

Interuniversity Institute for Biostatistics
and statistical Bioinformatics

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

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Updated: 05/25



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GitHub

<https://github.com/eR-Biostat>



@erbiostat

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 ?

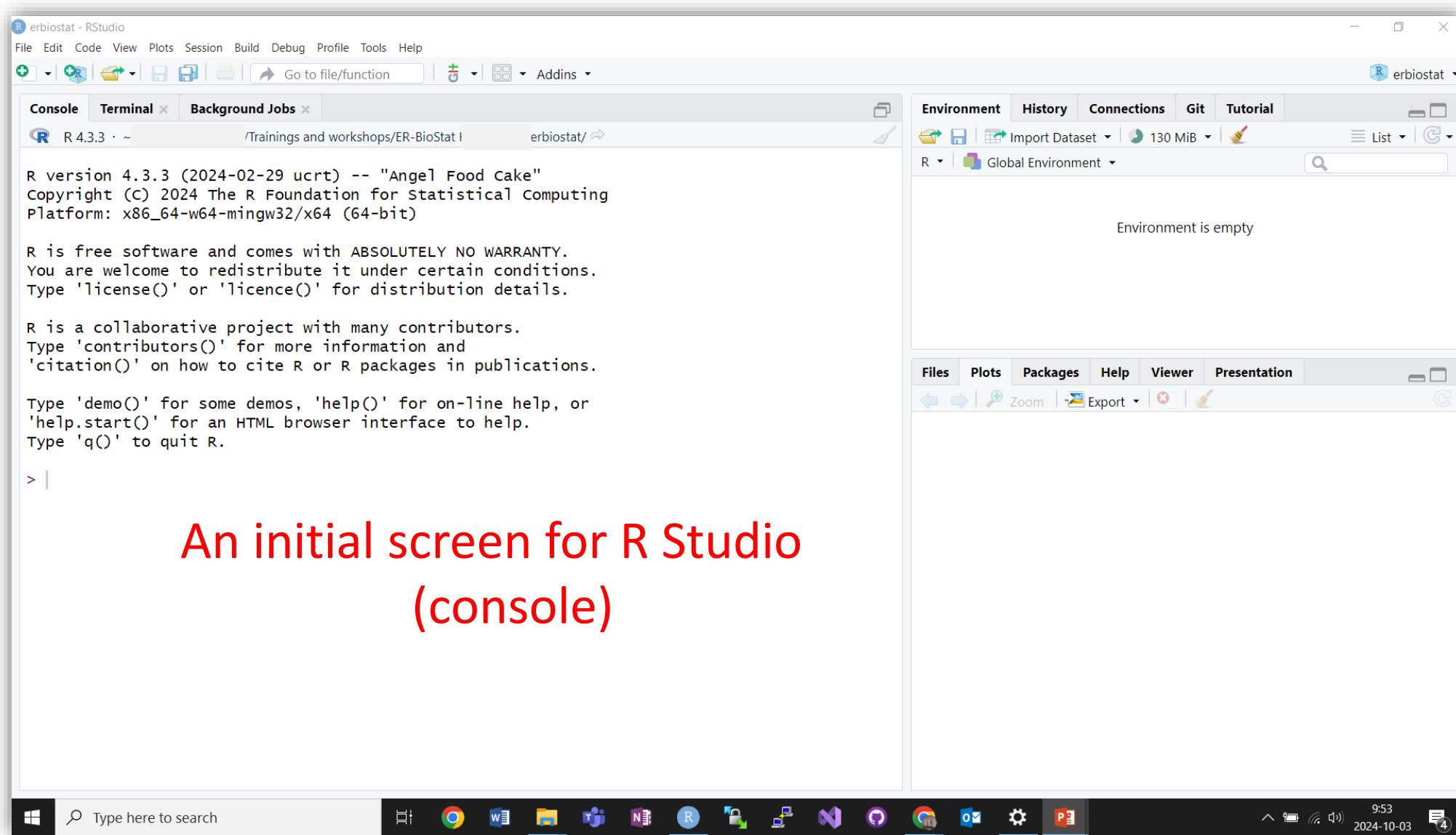
- R Studio is an integrated development environment (IDE) for R and Python.
 - It includes a **console, syntax-highlighting editor** that supports direct code execution.
 - Tools for plotting, history, debugging and workspace management.
- R Studio is available in **open source** and **commercial** editions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

What is R Studio ?

- More information:

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

R Studio



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

erbiostat - RStudio

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

cars\$dist

plot (x, y)

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

RGui (64-bit)

File History Resize Windows

R Console

```
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)

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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

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

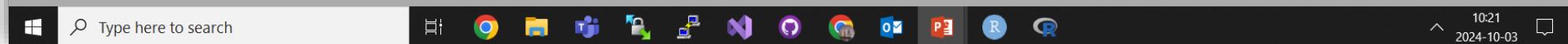
R Graphics: Device 2 (ACTIVE)

A scatter plot showing the relationship between car speed (x-axis) and stopping distance (y-axis). 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, with data points scattered across the plot area, generally increasing from left to right.

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

plot (x, y)

A similar plot in R



General structure of R

- R Functions.
- R packages (written by developers) as a part of the software:
 - `glm()`
- R packages (written by developers) uploaded in CRAN, Bioconductor, Github....
- 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. Red arrows point to the "Plots" and "Packages" tabs in the bottom navigation bar. The package manager pane shows a list of available packages in the User Library.

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

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

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.

A screenshot of an R session in RGui (64-bit). The R Console window shows the following text:

```
R version 4.3.3 (2024-02-29 ucrt)
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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Type 'license()' or 'licence()' for details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information.
Type 'citation()' on how to cite R or R packages.
Type 'demo()' for some demos, 'help()'
'help.start()' for an HTML browser interface,
Type 'q()' to quit R.

[Previously saved workspace restored]

> help(mtcars)
starting httpd help server ... done
>

> |
```

The R Help window displays the documentation for the mtcars dataset. The title is "R: Motor Trend Car Road Tests". 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 shown:

- [, 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
- [,11] carb Number of carburetors

A red arrow points to the first item in the list, and another red arrow points to the sixth item in the list.

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-30

> |
```

The estimated model

see next slide

Limited - R Editor

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

R Graphics: Device 2 (ACTIVE)

R Taskbar

The R code for the analysis

```
summary(mtcars)
plot(mtcars$wt, mtcars$mpg)
mean(mtcars$mpg)
fit.lm<-lm(mtcars$mpg~mtcars$wt) —————> fit a simple linear regression
model
summary(fit.lm)
```

The regression output

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

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 the R Markdown file `R_Course_UHasselt_demo_V0.Rmd`. The code is annotated with a red box around lines 18-22, which are highlighted in yellow. A red arrow points from the text "The R code" to this box.
- Console:** Shows the output of the R code, including the results of `summary(mtcars)`, `plot(mtcars$wt, mtcars$mpg)`, `mean(mtcars$mpg)`, the creation of a linear model `fit.lm <- lm(mtcars$mpg ~ mtcars$wt)`, and the summary of the model `summary(fit.lm)`. The output also includes the regression coefficients and their significance levels.
- Environment:** Shows the global environment with an object named `fit.lm` listed as 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 title "The R code" is overlaid in red text on the left side of the Source Editor area.

```
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)|
```

(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

The mtcars data : an analysis in R Studio

The screenshot illustrates the workflow for analyzing the mtcars dataset in R Studio. A red arrow points from the code editor to the 'Run' dropdown menu, which is open to show various execution options. Another red arrow points from the output console to the text 'The output'.

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
```

The R Studio interface includes the following components:

- File Edit Code View Plots Session Build Debug Profile Tools Help**
- Addins** dropdown
- Source Visual** tabs
- Run Selected Line(s) Ctrl+Enter** (highlighted in the dropdown menu)
- Run Current Chunk Ctrl+Shift+Enter**
- Run Next Chunk Ctrl+Alt+N**
- Run Setup Chunk**
- Run Setup Chunk Automatically** (checkbox checked)
- Run All Chunks Above Ctrl+Alt+Shift+P**
- Run All Chunks Below**
- Restart R and Run All Chunks**
- Restart R and Clear Output**
- Run All Ctrl+Alt+R**

Environment, **History**, **Connections**, **Git**, **Tutorial** tabs

Data pane: `fit.lm` (List of 12)

Files Plots Packages Help Viewer Presentation tabs

User Library pane (partial list):

- a4Core
- abind
- additivityT...
- ade4
- admisc
- alluvial
- analogue
- Annotatio...
- Manipulation of SQLite-based

Bottom status bar: 11:55, 2024-10-03

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*

Go to file/function Addins

Source Visual

```
1 ---  
2 title: "Demo 1"  
3 author: "Rudradev Sengupta, Bernard Osang'ir & Ziv Sh  
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)  
summary(fit.lm)
```

code

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

> |

Plot Zoom

mtcars\$mpg

mtcars\$wt

The estimated model

Environment History Connections Git Tutorial

Import Dataset 186 MB

Global Environment

fit.lm List of 12

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 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 in the screenshot:

- A bracket on the left labeled "YAML Header" points to the YAML header section.
- A bracket on the left labeled "Formatted Text" points to the introductory text and the "Including Plots" section.
- A bracket on the right labeled "Code Chunks" points to the R code blocks.
- A red arrow points from the text "summary(cars)" to the line "summary(cars)" in the code.
- A red arrow points from the text "plot(pressure)" to the line "plot(pressure)" in the code.

Programname.Rmd

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> – 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

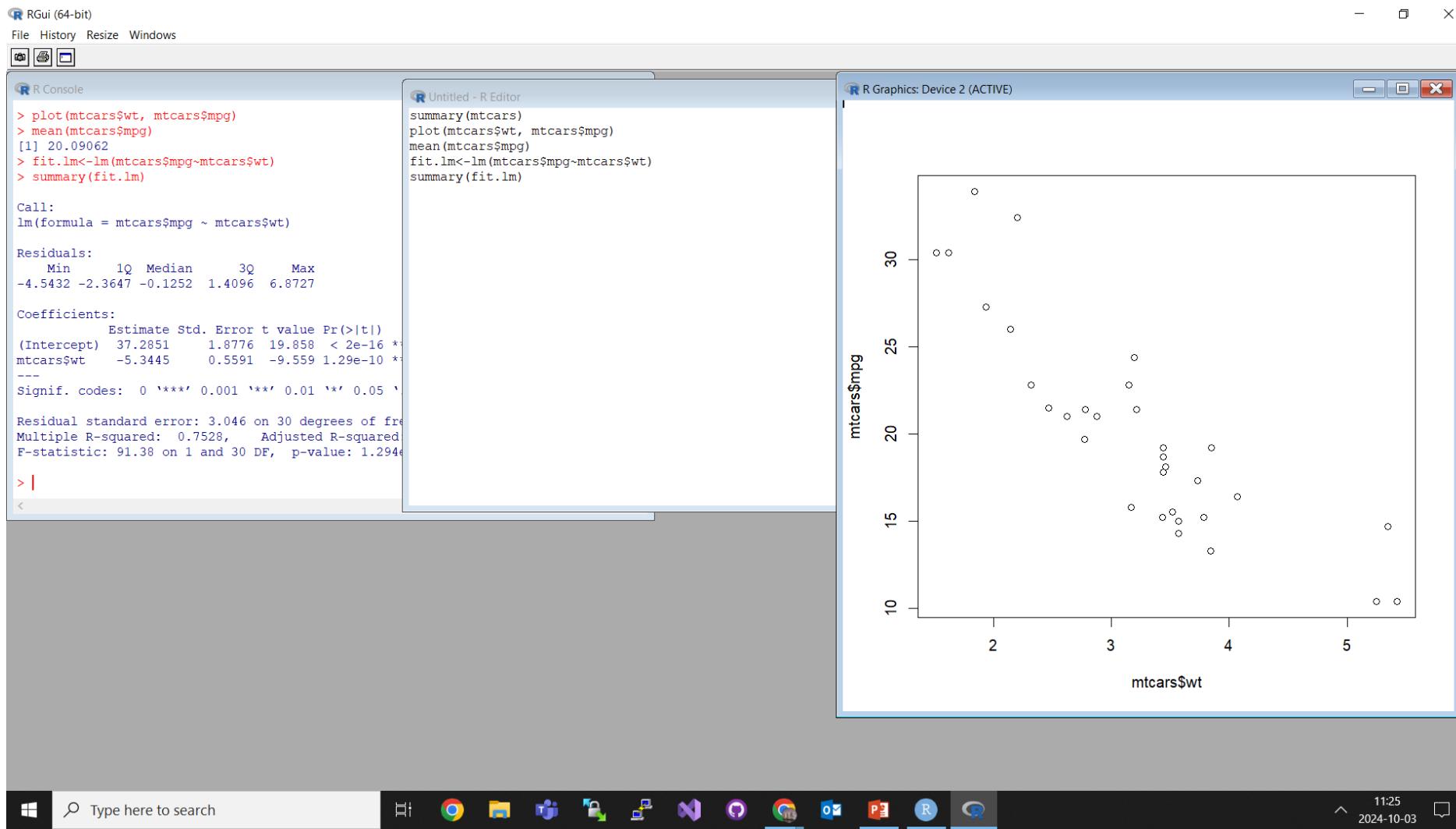
Part 1: Analysis with R and R Studio

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:

- Top Bar:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Includes icons for New Project, Open, Save, Run, Knit, and Addins.
- Source Editor:** Displays the R Markdown file `R_Course_UHasselt_demo_V0.Rmd*`. The code includes YAML front matter and R code for summarizing the mtcars dataset and fitting a linear model.
- Console:** Shows the output of the R session, including the summary of `mtcars`, a scatter plot of `wt` vs `mpg`, the mean of `mpg`, the fitted linear model `fit.lm`, and its summary statistics.
- Environment:** Shows the global environment with an object named `fit.lm`.
- Packages:** Shows the user library with packages like `a4Core`, `abind`, `additivityT...`, `ade4`, `admisc`, `alluvial`, `analogue`, and `Annotatio...`.
- Bottom Bar:** Windows taskbar with various application icons.

Analysis in R Studio

The screenshot shows the R Studio interface with several panels:

- Source Editor:** Displays R code for a document named "R_Course_UHasselt_demo_V0.Rmd". A red arrow points from the "Run" button in the toolbar to a context menu that is open over the code. The menu includes options like "Run Selected Line(s)", "Run Current Chunk", and "Run All".
- Console:** Shows the R environment and command-line output. It includes:
 - Significance 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 objects like "fit.lm" and "List of 12".
- Packages:** Shows the user library with packages such as a4Core, abind, additivityT..., ade4, admisc, alluvial, analogue, Annotation..., and Manipulation... listed.

Annotations in red text are present:

- "The R code" is placed over the Source Editor area.
- "The output" is placed over the Console output area.

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) 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
-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

Scatter plot showing the relationship between mtcars\$mpg (Y-axis, ranging from 10 to 30) and mtcars\$wt (X-axis, ranging from 2 to 5). The data points show a negative correlation, where lower weight is associated with higher fuel efficiency.

The estimated model

Graphical window

Scatter plot showing the same data as above, with a red arrow pointing to the 'Zoom' button in the RStudio toolbar. The plot is labeled 'Graphical window'.

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

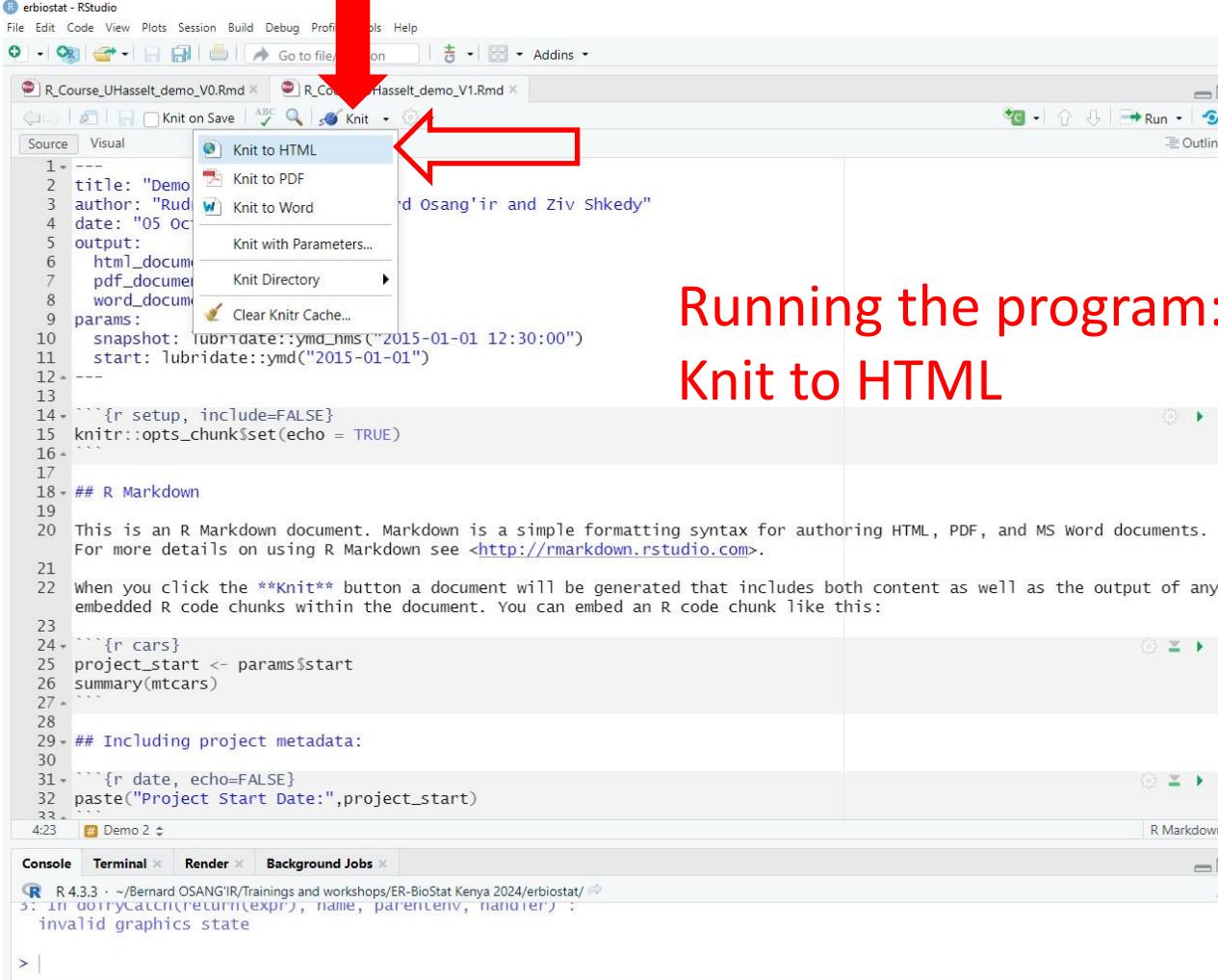
Title and info.

The screenshot shows the RStudio interface with two files open: `R_Course_UHasselt_demo_V0.Rmd` and `R_Course_UHasselt_demo_V1.Rmd`. The `V1.Rmd` file is the active document, displaying the following content:

```
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$set(echo = TRUE)  
16  
17 ## R Markdown  
18  
19 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents.  
For more details on using R Markdown see <http://rmarkdown.rstudio.com>.  
20  
21 When you click the **Knit** button a document will be generated that includes both content as well as the output of any  
embedded R code chunks within the document. You can embed an R code chunk like this:  
22  
23 ``{r cars}  
24 project_start <- params$start  
25 summary(mtcars)  
26  
27 ``  
28  
29 ## Including project metadata:  
30  
31 ``{r date, echo=FALSE}  
32 paste("Project Start Date:",project_start)  
33  
4:23 # Demo 2
```

A red bracket on the left side of the code area groups lines 1 through 17, labeled "YAML Header". A blue box highlights the text from line 19 to line 22, labeled "Example of free text". A red bracket on the left side of the code area groups lines 23 through 33, labeled "R code". The RStudio environment pane on the right shows the global environment and user library.

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' button in the toolbar, which has a dropdown menu open. The 'Knit to HTML' option is highlighted in the menu. The RStudio environment includes a sidebar with tabs for Environment, History, Connections, Git, and Tutorial, and a packages panel showing a list of installed packages.

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 queryCatch(returnExpr, handle, parentEnv, handleEnv) :
invalid graphics state

18:46
2024-10-03

Output: HTML

The screenshot illustrates the R Markdown workflow in RStudio. On the left, the R Markdown source code for "Demo 2" is shown, with a red circle highlighting the line "# R Markdown". A red arrow points from this line to the generated HTML output on the right. The HTML output displays the document title "Demo 2", authors "Rudradev Sengupta, Bernard Osang'ir and Ziv Shkedy", and the date "05 October 2024". The "R Markdown" section is also highlighted with a red box. A red arrow points from the "See page 43" text at the top right to this box. The "The output" text is also highlighted with a red box. The bottom of the screenshot shows the RStudio interface with tabs like "Console", "Terminal", and "Background Jobs", and a status bar indicating the date and time.

See page 43

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)
```

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:

```
## {r cars}  
project_start <- params$start  
summary(mtcars)
```

Including project metadata:

```
## [1] "Project Start Date: lubridate::ymd(\"2015-01-01\")"
```

Including Plots

The output

18:51
2024-10-03

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.

Go to file/function Addins

C:/Ziv_Temp_2023/Wprkshop_Kenya/Shortcourse/Rmarkdown1/Rmds/R_Course_UHasselt_demo_V1.html

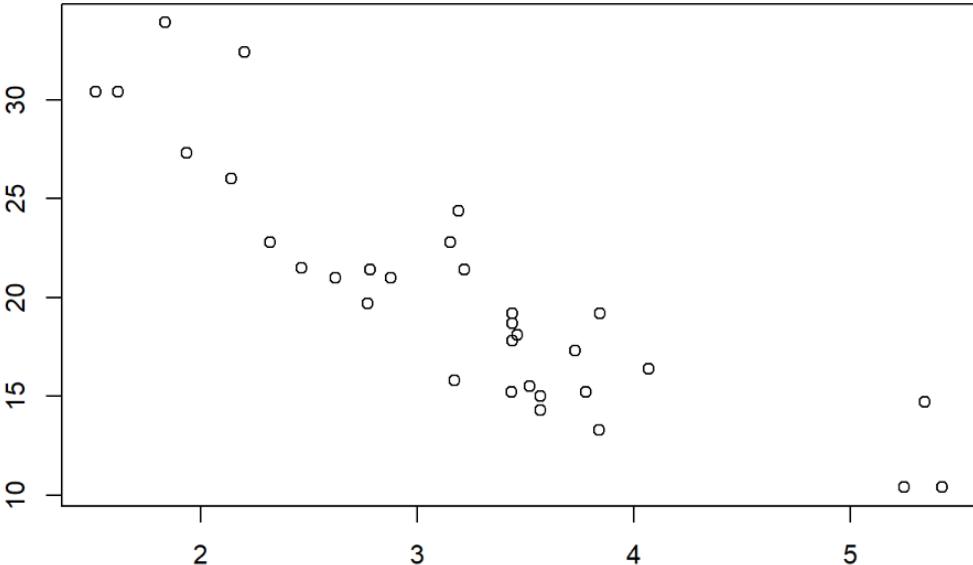
R_Course_UHasselt_demo_V1.html Open in Browser Find

Publish

Including Plots

You can also embed plots, for example:

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



A data frame with 15 observations on 2 variables.

8:23 ENG 9/05/2025 47

The HTML output

The screenshot shows the RStudio interface with an R Markdown file open on the left and its generated HTML output on the right.

Left Panel (RStudio Editor):

- File:** HD_Unsupervised_NBA_2017.R, Example_prog_2016.R, HD_Unsupervised_Examp
- Addins:** Go to file/function, Addins
- Source:** The code block contains the following R code:

```
49  
50  
51 ## Short Analysis  
52  
53 ``{r}  
54 mean(mtcars$mpg)  
55 fit.lm<-lm(mtcars$mpg~mtcars$wt)  
56 ``  
57  
58 ## Output for the regression model  
59  
60 ``{r}  
61 summary(fit.lm)  
62 ``  
63
```
- Console:** Displays the R startup message and the command `summary(fit.lm)`.

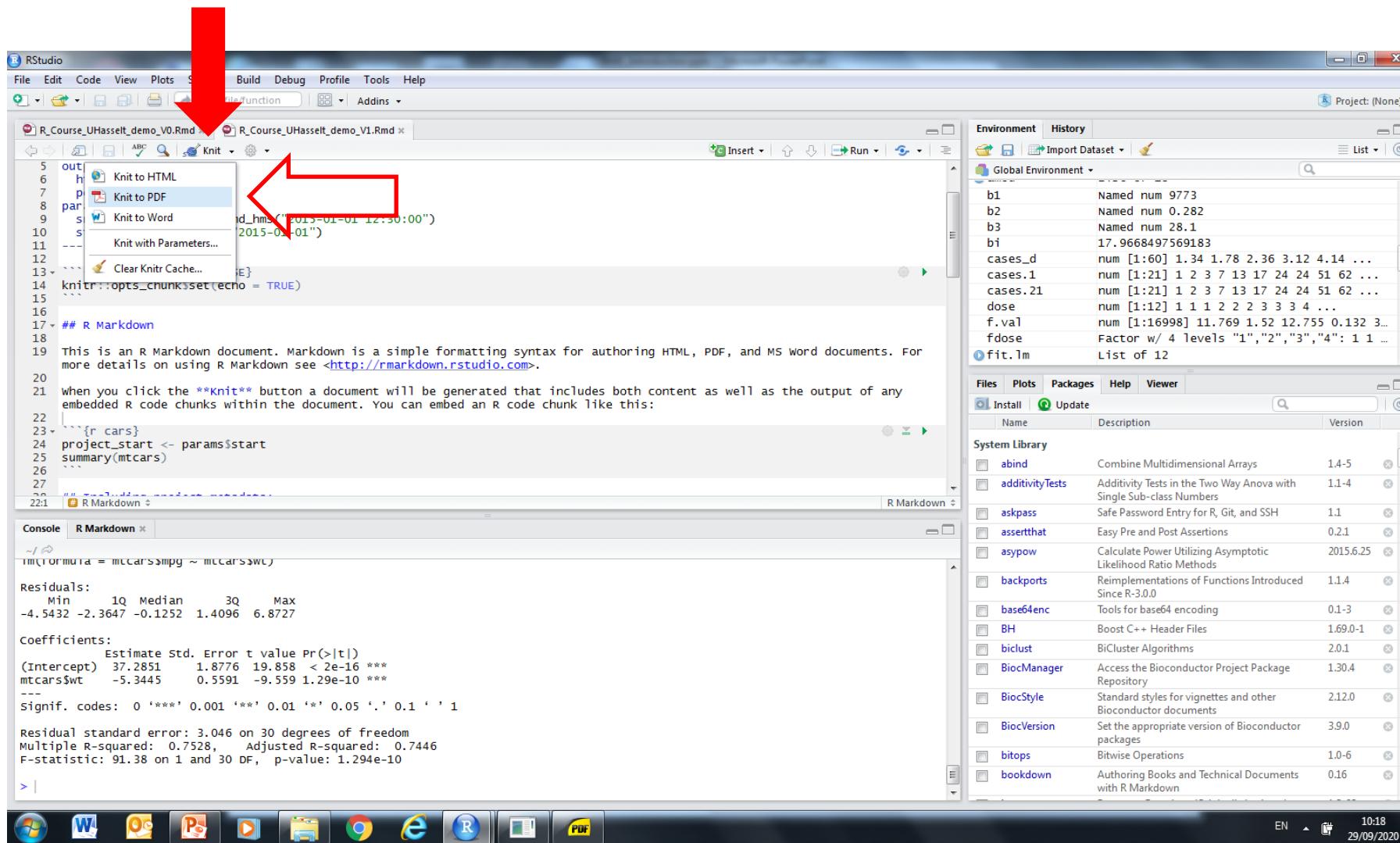
Right Panel (HTML Preview):

- Title:** C:/Ziv_Temp_2023/Wprkshop_Kenya/Shortcourse/Rmarkdown1/Rmds/R_Course_UHasselt_demo_V1.html
- Content:** The generated HTML output includes sections for "Short Analysis" and "Output for the regression model".
 - Short Analysis:** Shows the mean of mtcars\$mpg and the regression model fit.lm.
 - Output for the regression model:** Shows the summary statistics and coefficients for the regression model.
- Footnote:** 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 PDF output

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

Left Panel (RStudio Environment):

- Code Editor:** Shows the R Markdown code for "R_Course_UHasselt_demo_V0.Rmd". It includes code chunks for generating plots and tables, and an R code chunk for a linear regression model on the mtcars dataset.
- Console:** Displays the results of the R code execution, including the regression output and summary statistics for 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 top right, with the text "See page 43 for the title".
- Author:** "Rudradev Sengupta and Ziv Shkedy"
- Date:** "29 September 2020"
- Content:** The PDF includes an R Markdown section explaining the syntax and an "Output for the regression" section containing the regression results and summary statistics for the mtcars dataset.

Bottom Status Bar:

- Windows taskbar icons (File Explorer, Task View, Start, etc.)
- System tray icons (Network, Battery, Volume, etc.)
- System status: EN, 10:17, 29/09/2020

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 chunks for generating summary statistics and a scatter plot, along with their respective outputs. The RStudio environment shows the code editor, console, and file browser.

R Markdown Document 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.:4.800
## 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)
```

Scatter Plot:

A scatter plot showing the relationship between the weight of the car (wt) on the x-axis and its fuel efficiency (mpg) on the y-axis. The x-axis ranges from approximately 1.6 to 5.4, and the y-axis ranges from 10 to 35. The plot shows a negative correlation, with fuel efficiency generally decreasing as the weight of the car increases. There are several outliers at higher weights (around 4.5-5.0) and lower fuel efficiency (around 10-15 mpg).

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

RStudio Environment:

- Code Editor:** Shows the R Markdown file "R_Course_UHasselt_demo_V0.Rmd".
- Console:** Shows the R version information and a few commands entered.
- File Browser:** Shows a list of files and packages in the current project.
- Project:** Shows the project structure with files like "bles", "les", "les", and "bles".

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 middle section of the PDF content.

Code in R Markdown:

```
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  ````{r setup, include=FALSE}  
13  knitr::opts_chunk$set(echo = TRUE)  
14  ````  
15    
16    
17  ## R Markdown  
18  This is an R Markdown document.  
19  It is a simple example of how to use R  
20  documents. For more details,  
21  when you click the **Knit** button  
22  of any embedded R code chunk,
```

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 packages.  
  
Type 'demo()' for some demos,  
'help.start()' for an HTML browser-based help system,  
Type 'q()' to quit R.  
  
[workspace loaded from ~/RData]
```

PDF Content:

mtcars\$wt

Short Analysis

```
mean(mtcars$mpg)  
## [1] 20.09062  
fit.lm<-lm(mtcars$mpg~mtcars$wt)
```

Output for the regression model

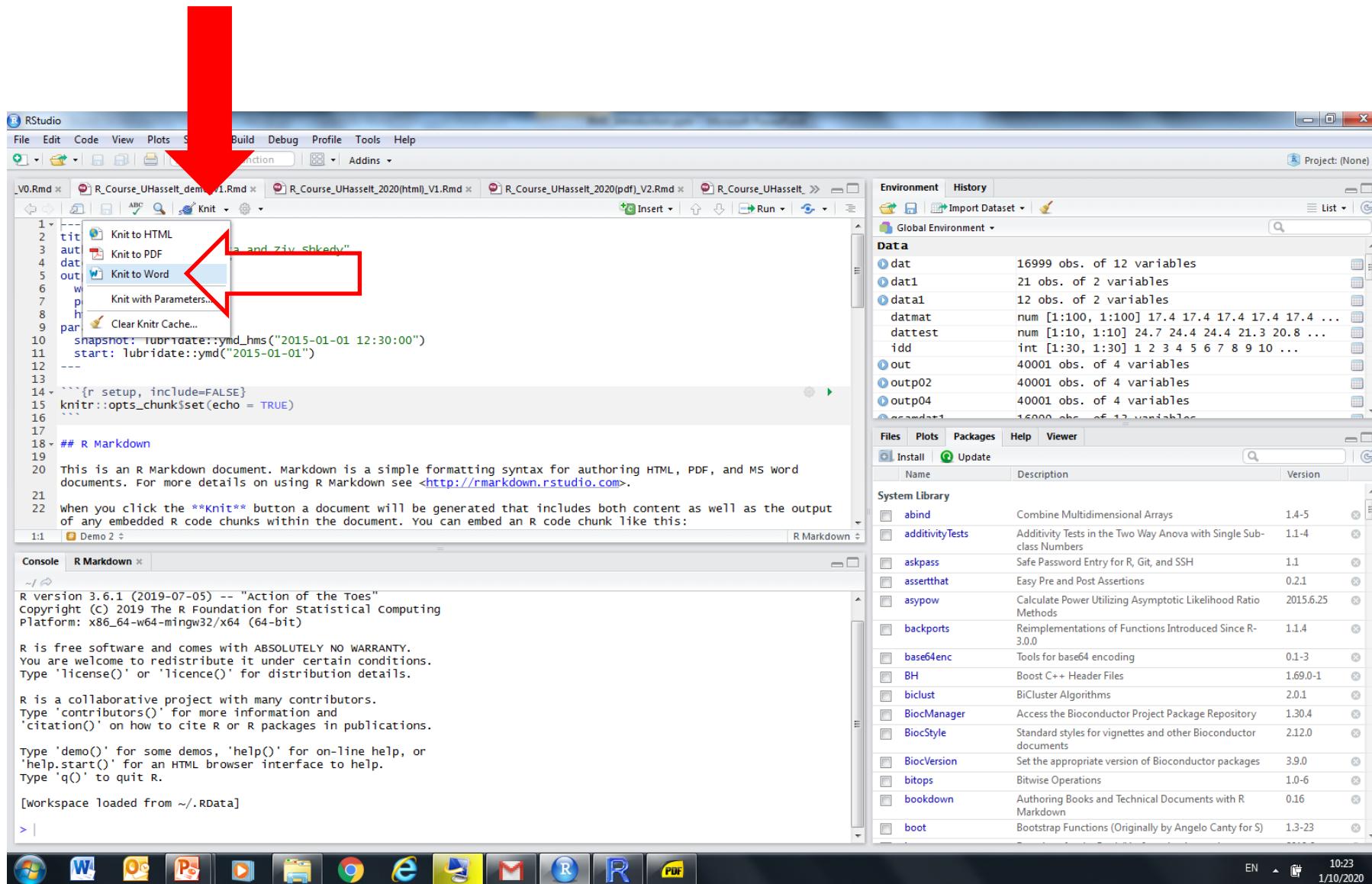
```
summary(fit.lm)  
  
##  
## Call:  
## lm(formula = mtcars$mpg ~ mtcars$wt)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -4.5432 -2.3647 -0.1252  1.4096  6.8727  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 37.2851    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
```

The regression output

12:12
30/09/2020

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

Knit to word



The word doc output

R_Course_UHasselt_demo_V1.docx [Read-Only] [Compatibility Mode] - Microsoft Word

File Home Insert Page Layout References Mailings Review View

Font Paragraph Styles Editing

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 10 to 30. The data points show a negative correlation, where lower weight is associated with higher mpg.

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

YAML Header

```
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
```

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 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 the following sections:

- 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**

On the right side of the slide, there is a red box containing the text:

**Very basic guide how
to produce a
markdown document**

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
```

Below the sections, there are two more sections:

- 1 Introduction**
- 2 Sections and subsections**

At the bottom of the slide, there is a footer with the text:

Ziv Shkedy
Hasselt University, Belgium
September 29, 2020

The PowerPoint ribbon at the top shows tabs for File, Home, Insert, Design, etc. The status bar at the bottom right shows "EN", "9:08", "6/10/2020", and a battery icon.

The program

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

Free text

RStudio interface showing R Markdown code and output:

Code Editor (R_Course_UHasselt_demo_V0.Rmd):

```
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
```

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)  
  
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:

| 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 |

Bottom Taskbar:

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: Console output showing R version 3.6.1 and a brief introduction to R.

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

Right Panel (File Explorer): Shows a list of files and packages in the current project.

R code in the output

The screenshot shows the RStudio interface with the following components:

- Top Bar:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Project Bar:** Project: (None).
- Left Panel:** Shows three open files: R_Course_UHasselt_demo_V0.Rmd, R_Course_UHasselt_demo_V1.Rmd, and R_Course_UHasselt_2020(html)_V1.Rmd.
- Code Editor:** Displays R code. A red bracket on the right side of the editor highlights the section from line 66 to line 85, which includes a code block and an echo=FALSE option.
- Console:** Shows the R startup message and basic usage instructions.
- Output:** Shows the R code execution results, including the output of the code block and the echo=FALSE example.
- Environment:** Shows the system library with various packages listed.
- Bottom Bar:** Icons for Windows, Word, Excel, Powerpoint, etc., and a status bar showing EN, 12:35, 30/09/2020.

How to include R code and output

```
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 output

The screenshot shows the RStudio interface with a browser window displaying the output of an R Markdown document. A red box highlights the code block and its output.

RStudio Environment:

- File Edit Code View Plots Session Help**
- Project: (None)**
- Console R Markdown**
- Workspace loaded from ~/.RData**
- Ziv Shkedy** Hasselt University, Belgium
September, 29, 2020

Browser Window Content:

C:/projects/eR-Biostat/Presentations/MD_SUSAN/R_Course_UHasselt_2020-html_V1.html

This is an example of a R Markdown file that produces HTML 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

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.

```
```{r}
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 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 editor, the R console displays the standard R startup message. To the right, the Global Environment pane lists various R objects and their details. The status bar at the bottom shows system icons and the date/time.

Produce a PDF output

R Course UHasselt demo V0.Rmd x R Course 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 ...

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

additivityTests

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)

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]

> |

EN 12:39 30/09/2020

The PDF output

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

- RStudio:** The leftmost window displays an R Markdown script titled "Basic Skills in R Markdown: the pdf file". It includes code for setting up the document, loading libraries (e1071, lattice, ggplot2, mvtnorm), and creating a new page. The R console below shows the standard R startup message and a warning about ggplot2 being built under R version 3.6.3.
- PDF Viewer:** The middle window shows a PDF document titled "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, such as "Introduction" (page 2), "Sections and subsections" (page 2), and "Including R code" (page 2).
- File Explorer:** The rightmost window is a file browser showing a list of files and folders. It includes a search bar and filters for "Dataset" and "List". Some of the files listed are "16999 obs. of 12 variables", "21 obs. of 2 variables", and "12 obs. of 2 variables".

Table of contents:
see next slide

The program

A screenshot of the RStudio interface. On the left, the R Markdown editor shows a code block 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: 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 editor, the text "toc: yes Produce the table of contents" is displayed in red. The R Markdown tab is selected in the bottom-left corner of the editor.

The right side of the interface shows the Environment pane, which displays the global environment variables and their values. The System Library pane shows a list of available R packages. The bottom of the screen shows the Windows taskbar with various application icons and the system clock indicating 12:40 on 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
104 histogram that was produced using the function <tt>qplot()</tt> function.
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 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]
> |

99 obs. of 12 variables
obs. of 2 variables
obs. of 2 variables
[1:100, 1:100] 17.4 17.4 17.4 17.4 17.4 ...
[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 ...
idd
out
outp02
outp04
scandat
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
Install Update
Name Description Version
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

The PDF output

A screenshot of the RStudio interface illustrating the creation of a PDF document. On the left, the R Markdown editor shows two files: `_Course_UHasselt_demo_V0.Rmd` and `R_Course_UHasselt_demo_V1.Rmd`. The V1 file contains R code demonstrating how to include a figure in a document. A red annotation highlights a section of the code: "Graphical displays in the document". The code uses the `qplot` function with the `geom = "histogram"` option to create a histogram. On the right, a PDF viewer window titled `R_Course_UHasselt_2020-pdf-V1.pdf` displays the resulting document. The highlighted section is now part of the PDF, showing the heading "Graphical displays in the document" and the R code. Below this, a histogram is shown on a grid, representing the ozone level distribution. The PDF viewer also includes a sidebar with project files and a status bar at the bottom.

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)
```

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

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.

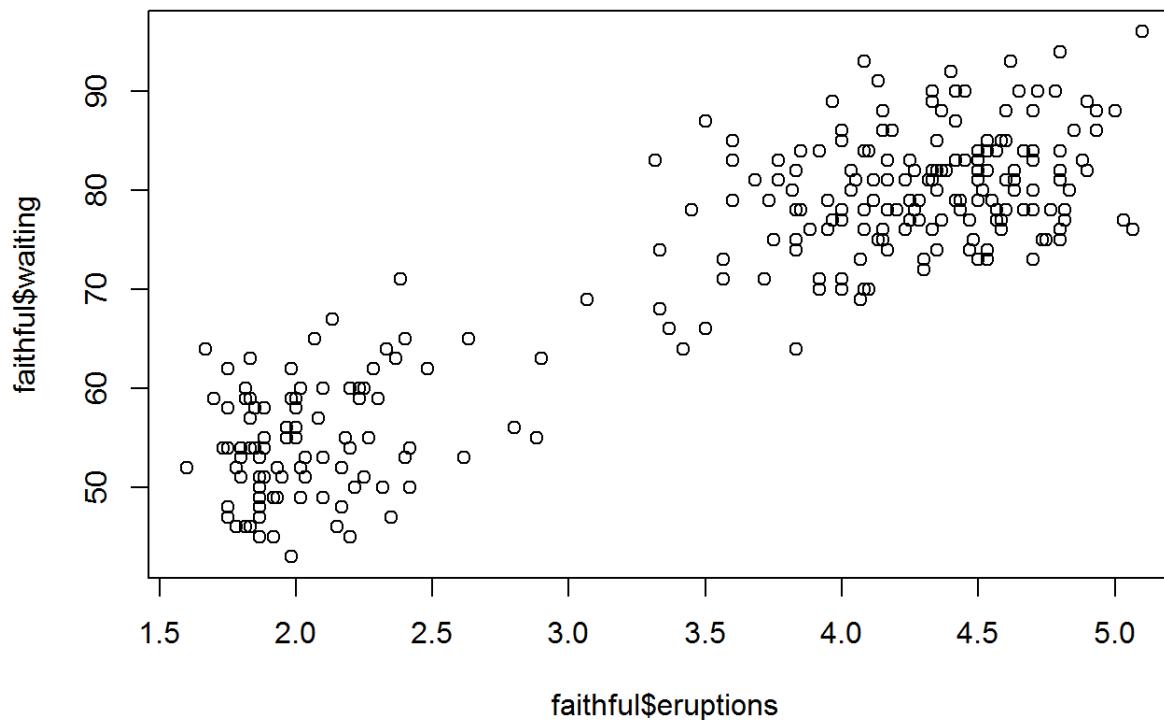
Eruption time and waiting time

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



Basic graphical
function in R

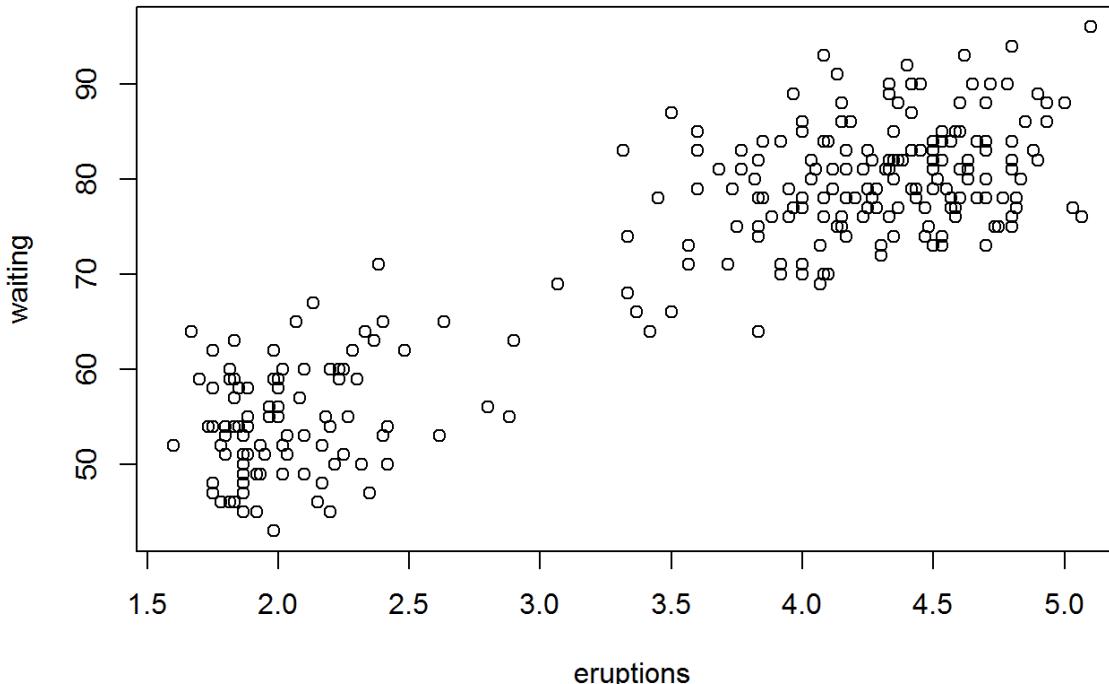
```
plot(x, y)
```



Eruption time and waiting time

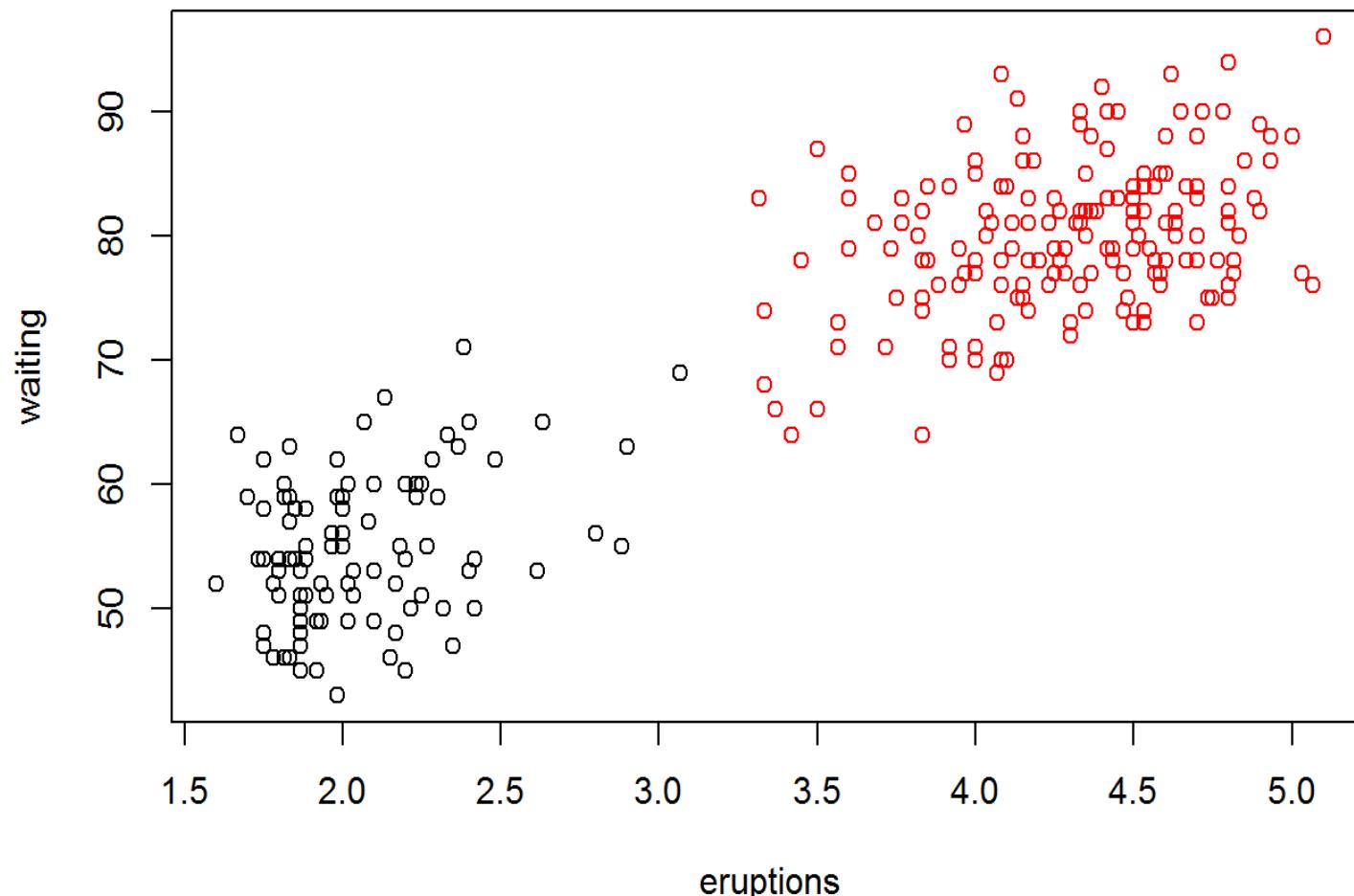
```
plot(faithful$eruptions, faithful$waiting,  
      xlab="eruptions", ylab="waiting")  
  
title("The old faithful data")
```

Adding title and text
for the labels.



Two clusters ?

The old faithful data



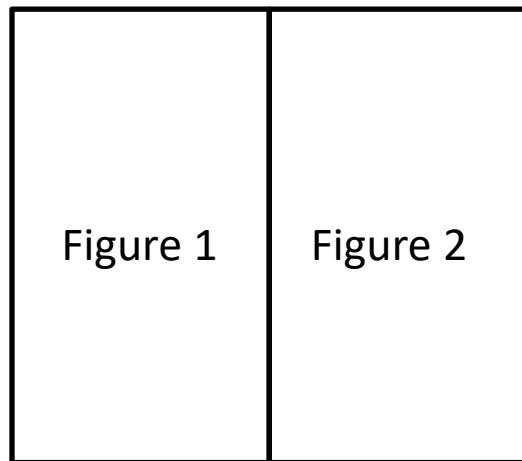
Distribution of eruption time

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

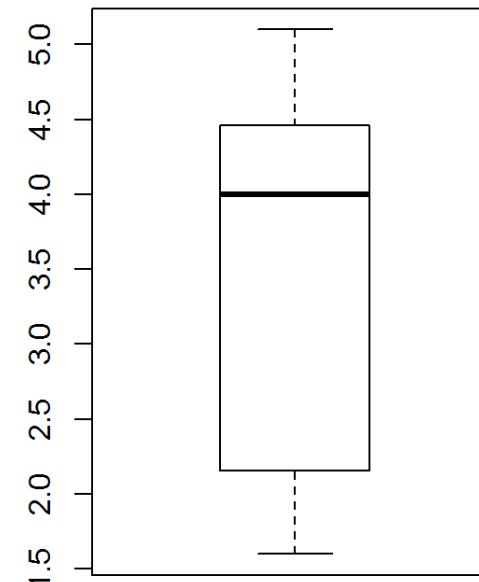
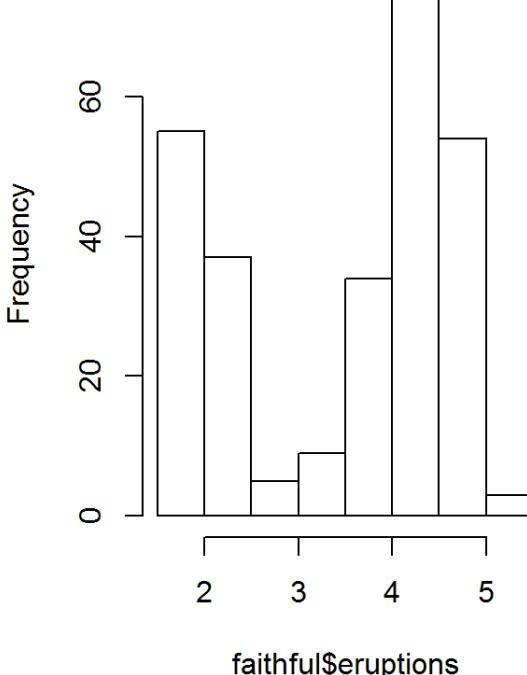
Split the graphical window

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

Split the graphical window



Histogram of faithful\$eruptions

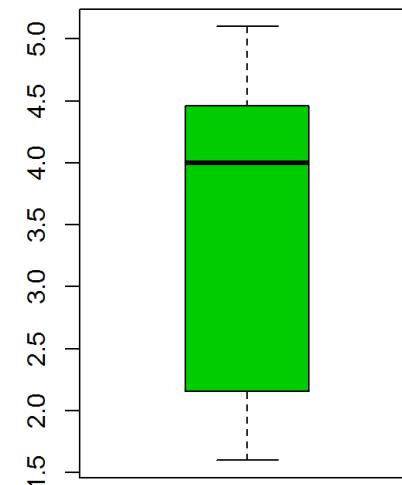
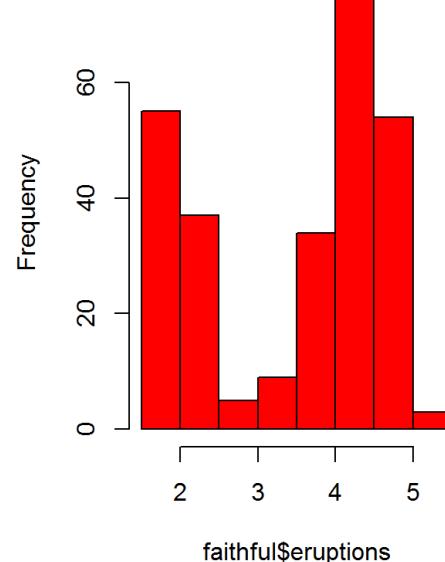


Distribution of eruption time

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

Change plot settings.

Histogram of faithful\$eruptions

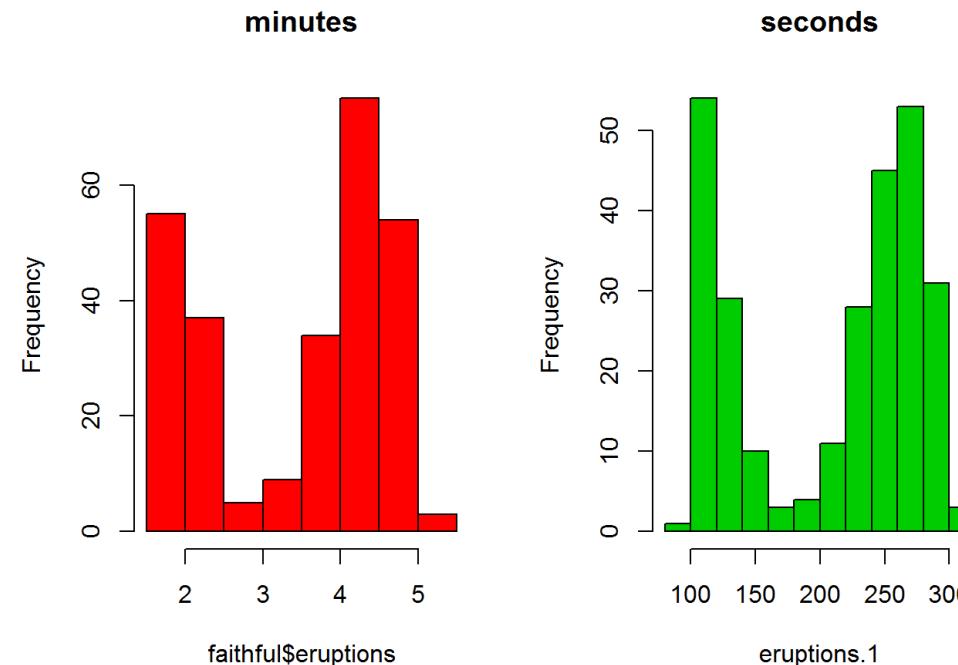


Distribution of eruption time in seconds

```
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 eruptions.
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 R code for the scatter plot.

The R markdown program & PDF output

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

_Course_UHasselt_demo_V0.Rmd x R_Course_UHasselt_demo_V1.Rmd x R_Course_UHasselt_2020(html)_V1.Rmd x

```
76  
77  
78 ~ ``{r}  
79 min(faithful$eruptions)  
80  
81  
82 Let us look once again in the scatterplot. we can add labels name and title  
83  
84  
85 ~ ``{r}  
86 plot(faithful$eruptions,faithful$waiting,  
87 xlab="eruptions",ylab="waiting")  
88 title("The old faithful data")  
89  
90  
91 In the next figure we use different colors for the two clusters.  
92  
93 ~ ``{r}  
94 plot(faithful$eruptions,faithful$waiting,  
95 xlab="eruptions",ylab="waiting")  
96 points(faithful$eruptions[faithful$eruptions>3.2],faithful$waiting[faithful$eruptions>3.2])  
97 title("The old faithful data")  
98  
99
```

31:11 The data ▾

Console R Markdown x

.../MD_SUSAN/R_Course_UHasselt_2020(pdf)_V2.Rmd

ordinary text without R code

|.....| 91%
label: unnamed-chunk-15
|.....| 94%
ordinary text without R code
|.....| 97%
label: unnamed-chunk-16
|.....| 100%
ordinary text without R code

```
"C:/Program Files/Rstudio/bin/pandoc/pandoc" +RTS -K512m -RTS R_Course_UHasselt_2020.Rmd --output R_Course_UHasselt_2020.pdf --highlight-style tango --mathjax --variable graphics=yes --variable "geometry:margin=1in" --compact-title  
pandoc.exe: Could not parse YAML header: mapping values are not allowed in this context  
output created: R_Course_UHasselt_2020-pdf_V2.pdf
```

R_Course_UHasselt_2020-pdf_V2.pdf

Page: 4 / 13

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 output

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

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

EN 14:59 30/09/2020

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

System Tray:

22°C Partly sunny 12:43 8/10/2024

Source vs Visual Editor

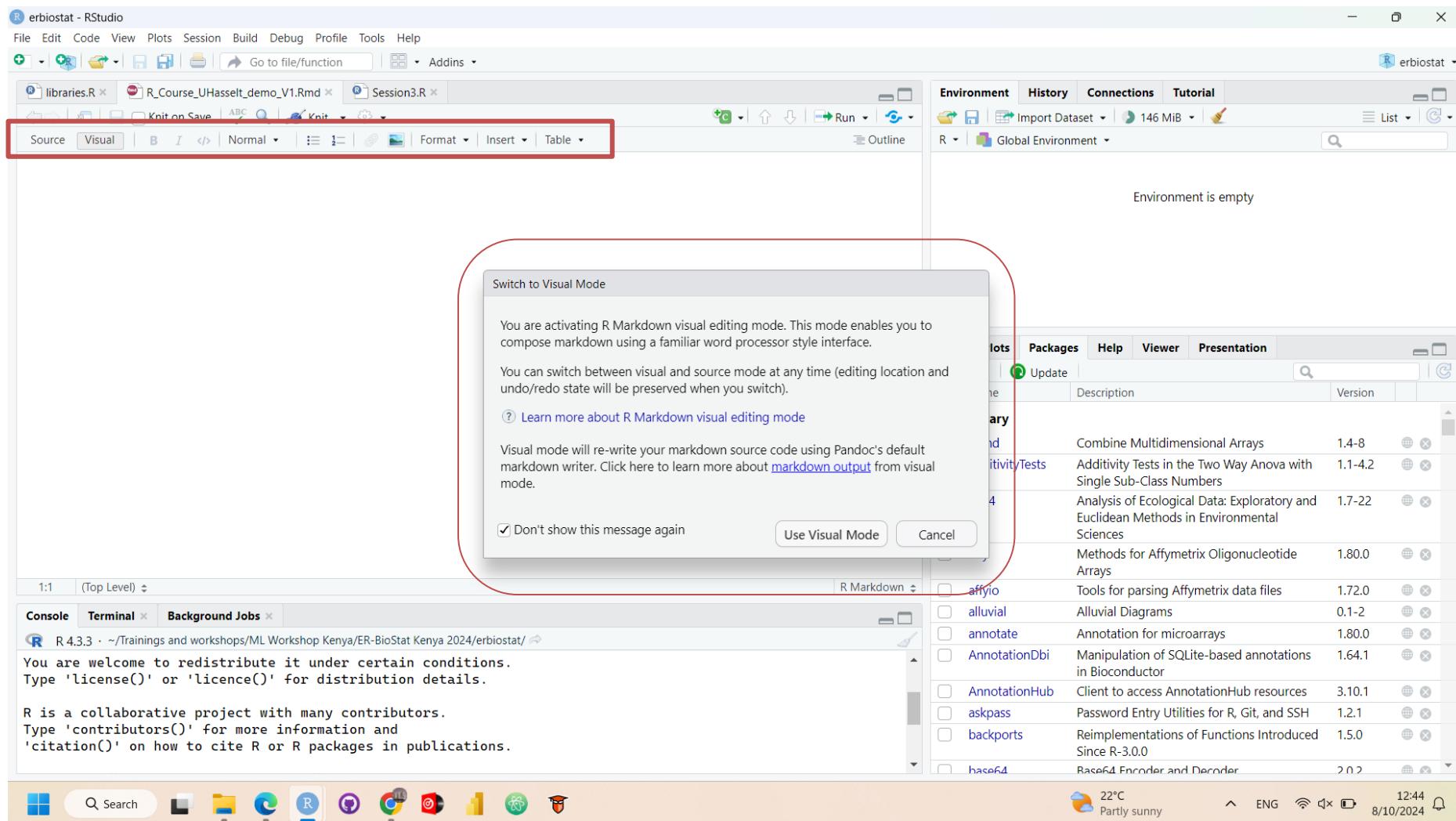
The screenshot shows the RStudio interface with the title bar "erbiostat - RStudio". The main area displays an R Markdown file named "R_Course_UHasselt_demo_V1.Rmd". The left pane shows the "Source" editor with the following code:

```
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("2024-10-05T00:00:00")  
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. It is intended to be used as  
MS Word documents. For more detail... 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  
1:1 # Demo 2
```

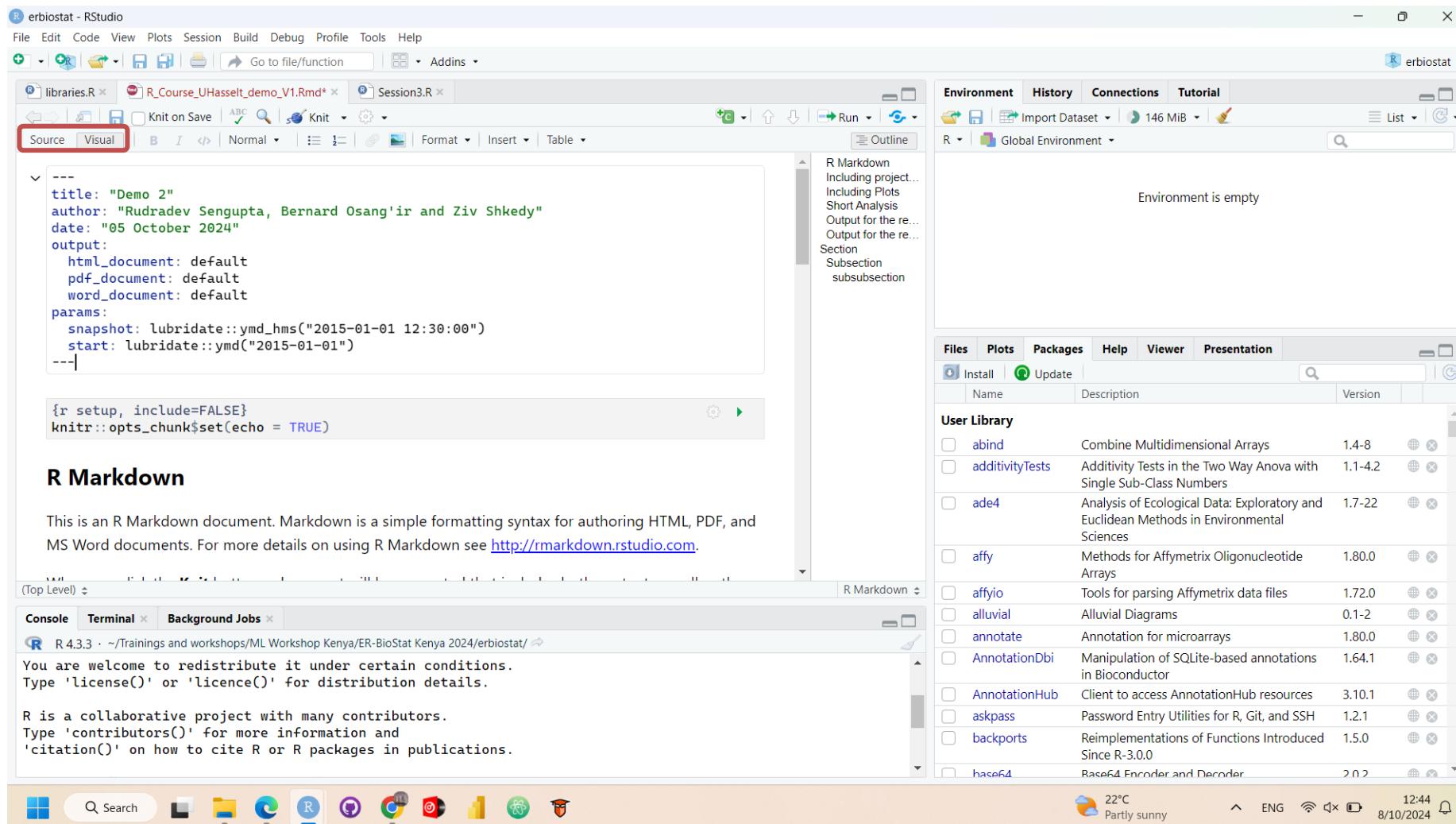
The right pane shows the "Visual" editor with a context menu open over the code. A blue arrow points to the "Use Visual Editor" option in the menu. The menu also includes options like "Preview in Window", "Preview Images and Equations", "Chunk Output Inline", and "Output Options...". Below the menu, a tooltip provides syntax information for R Markdown.

The bottom status bar shows system icons for search, file, browser, and other applications, along with the date and time (8/10/2024) and battery level (22%).

Source vs Visual Editor



Source vs Visual Editor



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.

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 | |

Including project metadata:

```
# R Markdown
# Project: erbiostat - RStudio
# Author: Rudradev Sengupta, Bernard Osang'ir and Ziv Shkedy
# Date: 05 October 2024
# Version: 1.4.8
# R version: 4.3.3
```

R 4.3.3 · ~/Trainings and workshops/ML Workshop Kenya/ER-BioStat Kenya 2024/erbiostat/R_Course_UHasselt_demo_V1.html

Type 'demo()' for some demos, 'help()' for on-line help, '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/R_Course_UHasselt_demo_V1.html]

22°C Partly sunny 12:46 8/10/2024

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 icons: New, Open, Save, Run, Knit, Addins.
- Project navigation: libraries.R, R_Course_UHasselt_demo_V1.Rmd*, Session3.R.
- File tabs: Go to file/function, Addins.
- 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 output of any **embedded R code** chunks within the document. You can
 - Code chunk:

```
{r cars}
project_start <- params$start
summary(mtcars)
```
- Console tab: R Markdown, Console, Terminal, Render, Background Jobs.
- Console output:

```
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 tab: Environment, History, Connections, Tutorial.
- Environment pane: Import Dataset, 149 MiB, List, Global Environment (empty).
- Packages tab: Install, Update, Packages, Help, Viewer, Presentation.
- Packages pane: User Library (list of packages).
- System status bar: 22°C, Partly sunny, ENG, 12:47, 8/10/2024.

Source vs Visual Editor

The screenshot shows the RStudio interface with two main panes. The left pane, titled 'R Markdown', displays a table with columns 'Column', 'Report', and 'P-value'. A blue arrow points upwards from the table towards the title 'R Markdown'. The text 'Direct editing' is overlaid on the table area. Below the table, the text 'Demonstration for visual' is followed by a note about knitting. The right pane shows the 'Environment' and 'Global Environment' tabs, both indicating an empty environment. At the bottom, the R console shows the R version 4.3.3 startup message and the Windows taskbar is visible.

R Markdown

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| Column | Report | P-value |
|--------|--------|---------|
| | | |
| | | |
| | | |

Direct editing

Demonstration for visual

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:

```
fr cars
```

R Markdown

Console Terminal × Render × Background Jobs ×

R 4.3.3 · ~/Trainings and workshops/ML Workshop Kenya/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.

Environment History Connections Tutorial

Import Dataset 149 MiB List

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 | 202 |

22°C Partly sunny 12:47 8/10/2024

Source vs Visual Editor

The screenshot shows the RStudio interface with two panes demonstrating the difference between Source and Visual editors.

Left Pane (Source Editor):

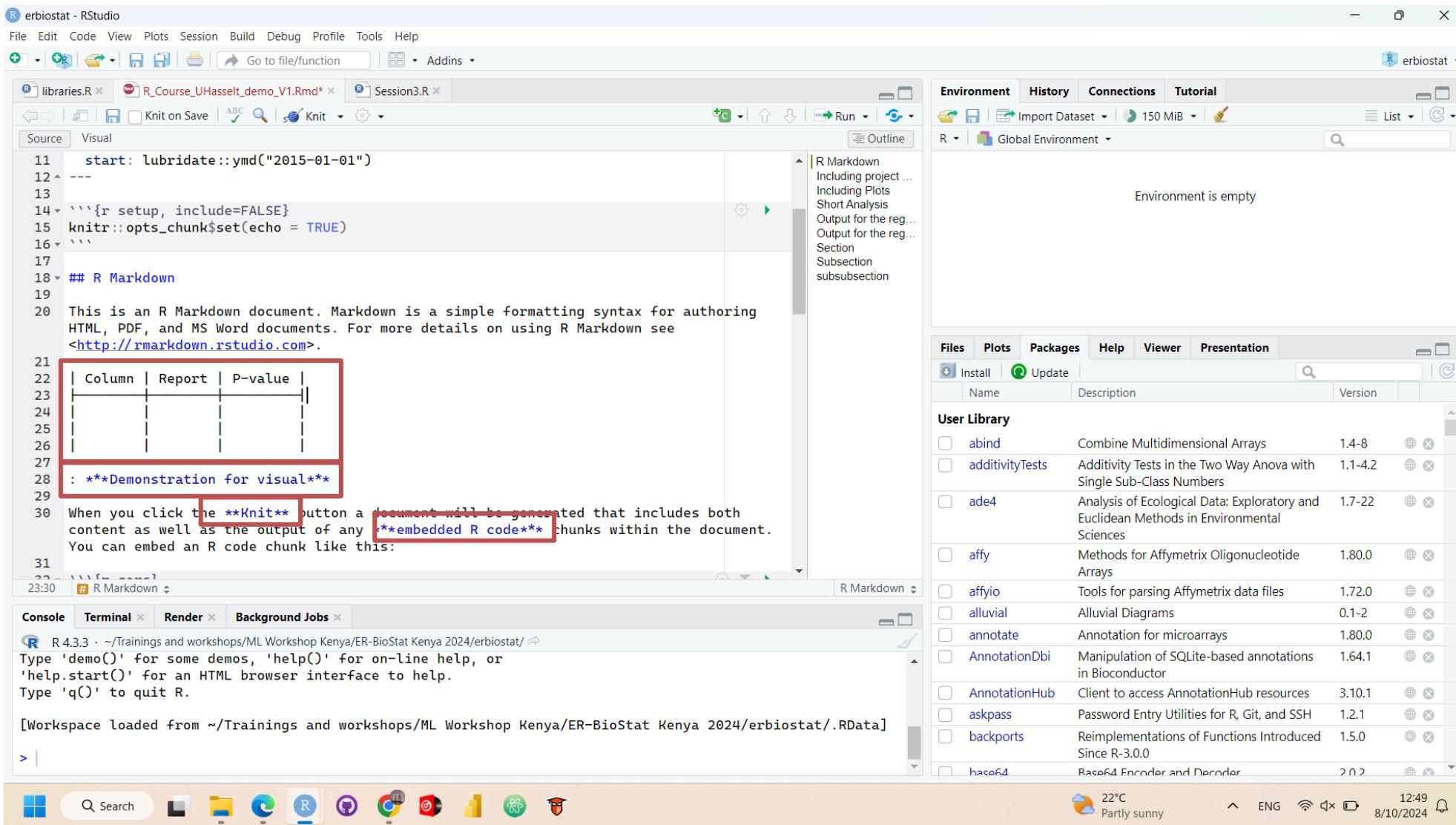
- Header:** erbiostat - RStudio
- Menu Bar:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help
- Toolbar:** Go to file/function, Addins
- File List:** libraries.R, R_Course_UHasselt_demo_V1.Rmd, Session3.R
- Editor:** Displays R Markdown code with a red arrow pointing to the "Report" column header of a table.
- Console:** Shows R code and output related to the mtcars dataset.

Right Pane (Visual Editor):

- Title Bar:** ~/Trainings and workshops/ML Workshop Kenya/ER-BioStat Kenya 2024/erbiostat/R_Course_UHasselt... R_Course_UHasselt_demo_V1.html
- Toolbar:** Publish, Find
- Content Area:**
 - ## 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>.
 - Demonstration for visual**
 - A table with columns: Column, Report, P-value.
 - Text explaining that clicking Knit generates a document including both content and R code output.
 - An R code block:

```
project_start <- params$start  
summary(mtcars)
```
 - The resulting table output from the R code:
- File Tree:** Shows various R packages and files.

Source vs Visual Editor



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