Session 6: Introduction to R Markdown

R for Stata Users

Luiza Andrade, Marc-Andrea Fiorina, Rob Marty, Rony Rodriguez-Ramirez, Luis Eduardo San Martin, Leonardo Viotti
The World Bank – DIME | WB Github

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Preamble

- Make sure you have the packages `tinytex`, `stargazer`, and `huxtable` installed

```
# Packages we used for other sessions, install only if needed
install.packages("dplyr")
install.packages("huxtable")

# New packages
install.packages("tinytex")
install.packages("stargazer")

# No need to load the packages for now
```

Preamble (5 min)

- Use `tinytex` to install LaTeX
- If you're using a WB computer:

1. Download this file: https://osf.io/sehzg
2. Run `tinytex:::install_prebuilt("location/to/file.zip")` (notice the triple colon)

- If you're not:

1. Run `tinytex::install_tinytex()`

Preamble

This will take a while. Leave it running

Preamble

- LaTeX can be unpredictable in WB computers. It's possible that this didn't work
- Don't worry for now, just follow the approppriate instructions we'll specify in the exercises

Introduction

- This is an **introduction** to R Markdown
- We'll show:
  1. How to write and knit (output) R Markdown documents
  2. How to format text and R code in R Markdown documents
  3. How to include regression tables in R Markdown documents

Table of contents

Dynamic documents

Dynamic documents and R Markdown

- Dynamic documents are documents that include both text and code outputs
- They are generated by a script and are updated automatically every time the script runs
- R Markdown is a type of dynamic document

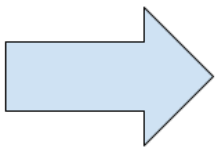
Dynamic documents

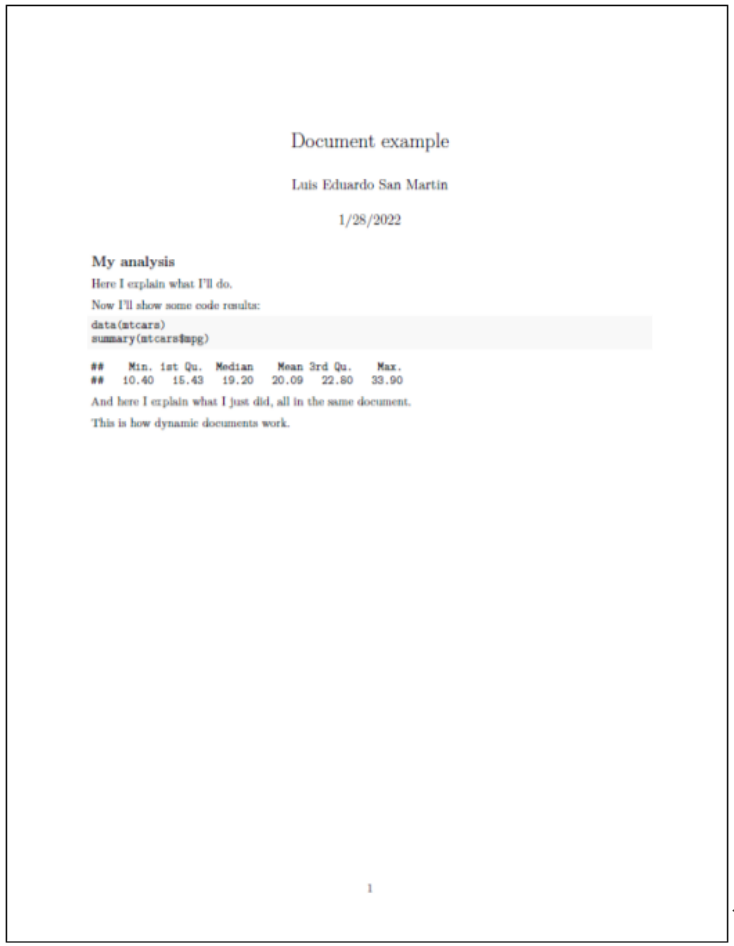
- Code and documentation is produced together

r-markdown-example.Rmd

Knit | Insert | Run

```
1  ---
2  title: "Document example"
3  author: "Luis Eduardo San Martin"
4  date: "1/28/2022"
5  output: pdf_document
6  ---
7
8  ## My analysis
9
10 Here I explain what I'll do.
11
12 Now I'll show some code results:
13
14 ```{r}
15 data(mtcars)
16 summary(mtcars$mpg)
17 ```
18
19 And here I explain what I just did, all in the same script.
20
21 This is how dynamic documents work.
22
```





Document example

Luis Eduardo San Martin

1/28/2022

My analysis

Here I explain what I'll do.

Now I'll show some code results:

```
data(mtcars)
summary(mtcars$mpg)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   10.40   15.43   19.20   20.09   22.80   33.90
```

And here I explain what I just did, all in the same document.

This is how dynamic documents work.

1

Why use dynamic documents?

- Increased research transparency. Documents are fully reproducible
- No more copying and pasting outputs from R to a document editor
- Nice option for simple documents that don't require a lot of formatting
- Can include code snippets

Knitting R Markdown documents

Knitting R Markdown documents

- R markdown combines text, R code, and rendered outputs
- The text follows Markdown's syntax
- The code and outputs follow R's syntax
- Knitting an R Markdown document is rendering the text and code portions into a single output
- The output can be a PDF, Word, or HTML document

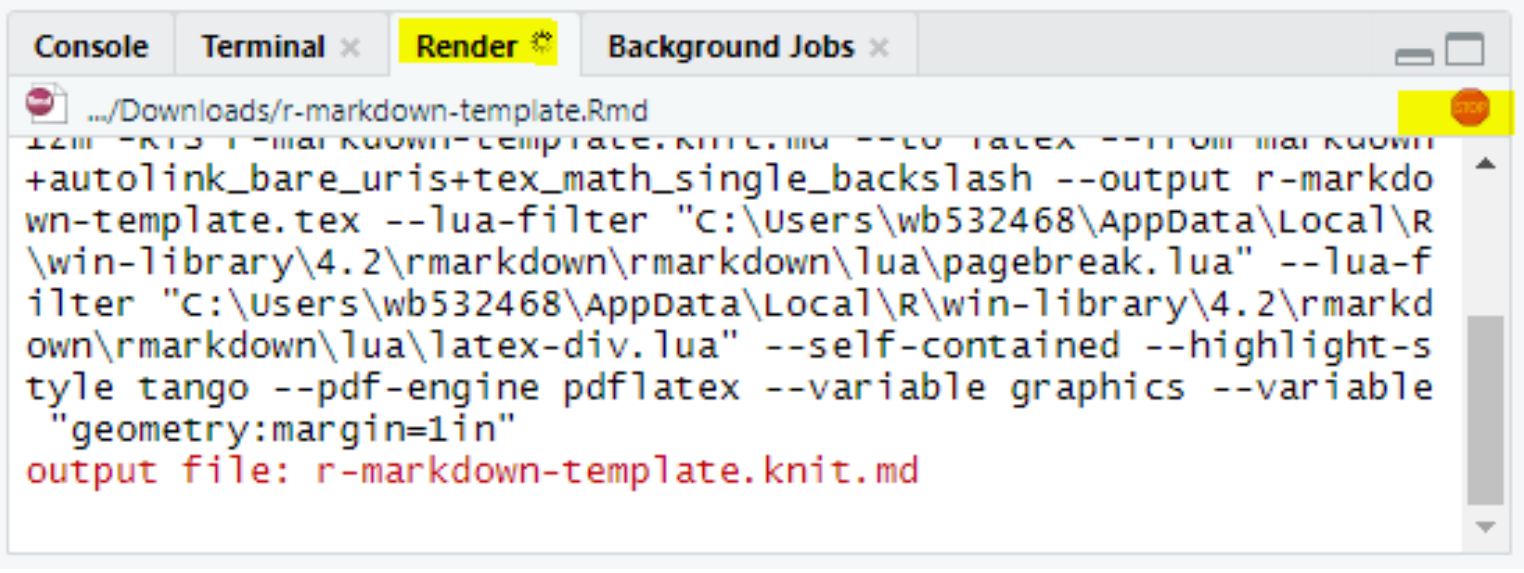
Knitting R Markdown documents

Exercise 1: Knit an R Markdown document (2 min, leave it running)

1. Go to the course repository: https://osf.io/86g3b/
2. In the files panel, download `R for Stata Users - 2023 March` > `scripts` > `r-markdown-template.Rmd`
3. Open this file in RStudio
   - If the installation of tinytex didn't work, change line 2 to: `output: html_document`
4. Click on `Knit`. If RStudio asks you to update some packages, select `Yes`

Knitting R Markdown documents

Note that this might take a while



We'll continue with markdown syntax while it finishes

Markdown

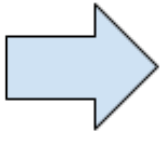
Markdown

- The text part of R Markdown follows the syntax of Markdown
- Markdown is a "light" markup language. It's similar to Latex or HTML, but simpler
- Markdown was designed to be easily readable while allowing to format text and document sections

Markdown - Headers

- Headers in markdown are preceded by pound (`#`) symbols
- Additional pound symbols denote a lower level in the headers hierarchy

```
# This is a header
## Subheader 1
### Subheader 2
#### Subheader 3
```



This is a header

Subheader 1

Subheader 2

Subheader 3

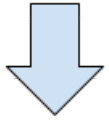
Markdown - Paragraphs

- Text not preceded by special symbols are regular paragraphs.

```
## Paragraphs

This is a line of text.
This is another line in the same paragraph.

New paragraphs are separated by two line breaks.
```



Paragraphs

This is a line of text. This is another line in the same paragraph.

New paragraphs are separated by two line breaks.

Markdown - Text emphasis

- Emphasized text is enclosed by special symbols.

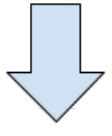
```
## Text emphasis

Text in italics goes between *asterisks* or _underscores_.

Text in bold goes between **two asterisks** or __two underscores__.

You can combine asterisks and underscores to **emphasize with italics and
bold _at the same time_**.

Strikethrough text ~~uses two tildes~~.
```



Text emphasis

Text in italics goes between *asterisks* or *underscores*.

Text in bold goes between **two asterisks** or **two underscores**.

You can combine asterisks and underscores to **emphasize with italics and bold *at the same time***.

Strikethrough text ~~uses two tildes~~.

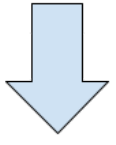
Markdown - Lists

- Markdown allows us to use both ordered and unordered lists.

```
## Lists

Ordered lists:

1. Include a number and a dot before every item
2. Also remember to include a blank line before the beginning of the list
1. The actual number does not matter, the item will have the correct order
number
```



Lists

Ordered lists:

1. Include a number and a dot before every item
2. Also remember to include a blank line before the beginning of the list
3. The actual number does not matter, the item will have the correct order number

Markdown - Lists

- Markdown allows us to use both ordered and unordered lists.

```
Unordered lists:

* You can use an asterisk
+ Or a plus symbol
- Or a minus symbol
```

Unordered lists:

- You can use an asterisk
- Or a plus symbol
- Or a minus symbol

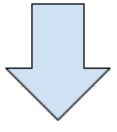
Markdown - Links

- We can also include links as text in Markdown.

```
## Links

Include the link text in brackets followed by the URL in parentheses.
Like this:

This is [the WB website](https://https://www.worldbank.org)
```



Links

Include the link text in brackets followed by the URL in parentheses. Like this:

This is the WB website

https://https://www.worldbank.org

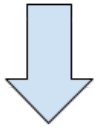
Markdown - Tables

- Lastly, we can include tables in Markdown text.

```
## Tables

Use vertical lines to separate columns and at least three dashes to separate column headers.

|This is column 1|This is column 2|
|----------------|----------------|
|Row 1           |Row 1           |
|Row 2           |Row 2           |
```



Tables

Use vertical lines to separate columns and at least three dashes to separate column headers.

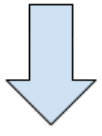
This is column 1	This is column 2
Row 1	Row 1
Row 2	Row 2

Markdown - Tables

- Lastly, we can include tables in Markdown text.

```
The width of the cells can vary in the markdown text and the output will look the same.

|This is column 1    |This is column 2|
|---|-----------|
|Row 1    |Row 1      |
|Row 2       |Row 2|
```

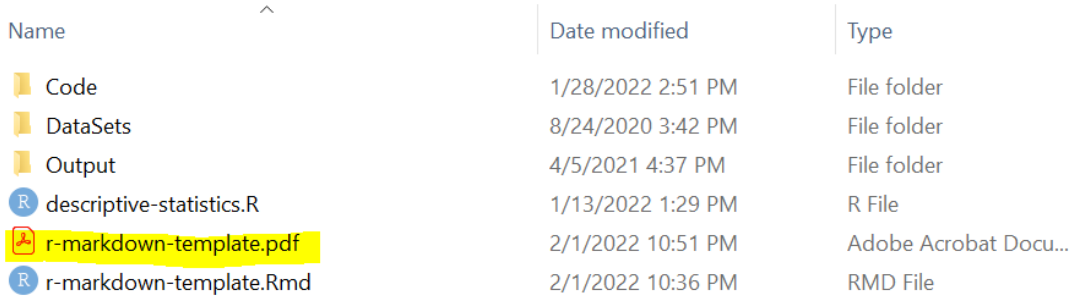


The width of the cells can vary in the markdown text and the output will look the same.

This is column 1	This is column 2
Row 1	Row 1
Row 2	Row 2

Exercise 1 results

- If exercise 1 worked, you'll now see this PDF file (or HTML) in the folder where you saved `r-markdown-template.Rmd`



- If it's still running, let it run until it finishes
- If it failed, try again after changing `output: html_document` in line 2

R Code

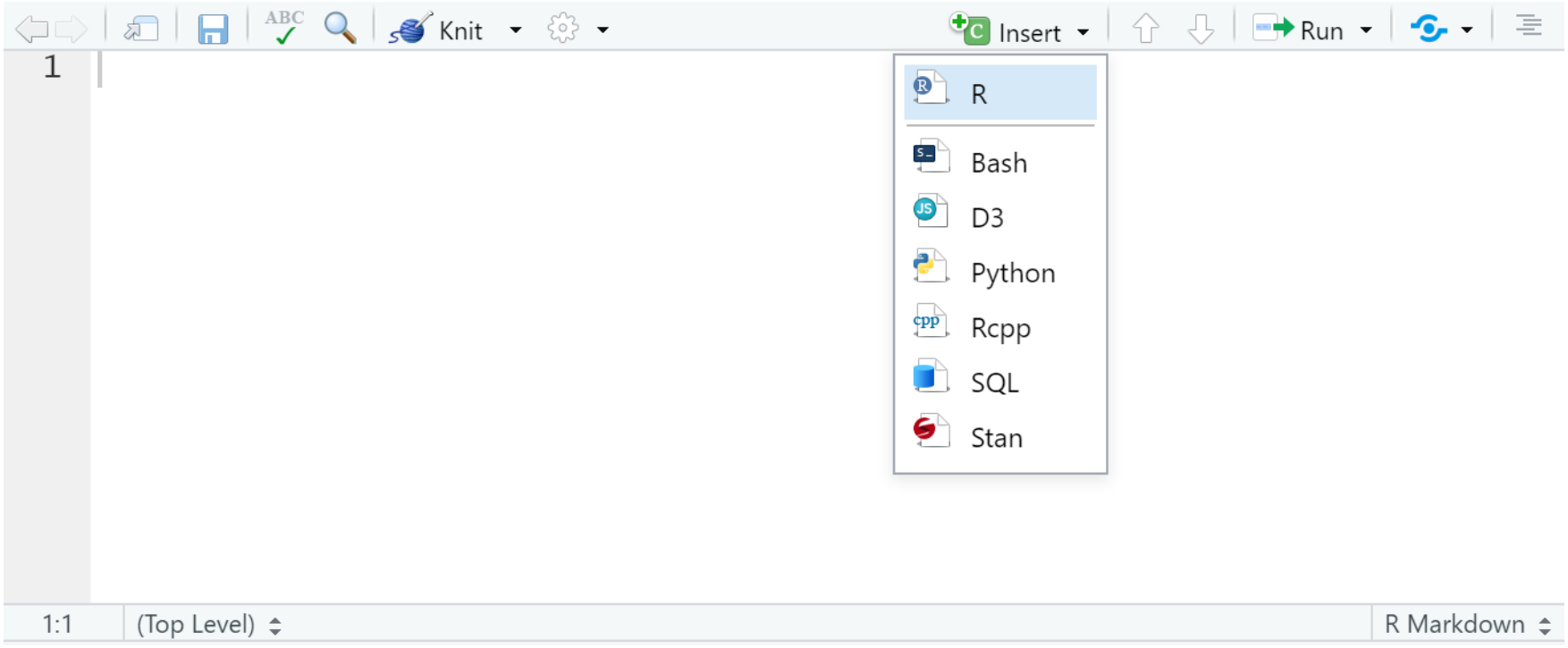
Including R code

- R code in R Markdown goes inside **fenced code blocks**, as the one below

````
```{r}
# Your R code goes here
```
````

Including R code

- To add new block, you can type the fences directly, go to `Insert` > `R` in the script panel of RStudio, or type `CTRL` + `ALT` + `i`



Including R code

Exercise 2: Include the summary of a variable (2 min)

1. Create a header named `R Code` at the bottom of `r-markdown-template.Rmd`
2. Create a new fenced code block where you load the dataset `mtcars`
   - `mtcars` is a built-in dataset. Load it with: `data(mtcars)`
3. Inside the same block, get the summary of the variable `mpg` with `summary(mtcars$mpg)`
4. Knit. You'll have to close the PDF document if you have it opened

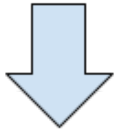
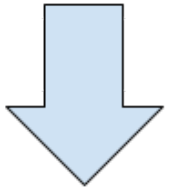
Including R code

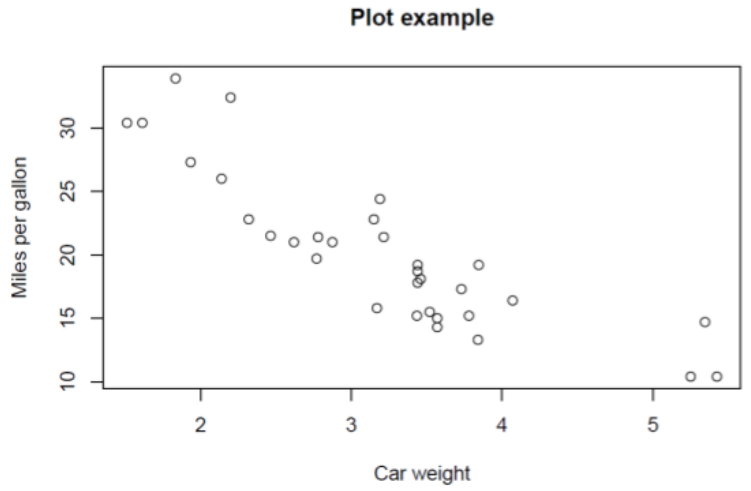
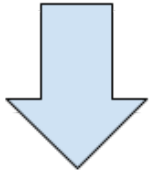
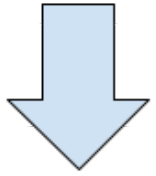
````
## R Code

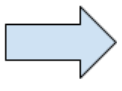
```{r}
data(mtcars)
summary(mtcars$mpg)
```
````

Including R code

```
# R code

```{r}
data(mtcars)
summary(mtcars$mpg)
```
```



R code

```
data(mtcars)
summary(mtcars$mpg)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   10.40   15.43   19.20   20.09   22.80   33.90
```

Including R code

- Note that the output echoes both the code and the output
- What if we wanted to include the output but not the code?
- We use the argument `echo = FALSE` in the fenced code block for that
- Code block arguments are separated by commas inside the curly brackets, as in: `{r, echo = FALSE}`

Including R code

Exercise 3: Omit the code when knitting R code (1 min)

1. Add the option `echo = FALSE` to the fenced code block created in exercise 2
2. Knit the document and see how it's different now

Including R code

````
```{r, echo = FALSE}
data(mtcars)
summary(mtcars$mpg)
```
````

Including R code

```
# R code

```{r, echo = FALSE}
data(mtcars)
summary(mtcars$mpg)
```
```



R code

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   10.40   15.43   19.20   20.09   22.80   33.90
```

Including R code

- To include only R code but not the output, we use the option `eval = FALSE`

````
```{r, eval = FALSE}
data(mtcars)
summary(mtcars$mpg)
```
````

Including R code

```
# R code
```

```
```{r, eval = FALSE}
data(mtcars)
summary(mtcars$mpg)
```
```

R code

```
data(mtcars)
summary(mtcars$mpg)
```

R Plots

Including R plots

- Adding R plots is similar to adding R code
- Include the code producing the plot in a fenced block
- The block option `echo = FALSE` is useful when we only want to include the plot but not the code producing it

Including R plots

Exercise 4: Include an R plot in your document (2 min)

1. Create a header named `R Plots`
2. Create a new fenced code block with the option `echo = FALSE`
3. Add the following code inside the new block:

```
plot(mtcars$wt,
     mtcars$mpg,
     main = "Plot example",
     xlab = "Car weight",
     ylab = "Miles per gallon")
```

Including R plots

````
# R plots

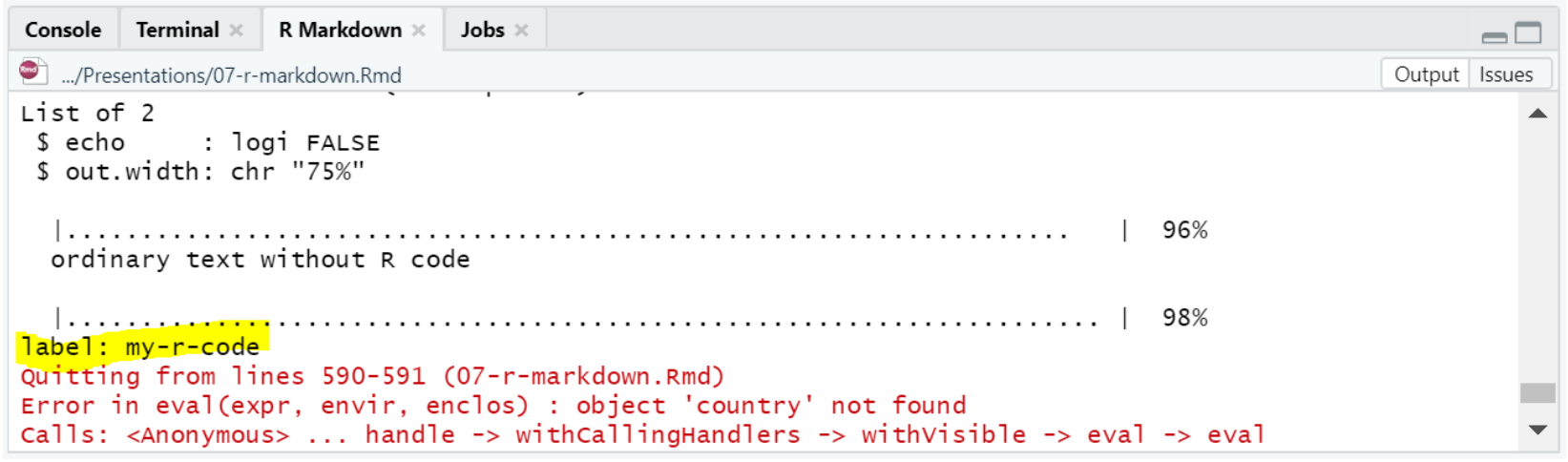
```{r, echo = FALSE}
plot(mtcars$wt,
     mtcars$mpg,
     main = "Plot example",
     xlab = "Car weight",
     ylab = "Miles per gallon")
```
````

Including R plots

```
# R Plots

```{r, echo = FALSE}
plot(mtcars$wt,
     mtcars$mpg,
     main = "Plot example",
     xlab = "Car weight",
     ylab = "Miles per gallon")
```
```

R Plots



Inline code

Including code inline

- Inline code is enclosed by backtick followed by an r (`` `r` ``) and a single backtick
- For example:

```
The mean of mpg is `r mean(mtcars$mpg)`.
```

- Will be rendered as:

The mean of mpg is 20.090625.

Including code inline

Exercise 5 (2 min)

1. Create a new header named `Inline code` in `markdown-template.Rmd`
2. Add an unordered list with the following text and include inline R code to render the corresponding numbers in each case
   - The number of elements in mtcars is: (use function `nrow(mtcars)`)
   - The mean of weight is: (use function `mean(mtcars$wt)`)
   - The standard deviation is: (use function `sd(mtcars$wt)`)

Including code inline

```
# Inline code

- The number of elements in mtcars is `r nrow(mtcars)`
- The mean of weight is `r mean(mtcars$wt)`
- The standard deviation is `r sd(mtcars$wt)`
```

Including code inline

```
# Inline code

- The number of elements in mtcars is: `r nrow(mtcars)`
- The mean of weight is: `r mean(mtcars$wt)`
- The standard deviation is: `r sd(mtcars$wt)`
```



Inline code

- The number of elements in mtcars is: 32
- The mean of weight is: 3.21725
- The standard deviation is: 0.9784574

Including code inline

You can use the function `round()` to control the number of decimals displayed.

```
# Inline code

- The number of elements in mtcars is `r nrow(mtcars)`
- The mean of weight is `r round(mean(mtcars$wt), 1)`
- The standard deviation is `r round(sd(mtcars$wt), 2)`
```

Including code inline

You can use the function `round()` to control the number of decimals displayed.

```
# Inline code

- The number of elements in mtcars is: `r nrow(mtcars)`
- The mean of weight is: `r round(mean(mtcars$wt), 1)`
- The standard deviation is: `r round(sd(mtcars$wt), 2)`
```



Inline code

- The number of elements in mtcars is: 32
- The mean of weight is: 3.2
- The standard deviation is: 0.98

Including code inline

You can also combine R inline code with the markdown syntax for tables to produce statistics tables.

```
# Inline code in tables

|Column: weight| Value                          |
|--------------|--------------------------------|
|N             |`r nrow(mtcars)`                |
|Mean          |`r round(mean(mtcars$wt), 1)`|
|SD            |`r round(sd(mtcars$wt), 2)`  |
```

Including code inline

You can also combine R inline code with the markdown syntax for tables to produce statistics tables.

```
# Inline code in tables

|Column: weight| Value                          |
|--------------|--------------------------------|
|N             | `r nrow(mtcars)`               |
|Mean          | `r round(mean(mtcars$wt), 1)`  |
|SD            | `r round(sd(mtcars$wt), 2)`    |
```

Inline code in tables

Column: weight	Value
N	32
Mean	3.2
SD	0.98

Including regression outputs

Including regression outputs

- In a previous session, we saw that we can produce regression tables in LaTeX
- We can use code producing LaTeX outputs along with the code block option `results = "asis"` to display them in the knitted document

Including regression outputs - Stargazer

- First, we'll start with the function `stargazer()` from the package `stargazer`
- The first argument of `stargazer()` is a regression result
- We also include the arguments `echo = FALSE` and `message = FALSE` in the code block to omit printing the code and messages that appear when loading stargazer
- In `stargazer()` we include `header = FALSE` to omit printing stargazer metadata

Important: When using external packages in RMarkdown, you need to have them loaded in a code block regardless of if they're already loaded in your current session. Libraries have to load again for each knit.

Including regression outputs - Stargazer

```
```{r, echo = FALSE, message = FALSE, results = "asis"}
# Loading stargazer
library(stargazer)

# Creating a simple regression
model <- lm(mpg ~ cyl + hp, data = mtcars)

# Printing it with stargazer
stargazer(model, header = FALSE) # add: type = "html" if knitting to HTML
```
```

Including regression outputs - Stargazer

```r
# Loading stargazer
library(stargazer)

# Creating a simple regression
model <- lm(mpg ~ cyl + hp, data = mtcars)

# Printing it with stargazer
stargazer(model, header = FALSE)
```

Table 2:

	Dependent variable:
	mpg
cyl	−2.265***
	(0.576)
hp	−0.019
	(0.015)
Constant	36.908***
	(2.191)
Observations	32
R^2	0.741
Adjusted R^2	0.723
Residual Std. Error	3.173 (df = 29)
F Statistic	41.422*** (df = 2; 29)
Note:	*p<0.1; **p<0.05; ***p<0.01

Including regression outputs - Stargazer

Exercise 6 (3 min)

1. Create a new header named `Regressions - Stargazer` in `r-markdown-template.Rmd`
2. Add a new code block with the arguments `echo = FALSE` and `results = "asis"`
3. Load stargazer in the code block
4. Add a regression of the variable `mpg` on `wt` and `hp`
5. Use stargazer's arguments `header = FALSE`, `title = "your_title"` and `omit = c("Constant")` to customize your table
    - If your output is HTML instead of PDF, include the argument `type = "html"` in `stargazer()`

Including regression outputs - Stargazer

````
# Regressions - Stargazer

```{r, echo = FALSE, message = FALSE, results = "asis"}
library(stargazer)
model <- lm(mpg ~ wt + hp, data = mtcars)
stargazer(model,
          header = FALSE,
          title = "Best table ever",
          omit = c("Constant"))
```
````

Including regression outputs - Stargazer

Table 2: Best table ever

	Dependent variable:
	mpg
wt	-3.878^{***}
	(0.633)
hp	-0.032^{***}
	(0.009)
Observations	32
R^2	0.827
Adjusted R^2	0.815
Residual Std. Error	2.593 (df = 29)
F Statistic	69.211^{***} (df = 2; 29)
Note:	*p<0.1; **p<0.05; ***p<0.01

Including regression outputs - Huxtable

- Remember `huxtable`? we can also use it to include regression tables in R Markdown
- The advantage of using `huxtable` compared to `stargazer` is that we don't have to define the type of output we're generating with R Markdown. `huxtable` automatically detects it and will transform the output as needed in the resulting document
- `huxtable` has an important disadvantage, though: it requires to install external libraries in your local LaTeX installation

Including regression outputs - Huxtable

- Conveniently, the library `huxtable` has a function that handles that installation for us (needed only if you're knitting to PDF)

```
# Only if you're knitting to PDF:
huxtable::install_latex_dependencies()
```

- Once this finishes, we can use `huxtable` with R Markdown

Including regression outputs - Huxtable

- For regressions, we use the function `huxreg()` as in the example below
- Note that the option `results = "asis"` is not used with `huxtable`

````
```{r, echo = FALSE, warning = FALSE}
library(huxtable)
model <- lm(mpg ~ wt + hp, data = mtcars)
huxreg(model)
```
````

Including regression outputs - Huxtable

- For regressions, we use the function `huxreg()` as in the example below
- Note that the option `results = "asis"` is not used with `huxtable`

```r
```{r, echo = FALSE, warning = FALSE}
library(huxtable)
model <- lm(mpg ~ wt + hp, data = mtcars)
huxreg(model)
```
```



	(1)
(Intercept)	37.227 ***
	(1.599)
wt	-3.878 ***
	(0.633)
hp	-0.032 **
	(0.009)
N	32
R2	0.827
logLik	-74.326
AIC	156.652

*** p < 0.001; ** p < 0.01; * p < 0.05.

Including regression outputs - Huxtable

Exercise 7: Now with Huxtable (2 min)

1. Create a new header named `Regressions - Huxtable` in `r-markdown-template.Rmd`
2. Add a new code block with the argument `echo = FALSE`
3. Load huxtable in the code block
4. Add a regression table of the variable `mpg` on `wt` and `hp` using `huxreg()`
5. Use huxreg's argument `omit_coefs = c("(Intercept)")` to customize your table

Including regression outputs - Huxtable

````
# Regressions - Huxtable

```{r, echo = FALSE, warning = FALSE}
library(huxtable)
model <- lm(mpg ~ wt + hp, data = mtcars)
huxreg(model,
       omit_coefs = c("(Intercept)"))
```
````

Including regression outputs - Huxtable

	(1)
wt	-3.878 ***
	(0.633)
hp	-0.032 **
	(0.009)
N	32
R2	0.827
logLik	-74.326
AIC	156.652

*** p < 0.001; ** p < 0.01; * p < 0.05.

Including regression outputs - Huxtable

- If you want to include a title in your regression, use the command `set_caption()` with the result of `huxreg()` as argument

```
```{r, echo = FALSE, warning = FALSE}
library(huxtable)
library(dplyr)
model <- lm(mpg ~ wt + hp, data = mtcars)
table <- huxreg(model,
       omit_coefs = c("(Intercept)"))
table %>% set_caption("Another nice table")
```
```

Including regression outputs - Huxtable

Table 3: Another nice table

	(1)
wt	-3.878 ***
	(0.633)
hp	-0.032 **
	(0.009)
N	32
R2	0.827
logLik	-74.326
AIC	156.652

*** p < 0.001; ** p < 0.01; * p < 0.05.

Thank you!

Annex

Annex - Opening a new R Markdown in R Studio

- Go to `File` > `New File` > `R Markdown`
- You can register the author name and the document title. This can be changed later if needed
- You can also define the default output format (HTML, PDF, Word). This can also be changed later
- Selecting `OK` will generate a template with document sections and code blocks that you can modify
- Selecting `Create Empty Document` will ignore the author, title, and output format registered and will result in a completely blank R Markdown document

Annex - Author, title, and output type

- The section enclosed in `---` at the beginning of the document can contain the author, title, and default output format
- You can add the author and document title with `author: NAME` and `title: TITLE`
- You can also change the default output format. Some options are:
  - `output: html_document`
  - `output: pdf_document`
  - `output: word_document`
  - `output: beamer_presentation`

Annex - Naming R code blocks

- You can name R code blocks if you add the name after the `r` in the initial brackets
- The example below has the name `my-r-code`

````
```{r my-r-code}
summary(mtcars$mpg)
```
````

Annex - Naming R code blocks

- This is very convenient to debug code blocks by clicking on `Output` under the `R Markdown` tab of the console, in case your file has an error



Annex - Including images

- The Markdown syntax to include images is: `![Image name](path/to/image)`
- For example:

```
![R logo](img/r-markdown/r-logo.jpg)
```

- Renders:

Annex - Including a LaTeX preamble in a PDF doc

- If you want to further customize a PDF document in R Markdown and you're familiar with LaTeX, you can include a LaTeX preamble that will be executed when you knit your document
- To enable this feature, replace `output: pdf_document` with the following code in the section enclosed by the three dashes (`---`) at the beginning of your document

```
output:
  pdf_document:
    includes:
      in_header: "preamble.tex"
```

Annex - Looking ahead

- Markdown guide
- R Markdown: The Definitive Guide
- An introduction to Stata Markdown
- Stargazer official manual
- Introduction to Huxtable