1    2   gut  0.40
> dat[, 1]
[1] 2 6 7 9
> dat[, "vecA"]  # selection with name
[1] 2 6 7 9
```

- To select multiple rows/columns, we again have to supply them as vectors:

```
> dat[ c(1, 4), c(1, 2) ]
vecA      vecB
1    2       gut
4    9       gut
```

Logicals

- Logicals are an important class in R and can only take the values TRUE or FALSE:

```
> Lvec <- c(TRUE, FALSE, TRUE, TRUE)
> Lvec
[1] TRUE FALSE TRUE TRUE
```

- Logicals are the result of logical operators:

```
> 5 > 3
[1] TRUE
> 6 == 5   # is equal to
[1] FALSE
> c(2, 4, 6)  <  4   # applied to a vector
[1] TRUE FALSE FALSE
```

Selection of elements with logicals

- Logicals can be used to select elements:

```
> alter <- c(18, 20, 31, 34)
> alter
[1] 18 20 31 34

> alter[ c(3, 4) ]
[1] 31 34
> alter[ c(FALSE, FALSE, TRUE, TRUE) ]
[1] 31 34
```

- Using a logical operator to create logical vector:

```
> alter > 30
[1] FALSE FALSE TRUE TRUE
```

- Use directly in square brackets:

```
> alter[alter > 30]
[1] 31 34
```

Selection of elements with logicals

- Logicals can be used to select elements:

```
> alter <- c(18, 20, 31, 34)
> alter
[1] 18 20 31 34

> alter[ c(3, 4) ]
[1] 31 34
> alter[ c(FALSE, FALSE, TRUE, TRUE) ]
[1] 31 34
```

Same thing

- Using a logical operator to create logical vector:

```
> alter > 30
[1] FALSE FALSE TRUE TRUE
```

- Use directly in square brackets:

```
> alter[alter > 30]
[1] 31 34
```

Selection of elements with logicals

- Logicals can be used to select **rows in a data frame**:

```
> dat
 vecA      vecB  vecC
1    2       gut  0.40
2    6 schlecht  0.20
3    7    mittel  0.33
4    9       gut  0.90

> dat[c(FALSE, FALSE, TRUE, TRUE), ]
  vecA      vecB  vecC
3    7    mittel  0.33
4    9       gut  0.90
```

- Using a logical operator:

```
> dat[dat$vecA > 6, ]
  vecA      vecB  vecC
3    7    mittel  0.33
4    9       gut  0.90

> dat[dat$vecB == "gut", ]
  vecA     vecB  vecC
1    2      gut  0.40
4    9      gut  0.90
```

Exercise: R basics

- Find the exercise at:

https://github.com/Swiss-Paraplegic-Research/Workshop/**Part1_RBasics/Exercise**