DATA ANALYSIS
WITH R AND THE TIDYVERSE

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2 THE COURSE

- Objectives
  - Powerful data analysis and visualization from little programming skills
- R and the tidyverse
  - R: core statistical software
  - Tidyverse: extensions to R + more readable code
- Content
  - Brief overview of the basics (this document)
  - Tidyverse Tutorial
  - Extra exercises

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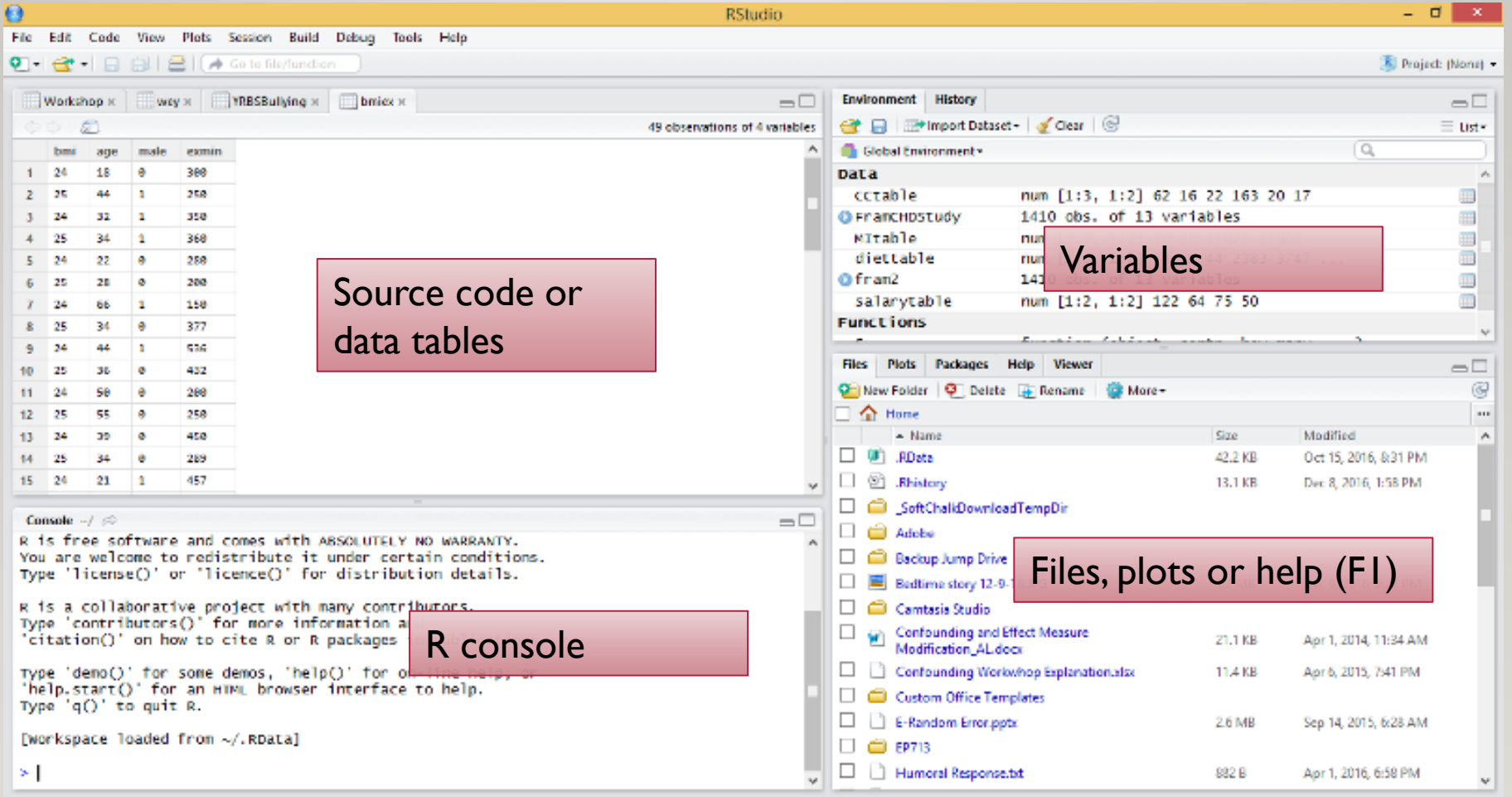
BRIEF OVERVIEW OF THE BASICS IN R

4 R STUDIO INTERFACE



5 TIPS

- The # symbol indicates to R that what follows is a comment
- Commands are separated by a new line
  - Lists, piped commands and content within parentheses or brackets can be spread over different lines
- Parentheses and brackets must be closed
- R is case sensitive

```
# LOAD LIBRARY
library(tidyverse)

# LOAD AND DISPLAY TABLE
column_names <- c("probe_id", "expression", "present")

cd103minus <- read_tsv(
  "file.tsv",
  col_names=column_names
)

cd103minus %>%
  select(probe_id, expression) %>%
  head()
```

6 TIPS

- Some keyboard shortcuts
  - **[TAB]** for text auto-completion of function or object names
  - **[CTRL]+[ENTER]** to run the selected lines from the code editor to the console
  - **[ALT]+[-]** to insert assignment symbols (**<-**)
  - **[CTRL]+[SHIFT]+[m]** to insert the pipe symbols (**%>%**)
  - In the console, use arrow keys to traverse through the history of commands
    - "Up arrow" – traverse backwards (older commands)
    - "Down arrow" – traverse forward (newer commands)

7 AS CALCULATOR

Symbol	Meaning
+	add
-	subtract
*	multiply
/	divide
^	power (e.g. 2^3 is equal to 8)

- Simple operations
  - 1+3 # will return 4
- Statistical functions
  - sqrt(81) # will the square root of 81 that is 9
  - 1 + abs(-4) # will return absolute value of -4 plus 1 = 5
- The Order of Operations
  - Do calculations inside Parentheses first
    - $6 \times (5 + 3) = 6 \times 8 = 48$
  - Then compute Exponents (Powers, Roots) before multiplication and division
    - $5 \times 2^2 = 5 \times 4 = 20$
  - Then Multiply or Divide (before you Add or Subtract)
    - $2 + 5 \times 3 = 2 + 15 = 17$
  - Otherwise just go left to right

8 OBJECTS AND VARIABLES

- R stores everything in objects having defined types
- Some common object types
  - numeric (e.g. 1, 25.5, 1e-6)
  - character (e.g. “ABCD”, “Hello World 24!”)
  - logical (TRUE or T, FALSE or F, NA for not applicable))
  - factor: categorical values (numeric index associated to character labels)
  - vector: used to store a set of objects
  - function: (e.g. library, abs, sqrt)
- Variables
  - Names to remember and reuse objects
  - `x <- 2 #` variable x is assigned value 2
- The class function returns the type
  - class(x) # R returns "numeric"
  - class("ABC") # R returns “character"

9 VECTORS

```
# Vector of 4 numeric objects
x <- c(1.2, # 1st object
       2.3, # 2nd object
       0.2, # 3rd object
       1.1) # 4th object

# Indexing some values
X                  # 1.2 2.3 0.2 1.1
x[1]               # 1.2
x[ length(x) ]     # 1.1
x[3]               # 0.2
x[ c(2,3,4) ]      # 2.3 0.2 1.1
x[ 2:4 ]           # 2.3 0.2 1.1
```

10 TABLES

- Several types of tables
- matrix - table of objects of the same type
- data.frame - table of objects of same or different types
- tibble – extension of data.frame for working with large tables
  - tibbles have a refined print method (default few rows and columns fit screen)
  - each column reports its type
    - numerics may be detailed as integers (int) or double precision values (dbl)

TABLES

TABLE [ROW, COL]

TABLE$COL[ROW]

```
df <- data_frame(
    x = 1:5, y = 1, z = x^2+y
)
df
```

```
# A tibble: 5 x 3
      x     y     z
  <int> <dbl> <dbl>
1     1     1     2
2     2     1     5
3     3     1    10
4     4     1    17
5     5     1    26
```

```
df[1,1] # 1
df[1,2] # 1
df[1,3] # 2
df[1,] # 1 1 2
df[1,3] # 2
df[2,3] # 5
df[,3] # 2 5 10 17 26
df$z   # 2 5 10 17 26
df[ 4:5 , 1:2 ]
# A tibble: 2 x 2
      x     y
  <int> <dbl>
1     4     1
2     5     1
```

12 FOR LOOPS

```
# Vector of character objects
x <- c("file1.csv", # 1st object
       "file2.csv", # 2nd object
       "file3.csv") # 3rd object

# Looping on some values
for(my_file in x){
    text <- paste("We have", my_file)
    print(text)
}
```

```
[1] "We have file1.csv"
[1] "We have file2.csv"
[1] "We have file3.csv"
```

13 LOGICAL OPERATIONS

```
1<2                          # TRUE

! (1<3)                      # FALSE (logical NOT: !)

1 != 3                       # TRUE

(3 != 1) & (2 >= 1.9)        # TRUE  (logical AND: &)

(3 == 1) | (3 < 5)           # TRUE  (logical OR: |)

y <- c(TRUE, FALSE, 5>2)

Y                            # TRUE FALSE TRUE
```

Symbol	Meaning
==	logical equals
!=	not equal
!	logical NOT
&	logical AND
|	logical OR
<	less than
<=	less than or equal to
>	greater than
>=	greater than or equal to

Command	Result
TRUE	TRUE
FALSE	FALSE
! TRUE	FALSE
! FALSE	TRUE
TRUE & TRUE	TRUE
TRUE & FALSE	FALSE
FALSE & FALSE	FALSE
TRUE | TRUE	TRUE
TRUE | FALSE	TRUE
FALSE | FALSE	FALSE

14 SOME USEFUL FUNCTIONS

For more details see help pages

- Table statistics
  - rownames(x)
  - colnames(x)
  - dim(x) – number of rows and columns
  - summary(x) – summary statistics
- Table join / merge
  - left_join()
  - full_join()
  - rbind() – add rows (base R)
  - cbind() – add columns (base R)
- Statistics
  - length(x)
  - max(x)
  - min(x)
  - sum(x)
  - mean(x)
  - median(x)
  - var(x)
  - sd(x)
  - cor() – correlation coefficient
  - t.test() – Student's t-test
- Other
  - seq() – sequence of numbers

R TUTORIAL

LINK TO TUTORIAL AND DATA FILES AVAILABLE AT:

HTTPS://CBDM.UNI-MAINZ.DE/MB21/