

Interuniversity Institute for Biostatistics
and statistical Bioinformatics

An introduction to R: Basic skills in R Studio and R Markdown

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Updated: 07/25



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Overview

- R Studio/R markdown.
- How to produce output using R markdown ?
- How to develop output using R markdown ?
- Main concept:
 - we run the same analysis multiple times and show how to produce different type of output.
- Analysis:
 - simple plot + simple linear regression.

Rmd programs for the class today

- To run the analysis presented in the slides you need the following Rmd programs:

Dataset	Rmd file	Output
mtcars	R_course_UHasselt_demo_V0.Rmd	R code in a RMakdown file
mtcars	R_course_UHasselt_demo_V1.Rmd	Produce simple HTML/PDF output for a report
Airquality	R_course_UHasselt_2021(html)_V1.Rmd	Produce a HTML output (example how to work with R markdown)
Airquality	R_course_UHasselt_2021(pdf)_V1.Rmd	Produce HTML/PDF output
Old Faithful	R_course_UHasselt_2021(pdf)_V2.Rmd	A report for an example of a simple analysis (HTML/PDF)

See later in the slides how these files are used and which type of output can be produced.

R Studio

What is R Studio ?

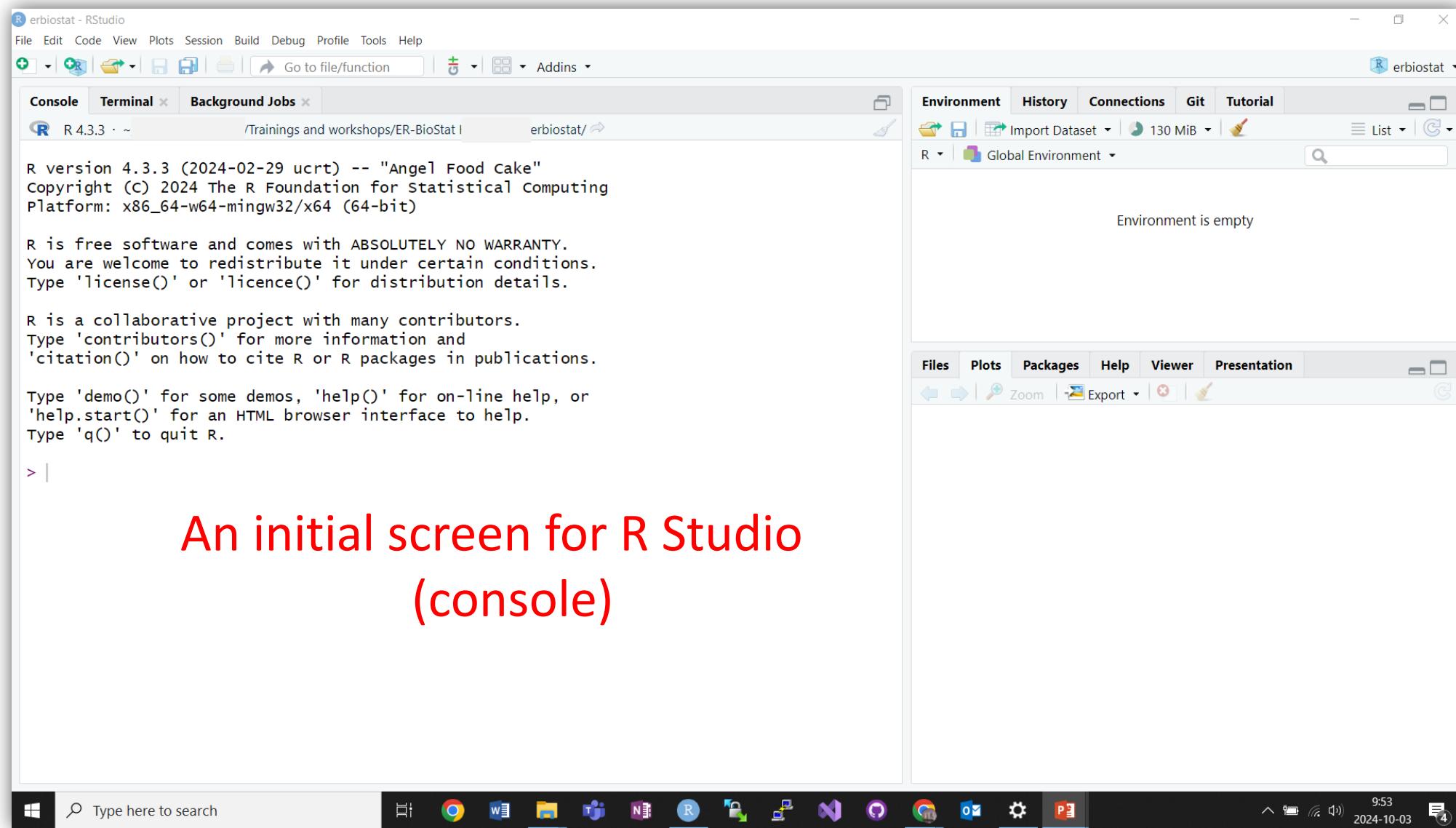
- R Studio is an integrated development environment (IDE) for R and Python.
 - It includes a **console, syntax-highlighting editor** that supports direct code execution.
 - Tools for plotting, history, debugging and workspace management.
- R Studio is available in **open source** and **commercial** editions and runs on the desktop (Windows, Mac, and Linux).

What is R Studio ?

- More information:

<https://rstudio.com/products/rstudio/>

R Studio



An initial screen for R Studio
(console)

Load data in RStudio

The screenshot shows the RStudio interface. On the left, the 'Source' tab of the 'Kenya2025_SurvivalWorkshop.Rmd' file is open, displaying R code for setting up a workshop. On the right, the 'Environment' tab is active, showing an 'Environment is empty' message. A red box highlights the 'Import Dataset' dropdown menu, which includes options: 'From Text (base)...', 'From Text (readr)...', 'From Excel...', 'From SPSS...', 'From SAS...', and 'From Stata...'. Below the environment, the 'Files' tab is selected, showing a single project folder named 'WorkshopKE25.Rproj'.

```
1 ---  
2 ---  
3 title: "Survival Analysis and Machine Learning Workshop"  
4 author: "Kenya 2025 - Hogan, Mwangi, Mugo, Okutse, Shkedy"  
5 date: "14-17 July 2025"  
6 output: html_document  
7 ---  
8  
9 `r setup, include=FALSE}  
10 knitr::opts_chunk$set(echo = TRUE)  
11 knitr::opts_knit$set(root.dir = "C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025")  
12 library(survival)  
13 library(splines)  
14 library(dplyr)  
15  
16 ...  
17  
18 # Load data  
19 `r{  
20 # Load the dataset (htn_dat must be preloaded or attached)  
21:26 C Chunk 2
```

R 4.4.2 · C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/WorkshopKE25/

```
n_dat.csv': No such file or directory> Error in file(file, "rt") : cannot open the connection> # Load the dataset (htn_dat must be preloaded or attached)  
> htn_dat <- read.csv("C:\\\\Users\\\\Lenovo\\\\Desktop\\\\Bernard Osangir\\\\Workshop KE25\\\\EldoretShortCourse2025\\\\Data For2025\\\\htn_dat.csv")  
Warning in file(file, "rt") :  
  cannot open file 'C:\\\\Users\\\\Lenovo\\\\Desktop\\\\Bernard Osangir\\\\Workshop KE25\\\\EldoretShortCourse2025\\\\DataFor2025\\\\htn_dat.csv': No such file or directoryError in file(file, "rt") : cannot open the connection  
> library(readxl)  
> htn_dat_csv <- read_excel("C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv.xlsx")  
> View(htn_dat_csv)  
> library(readxl)  
> htn_dat_csv <- read_excel("C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv.xlsx")  
> remove(htn_dat_csv)  
> |
```

13°C Deels bewolkt 23:53 8 13/07/2025

Load data in RStudio

R WorkshopKE25 - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Kenya2025_SurvivalWorkshop.Rmd*

Import Excel Data

Source Vis

File/URL: C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv.xlsx

Browse...

Data Preview:

DBP (double)	SBP (double)	BMI (character)	age (double)	married (character)	male.gender (double)	hgb_centered (character)	adv_HIV (character)	survtime (double)	event (double)	arv_naive (double)	urban.clinic (double)
60	90	NA	28.00000	0.0		0	NA	NA	338	1	1
75	110	27.3399124	26.45859	1.0		0	-3.8999996	0.0	439	1	1
60	80	17.6897888	42.95140	0.0		0	-3.1999998	NA	752	1	1
60	90	19.8540802	50.14921	1.0		1	NA	NA	526	1	1
60	100	21.2952938	30.55441	0.0					215	1	1
60	120	16.8801937	20.37235	1.0					272	1	1
59	100	22.0385666	28.79398	0.0		0	NA	NA	1669	1	1
60	100	21.5800419	49.15263	0.0		1	0.8000002	NA	388	1	0
70	120	19.0677109	29.70568	1.0		0	-1.0	NA	14	1	1
58	110	26.0583534	28.20808	1.0		0	NA	NA	419	1	1
60	100	16.6524944	45.72485	0.0		0	NA	1.0	445	1	1
...

DATA

Console Te

R 4.4.2

n_dat.csv

(htn_dat
> htn_dat
For2025\\h
Warning in
cannot d
n_dat.csv
> library
> htn_dat
or2025\\ht
> View(ht
> library
> htn_dat
or2025\\htn_dat.csv.xlsx
> remove(htn_dat_csv)
> |

Import Options:

Name: htn_dat_csv Max Rows: First Row as Names

Sheet: Default Skip: 0 Open Data Viewer

Range: A1:D10 NA:

Code Preview:

```
library(readxl)
htn_dat_csv <- read_excel("C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25
/ElodretShortCourse2025/DataFor2025/htn_dat.csv.xlsx")
View(htn_dat_csv)
```

CODE

Import Cancel

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ENG

23:53

13/07/2025

Load data in RStudio

The screenshot shows the RStudio interface with two main panels and a console.

Left Panel (Data View): Displays a data frame titled "htn_dat_csv" with 13 rows and 15 columns. The columns are labeled: DBP, SBP, BMI, age, married, male.gender, hgb_centered, adv_HIV, survtime, event, and arv_naive. A blue box highlights the word "DATA".

	DBP	SBP	BMI	age	married	male.gender	hgb_centered	adv_HIV	survtime	event	arv_naive
1	60	90	NA	28.00000	0.0		0	NA	NA	338	1
2	75	110	27.3399124	26.45859	1.0		0	-3.8999996	0.0	439	1
3	60	80	17.6897888	42.95140	0.0		0	-3.1999998	NA	752	1
4	60	90	19.8540802	50.14921	1.0		1	NA	NA	526	1
5	60	100	21.2952938	30.55441	0.0		1	-0.3999996	NA	215	1
6	60	120	16.8801937	20.37235	1.0		0	-4.0	NA	272	1
7	59	100	22.0385666	28.79398					1669		
8	60	100	21.5800419	49.15263					388		
9	70	120	19.0677109	29.70568	1.0		0	-1.0	NA	14	1
10	58	110	26.0583534	28.20808	1.0		0	NA	NA	419	1
11	60	100	16.6524944	45.72485	0.0		0	NA	1.0	445	1
12	60	120	23.0681953	40.53114	1.0		1	-3.9300003	1.0	914	1
13	53	127	21.989893	32.91992	1.0		0	-1.3000002	1.0	23	1

Showing 1 to 13 of 4,999 entries, 15 total columns

Right Panel (Environment View): Shows the "htn_dat_csv" data object in the Global Environment. It contains 4999 observations and 15 variables. A blue box highlights the word "DATA OBJECT".

Console: Displays R code for loading the data. A blue box highlights the word "OPERATION".

```
R - R 4.4.2 · C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/WorkshopKE25/htn_dat.csv
Warning in file(file, "rt") :
  cannot open file 'C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv': No such file or directory
Error in file(file, "rt") : cannot open the connection
> library(readxl)
> htn_dat_csv <- read_excel("C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv.xlsx")
> View(htn_dat_csv)
> library(readxl)
> htn_dat_csv <- read_excel("C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv.xlsx")
> remove(htn_dat_csv)
> library(readxl)
> htn_dat_csv <- read_excel("C:/Users/Lenovo/Desktop/Bernard Osangir/Workshop KE25/EldoretShortCourse2025/DataFor2025/htn_dat.csv.xlsx")
> View(htn_dat_csv)
> |
```

13°C Deels bewolkt 23:53 13/07/2025

Load data in RStudio

The screenshot shows the RStudio interface with the following components:

- Top Bar:** Shows the title "WorkshopKE25 - RStudio" and a menu bar with File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Source Editor:** Displays an R Markdown script named "Kenya2025_SurvivalWorkshop.Rmd". The code includes library imports for survival, splines, and dplyr, followed by code to load a dataset from a CSV file named "htn_dat_csv".
- R Console:** Shows the output of the R session, including the structure of the loaded dataset "htn_dat".
- Environment Tab:** Shows two objects: "htn_dat" and "htn_dat_csv", both with 4999 observations and 15 variables.
- File Explorer:** A sidebar showing the file structure of the current workspace. A blue arrow points to the "Import Dataset..." option under the "htn_dat" folder, which is highlighted with a red box. A blue callout bubble labeled "DIRECTORY" is positioned above the file tree.
- Bottom Status Bar:** Includes icons for search, file operations, and system status (13°C, Deels bewolkt, ENG, battery level, 23:55, 13/07/2025).

The cars dataset in R

The data give the speed of cars and the distances taken to stop. Note that the data were recorded in the 1920s.

Two variables:

- Cars' speed.
- Cars' stopping distance.

```
> head(cars)
```

	speed	dist
--	-------	------

1	4	2
2	4	10
3	7	4
4	7	22
5	8	16
6	9	10

R Studio: example

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File Edit Code View Plots Session Build Debug Profile Tools Help

Console Terminal Background Jobs

R 4.3.3 · ~/Bernard OSANG'IR/Trainings and workshops/ER-BioStat Kenya 2024/erbiostat/

```
R version 4.3.3 (2024-02-29 ucrt) -- "Angel Food Cake"
Copyright (C) 2024 The R Foundation for statistical computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> plot(cars$speed, cars$dist)
>
```

A plot in R Studio

- The **cars** dataset.
- Plot of the car's speed versus stopping distance.

Plot Zoom

plot (x, y)

The scatter plot shows the relationship between car speed (x-axis, ranging from 5 to 25) and stopping distance (y-axis, ranging from 0 to 120). The data points show a positive correlation, with higher speeds generally corresponding to greater stopping distances. A red annotation 'plot (x, y)' is overlaid on the plot area.

cars\$dist

cars\$speed

Version

- 1.50.0
- 1.4-5
- 1.1-4.1
- 1.7-22
- 0.35
- 0.1-2
- 0.17-6
- 1.64.1

Type here to search

10:26
2024-10-03

R: example

The screenshot shows the RGui interface with three windows:

- R Console**: Displays the R startup message and a command line:

```
R version 4.3.3 (2024-02-29 ucrt) -- "Angel Food Cake"  
Copyright (C) 2024 The R Foundation for Statistical Computing  
Platform: x86_64-w64-mingw32/x64 (64-bit)  
  
R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.  
  
R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.  
  
Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.  
  
[Previously saved workspace restored]  
  
> plot(cars$speed, cars$dist)
```
- Untitled - R Editor**: Shows the R code: `plot(cars$speed, cars$dist)`
- R Graphics: Device 2 (ACTIVE)**: Displays a scatter plot of stopping distance versus speed. The x-axis is labeled "cars\$speed" and ranges from 5 to 25. The y-axis is labeled "cars\$dist" and ranges from 0 to 120. The plot shows a positive correlation.

A similar plot in R

• The `cars` dataset.
• Plot of the car's speed versus stopping distance.

`plot(x, y)`



General structure of R

- R Functions.
 - `glm()` or `plot(x, y)`
- R packages (written by developers) as a part of the software:
 - `utils::`
- R packages (written by developers) uploaded in CRAN, Bioconductor, Github....
 - `ggplot2::`
- R packages (written by the user=you).

R functions

Example:

```
function (data)
```

```
> var (x)
```

The R function

data

A procedure that was programmed in R that uses data to produce output.

Calculate the sample variance.

$$s^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2$$

R packages

- A package in R: a **collection of functions** that can be used for analysis or data management.
- Example: the `nlme` package for linear mixed models.
- Some packages are included in R, and some can be installed from CRAN/Bioconductor.
- **CRAN**: website with R packages ready to be installed and used.

<https://cran.r-project.org/>

R Studio: packages

The screenshot shows the R Studio interface. The console window displays the R startup message and a command to plot cars data. A red arrow points from the text "Upload new a package to R Studio" to the "Install Packages" dialog box. A callout box contains the text: "If you try to run the Rmd programs, you will probably need to install some packages." The environment pane shows an empty global environment. The packages pane shows a list of available packages in the user library.

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File Edit Code View Plots Session Build Debug Profile Tools Help

Console Terminal x Background Jobs x

R version 4.3.3 (2024-02-29 ucrt) -- "Angel Food Cake"
Copyright (c) 2024 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
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R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> plot(cars\$speed, cars\$dist)

> |

Upload new a package to R Studio

If you try to run the Rmd programs, you will probably need to install some packages.

Install Packages

Install from: Repository (CRAN)

Packages (separate multiple with space or comma):

Install to Library: C:/Users/bosangir/AppData/Local/R/win-library/4.3 [Default]

Install dependencies

Install Cancel

erbiostat

Environment History Connections Git Tutorial

Import 161 MiB List

Global Environment

Environment is empty

File Plots Packages Help Viewer Presentation

Install Update Name Description Vers...

User Library

Name	Description	Vers...
a4Core	Automated Affymetrix Array Analysis Core Package	1.50.0
abind	Combine Multidimensional Arrays	1.4-5
additivity...	Additivity Tests in the Two Way Anova with Single Sub-Class Numbers	1.1-4.1
ade4	Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences	1.7-22
admisc	Adrian Dusa's Miscellaneous	0.35
alluvial	Alluvial Diagrams	0.1-2
analogue	Analogue and Weighted Averaging Methods for Paleoenvironmental	0.17-6

10:41 2024-10-03

Example 1

The mtcars data

Part 1: R and R Studio

- Example of a data analysis: the `mtcars` data.
 - Use `help(mtcars)` to get information about the data.
-
- ✓ Running the analysis in R.
 - ✓ Running the analysis in R-Studio.

The mtcars data: analysis in R

- Use `help(mtcars)` in R.

The screenshot shows an R session in RGui (64-bit) with the following details:

- R Console:** Displays the R environment, including the R version (4.3.3), copyright information, and a history of commands entered by the user. The user has run `> help(mtcars)`, which has started an httpd help server.
- R Help Window:** Titled "R: Motor Trend Car Road Tests", it shows the documentation for the "mtcars" dataset. The "Description" section states: "The data was extracted from the 1974 *Motor Trend* US magazine, and comprises fuel consumption and 10 aspects of automobile design and performance for 32 automobiles (1973–74 models)." The "Format" section describes it as "A data frame with 32 observations on 11 (numeric) variables." Below this, a list of variables is provided, each preceded by a red arrow pointing to the text "Description of the data in the help system." The variables listed are: [, 1] mpg Miles/(US) gallon, [, 2] cyl Number of cylinders, [, 3] disp Displacement (cu.in.), [, 4] hp Gross horsepower, [, 5] drat Rear axle ratio, [, 6] wt Weight (1000 lbs), [, 7] qsec 1/4 mile time, [, 8] vs Engine (0 = V-shaped, 1 = straight), [, 9] am Transmission (0 = automatic, 1 = manual), [,10] gear Number of forward gears, and [,11] carb Number of carburetors.

Description of the data in the help system.

The mtcars data in R

```
> head(mtcars)
```

		mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda	RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
Mazda	RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
Datsun	710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
Hornet	4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
Hornet	Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
Valiant		18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

- 
- Variables in the data.
 - For our example: mpg and wt.

Analysis

- Plot mpg Vs. weight.
- Calculate the mean weight.
- Fit a simple regression model for mpg on Weight.

To run the analysis in the example, use the program in R Studio:

[R_course_UHasselt_demo_V0.Rmd](#)

Analysis in basic R & output

RGui (64-bit)

File History Resize Windows

R Console

```
> plot(mtcars$wt, mtcars$mpg)
> mean(mtcars$mpg)
[1] 20.09062
> fit.lm<-lm(mtcars$mpg~mtcars$wt)
> summary(fit.lm)

Call:
lm(formula = mtcars$mpg ~ mtcars$wt)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.5432 -2.3647 -0.1252  1.4096  6.8727 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 37.2851    1.8776 19.858 < 2e-16 ***
mtcars$wt   -5.3445    0.5591 -9.559 1.29e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared:  0.7528, Adjusted R-squared:  0.7497 
F-statistic: 91.38 on 1 and 30 DF,  p-value: 1.294e-16
```

Untitled - R Editor

```
summary(mtcars)
plot(mtcars$wt, mtcars$mpg)
mean(mtcars$mpg)
fit.lm<-lm(mtcars$mpg~mtcars$wt)
summary(fit.lm)
```

see next slide

R Graphics: Device 2 (ACTIVE)

The estimated model

Windows Taskbar: Type here to search, Chrome, File Explorer, Microsoft Teams, Lock, Start, R, 11:25, 2024-10-03

The R code for the analysis

```
summary(mtcars)
plot(mtcars$wt,mtcars$mpg)
mean(mtcars$mpg)
fit.lm<-lm(mtcars$mpg~mtcars$wt)
summary(fit.lm)
```

The regression output

fit a simple linear regression model

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$$

mtcars\$mpg
response

mtcars\$wt
predictor

The mtcars data: an analysis in R Studio

The screenshot shows the R Studio interface with the following components:

- Source Editor:** Displays an R Markdown file named "R_Course_UHasselt_demo_V0.Rmd". The code is annotated with a red box highlighting the following lines:

```
18 summary(mtcars)
19 plot(mtcars$wt,mtcars$mpg)
20 mean(mtcars$mpg)
21 fit.lm<-lm(mtcars$mpg~mtcars$wt)
22 summary(fit.lm)
```

A red arrow points from the text "The R code" to this highlighted section.
- Console:** Shows the output of the R code:

```
(Intercept) 37.2851 1.8776 19.858 < 2e-16 ***
mtcars$wt -5.3445 0.5591 -9.559 1.29e-10 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared: 0.7528, Adjusted R-squared: 0.7446
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10
```
- Environment:** Shows the global environment with an object named "fit.lm" which is a "List of 12".
- Packages:** Shows the user library with various packages installed, such as a4Core, abind, additivityT... , ade4, admisc, alluvial, analogue, and Annotatio... .

The mtcars data : an analysis in R Studio

The screenshot illustrates the workflow for analyzing the mtcars dataset in R Studio. On the left, the R Markdown source code is shown, containing setup code for a presentation and the main analysis. A red arrow points from the code area to a context menu that appears when the 'Run' button is clicked. This menu includes options like 'Run Selected Line(s)', 'Run Current Chunk', and 'Run All'. A second red arrow points from the bottom of this menu down to the RStudio interface. Below the code editor, the 'Console' tab shows the output of the R code, including statistical summaries and regression results. A blue box highlights the text 'The R code' over the source code area. Another blue box highlights 'The output' over the console output area. The right side of the interface shows the 'Environment' tab with the 'fit.lm' object listed, and the 'Packages' tab showing a list of installed packages.

The R code

```
1 ---  
2 title: "Demo 1"  
3 author: "Rudradev Sengupta, Bernard Osang'ir & Ziv Shkedy"  
4 date: "01/10/24"  
5 output:  
6   html_document: default  
7   word_document: default  
8   pdf_document: default  
9 params:  
10   snapshot: "lubridate::ymd_hms(\"2015-01-01 12:30:00\")"  
11   start: "lubridate::ymd(\"2015-01-01\")"  
12 ---  
13  
14 {r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16  
17  
18 summary(mtcars)  
19 plot(mtcars$wt,mtcars$mpg)  
20 mean(mtcars$mpg)  
21 fit.lm<-lm(mtcars$mpg~mtcars$wt)  
22 summary(fit.lm)
```

The output

```
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
Residual standard error: 3.046 on 30 degrees of freedom  
Multiple R-squared:  0.7528, Adjusted R-squared:  0.7446  
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10
```

Analysis in R Studio: the output

R erbiostat - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

R_Course_UHasselt_demo_V0.Rmd* Knit on Save ABC Knit Addins

Source Visual

```
1 ---  
2 title: "Demo 1"  
3 author: "Rudradev Sengupta, Bernard Osang'ir & Ziv Shmilovici"  
4 date: "01/10/24"  
5 output:  
6   html_document: default  
7   word_document: default  
8   pdf_document: default  
9 params:  
10  snapshot: "lubridate::ymd_hms('2015-01-01 12:30:00')"  
11  start: "lubridate::ymd('2015-01-01')"  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ``  
17  
18 summary(mtcars)  
19 plot(mtcars$wt, mtcars$mpg)  
20 mean(mtcars$mpg)  
21 fit.lm<-lm(mtcars$mpg~mtcars$wt)  
22 summary(fit.lm)
```

22:16 (Top Level) code

Console Terminal Background Jobs

R 4.3.3 · ~/Bernard OSANG'IR/Trainings and workshops/ER-BioStat Kenya 2024/erbiostat/

	Min	1Q	Median	3Q	Max
mtcars\$wt	-4.5432	-2.3647	-0.1252	1.4096	6.8727

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	37.2851	1.8776	19.858	< 2e-16 ***
mtcars\$wt	-5.3445	0.5591	-9.559	1.29e-10 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared: 0.7528, Adjusted R-squared: 0.7446
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10

Plot Zoom

mtcars\$mpg

mtcars\$wt

The estimated model

Environment History Connections Git Tutorial

Import Dataset 186 MiB List

Data fit.lm List of 12

Global Environment

Files Plots Packages Help Viewer Presentation

Zoom

Graphical window

12:14 2024-10-03

R Studio

- So far, R Studio (in this setting): similar to R BUT....
- R Studio + R markdown: a different level of output.

R markdown

R markdown: what?

- Markdown allows you to write a file format independent document using an **easy-to-read** and **easy-to-write** plain text format.
- Instead of marking up text so that is easy for a computer to read
 - e.g. HTML: <html><body>Name</body></html>
- The goal is to mark down the text so that it is easy and human-readable (instead of machine-readable):
 - e.g. ****Name****
- The most easy way to understand it: R markdown allows us to write free text and run R together in the same file.

R markdown: what?

- Markdown is a specific Markup language which is structured very loosely
=> any file format can be generated using pandoc.
- Pandoc: R function to convert documents To other formats.
- From one Markdown document you can generate different file formats:
 - **HTML**
 - **PDF**
 - **Docx**
 - **slideshows**
 - **rtf, etc.**
- The downside is that there is slightly less control over formatting.

R markdown: what?

- Extension of Markdown via R:
 - Allowing *R code* and its *results* to be merged with Markdown.
 - Ensuring that *R Markdown documents are fully reproducible*.
 - Enabling extra modifications to the original markdown specification.
- Provides a *unified authoring framework for data science*, combining your code, its results, etc.
- In practice: just by changing the dataset, the entire analysis can be rerun, and the new report can be produced.
- Integrates a number of R packages and external tools.

R markdown: what?

- A lot of online materials.
- RMarkdown Cheat Sheet: *Help > Cheatsheets > R Markdown Cheat Sheet* (<https://www.rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf>)
- RMarkdown Reference Guide: *Help > Cheatsheets > R Markdown Reference Guide*
- Both cheatsheets are also available at <http://rstudio.com/cheatsheets>
- *Help > Markdown Quick Reference*

The R markdown program: components

The screenshot shows the RStudio interface with an R Markdown file named 'demo.Rmd' open. The file contains the following content:

```
1 ---  
2 title: "Demo"  
3 author: "Rudradev Sengupta"  
4 date: "16 July 2019"  
5 output: html_document  
6 ---  
7  
8 ```{r setup, include=FALSE}  
9 knitr::opts_chunk$set(echo = TRUE)  
10  
11 ## R Markdown  
12  
13 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
14  
15 when you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:  
16  
17 ```{r cars}  
18 summary(cars)  
19  
20 ## Including Plots  
21  
22 You can also embed plots, for example:  
23  
24 ```{r pressure, echo=FALSE}  
25 plot(pressure)  
26  
27 Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.  
28  
29  
30
```

Annotations with arrows point to specific parts of the code:

- A bracket labeled "YAML Header" points to the YAML header at the top.
- A bracket labeled "Formatted Text" points to the explanatory text and the "Including Plots" section.
- A bracket labeled "R code" points to the R code chunks, specifically the `summary(cars)` and `plot(pressure)` lines.
- A bracket labeled "Code Chunks" points to the code blocks indicated by the triple backticks.

The RStudio interface also shows the console output at the bottom, which includes the command used to run pandoc and the resulting output file 'demo.html'.

There are principally three sections to an R Markdown document:

- YAML header surrounded by `---`
- Code chunks surrounded by `````
- Free text mixed with simple text formatting like `#heading` and `_italics_`

Starting point

- Available materials to try out:
 - <https://teams.microsoft.com/#/files/Reference%20Material?threadId=19:05ec12c79df7460ca9cdfbd8b620f16a@thread.skype&ctx=channel&context=Rmarkdown%2520Help%252FAssignment%25206> – templates by Stefan to create pdf/html/.. documents
 - <https://teams.microsoft.com/#/files/Reference%20Material?threadId=19:05ec12c79df7460ca9cdfbd8b620f16a@thread.skype&ctx=channel&context=Code%2520Repository%252FAssignment%25206> – solutions for Assignment 6, by different groups in US

Starting point

- Available materials to try out:
 - https://rmarkdown.rstudio.com/articles_intro.html
 - materials from RStudio

Example 1 (continue)

The mtcars data

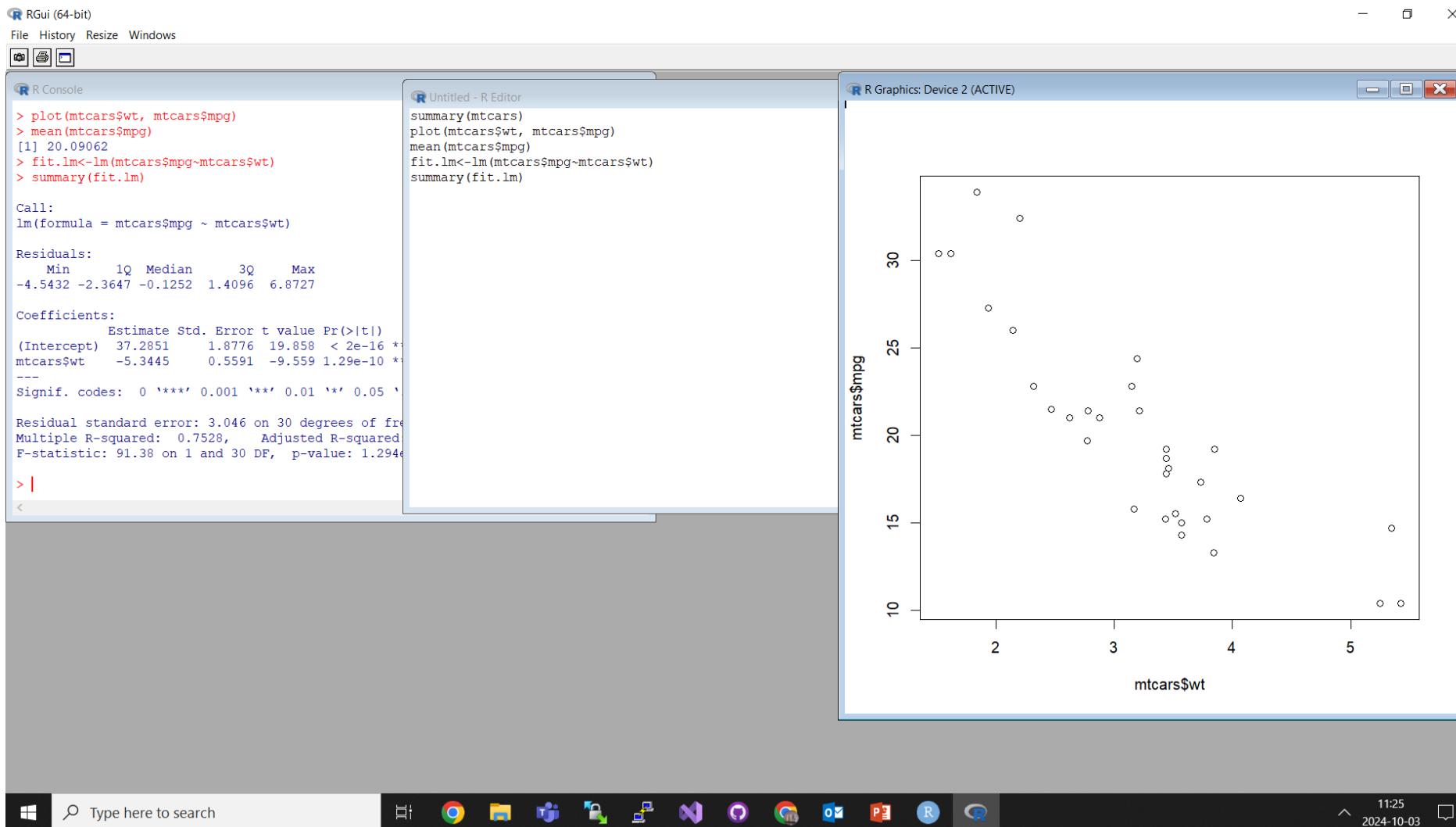
Part 1: Analysis with R and R Studio

Analysis

- Plot mpg Vs. weight.
- Calculate the mean weight.
- Fit a regression model for Mpg on Weight.
- R code: [see next page](#).

Analysis in R

- The same slides as 18-22.



Analysis in R Studio

The screenshot shows the R Studio interface with the following components:

- Code Editor:** The main window displays an R Markdown file named "R_Course_UHasselt_demo_V0.Rmd". The code includes a YAML front matter section with metadata like title, author, date, and output type, followed by R code that loads the mtcars dataset, plots weight vs miles per gallon, calculates the mean mpg, fits a linear model (fit.lm), and prints its summary.
- Console:** Below the code editor, the R console shows the results of the executed R code, including the regression output for the fit.lm model.
- Environment Browser:** On the right side, the Environment tab is selected, showing the global environment with an object named "fit.lm" which is a list of 12 items.
- Packages:** The Packages tab in the environment browser lists various R packages installed in the user library, such as a4Core, abind, additivityT, ade4, admisc, alluvial, analogue, Annotatio..., and Manipulation of SQLite-based.
- System:** The bottom of the screen shows the Windows taskbar with icons for Start, Search, Task View, File Explorer, Task Manager, Control Panel, File History, and others. The system tray shows the date and time as 11:52 2024-10-03.

Analysis in R Studio

The screenshot shows the R Studio interface with several key components highlighted:

- R code (Source tab):** The main pane where R code is written. A red arrow points from the text "The R code" to this area.
- Run menu:** A context menu is open over the run button in the toolbar. It contains options like "Run Selected Line(s)", "Run Current Chunk", and "Run All". A red arrow points from the text "The output" to this menu.
- Console:** The bottom-left pane showing the execution results of the R code. It includes the R prompt (>), the summary of the mtcars dataset, the linear regression output, and the signifi-
- Output:** A blue box labeled "The output" surrounds the text in the Console pane.
- Environment pane:** The right-hand pane showing the global environment, user library, and other RStudio features. A red arrow points from the text "The output" to this area.

The R code in the Source tab:

```
1 ---  
2 title: "Demo 1"  
3 author: "Rudradev Sengupta, Bernard Osang'ir & Ziv Shkedy"  
4 date: "01/10/24"  
5 output:  
6   html_document: default  
7   word_document: default  
8   pdf_document: default  
9 params:  
10  snapshot: "lubridate::ymd_hms(\"2015-01-01 12:30:00\")"  
11  start: "lubridate::ymd(\"2015-01-01\")"  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16  
17  
18 summary(mtcars)  
19 plot(mtcars$wt,mtcars$mpg)  
20 mean(mtcars$mpg)  
21 fit.lm<-lm(mtcars$mpg~mtcars$wt)  
22 summary(fit.lm)
```

The output in the Console pane:

```
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
Residual standard error: 3.046 on 30 degrees of freedom  
Multiple R-squared:  0.7528, Adjusted R-squared:  0.7446  
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10
```

Analysis in R Studio

R erbiostat - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

R_Course_UHasselt_demo_V0.Rmd*

Source Visual

```
1 ---  
2 title: "Demo 1"  
3 author: "Rudradev Sengupta, Bernard Osang'ir & ziv Shmilovich"  
4 date: "01/10/24"  
5 output:  
6   html_document: default  
7   word_document: default  
8   pdf_document: default  
9 params:  
10  snapshot: "lubridate::ymd_hms(\"2015-01-01 12:30:00\")"  
11  start: "lubridate::ymd(\"2015-01-01\")"  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ``  
17  
18 summary(mtcars)  
19 plot(mtcars$wt, mtcars$mpg)  
20 mean(mtcars$mpg)  
21 fit.lm<-lm(mtcars$mpg~mtcars$wt)  
22 summary(fit.lm)
```

22:16 (Top Level) ↓

Console Terminal Background Jobs

R 4.3.3 · ~/Bernard OSANG'IR/Trainings and workshops/ER-BioStat Kenya 2024/erbiostat/

Min	1Q	Median	3Q	Max
-4.5432	-2.3647	-0.1252	1.4096	6.8727

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	37.2851	1.8776	19.858	< 2e-16 ***
mtcars\$wt	-5.3445	0.5591	-9.559	1.29e-10 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared: 0.7528, Adjusted R-squared: 0.7446
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10

code

Plot Zoom

The estimated model

mtcars\$mpg

mtcars\$wt

Environment History Connections Git Tutorial

fit.lm List of 12

Files Plots Packages Help Viewer Presentation

Zoom

Graphical window

mtcars\$mpg

mtcars\$wt

12:14 2024-10-03

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Part 2: Analysis with R markdown

To run the analysis in the example, use the program in R Studio:

R_course_UHasselt_demo_V1.Rmd

Different types of Output

- Two types of output:
 - HTML.
 - PDF.
 - DOCX
- Text and R code in the same document.

Running R in Markdown

- General form:

```
```{r}  
R code
```
```

Code chunks for
the analysis.

- Example of a scatterplot:

```
```{r}  
plot(x, y)
```
```

Use the function `plot()` to
produce a scatterplot.

The Rmd program

Title and info.

The screenshot shows the RStudio interface with the following annotations:

- YAML Header:** A red curly brace on the left side of the code editor highlights the YAML header section from line 1 to line 17. A red arrow points to the "title: Demo 2" line.
- R code:** A red curly brace on the left side of the code editor highlights the R code chunk from line 18 to line 33. It includes code to load the mtcars dataset and print its summary.
- Example of free text:** A blue box highlights the explanatory text from line 20 to line 58, which describes R Markdown and the Knit button.

Code in the Rmd file:

```
1 ---  
2 title: Demo 2"  
3 author: "Rudradev Sengupta, Bernard Osang'ir and Ziv Shkedy"  
4 date: "05 October 2024"  
5 output:  
6   html_document: default  
7   pdf_document: default  
8   word_document: default  
9 params:  
10  snapshot: lubridate::ymd_hms("2015-01-01 12:30:00")  
11  start: lubridate::ymd("2015-01-01")  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ---  
17  
18 ## R Markdown  
19  
20 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents.  
For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
21  
22 When you click the **Knit** button a document will be generated that includes both content as well as the output of any  
embedded R code chunks within the document. You can embed an R code chunk like this:  
23  
24 ``{r cars}  
25 project_start <- params$start  
26 summary(mtcars)  
27 ---  
28  
29 ## Including project metadata:  
30  
31 ``{r date, echo=FALSE}  
32 paste("Project Start Date:",project_start)  
33  
4:23 # Demo 2
```

Environment pane:

- Global Environment: fit.lm (List of 12)

Files pane:

- User Library:
- a4Core, abind, additivityTests, ade4, admisc, alluvial, analogue, AnnotationDbi, aptot, AsioHeaders, askpass, assertthat, babelgene

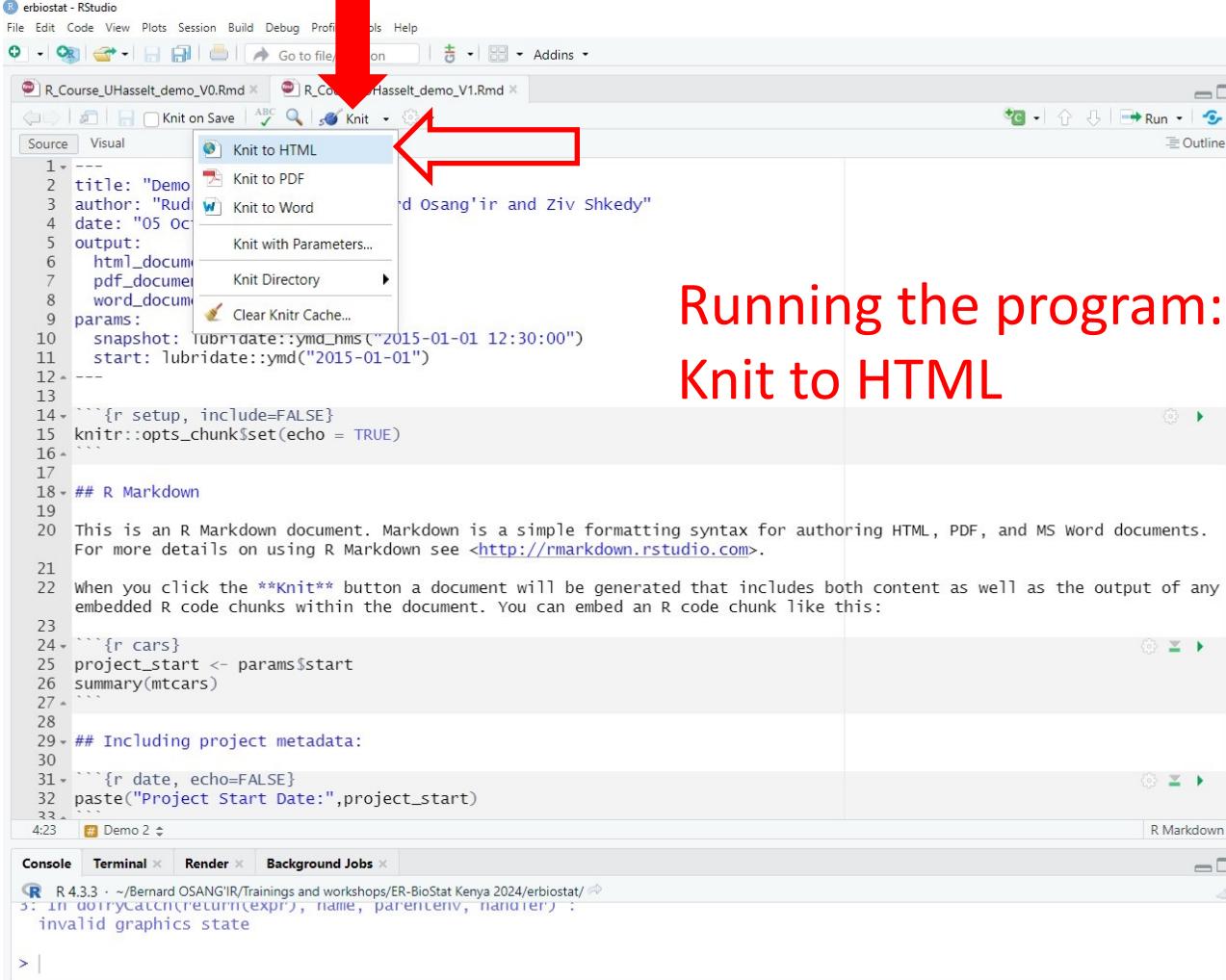
Console output:

```
R 4.3.3 · ~/Bernard OSANG'IR/Trainings and workshops/ER-BioStat Kenya 2024/erbiostat/  
Min 1Q Median 3Q Max  
-4.5432 -2.3647 -0.1252 1.4096 6.8727
```

System tray:

```
18:39  
2024-10-03
```

Knit to HTML (how to run the program)



A screenshot of the RStudio interface. The main window shows an R Markdown file named "R_Course_UHasselt_demo_V0.Rmd". A red arrow points from the text "Running the program: Knit to HTML" to the "Knit to HTML" option in the "Knit" dropdown menu. The "Knit" menu also includes options for PDF, Word, and parameters. The RStudio environment is visible with tabs for Environment, History, Connections, Git, and Tutorial. The Global Environment pane shows a list of objects, and the Packages pane lists various R packages. The bottom navigation bar includes tabs for Console, Terminal, Render, and Background Jobs.

Running the program:
Knit to HTML

```
1 ---  
2 title: "Demo"  
3 author: "Rudolf Hasselt"  
4 date: "05 Oct 2015"  
5 output:  
6 html_document  
7 pdf_document  
8 word_document  
9 params:  
10 snapshot: lubridate::ymd_hms("2015-01-01 12:30:00")  
11 start: lubridate::ymd("2015-01-01")  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ``-  
17  
18 ## R Markdown  
19  
20 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents.  
For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
21  
22 When you click the **Knit** button a document will be generated that includes both content as well as the output of any  
embedded R code chunks within the document. You can embed an R code chunk like this:  
23  
24 ``{r cars}  
25 project_start <- params$start  
26 summary(mtcars)  
27 ``-  
28  
29 ## Including project metadata:  
30  
31 ``{r date, echo=FALSE}  
32 paste("Project Start Date:",project_start)  
33 ``-
```

Console Terminal Render Background Jobs

R 4.3.3 · ~/Bernard OSANG'IR/Trainings and workshops/ER-BioStat Kenya 2024/erbiostat/ ↵
3: in worrycatch(return(expr), name, parentenv, handler) :
invalid graphics state

18:46
2024-10-03

Output: HTML

The screenshot illustrates the RStudio interface for generating an HTML document from an R Markdown file.

Left Panel (RStudio Editor): Shows the R Markdown source code for "Demo 2". A red circle highlights the line "# R Markdown". Red arrows point from this line to the rendered title "Demo 2" in the browser window and to the "R Markdown" section in the output preview.

Right Panel (Browser Preview): Displays the generated HTML page titled "Demo 2". The title and subtitle "R Markdown" are highlighted with a red box. The text "The output" is overlaid in red on the right side of the preview. The preview shows the rendered content, including the R Markdown introduction and the summary of the mtcars dataset.

Bottom Panel (Console): Shows the R command-line interface with the following session history:

```
R 4.3.3 · ~/Bernard OSANG'IR/Trainings and workshops/ER-BioStat Kenya 2024/erbiostat/ ↵ 3: in dotryCatch(return(expr), name, parentenv, handler) : ↵   invalid graphics state
```

System Taskbar: Shows the Windows taskbar with various application icons.

Page Elements:

- See page 43:** A red arrow points from the "See page 43" text at the top right towards the rendered title in the browser.
- The output:** The text "The output" is overlaid in red on the right side of the browser preview.
- Including project metadata:** A section in the browser preview containing the R code `## Project Start Date: lubridate::ymd(\"2015-01-01\")`.
- Including Plots:** A section in the browser preview indicating where plots would be included.

The HTML output

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

HD_Unsupervised_NBA_2017.R Example_prog_2016.R HD_Unsupervised_Examp

Source Visual

Including Plots

You can also embed plots, for example:

```
plot(mtcars$wt,mtcars$mpg)
```

Note that the `echo = FALSE` parameter was added to the code that generated the plot.

```
```{r,echo = FALSE}
plot(mtcars$wt,mtcars$mpg)
````
```

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

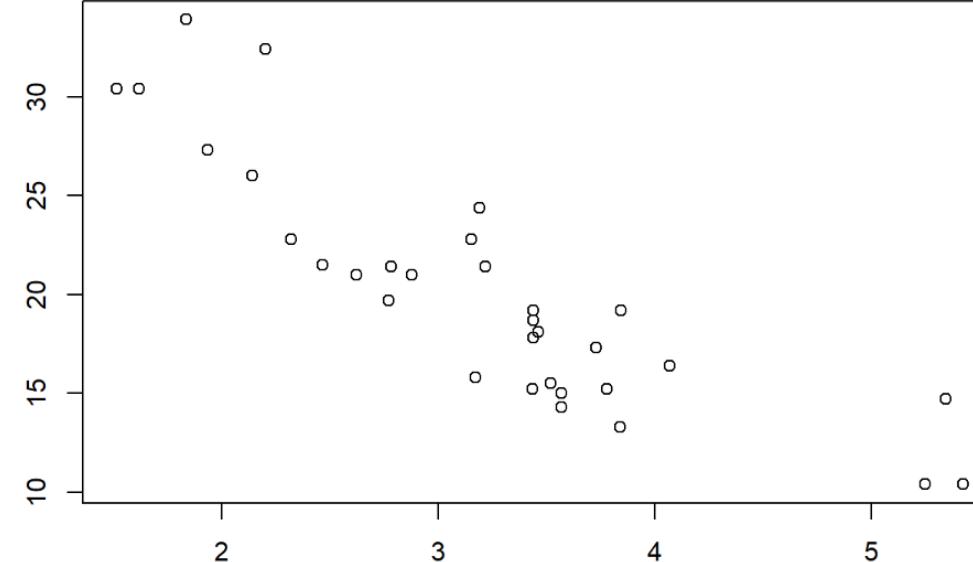
Console Terminal Render Background Jobs

R 4.3.2 · C:/Ziv_Temp_2023/Wprkshop_Kenya/Shortcourse/Rmarkdown1/Rmds/

Including Plots

You can also embed plots, for example:

```
plot(mtcars$wt,mtcars$mpg)
```



A data frame with 15 observations on 2 variables.

51

The HTML output

The screenshot shows the RStudio interface with an R Markdown file open and its corresponding HTML output displayed in a browser window.

Left Panel (RStudio):

- File:** HD_Unsupervised_NBA_2017.R, Example_prog_2016.R, HD_Unsupervised_Examp
- Tools:** Go to file/function, Addins
- Code Editor:** Shows R code for calculating the mean of mpg and fitting a regression model to mpg vs wt. It also includes sections for short analysis and output for the regression model.
- Console:** Displays the R startup message and basic information about the R environment.

Right Panel (Browser Window):

- Title:** C:/Ziv_Temp_2023/Wprkshop_Kenya/Shortcourse/Rmarkdown1/Rmds/R_Course_UHasselt_demo_V1.html
- Content:** The generated HTML document contains two main sections:
 - Short Analysis:** Contains the R code `mean(mtcars\$mpg)` and its output `## [1] 20.09062`.
 - Output for the regression model:** Contains the R code `summary(fit.lm)` and its output, which is a detailed summary of the linear regression model fit to the mtcars dataset.
- Bottom Status Bar:** A data frame with 15 observations on 2 variables.

The Rmd output

- Output in **ONE** document.
- Text and R output.
- R code can be included.
- Type of document: HTML/PDF.
- **The data analyst designs the output.**

Knit to PDF

The screenshot shows the RStudio interface. In the top-left corner, there are two tabs: 'R_Course_UHasselt_demo_V0.Rmd' and 'R_Course_UHasselt_demo_V1.Rmd'. A red arrow points from the text above to the 'Knit' button in the toolbar, which has a dropdown menu open. The 'Knit to PDF' option is highlighted with a red box. The main workspace shows R code for a linear regression model. The 'Environment' tab in the sidebar displays various global variables. The bottom status bar shows system icons and the time '10:18 29/09/2020'.

```
5 out<-
6 h<-
7 p<-
8 par<-
9 si<-
10 si<-
11 si<-
12 ...<-
13 ...<-
14 knitr::opts_chunk$set(echo = TRUE)
15 ...
16 ...
17 ## R Markdown
18
19 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For
more details on using R Markdown see <http://rmarkdown.rstudio.com>.
20
21 when you click the **Knit** button a document will be generated that includes both content as well as the output of any
embedded R code chunks within the document. You can embed an R code chunk like this:
22
23 ``{r cars}
24 project_start <- params$start
25 summary(mtcars)
26 ...
27 ...
28 ...
29 ...
22:1 R Markdown
```

Console R Markdown x

```
~/
#> mtcars$mpg ~ mtcars$wt
```

Residuals:

| Min | 1Q | Median | 3Q | Max |
|---------|---------|---------|--------|--------|
| -4.5432 | -2.3647 | -0.1252 | 1.4096 | 6.8727 |

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) |
|-------------|----------|------------|---------|--------------|
| (Intercept) | 37.2851 | 1.8776 | 19.858 | < 2e-16 *** |
| mtcars\$wt | -5.3445 | 0.5591 | -9.559 | 1.29e-10 *** |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared: 0.7528, Adjusted R-squared: 0.7446
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10

10:18 29/09/2020

The PDF output

A screenshot of the RStudio interface illustrating the generation of a PDF document from R Markdown code.

Left Panel (RStudio Environment):

- Code Editor:** Shows the R Markdown file `R_Course_UHasselt_demo_V0.Rmd`. The code includes R code chunks and a section titled "R Markdown".
- Console:** Displays the output of the R code, including statistical results for a linear regression model on the `mtcars` dataset.

Right Panel (PDF Preview):

- Title:** The title "Demo 2" is highlighted with a red box and an annotation pointing to it from the text "See page 43 for the title".
- Author:** "Rudradev Sengupta and Ziv Shkedy"
- Date:** "29 September 2020"
- Content:** The PDF includes sections on "R Markdown", "Including project metadata", and "Including Plots". It also shows the summary statistics for the `mtcars` dataset.

Annotations:

- A large red arrow points from the "R Markdown" section in the RStudio code editor to the corresponding section in the PDF preview.
- A red box highlights the title "Demo 2" in the PDF preview.
- A red arrow points from the text "See page 43 for the title" at the top right of the slide to the title in the PDF preview.

The PDF output

The screenshot shows the RStudio interface with a PDF output window open. The PDF window displays an R Markdown document titled "Demo 2". The document includes code for generating project metadata, including plots, and a scatter plot of mtcars\$wt vs mtcars\$mpg. The sidebar on the right shows a list of packages and their versions.

R Markdown Document Content:

```
1 ---  
2 title: "Demo 2"  
3 author: "Rudradev Sengupta"  
4 date: "29 September 2020"  
5 output:  
6   pdf_document: default  
7   html_document: default  
8 params:  
9   snapshot: lubridate::ymd  
10  start: lubridate::ymd  
11 ---  
12   
13 ```{r setup, include=FALSE}  
14 knitr::opts_chunk$set(  
15   ---  
16 )  
17 ## R Markdown  
18   
19 This is an R Markdown document. It provides a simple way to create  
20 documents. For more details about R Markdown, see  
21 http://rmarkdown.rstudio.com.  
22 When you click the Knit button below, a document will be generated that includes  
23 any embedded R code chunks and the output of those chunks.  
24 You can also embed plots, for example:  
25 plot(mtcars$wt, mtcars$mpg)  
26   
27 Including Plots  
28 You can also embed plots, for example:  
29 plot(mtcars$wt, mtcars$mpg)  
30   
31 Output for the regression model  
32 Output for the regression model
```

Console Output:

```
R version 3.6.1 (2019-07-05) -- "Action of the Toad"  
Copyright (C) 2019 The R Foundation for Statistical Computing  
Platform: x86_64-w64-mingw32/x64 (64-bit)  
  
R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for more information.  
  
R is a collaborative project with many contributors.  
Type 'contributors()' for more information.  
Type 'citation()' on how to cite R or its package.  
  
Type 'demo()' for some demos,  
'help.start()' for an HTML browser-based help system,  
Type 'q()' to quit R.  
  
[workspace loaded from ~/RData]  
> |
```

PDF Output Content:

Median :0.0000 Median :4.0000 Median :2.000
Mean : 0.4062 Mean :3.688 Mean :2.812
3rd Qu.:1.0000 3rd Qu.:4.000 3rd Qu.:4.000
Max. :1.0000 Max. :5.000 Max. :8.000

Including project metadata:
[1] "Project Start Date: lubridate::ymd(\"2015-01-01\")"

Including Plots

You can also embed plots, for example:

```
plot(mtcars$wt, mtcars$mpg)
```

mtcars\$mpg

mtcars\$wt

Note that the echo = FALSE parameter was added to the code chunk to prevent printing of the R code that generated the plot.

Sidebar:

- Project: (None)
- File List
- Version History
- Angelo Canti for S 1.3-23

The PDF output

The screenshot shows the RStudio interface with a PDF output window open. The PDF contains R code and its output. A red text overlay 'The regression output' is placed over the summary of a linear model. The RStudio interface includes a left sidebar with a file tree, a top menu bar, and several panes on the right.

PDF Content:

```
mtcars$wt  
  
Short Analysis  
mean(mtcars$mpg)  
## [1] 20.09062  
fit.lm<-lm(mtcars$mpg~mtcars$wt)  
  
Output for the regression model  
summary(fit.lm)  
  
##  
## Call:  
## lm(formula = mtcars$mpg ~ mtcars$wt)  
##  
## Residuals:  
##    Min     1Q   Median     3Q    Max  
## -4.5432 -2.3647 -0.1252  1.4096  6.8727  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 37.2851    1.8776 19.858 < 2e-16 ***  
## mtcars$wt   -5.3445    0.5591 -9.559 1.29e-10 ***  
  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##
```

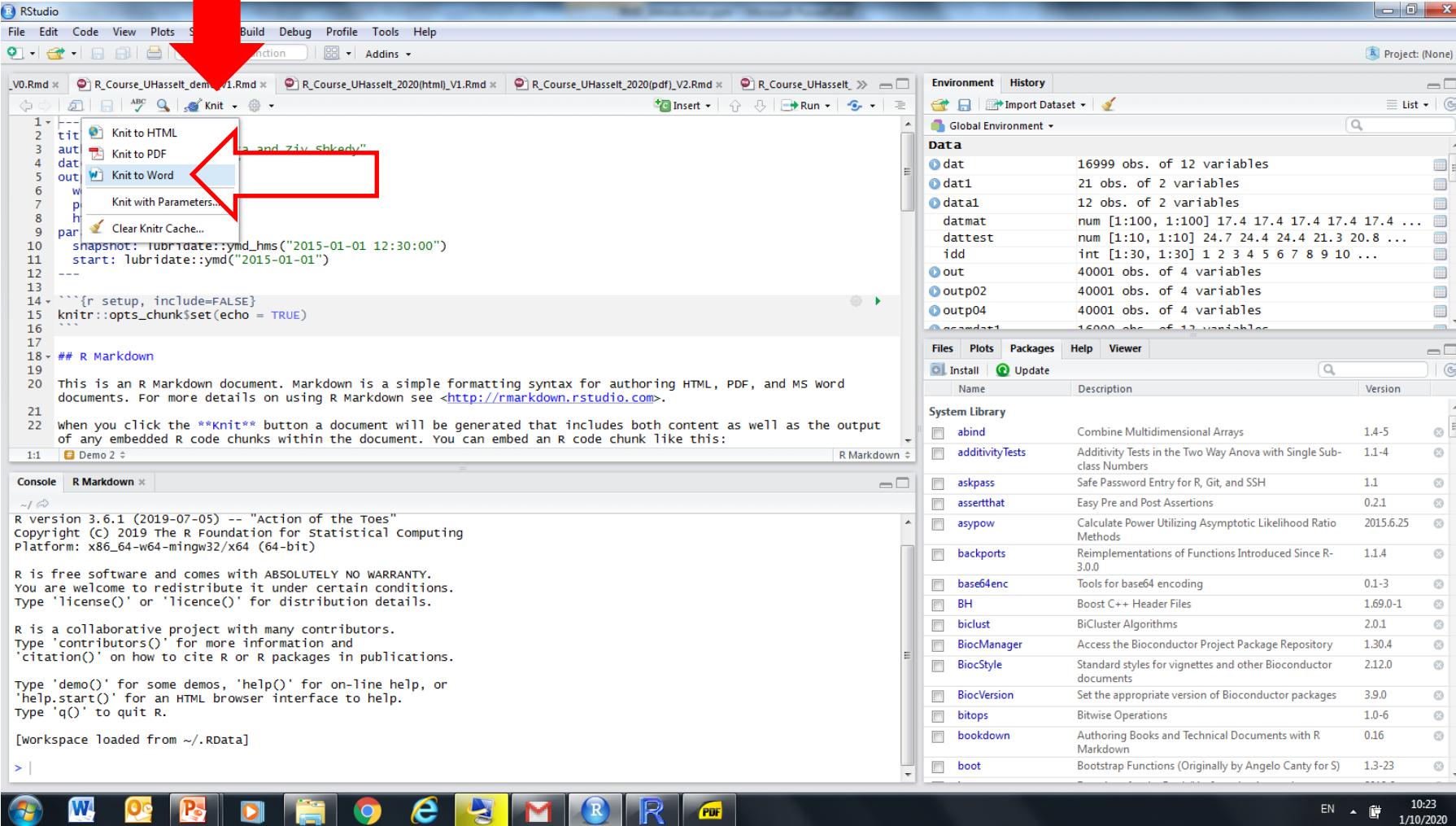
Red Text Overlay: The regression output

RStudio Interface:

- File:** File Edit Code View Plots Session
- Project:** Project: (None)
- Code Editor:** Shows R_Course_UHasselt_demo_V1.Rmd
- Console:** Shows R version 3.6.1 (2019-07-05) and workspace loaded from ~/.RData
- Plots:** Shows a histogram of mtcars\$wt.
- Environment:** Shows the mtcars dataset.
- Help:** Shows help pages like lm, summary, and lmtest.
- File Explorer:** Shows files like R_Course_UHasselt_demo_V0.Rmd.
- Task View:** Shows various packages installed.

Important: To produce the PDF file, you will need to install [LaTeX](#) or [Tex](#)

Knit to word



A screenshot of the RStudio interface. In the top-left corner, there is a red arrow pointing down at the 'Knit' button in the toolbar. The 'Knit' button has a dropdown menu open, showing options: 'Knit to HTML', 'Knit to PDF', 'Knit to Word', and 'Knit with Parameters...'. The 'Knit to Word' option is highlighted with a red box. The main workspace shows an R Markdown document with code and text. The right side of the screen features the Environment and Global Environment panes, and the bottom has a taskbar with various icons.

```
1 ---  
2 tit  
3 aut  
4 dat  
5 out  
6 w  
7 p  
8 h  
9 par  
10 snapshot::lubridate::ymd_hms("2015-01-01 12:30:00")  
11 start::lubridate::ymd("2015-01-01")  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ``  
17  
18 ## R Markdown  
19  
20 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
21  
22 when you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:  
1:1 Demo 2
```

R version 3.6.1 (2019-07-05) -- "Action of the Toes"
Copyright (C) 2019 The R Foundation for Statistical computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[workspace loaded from ~/RData]

EN 10:23 1/10/2020

The word doc output

Screenshot of Microsoft Word showing R Markdown output and an embedded R plot.

The Word document contains the following content:

- Demo 2**
- Rudradev Sengupta and Ziv Shkedy
- 29 September 2020
- R Markdown**
- This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.
- When you click the Knit button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
project_start <- params$start
summary(mtcars)
```

```
## #>   mpg      cyl      disp      hp
## #>   Min. :10.40  Min. :4.000  Min. :71.1  Min. :52.0
## #>   1st Qu.:15.43 1st Qu.:4.000 1st Qu.:120.8 1st Qu.:96.5
## #>   Median :19.20 Median :6.000  Median :196.3 Median :123.0
## #>   Mean   :20.09 Mean   :6.188  Mean   :230.7 Mean   :146.7
## #>   3rd Qu.:22.80 3rd Qu.:8.000 3rd Qu.:326.0 3rd Qu.:180.0
## #>   Max.   :33.90 Max.   :8.000  Max.   :472.0 Max.   :335.0
## #>
## #>   drat      wt      qsec      vs
## #>   Min. :2.760  Min. :1.513  Min. :14.50  Min. :0.0000
## #>   1st Qu.:3.080 1st Qu.:2.581 1st Qu.:16.89 1st Qu.:0.0000
## #>   Median :3.695  Median :3.325  Median :17.71  Median :0.0000
## #>   Mean   :3.597  Mean   :3.217  Mean   :17.85  Mean   :0.4375
## #>   3rd Qu.:3.920 3rd Qu.:3.610 3rd Qu.:18.90 3rd Qu.:1.0000
## #>   Max.   :4.930  Max.   :5.424  Max.   :22.90  Max.   :1.0000
## #>
## #>   am      gear      carb
## #>   Min. :0.0000  Min. :3.000  Min. :1.000
## #>   1st Qu.:0.0000 1st Qu.:3.000 1st Qu.:2.000
## #>   Median :0.0000  Median :4.000  Median :2.000
```

- plot(mtcars\$wt, mtcars\$mpg)**

A scatter plot showing the relationship between weight (wt) on the x-axis and miles per gallon (mpg) on the y-axis. The x-axis ranges from approximately 2 to 5, and the y-axis ranges from approximately 10 to 30. The data points show a negative correlation, with higher weights generally corresponding to lower fuel efficiency.

Note that the echo = FALSE parameter was added to the code chunk to prevent printing of the R code that generated the plot.

Example 2

Output development

Focus

- How to develop an output document:
 - HTML.
 - PDF/HTML.
- Sections/Subsections.
- R code as a part of the text or not?

The program

- A simple user guide for a document that includes:
 - Free text.
 - R code.
 - Graphical displays.
- To produce the document:
 - run the programs in R Studio.

Development of a **HTML** document

- The output:
 - HTML document.

To run the analysis in the example, use the program in R Studio:

[`R_course_UHasselt_2021\(html\)_V1.Rmd`](#)

The program

R_course_UHasselt_2020(html)_V1.Rmd

```
1 ---  
2 title: "Basic skills in R Markdown"  
3 author:  
4 - name: Ziv Shkedy  
5   affiliation: Hasselt University, Belgium  
6 subtitle: The HTML file (2020)  
7  
8 #institute: UHasselt  
9 date: September, 29, 2020  
10 output:  
11   rmdformats::readthedown:  
12     highlight: kate  
13     use_bookdown: TRUE  
14 vignette: >  
15   %>%vignetteEngine{knitr::rmarkdown}  
16 editor_options:  
17   chunk_output_type: console  
18 categories: ["R"]  
19 bibliography: bibliography.bib  
20 ---  
21  
22  
23 <script type="text/javascript"  
24   src="http://cdn.mathjax.org/mathjax/latest/MathJax.js?config=TeX-AMS-MML_HTMLorMML">  
1:1 Basic Skills in R Markdown
```

YAML Header

R version 3.6.1 (2019-07-05) -- "Action of the Toes"
Copyright (C) 2019 The R Foundation for statistical computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
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Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[workspace loaded from ~/.RData]

> |

Environment History

Data

- dat 16999 obs. of 12 variables
- dat1 21 obs. of 2 variables
- data1 12 obs. of 2 variables
- datmat num [1:100, 1:100] 17.4 17.4 17.4 17.4 ...
- dattest num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
- idd int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
- out 40001 obs. of 4 variables
- outp02 40001 obs. of 4 variables
- outp04 40001 obs. of 4 variables
- scamdat1 16000 obs. of 12 variables

Files Plots Packages Help Viewer

System Library

- abind Combine Multidimensional Arrays 1.4-5
- additivityTests Additivity Tests in the Two Way Anova with Single Sub-class Numbers 1.1-4
- askpass Safe Password Entry for R, Git, and SSH 1.1
- assertthat Easy Pre and Post Assertions 0.2.1
- asypow Calculate Power Utilizing Asymptotic Likelihood Ratio Methods 2015.6.25
- backports Reimplementations of Functions Introduced Since R-3.0.0 1.1.4
- base64enc Tools for base64 encoding 0.1-3
- BH Boost C++ Header Files 1.69.0-1
- biclust BiCluster Algorithms 2.0.1
- BiocManager Access the Bioconductor Project Package Repository 1.30.4
- BiocStyle Standard styles for vignettes and other Bioconductor documents 2.12.0
- BiocVersion Set the appropriate version of Bioconductor packages 3.9.0
- bitops Bitwise Operations 1.0-6
- bookdown Authoring Books and Technical Documents with R Markdown 0.16
- boot Bootstrap Functions (Originally by Angelo Canty for S) 1.3-23

EN 9:04 6/10/2020

The HTML output

The screenshot shows a Microsoft PowerPoint window with the title bar "RMD Introduction.pptx - Microsoft PowerPoint". The slide content is titled "Basic Skills in R Markdown". The slide contains several sections and subsections, including:

- 1 Introduction
- 2 Sections and subsections
- 3 Including R code
- 4 Items
- 5 Use R as a part of your text
- 6 How to add a link to your document
- 7 How to create a math formula
- 8 Just do it

The slide also includes two code snippets:

```
## Warning: package 'ggplot2' was built under R version 3.6.3
```

```
## Warning: package 'mvtnorm' was built under R version 3.6.2
```

On the left side of the slide, there is a sidebar with four small preview images labeled 57, 58, 59, and 60, which likely correspond to other slides in the presentation.

Very basic guide how to produce a markdown document

This document provides basic tools to produce a html file using R markdown. The best way to use this document is to run the file in R studio and then read the .Rmd file to see how the output was created. The file can be used to produce a very basic html document an you can add later more components to you document.

1 Introduction

This is a an example of a R markdown file that produces htnl output. This is a section in the document.

2.1 Subsection

This text appears in a subsection

2.1.1 Subsubsection

This text is a part of a subsection.

3 Including R code

The program

An example how to create section/subsection/subsubsection...

Free text

RStudio interface showing R Markdown code and a list of packages.

R Markdown Code:

```
49 This document provides basic tools to produce a html file using R markdown. The best way to use this document is  
50 to run the file in R studio and then read the <tt>.Rmd</tt> file to see how the output was created. The file can  
be used to produce a very basic html document an you can add later more components to you document.  
51 # Sections and subsections  
52 This is a an example of a R markdown file that produces htnl output. This is a section in the document.  
53 ## Subsection  
54 This text apears in a subsection  
55 ### Subsubsection  
56 This text is a part of a subsection.  
57  
58 # Including R code  
59  
60 ## Print R code and output  
61  
62 This is an example how to include R code and output in the document. we use the <tt>airquality</tt> data as an  
63  
64  
65  
66  
67  
68  
69  
70 This is an example how to include R code and output in the document. we use the <tt>airquality</tt> data as an  
16:17 Basic Skills in R Markdown
```

Console Output:

```
R version 3.6.1 (2019-07-05) -- "Action of the Toes"  
Copyright (C) 2019 The R Foundation for Statistical computing  
Platform: x86_64-w64-mingw32/x64 (64-bit)  
  
R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.  
  
R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.  
  
Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.  
  
[workspace loaded from ~/RData]
```

Environment View:

| Package | Description | Version |
|-----------------|---|-----------|
| additivityTests | Additivity Tests in the Two Way Anova with Single Sub-class Numbers | 1.1-4 |
| askpass | Safe Password Entry for R, Git, and SSH | 1.1 |
| assertthat | Easy Pre and Post Assertions | 0.2.1 |
| asypow | Calculate Power Utilizing Asymptotic Likelihood Ratio Methods | 2015.6.25 |
| backports | Reimplementations of Functions Introduced Since R-3.0.0 | 1.1.4 |
| base64enc | Tools for base64 encoding | 0.1-3 |
| BH | Boost C++ Header Files | 1.69.0-1 |
| bclust | BiCluster Algorithms | 2.0.1 |
| BiocManager | Access the Bioconductor Project Package Repository | 1.30.4 |
| BiocStyle | Standard styles for vignettes and other Bioconductor documents | 2.12.0 |
| BiocVersion | Set the appropriate version of Bioconductor packages | 3.9.0 |
| bitops | Bitwise Operations | 1.0-6 |
| bookdown | Authoring Books and Technical Documents with R Markdown | 0.16 |
| boot | Bootstrap Functions (Originally by Angelo Canty for S) | 1.3-23 |

EN 12:30 30/09/2020

The output

The screenshot shows the RStudio interface with the following components:

- Left Panel (Code Editor):** Displays the R Markdown file `R_Course_UHasselt_demo_V0.Rmd`. The code includes YAML front matter, sections, and R code chunks.
- Middle Panel (Preview):** Shows the generated HTML output titled "Basic Skills in R Markdown".
 - Section 1:** Introduction
 - Section 2:** Sections and subsections
 - Section 3:** Including R code

The preview pane shows two R code chunks with warning messages:

```
## Warning: package 'ggplot2' was built under R version 3.6.3
```

```
## Warning: package 'mvtnorm' was built under R version 3.6.2
```

Bottom Left: R console output showing R version 3.6.1 (2019-07-05) and a workspace summary.

Bottom Right: A sidebar showing a list of packages and their versions.

Bottom Center: A red box highlights the "Sections and subsections" section in the preview pane.

R code in the output

The screenshot shows the RStudio interface. On the left, the R Markdown editor displays the following R code:

```
63  
64  
65  
66 # Including R code  
67  
68 ## Print R code and output  
69  
70 This is an example how to include R code and output in the document. We use the <tt>airquality</tt> data as an  
example.  
71  
72  
73 ``{r}  
74 x<-na.omit(airquality$ozone)  
75 print(x)  
76 ``  
77  
78 ## Do not print the R code but print the output  
79  
80 If we do not want to print the R code, but we want to see the output use the option <tt>echo=FALSE</tt>:  
81  
82 ``{r,echo=FALSE}  
83 x<-na.omit(airquality$ozone)  
84 print(x)  
85
```

The right side of the interface shows the RStudio environment pane, which includes a system library browser. A red bracket on the right margin of the code editor points towards the environment pane, and a red callout box contains the text:

How to include R code and output

The RStudio toolbar at the bottom includes icons for various applications like Word, Excel, and R.

The output

The screenshot shows the RStudio interface with an R Markdown file open. The left pane displays the R Markdown code, and the right pane shows the generated HTML output. A red box highlights the section where R code is included.

RStudio Interface:

- File Edit Code View Plots Session Help**
- Project: (None)**
- Console R Markdown**
- Output:** C:/projects/eR-Biostat/Presentations/MD_SUSAN/R_Course_UHasselt_2020-html_V1.html
- Knit** button

Code Editor (Left):

```
59
60  ## Subsubsection
61
62 This text is a part of
63
64
65
66 # Including R code
67
68 ## Print R code and ou
69
70 This is an example how
example.
71
72
73 ``{r}
74 x<-na.omit(airquality)
75 print(x)
76
77
78 ## Do not print the R
79
80 If we do not want to p
81
```

Output (Right):

Basic Skills in R Markdown

1 Introduction

2 Sections and subsections

2.1 Subsection

This text appears in a subsection

2.1.1 Subsubsection

This text is a part of a subsection.

3 Including R code

3.1 Print R code and output

This is an example how to include R code and output in the document. We use the airquality data as an example.

```
x<-na.omit(airquality$Ozone)
print(x)
```

```
## [1] 41 36 12 18 28 23 19 8 7 16 11 14 18 14 34 6 30 11 1 11 4 32
## [24] 45 115 37 29 71 39 23 21 37 20 12 13 135 49 32 64 40 77 97 97 85 10
## [47] 7 48 35 61 79 63 16 80 108 20 52 82 50 64 59 39 9 16 78 35 66 122
## [70] 110 44 28 65 22 59 23 31 44 21 9 45 168 73 76 118 84 85 96 78 73 91
## [93] 32 20 23 21 24 44 21 28 9 13 46 18 13 24 16 13 23 36 7 14 30 14
## [116] 20
## attr(,"na.action")
## [1] 5 10 25 26 27 32 33 34 35 36 37 39 42 43 45 46 52 53 54 55 56 57
## [25] 60 61 65 72 75 83 84 102 103 107 115 119 150
## attr(,"class")
## [1] "omit"
```

3.2 Do not print the R code but print the output

Development of a **PDF/HTML** document

- The output:
 - PDF/HTML document (the user can choose).

To run the analysis in the example, use the program in R Studio:

[`R_course_UHasselt_2021\(pdf\)_V1.Rmd`](#)

The program

R_course_UHasselt_2021(pdf)_V1.Rmd

A screenshot of the RStudio interface. On the left, the code editor shows an R Markdown file named 'R_course_UHasselt_2021(pdf)_V1.Rmd'. A red arrow points from the text 'Produce a PDF output' to the 'Knit' button in the toolbar above the code editor. The 'Knit' button has a dropdown menu open, showing options like 'Knit to HTML', 'Knit to PDF', and 'Knit to Word'. The 'Knit to PDF' option is highlighted. Below the code editor is the R console, which displays the standard R startup message. To the right of the code editor are the Global Environment and Packages panes. The Global Environment pane lists various data frames and objects. The Packages pane shows the installed packages and their versions.

Produce a PDF output

RCourse_UHasselt_demo_V0.Rmd x RCourse_UHasselt_demo_V1.Rmd x R_Course_UHasselt_2020(html)_V1.Rmd x R_Course_UHasselt_2020(pdf)_V1.Rmd x

File Edit Code View Plots Search Build Debug Profile Tools Help

Knit

1 to 20)

16999 obs. of 12 variables

21 obs. of 2 variables

12 obs. of 2 variables

num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...

num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...

int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...

40001 obs. of 4 variables

40001 obs. of 4 variables

40001 obs. of 4 variables

16000 obs. of 12 variables

System Library

abind Additivity Tests in the Two Way Anova with Single Sub-class Numbers

askpass Safe Password Entry for R, Git, and SSH

assertthat Easy Pre and Post Assertions

asypow Calculate Power Utilizing Asymptotic Likelihood Ratio Methods

backports Reimplementations of Functions Introduced Since R-3.0.0

base64enc Tools for base64 encoding

BH Boost C++ Header Files

biclust BiCluster Algorithms

BiocManager Access the Bioconductor Project Package Repository

BiocStyle Standard styles for vignettes and other Bioconductor documents

BiocVersion Set the appropriate version of Bioconductor packages

bitops Bitwise Operations

bookdown Authoring Books and Technical Documents with R Markdown

boot Bootstrap Functions (Originally by Angelo Canty for S)

RStudio

File Edit Code View Plots Search Build Debug Profile Tools Help

Project: (None)

Environment History

Global Environment

Data

dat dat1 data1 datamat dattest idd out outp02 outp04 escandat1

Console R Markdown

R version 3.6.1 (2019-07-05) -- "Action of the Toes"

Copyright (C) 2019 The R Foundation for statistical computing

Platform: x86_64-w64-mingw32/x64 (64-bit)

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R is a collaborative project with many contributors.

Type 'contributors()' for more information and

'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or

'help.start()' for an HTML browser interface to help.

Type 'q()' to quit R.

[workspace loaded from ~/.RData]

> |

EN 12:39 30/09/2020

WPS Office e R

The PDF output

The image shows a Windows desktop environment with three windows open:

- RStudio:** On the left, the RStudio interface is visible. It shows an R Markdown file named `_Course_UHasselt_demo_V0.Rmd` with the following content:

```
1 ---  
2 title: 'Basic skills in R Markdown: the pdf file'  
3 output:  
4   pdf_document: default  
5   html_document: default  
6   word_document: default  
7 subtitle: ziv shkedy (2020)  
8 layout: page  
9 toc: yes  
10 ---  
11 ---  
12 output: html_document  
13 use_bookdown: TRUE  
14 ---  
15  
16 ````{r,echo=FALSE}  
17 library(e1071)  
18 library(lattice)  
19 library(ggplot2)  
20 library(mvtnorm)  
21  
22  
23 \newpage  
24  
16:18 [R Markdown] >|
```

- PDF Viewer:** In the center, a PDF viewer window titled "R_Course_UHasselt_2020-pdf_V1.pdf" displays the generated PDF document. The title is "Basic Skills in R Markdown: the pdf file" by Ziv Shkedy (2020). The PDF contains a table of contents with various sections and their page numbers.
- File Explorer:** On the right, a file explorer window titled "Dataset" shows a list of files and folders, likely related to the R project.

Table of contents (from the PDF):

| Section | Page |
|---|------|
| Introduction | 2 |
| Sections and subsections | 2 |
| Subsection | 2 |
| Subsubsection | 2 |
| Including R code | 2 |
| Print R code and output | 2 |
| Do not print the R code but print the output | 2 |
| Items | 3 |
| Use R as a part of your text | 3 |
| Example: summary statistics | 3 |
| Graphical displays in the document | 3 |
| How to add a link to your document | 4 |
| How to create a math formula | 4 |
| Just do it | 7 |
| Analysis of the cars data | 7 |
| Expected output | 7 |
| ## Warning: package 'ggplot2' was built under R version 3.6.3 | |
| ## Warning: package 'mvtnorm' was built under R version 3.6.2 | |

Table of contents:
see next slide

The program

A screenshot of the RStudio interface. The left pane shows an R Markdown file with the following code:

```
1 ---  
2 title: 'Basic skills in R Markdown: the pdf file'  
3 output:  
4   pdf_document: default  
5   html_document: default  
6   word_document: default  
7 subtitle: zivishkedy (2020)  
8 layout: page  
9 toc: yes  
10 ---  
11 ---  
12 output: html_document  
13 use_bookdown: TRUE  
14 ---  
15  
16 ```{r, echo=FALSE}  
17 library(e1071)  
18 library(lattice)  
19 library(ggplot2)  
20 library(mvtnorm)  
21 ````  
22  
23 \newpage  
24
```

A red arrow points to the line `toc: yes`. To the right of the code, there is red text: **toc: yes Produce the table of contents**.

The right pane shows the Environment tab of the Global Environment panel, listing various objects:

| Data | Description |
|---------|---|
| dat | 16999 obs. of 12 variables |
| dat1 | 21 obs. of 2 variables |
| data1 | 12 obs. of 2 variables |
| datmat | num [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ... |
| dattest | num [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ... |
| idd | int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ... |
| out | 40001 obs. of 4 variables |
| outp02 | 40001 obs. of 4 variables |
| outp04 | 40001 obs. of 4 variables |
| outmat | 16000 obs. of 12 variables |

The bottom status bar shows the system tray icons and the date/time: 12:40 30/09/2020.

The program

A section that explains how to include a figure in the document.

90 var(x)
91
92 ## Graphical displays in the document
93 A histogram for the ozone level can be produced using the function <t
"histogram"></tt>:
94
95 ``{r}
96 Ozone.R<-data.frame(x)
97 qplot(x, data = Ozone.R, geom = "histogram", binwidth = 0.1)
98
99 To add a caption to the figure we use <tt>[r figchp1,fig.cap="Sepal length (III)"]</tt>.
100
101 102
103 we can refer to the figure from the text in the document. For example, Figure \@ref(fig:figchp2) presents a
histogram that was produced using the function <tt>qplot()</tt> function.
104
105 ``{r figchp1,fig.cap="Sepal length (III)"}
106 Ozone.R<-data.frame(x)
107 qplot(x, data = Ozone.R, geom = "histogram", binwidth = 0.1)
108
109
110 20:17 [Chunk 1] R Markdown

R version 3.6.1 (2019-07-05) -- "Action of the Toes"
Copyright (c) 2019 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[workspace loaded from ~/RData]

Console R Markdown

Project: (None)

Environment History

99 obs. of 12 variables
obs. of 2 variables
obs. of 2 variables
int [1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
int [1:10, 1:10] 24.7 24.4 24.4 21.3 20.8 ...
int [1:30, 1:30] 1 2 3 4 5 6 7 8 9 10 ...
40001 obs. of 4 variables
40001 obs. of 4 variables
40001 obs. of 4 variables
16000 obs. of 12 variables

Files Plots Packages Help Viewer

Name Description Version

System Library

| Name | Description | Version |
|-----------------|---|-----------|
| abind | Combine Multidimensional Arrays | 1.4-5 |
| additivityTests | Additivity Tests in the Two Way Anova with Single Sub-class Numbers | 1.1-4 |
| askpass | Safe Password Entry for R, Git, and SSH | 1.1 |
| assertthat | Easy Pre and Post Assertions | 0.2.1 |
| asypow | Calculate Power Utilizing Asymptotic Likelihood Ratio Methods | 2015.6.25 |
| backports | Reimplementations of Functions Introduced Since R-3.0.0 | 1.1.4 |
| base64enc | Tools for base64 encoding | 0.1-3 |
| BH | Boost C++ Header Files | 1.69.0-1 |
| biclust | BiCluster Algorithms | 2.0.1 |
| BiocManager | Access the Bioconductor Project Package Repository | 1.30.4 |
| BiocStyle | Standard styles for vignettes and other Bioconductor documents | 2.12.0 |
| BiocVersion | Set the appropriate version of Bioconductor packages | 3.9.0 |
| bitops | Bitwise Operations | 1.0-6 |
| bookdown | Authoring Books and Technical Documents with R Markdown | 0.16 |
| boot | Bootstrap Functions (Originally by Angelo Canty for S) | 1.3-23 |

EN 12:43 30/09/2020

The PDF output

A section that explains how to include a figure in the document.

The screenshot shows the RStudio interface. On the left, the code editor displays R code for generating a histogram. The code includes a section explaining how to add a caption to the figure. The right side shows the generated PDF output, which includes the explanatory text and a histogram plot. The histogram plot has a y-axis from 0 to 6 and an x-axis with many small bars. The bottom status bar shows the date and time: 12:42 30/09/2020.

```
90 var(x)
91
92 ## Graphical displays in the document
93 A histogram for the Ozone level can be produced using the function qplot with the option geom = "histogram":
94 "histogram"</tt>:
95
96 ``{r}
97 Ozone.R<-data.frame(x)
98 qplot(x, data = Ozone.R, geom = "histogram", binwidth = 0.1)
99
100
101
102 To add a caption to the figure we use <tt>(r figcap</tt>
103 ``{r figcap="Sepal length (III)"}
104 Ozone.R<-data.frame(x)
105 qplot(x, data = ozone.R, geom = "histogram", binwidth = 0.1)
106
107 we can refer to the figure from the text in the document by using the <tt>(r figref</tt>
108 histogram that was produced using the function <tt>qplot</tt>
109
110
111
20:17 [2] <Chunk1>
```

Graphical displays in the document

A histogram for the Ozone level can be produced using the function qplot with the option geom = "histogram":

```
Ozone.R<-data.frame(x)
qplot(x, data = Ozone.R, geom = "histogram", binwidth = 0.1)
```

6
4
2

12:42 30/09/2020

Example 3

Very simple analysis

To run the analysis in the example, use the program in R Studio:

[R_course_UHasselt_2021\(pdf\)_V2.Rmd](#)

Produce a report for an analysis

- How to use Rmd to produce a report about an analysis ?
- Why this is important ?
- Example: the old faithful dataset.
 - Part 1: the analysis.
 - Part 2: the analysis + report using Rmd (you need to run the program
 - [R_course_UHasselt_2020\(pdf\)_V2.Rmd](#)

Exploratory analysis of the Old Faithful dataset

- Old Faithful is a geyser that is found in Yellowstone National Park, in Wyoming.
- It is one of the most famous attractions at Yellowstone National Park.
- Old Faithful is unique because of how long and how often it erupts.



Exploratory analysis of the Old Faithful dataset

- Our aim is to explore the association between the time between eruptions (waiting time) and the duration of the eruption.
- For the analysis we use **basic graphical R functions** and **functions to calculate descriptive statistics** for the data.
- Output: PDF format.

The data in R

```
>head(faithful)
```

The name of the data in R

```
## eruptions waiting
## 1 3.600 79
## 2 1.800 54
## 3 3.333 74
## 4 2.283 62
## 5 4.533 85
## 6 2.883 55
```

A data frame with two variables:
eruption and waiting time.

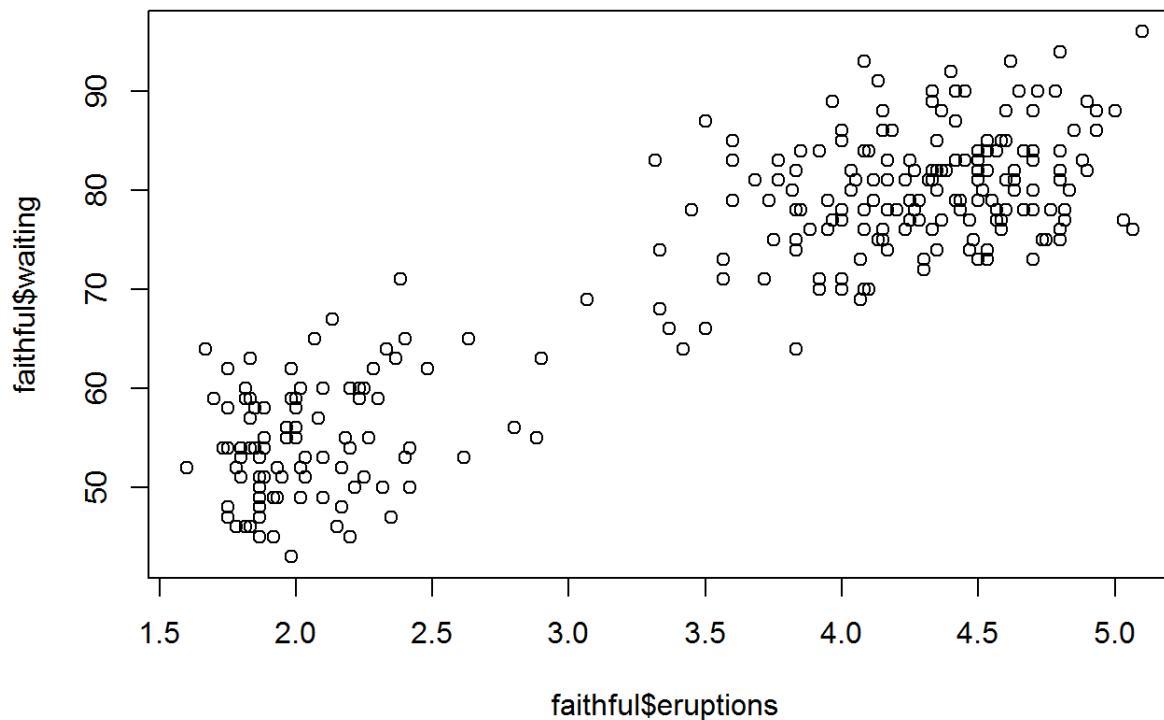
Eruption time and waiting time

```
plot(faithful$eruptions, faithful$waiting)
```



Basic graphical
function in R

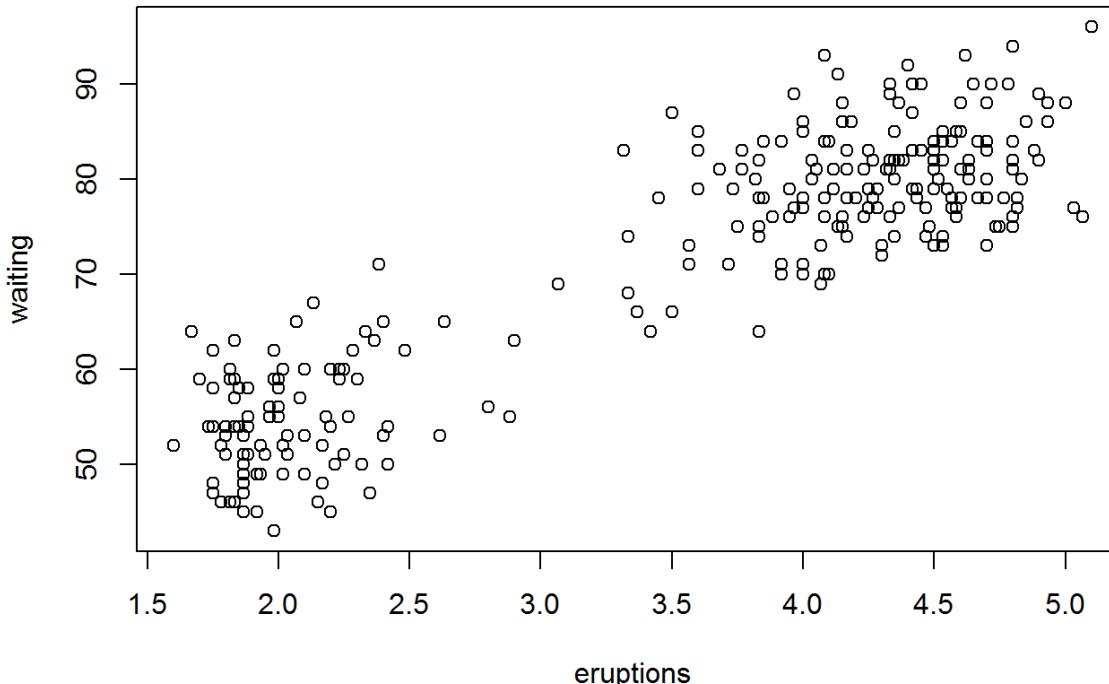
```
plot(x, y)
```



Eruption time and waiting time

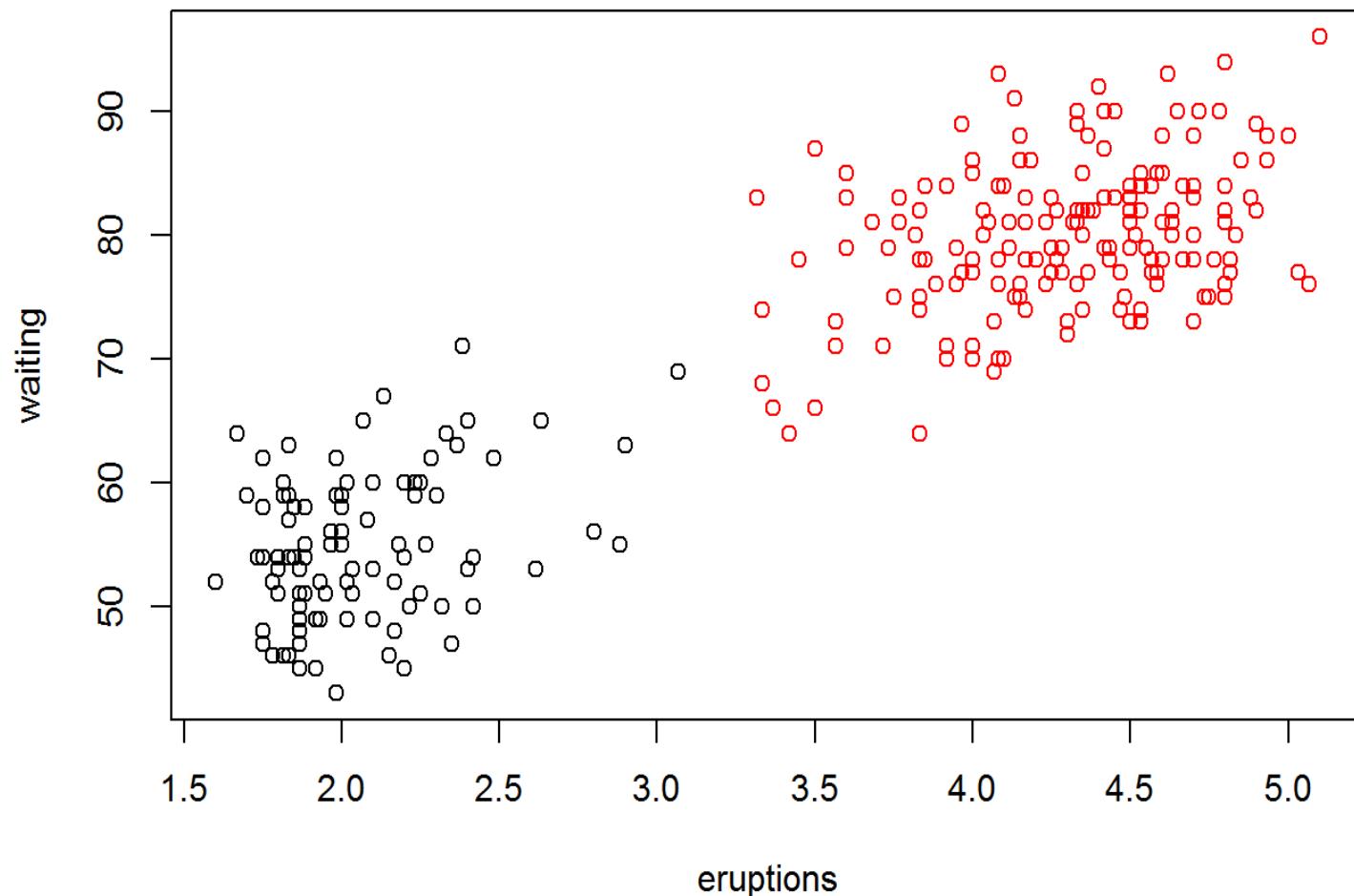
```
plot(faithful$eruptions, faithful$waiting,  
      xlab="eruptions", ylab="waiting")  
  
title("The old faithful data")
```

Adding title and text
for the labels.



Two clusters ?

The old faithful data



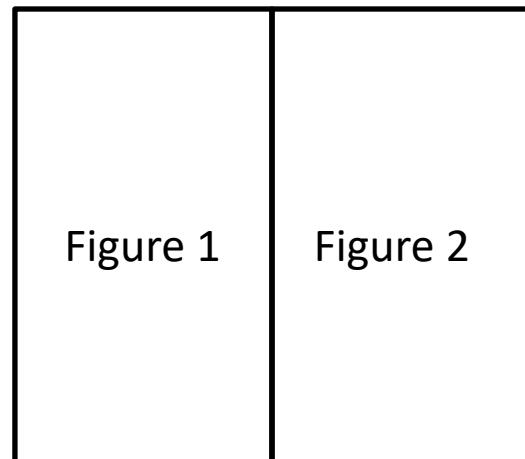
Distribution of eruption time

```
par(mfrow=c(1, 2))
```

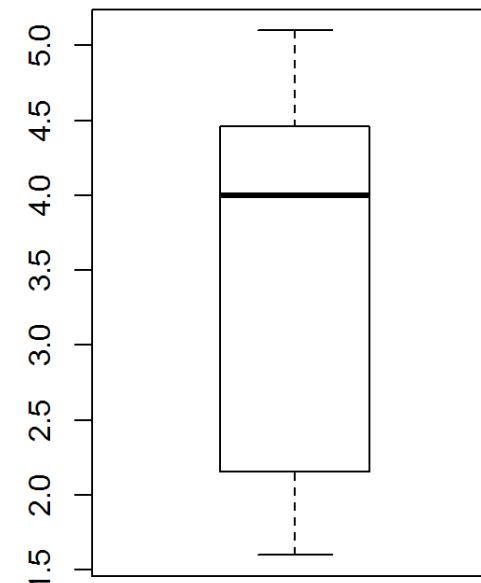
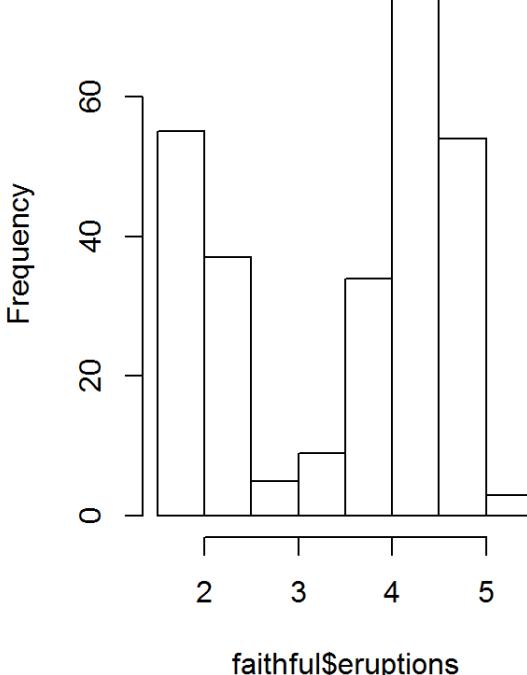
Split the graphical window

```
hist(faithful$eruptions)  
boxplot(faithful$eruptions)
```

Split the graphical window



Histogram of faithful\$eruptions

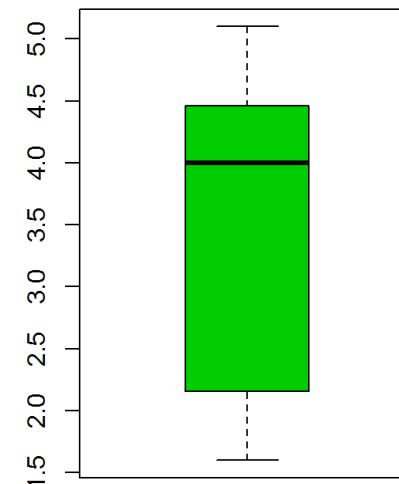
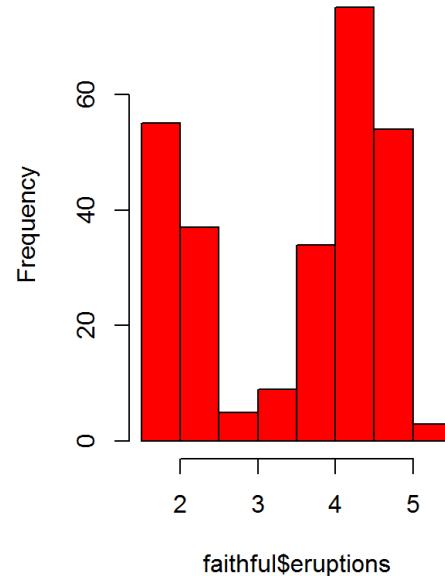


Distribution of eruption time

```
par(mfrow=c(1, 2))  
hist(faithful$eruptions, col=2)  
boxplot(faithful$eruptions, col=3)
```

Change plot settings.

Histogram of faithful\$eruptions

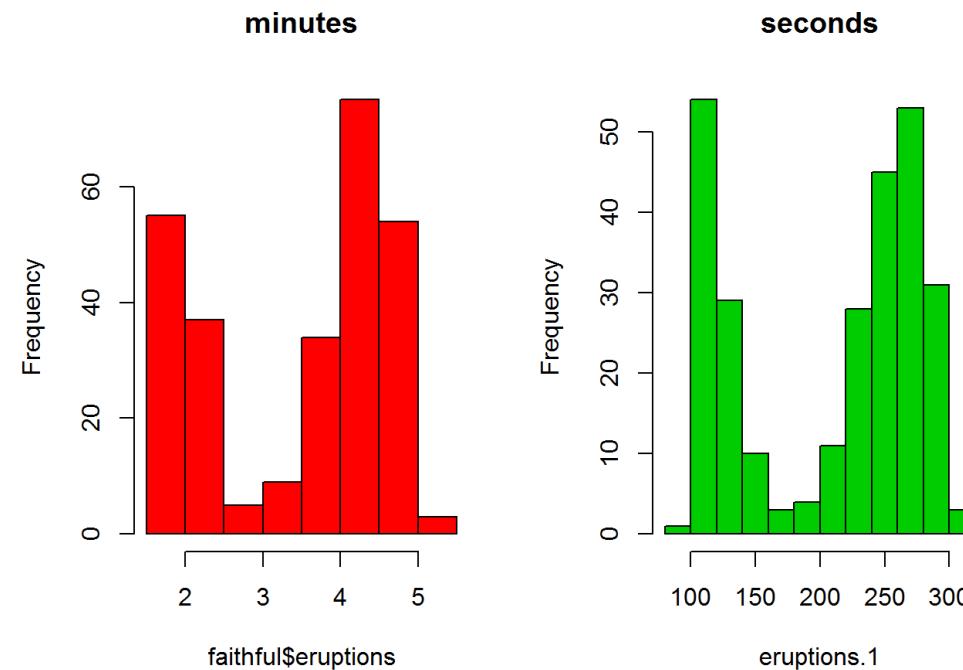


Distribution of eruption time in seconds

```
eruptions.1<-faithful$eruptions*60  
par(mfrow=c(1,2))  
hist(faithful$eruptions, col=2,main="minutes")  
hist(eruptions.1, col=3,main="seconds")
```

Create a new object:

eruptions.1



The Rmd program

- Repeat the analysis above.
- Produce a report for the analysis.
- Output: PDF format.
- Run the analysis in your own laptop to see the report.
- Rmd program:

R_course_UHasselt_2021(pdf)_V2.Rmd

The R markdown program & PDF output

R_course_UHasselt_2021(pdf)_V2.Rmd

The screenshot shows the RStudio interface with two main windows. On the left, the R Markdown editor displays the following R code:

```
25 # Introduction
26 
27 old Faithful is a geyser that is found in Yellowstone National Park, in wyom
28 attractions at Yellowstone National Park. old Faithful is unique because of
29 aim is to explore the time between eruptions and the duration of the eruption
30 graphical R functions and functions to calculate descriptive statistics for
31 # The data
32 
33 Data recorded from 1990 measured the time between eruptions and the duration
34 minutes. This data set was based on 272 observations of old Faithful's erupt
35 eruption time in mins and waiting time to next eruption (in mins). Both vari
36 ````{r}
37 head(faithful)
38 ````

39
40
41 # Analysis of the old faithful data
42
43 ## Eruption time and waiting time
```

A red arrow points from the line `head(faithful)` to the corresponding output in the PDF window. The PDF window on the right shows the generated document:

Introduction

Old Faithful is a geyser that is found in Yellowstone National Park, in Wyoming. It is one of the most famous attractions at Yellowstone National Park. Old Faithful is unique because of how long and how often it erupts. Our aim is to explore the time between eruptions and the duration of the eruption. For the analysis we use basic graphical R functions and functions to calculate descriptive statistics for the data.

The data

Data recorded from 1990 measured the time between eruptions and the duration of the eruption, both taken in minutes. This data set was based on 272 observations of Old Faithful's eruptions and consists of 2 variables: eruption time in mins and waiting time to next eruption (in mins). Both variables are numeric.

Analysis of the old faithful data

Eruption time and waiting time

By looking at the scatter plot, we can see a visual representation of the data.

```
plot(faithful$eruptions,faithful$waiting)
```

The PDF window also includes a red box highlighting the data frame output:

| | eruptions | waiting |
|------|-----------|---------|
| ## 1 | 2.880 | 79 |
| ## 2 | 1.800 | 54 |
| ## 3 | 3.333 | 74 |
| ## 4 | 2.283 | 62 |
| ## 5 | 4.533 | 85 |
| ## 6 | 2.883 | 55 |

The R markdown program & PDF output

The screenshot shows the RStudio interface with two R Markdown files open:

- `_Course_UHasselt_demo_V0.Rmd`: Contains R code for plotting the `faithful` dataset.
- `R_Course_UHasselt_demo_V1.Rmd`: Contains R code for plotting the `faithful` dataset.
- `R_Course_UHasselt_2020(html)_V1.Rmd`: Shows the resulting PDF output.

A red arrow points from the R code in the `R_Course_UHasselt_demo_V1.Rmd` file to the corresponding code in the PDF output. The PDF output includes the following text and code:

R code as a part of your text in the output

```
## [1] 96  
and the minimum eruption time is  
min(faithful$eruptions)  
## [1] 1.6  
Let us look once again in the scatterplot. We can add labels name and title  
plot(faithful$eruptions,faithful$waiting,  
xlab="eruptions",ylab="waiting")  
title("The old faithful data")
```

The old faithful data

The scatterplot displays the relationship between eruption duration (x-axis) and waiting time (y-axis). The x-axis ranges from 1.5 to 5.0, and the y-axis ranges from 50 to 90. The data points are scattered, forming two distinct clusters. The text "The output" is overlaid on the plot area.

In the next figure we use different colors for the two clusters.

```
plot(faithful$eruptions,faithful$waiting,  
xlab="eruptions",ylab="waiting")
```

At the bottom of the RStudio interface, the status bar shows the command used to generate the PDF and the current system time.

What did we see today ?

- R Studio.
- R markdown + output.
- Basic graphical functions in R and how to control the figure (title, colors etc).
- Do the analysis in the file:

R_course_UHasselt_2021 (pdf) _v2 .Rmd

Extra sildes

Source vs Visual Editor

Source vs Visual Editor

The screenshot shows the RStudio interface with a blue arrow pointing to the 'Knit' button in the toolbar above the code editor.

Code Editor (Source View):

```
1 ---  
2 title: "Demo 2"  
3 author: "Rudradev Sengupta, Bernard Lang'ir and Ziv Shkedy"  
4 date: "05 October 2024"  
5 output:  
6   html_document: default  
7   pdf_document: default  
8   word_document: default  
9 params:  
10  snapshot: lubridate::ymd_hms("2015-01-01 12:30:00")  
11  start: lubridate::ymd("2015-01-01")  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ```  
17  
18 ## R Markdown  
19  
20 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and  
MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
21  
22 When you click the Knit button a document will be generated that includes both content as well as  
the output of any embedded R code chunks within the document. You can embed an R code chunk like  
this:  
23  
24 # Demo 2
```

Environment View:

Environment is empty

Packages View:

| Name | Description | Version |
|-----------------|--|---------|
| abind | Combine Multidimensional Arrays | 1.4-8 |
| additivityTests | Additivity Tests in the Two Way Anova with Single Sub-Class Numbers | 1.1-4.2 |
| ade4 | Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences | 1.7-22 |
| affy | Methods for Affymetrix Oligonucleotide Arrays | 1.80.0 |
| affyio | Tools for parsing Affymetrix data files | 1.72.0 |
| alluvial | Alluvial Diagrams | 0.1-2 |
| annotate | Annotation for microarrays | 1.80.0 |
| AnnotationDbi | Manipulation of SQLite-based annotations in Bioconductor | 1.64.1 |
| AnnotationHub | Client to access AnnotationHub resources | 3.10.1 |
| askpass | Password Entry Utilities for R, Git, and SSH | 1.2.1 |
| backports | Reimplementations of Functions Introduced Since R-3.0.0 | 1.5.0 |
| base64d | Base64 Encoder and Decoder | 202 |

System Tray:

22°C Partly sunny 12:43 8/10/2024

Source vs Visual Editor

The screenshot shows the RStudio interface with the Source editor selected. A context menu is open over some R code, with a blue arrow pointing to the "Use Visual Editor" option. The menu also includes "Preview in Window", "Preview Images and Equations", "Chunk Output Inline", "Expand All Output", and "Clear Output". The Visual editor pane is empty. The Environment pane shows an empty global environment. The Packages pane lists various R packages in the User Library. The bottom status bar shows system information like battery level, temperature, and date.

R erbiostat - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

libraries.R x R_Course_UHasselt_demo_V1.Rmd x Session3.R x

Source Visual

```
1 ---  
2 title: "Demo 2"  
3 author: "Rudradev Sengupta, Bernar  
4 date: "05 October 2024"  
5 output:  
6 html_document: default  
7 pdf_document: default  
8 word_document: default  
9 params:  
10 snapshot: lubridate::ymd_hms("2015-01-01")  
11 start: lubridate::ymd("2015-01-01")  
12 ---  
13  
14 ``{r setup, include=FALSE}  
15 knitr::opts_chunk$set(echo = TRUE)  
16 ````  
17  
18 ## R Markdown  
19  
20 This is an R Markdown document. Ma  
MS Word documents. For more detail  
21  
22 When you click the Knit button a document will be generated that includes both content as well as  
the output of any embedded R code chunks within the document. You can embed an R code chunk like  
this:  
23
```

Ctrl+Shift+F4

Use Visual Editor

- ✓ Preview in Window
- ✓ Preview Images and Equations
- ✓ Show Previews Inline
- ✓ Chunk Output Inline
- Expand All Output
- Collapse All Output
- Clear Output
- Clear All Output
- Output Options...

syntax for authoring HTML, PDF, and
<http://rmarkdown.rstudio.com>.

Environment History Connections Tutorial

Import Dataset 146 MiB List

R Global Environment

Environment is empty

Files Plots Packages Help Viewer Presentation

Install Update

| Name | Description | Version |
|-----------------|--|---------|
| abind | Combine Multidimensional Arrays | 1.4-8 |
| additivityTests | Additivity Tests in the Two Way Anova with Single Sub-Class Numbers | 1.1-4.2 |
| ade4 | Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences | 1.7-22 |
| affy | Methods for Affymetrix Oligonucleotide Arrays | 1.80.0 |
| affyio | Tools for parsing Affymetrix data files | 1.72.0 |
| alluvial | Alluvial Diagrams | 0.1-2 |
| annotate | Annotation for microarrays | 1.80.0 |
| AnnotationDbi | Manipulation of SQLite-based annotations in Bioconductor | 1.64.1 |
| AnnotationHub | Client to access AnnotationHub resources | 3.10.1 |
| askpass | Password Entry Utilities for R, Git, and SSH | 1.2.1 |
| backports | Reimplementations of Functions Introduced Since R-3.0.0 | 1.5.0 |
| base64 | Base64 Encoder and Decoder | 2.0.2 |

User Library

Console Terminal Background Jobs

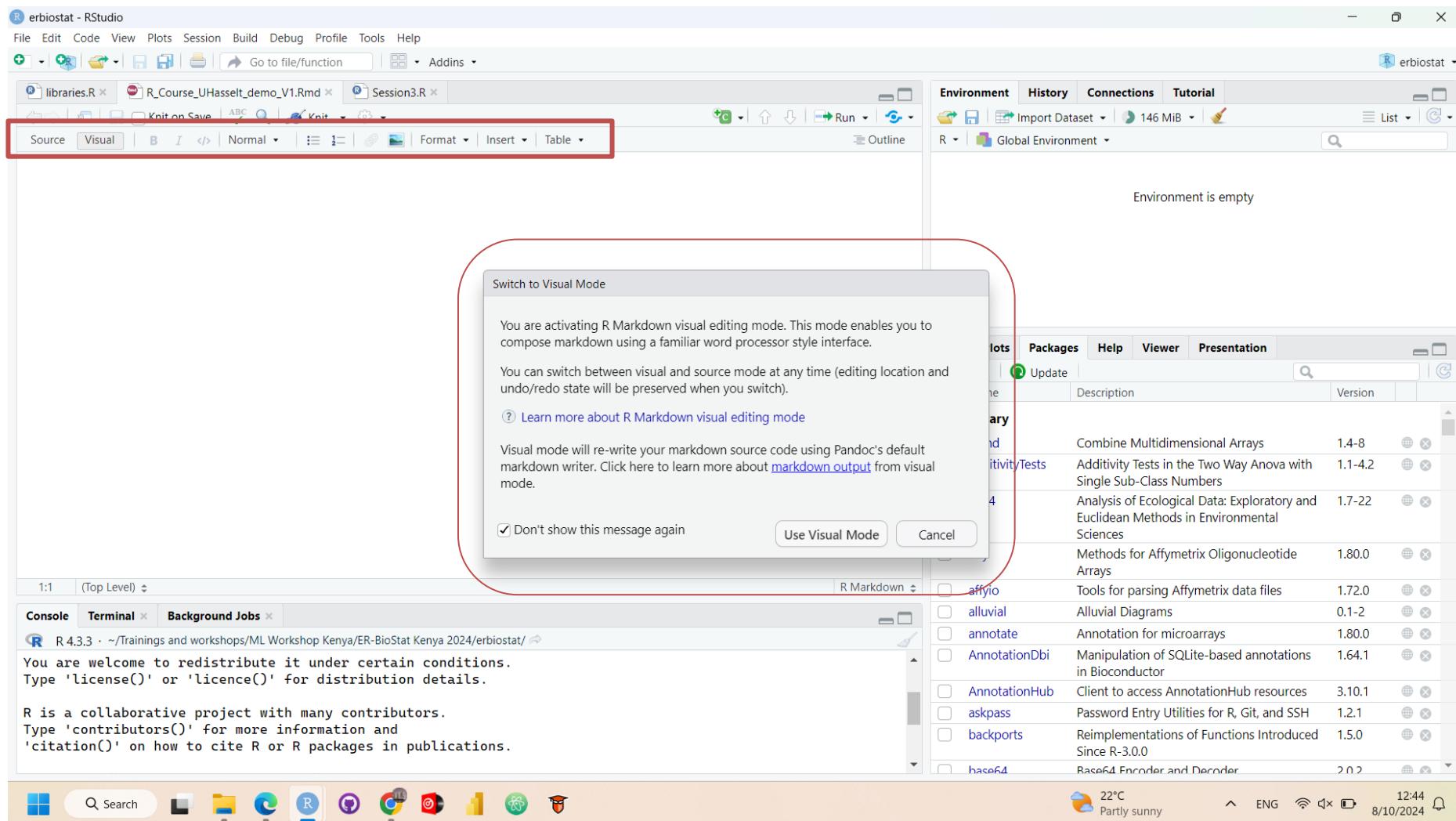
R 4.3.3 · ~/Trainings and workshops/ML Workshop Kenya/ER-BioStat Kenya 2024/erbiostat/

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R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

22°C Partly sunny 12:43 8/10/2024

Source vs Visual Editor



Source vs Visual Editor

The screenshot shows the RStudio interface with the Source tab selected in the top-left panel. The main workspace displays R Markdown code:

```
---  
title: "Demo 2"  
author: "Rudradev Sengupta, Bernard Osang'ir and Ziv Shkedy"  
date: "05 October 2024"  
output:  
  html_document: default  
  pdf_document: default  
  word_document: default  
params:  
  snapshot: lubridate::ymd_hms("2015-01-01 12:30:00")  
  start: lubridate::ymd("2015-01-01")  
---|  
  
{r setup, include=FALSE}  
knitr::opts_chunk$set(echo = TRUE)
```

The R Markdown panel on the right shows a tree structure for document sections: R Markdown, Including project..., Including Plots, Short Analysis, Output for the re..., Output for the re..., Section, Subsection, and subsection.

The Environment panel shows the message "Environment is empty".

The Packages panel lists the User Library with the following packages:

| Name | Description | Version |
|-----------------|--|---------|
| abind | Combine Multidimensional Arrays | 1.4-8 |
| additivityTests | Additivity Tests in the Two Way Anova with Single Sub-Class Numbers | 1.1-4.2 |
| ade4 | Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences | 1.7-22 |
| affy | Methods for Affymetrix Oligonucleotide Arrays | 1.80.0 |
| affyio | Tools for parsing Affymetrix data files | 1.72.0 |
| alluvial | Alluvial Diagrams | 0.1-2 |
| annotate | Annotation for microarrays | 1.80.0 |
| AnnotationDbi | Manipulation of SQLite-based annotations in Bioconductor | 1.64.1 |
| AnnotationHub | Client to access AnnotationHub resources | 3.10.1 |
| askpass | Password Entry Utilities for R, Git, and SSH | 1.2.1 |
| backports | Reimplementations of Functions Introduced Since R-3.0.0 | 1.5.0 |
| base64 | Base64 Encoder and Decoder | 202 |

The bottom status bar shows system information: Windows 10, 22°C, Partly sunny, ENG, 12:44, 8/10/2024.

Source vs Visual Editor

The screenshot shows the RStudio interface with two main panes. The left pane is the 'Source' editor, which displays R Markdown code. The right pane is the 'Visual' editor, which displays the generated HTML output. A red box highlights the 'Visual' tab in the Source editor's toolbar. A blue arrow points from the 'Knit' button in the Source editor to the 'Knit' button in the Visual editor. Another blue arrow points from the 'R Markdown' section in the Source editor to the 'R Markdown' section in the Visual editor. The Visual editor shows the rendered document titled 'Demo 2' with authors Rudradev Sengupta, Bernard Osang'ir, and Ziv Shkedy, and the date 05 October 2024. It includes sections on R Markdown and project metadata, and displays the summary of the mtcars dataset.

Demo 2

Rudradev Sengupta, Bernard Osang'ir and Ziv Shkedy

05 October 2024

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

When you click the Knit button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
project_start <- params$start  
summary(mtcars)
```

| ## | mpg | cyl | disp | hp |
|------------|--------|---------------|---------------|----------------|
| ## Min. | 10.40 | Min. :4.000 | Min. :71.1 | Min. :52.0 |
| ## 1st Qu. | 15.43 | 1st Qu.:4.000 | 1st Qu.:120.8 | 1st Qu.:96.5 |
| ## Median | 19.20 | Median :6.000 | Median :196.3 | Median :123.0 |
| ## Mean | 20.09 | Mean :6.188 | Mean :230.7 | Mean :146.7 |
| ## 3rd Qu. | 22.80 | 3rd Qu.:8.000 | 3rd Qu.:326.0 | 3rd Qu.:180.0 |
| ## Max. | 33.90 | Max. :8.000 | Max. :472.0 | Max. :335.0 |
| ## | drat | wt | qsec | vs |
| ## Min. | 2.760 | Min. :1.513 | Min. :14.50 | Min. :0.0000 |
| ## 1st Qu. | 3.080 | 1st Qu.:2.581 | 1st Qu.:16.89 | 1st Qu.:0.0000 |
| ## Median | 3.695 | Median :3.325 | Median :17.71 | Median :0.0000 |
| ## Mean | 3.597 | Mean :3.217 | Mean :17.85 | Mean :0.4375 |
| ## 3rd Qu. | 3.920 | 3rd Qu.:3.610 | 3rd Qu.:18.90 | 3rd Qu.:1.0000 |
| ## Max. | 4.930 | Max. :5.424 | Max. :22.90 | Max. :1.0000 |
| ## | am | gear | carb | |
| ## Min. | 0.0000 | Min. :2.000 | Min. :1.000 | |

Source vs Visual Editor

The screenshot shows the RStudio interface with a large blue arrow pointing from the Source Editor on the left to the Visual Editor on the right.

Source Editor (Left):

- File menu:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Libraries, Go to file/function, Addins.
- Editors:** libraries.R, R_Course_UHasselt_demo_V1.Rmd*, Session3.R.
- Buttons:** Knit on Save, ABC, Knit, Settings.
- Text Area:**

```
R Markdown
This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.
```

When you click the **Knit** button a document will be generated that includes the output of any **embedded R code** chunks within the document. You can

```
{r cars}
project_start <- params$start
summary(mtcars)
```
- Section:** Including project metadata:
- ```
{r date, echo=FALSE}
paste("Project Start Date:", project_start)
```
- Console:** R 4.3.3 · ~/Trainings and workshops/ML Workshop Kenya/ER-BioStat Kenya 2024/erbiostat/
- ```
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
```
- ```
[Workspace loaded from ~/Trainings and workshops/ML Workshop Kenya/ER-BioStat Kenya 2024/erbiostat/.RData]
```

**Visual Editor (Right):**

- Environment:** Environment is empty.
- History:** History tab.
- Connections:** Connections tab.
- Tutorial:** Tutorial tab.
- File menu:** Files, Plots, Packages, Help, Viewer, Presentation.
- Install:** Install button.
- Search:** Search bar.
- Table:** A list of installed packages:

Name	Description	Version
abind	Combine Multidimensional Arrays	1.4-8
additivityTests	Additivity Tests in the Two Way Anova with Single Sub-Class Numbers	1.1-4.2
ade4	Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences	1.7-22
affy	Methods for Affymetrix Oligonucleotide Arrays	1.80.0
affyio	Tools for parsing Affymetrix data files	1.72.0
alluvial	Alluvial Diagrams	0.1-2
annotate	Annotation for microarrays	1.80.0
AnnotationDbi	Manipulation of SQLite-based annotations in Bioconductor	1.64.1
AnnotationHub	Client to access AnnotationHub resources	3.10.1
askpass	Password Entry Utilities for R, Git, and SSH	1.2.1
backports	Reimplementations of Functions Introduced Since R-3.0.0	1.5.0
base64	Base64 Encoder and Decoder	202

- System Tray:** 22°C, Partly sunny, ENG, 12:47, 8/10/2024.

# Source vs Visual Editor

The screenshot shows the RStudio interface with two main panes demonstrating different editing modes.

**Left Pane (Source Editor):**

- R Markdown:** A table is displayed with columns labeled "Column", "Report", and "P-value".
- A large blue arrow points upwards from the table towards the "Column" header.
- The text "Direct editing" is overlaid on the table area.
- Demonstration for visual:** Below the table, it says: "When you click the **Knit** button a document will be generated that includes both content as well as the output of any **embedded R code** chunks within the document. You can embed an R code chunk like this:
- An R code chunk is shown in the console:

```
fr cars
```

- The R console output shows the R version and license information:

```
R version 4.3.3 (2024-02-29 ucrt) -- "Angel Food Cake"
Copyright (C) 2024 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
```

**Right Pane (Visual Editor):**

  - Environment:** Shows an empty environment.
  - Packages:** Shows the "User Library" with a list of packages:

Name	Description	Version	Action
abind	Combine Multidimensional Arrays	1.4-8	...
additivityTests	Additivity Tests in the Two Way Anova with Single Sub-Class Numbers	1.1-4.2	...
ade4	Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences	1.7-22	...
affy	Methods for Affymetrix Oligonucleotide Arrays	1.80.0	...
affyio	Tools for parsing Affymetrix data files	1.72.0	...
alluvial	Alluvial Diagrams	0.1-2	...
annotate	Annotation for microarrays	1.80.0	...
AnnotationDbi	Manipulation of SQLite-based annotations in Bioconductor	1.64.1	...
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base64	Base64 Encoder and Decoder	202	...

  - Global Environment:** Shows an empty global environment.

# Source vs Visual Editor

The screenshot illustrates the RStudio interface comparing the Source and Visual editors.

**Left Side (Source Editor):**

- File menu:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Go to file/function, Addins, Knit on Save, Knit, Format, Insert, Table.
- Text Area:** Displays R Markdown content, including a table and a code chunk.
- Console Area:** Shows R session output, including the mtcars dataset summary.

**Right Side (Visual Editor):**

- Title Bar:** R\_Course\_UHasselt\_demo\_V1.html, Open in Browser, Find.
- Content Area:** Displays the generated HTML document titled "Demo 2".
- Sidebar:** Shows a list of packages and their versions.
- Bottom Status Bar:** Includes system icons for battery, signal, and date/time (12:48, 8/10/2024).

A red arrow points from the table in the Source editor to the table in the Visual editor, indicating the result of the Knit process.

# Source vs Visual Editor

The screenshot shows the RStudio interface with two main panes: Source and Visual.

**Source Editor:** Displays R Markdown code. A red box highlights a table chunk:

Column	Report	P-value

Another red box highlights a section of text:

: \*\*\*Demonstration for visual\*\*\*

Below this, another red box highlights a note about knitting:

When you click the **Knit** button a document will be generated that includes both content as well as the output of any **embedded R code** chunks within the document.

**Visual Editor:** Shows a dropdown menu for R Markdown options, including "R Markdown Including project ...". The environment pane shows "Environment is empty".

**Console:** Shows the R command line with the R version and workspace information.

**Session:** Shows the global environment with a list of packages.

**Taskbar:** Includes icons for search, file, browser, and other applications.

**System Tray:** Shows the date, time (12:49), and battery status.

# What did we see today ?

- R Studio.
- R markdown + output.
- Basic graphical functions in R and how to control the figure (title, colors etc).
- Do the analysis in the file:
  - [\*\*R\\_course\\_UHasselt\\_2021\(pdf\)\\_V2.Rmd\*\*](#)
- Explore use of Source and Visual Editor