

## 4.1 Introduction to R: Hello World!

Julia Gallucci

Data Science Institute, University of Toronto

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# Acknowledgements

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# Outline of Topics

Getting Set up



R



RStudio

R basics

File types



Scripts



R markdown

Hello, world!

# Outline of Topics

## Getting Set up



R basics

File types



Hello, world!

# Getting set up with R/RStudio

## Steps for R

1. Go to <https://cloud.r-project.org/>
2. Click Download R for (your operating system).
3. For Windows, select install R for the first time. For Mac and Linux, select the download that is appropriate for your OS.
4. Download and install

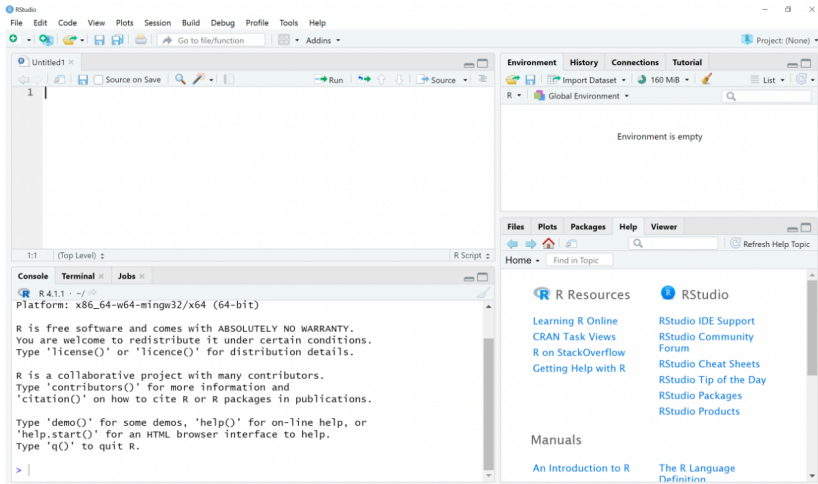
# Getting set up with R/RStudio

## Steps for RStudio

1. Go to <https://posit.co/download/rstudio-desktop/>
2. Under Products, look under Open Source and select \*RStudio.
3. Scroll down and select RStudio Desktop and DOWNLOAD RSTUDIO DESKTOP.
4. Select the DOWNLOAD button under the Free version of RStudio Desktop.
5. If the download that is “Recommended for your system” is correct, click the download button. If not, scroll down and find the version that is correct for your OS.
6. Download and install.
7. Open and test to ensure RStudio is working.

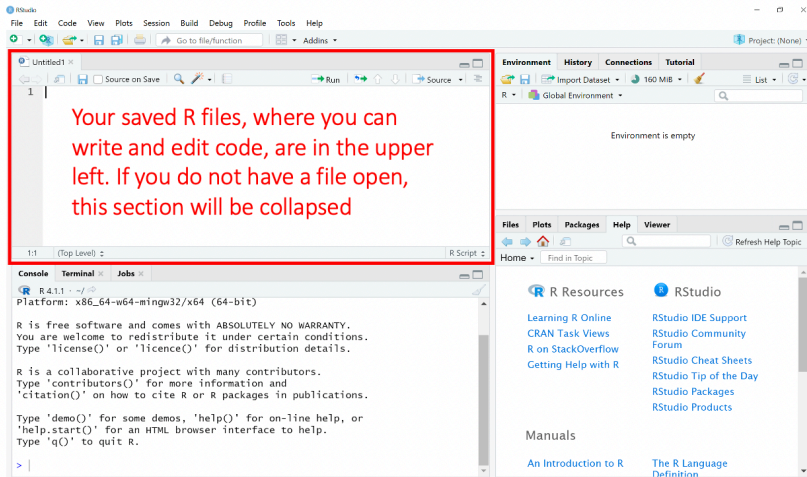
Questions?

# RStudio

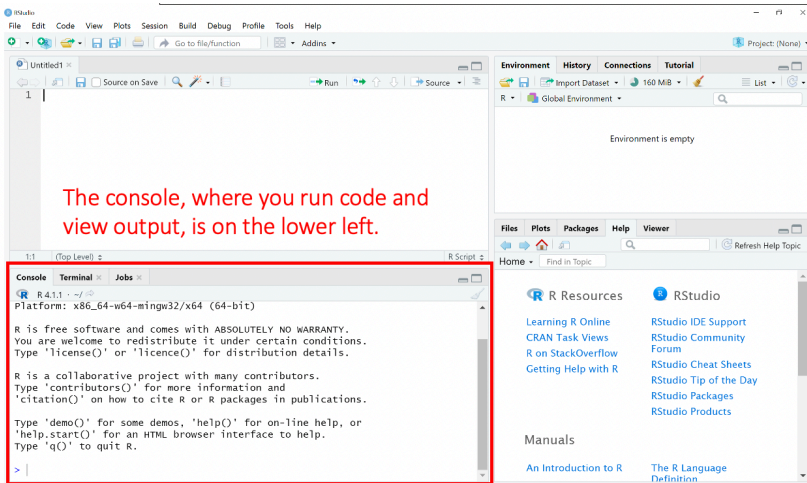




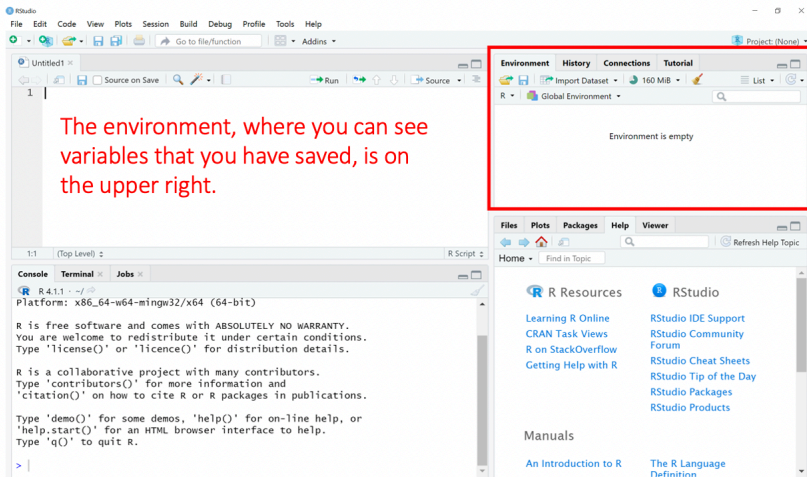
# Components of RStudio



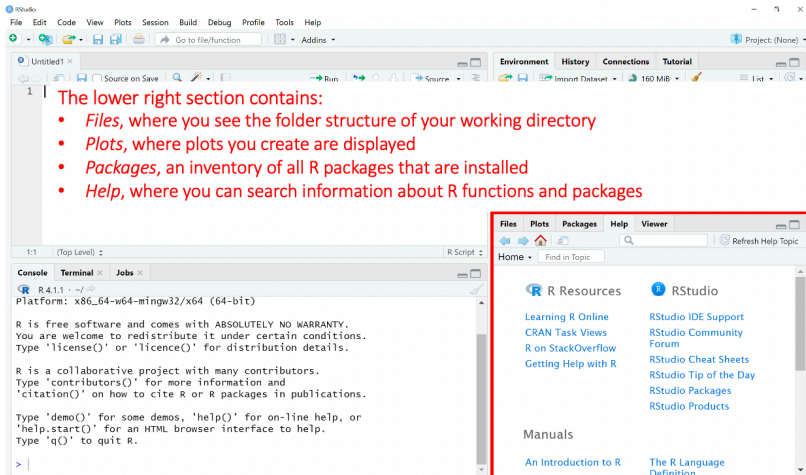
# Components of RStudio



# Components of RStudio



# Components of RStudio



# Interacting with R

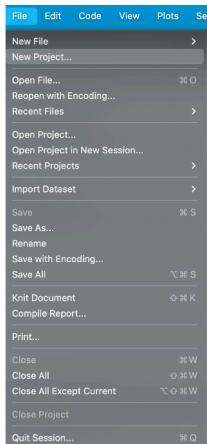
## Console

- ▶ Type commands directly into the console and press 'Enter' to execute
- ▶ Clear console with 'Ctrl' + 'L'
- ▶ If R is still waiting for you to enter more text, the console will show a `+` prompt.

## Script

- ▶ Put cursor at the end of the line to execute OR highlight the section.
- ▶ Press 'Ctrl' + 'Enter' on Windows, Mac OR 'Cmd' + 'Return' on Mac.

# R Project



Good to keep data, analyses and text in a single folder

RStudio interface for this is Projects.

- ▶ File → New project; choose New Directory  
→ New project

Enter a name for this folder (“directory”) and choose a convenient location for it. This will be your working directory (save as “DSI IntroR” on Desktop)

- ▶ Click on “Create” project, create a new file where we will type our scripts
- ▶ Go to file → New File → R script. Click the save icon on your toolbar and save your script as “script.R”

# Outline of Topics

Getting Set up



**R basics**

File types



Hello, world!

# Location

Current location of the file, if saved:

```
getwd()
```

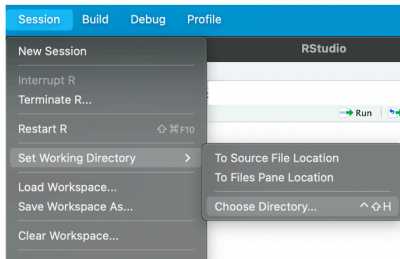
```
[1] "/cloud/project"
```

Set working directory by typing path:

```
#setwd("/Users/<Name>/Desktop")
```

Or (*recommended method*):

Session → Set Working Directory → Choose Directory...





# Coding style

Limit yourself to 80 characters per line.

Use comments. Don't describe what the code does, but explain why you wrote it that way.

Use only  $\leftarrow$  for assignment, not  $=$

Never reassign reserved words/built in functions (i.e., mean)

*Optional:* You may read more

- ▶ <https://google.github.io/styleguide/Rguide.html>
- ▶ [http://steipe.biochemistry.utoronto.ca/abc/index.php/RPR-Coding\\_style](http://steipe.biochemistry.utoronto.ca/abc/index.php/RPR-Coding_style)

# Features of R

In R, the indexing begins from 1.

```
set_of_numbers <- c(1:10)
set_of_numbers
```

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

```
set_of_numbers[1] #index 1
```

```
[1] 1
```

R is case sensitive (“X” is not the same as “x”).

```
x <- 1
X
```

```
Error in eval(expr, envir, enclos): object 'X' not found
```

## Mathematical operations in R

For now we will work in the console.

To run code, hit enter.

If it runs successfully, you will see a  $>$  on the line with the cursor.

If it instead shows a  $+$ , the command was incomplete. You can finish the command and hit enter, or hit ESCAPE to start again.

```
(27 +0.4 - 2 * 7 / 11) ^ 3
```

```
[1] 17835.37
```

Basic Math Operators	Operation
$x + y$	Addition
$x - y$	Subtraction
$x * y$	Multiplication
$x / y$	Division
$x ^ y$	Exponent
$x \% \% y$	Modulus

# Creating objects in R

`<-` is the assignment operator.

To assign the value 27 to the object named `num_participants`, you type:

```
num_participants <- 27
```

Rules for object names:

1. Must start with a letter
2. Can only contain letters, numbers, underscores, and periods
3. Typical style conventions; camelCase, snake\_case

Running the name of the object will display the object.

```
num_participants <- 27  
num_participants
```

```
[1] 27
```

# Built-in R Functions

R has a rich set of functions that can be used to perform almost every task for the user

Built-in functions perform many operations. They take the form:

`function_name(argument1 = value1, argument2 = value2, ...)`

```
sqrt(16)
```

```
[1] 4
```

```
seq(1,14)
```

```
[1] 1 2 3 4 5 6 7 8 9 10 11 12 13 14
```

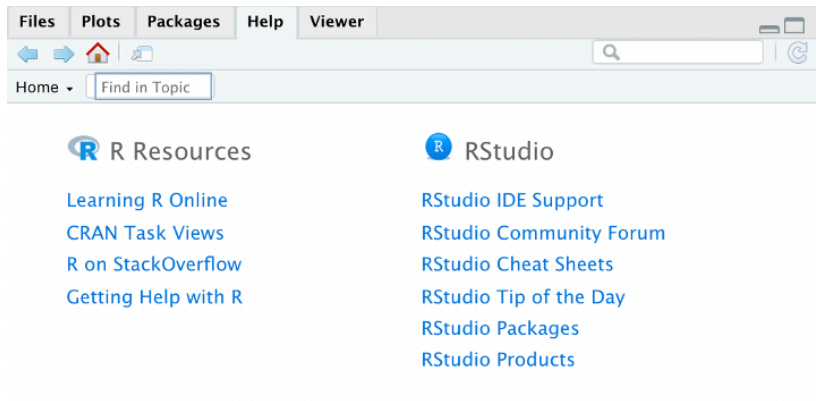
# Help in R

Online documentation for functions and variables in R exists.

Obtained by typing `help(function_name)` or `? function_name` at the Rprompt, where `function_name` refers to the name of function.

```
help(sqrt)
```

```
?sqrt
```



The screenshot shows the RStudio interface with the 'Help' pane open. The 'Find in Topic' search bar is active, and the 'R Resources' section is visible. The 'RStudio' section is also visible, listing various support resources.

Files	Plots	Packages	Help	Viewer
Home ▾	Find in Topic			
<b>R Resources</b>		<b>RStudio</b>		
<a href="#">Learning R Online</a>		<a href="#">RStudio IDE Support</a>		
<a href="#">CRAN Task Views</a>		<a href="#">RStudio Community Forum</a>		
<a href="#">R on StackOverflow</a>		<a href="#">RStudio Cheat Sheets</a>		
<a href="#">Getting Help with R</a>		<a href="#">RStudio Tip of the Day</a>		
		<a href="#">RStudio Packages</a>		
		<a href="#">RStudio Products</a>		

# R packages

Packages are collections of R functions, data, and compiled code.

Libraries are directories in R where the packages are stored.

Built-in functions are part of R standard or base packages and do not need to be downloaded.

```
library(help = "base")
```

```
library(help = "stats")
```

Some functions are not built-in. To get these, need to download packages

R packages extend R's functionality.

# R packages

Popular repositories for Packages:

The Comprehensive R Archive Network (CRAN)

▶ <https://cran.r-project.org/web/packages/>

Bioconductor

▶ <https://www.bioconductor.org/packages/release/bioc/>

GitHub



<https://github.com/search?q=r+packages&type=registrypackages>

*Note:* Depending on the source of the package download, instructions may differ. Typically:

```
install.packages("tidyverse") #download a package  
library(tidyverse) #load it into your RStudio session
```

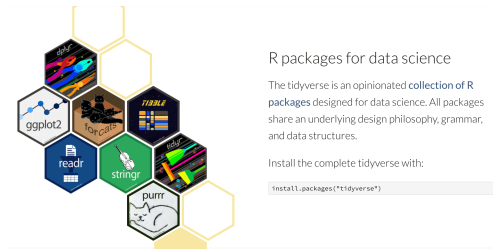


# Tidyverse Package

Tidyverse is a package from CRAN.

(<https://cran.rproject.org/web/packages/tidyverse/index.html>)

To get more details on tidyverse package..



```
ls("package:tidyverse") # list all functions in package
```

```
[1] "tidyverse_conflicts" "tidyverse_deps"      "tidyverse_
```

```
[4] "tidyverse_packages" "tidyverse_sitrep"    "tidyverse_
```

```
?tidyverse # get information on package
```

In class exercise

# Basic R Operations

1. Create an object named `my_sequence` that is a sequence from 1 to 7.
2. Use an R function to take the square roots of all the numbers in the sequence. Save this new sequence as an object named `sqrt_sequence`.
3. Multiply `sqrt_sequence` by 5.

# Basic R Operations

```
my_sequence <- c(1:7)
```

```
my_sequence
```

```
[1] 1 2 3 4 5 6 7
```

```
sqrt_sequence <- sqrt(my_sequence)
```

```
sqrt_sequence
```

```
[1] 1.000000 1.414214 1.732051 2.000000 2.236068 2.449490 2.645751
```

```
sqrt_sequence * 5
```

```
[1] 5.000000 7.071068 8.660254 10.000000 11.180340 12.247449 13.228756
```

# Package installation & loading

1. Install and load the faraway library

## Package installation & loading

```
install.packages("faraway")  
library(faraway)
```

# Outline of Topics

Getting Set up



R basics

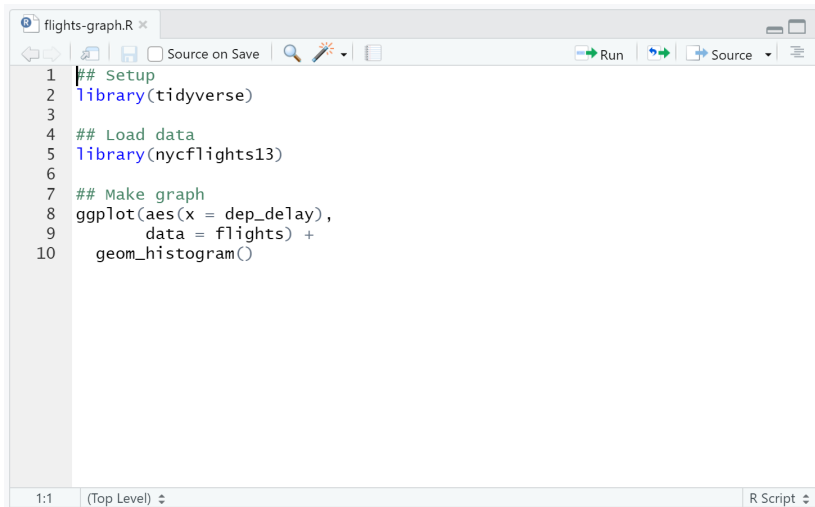
**File types**



Hello, world!

# R Scripts

Files where you can save and edit your code



The screenshot shows an R script editor window with a single file named 'flights-graph.R'. The window has a standard toolbar with icons for navigation, saving, and running. The script content is as follows:

```
1 ## Setup
2 library(tidyverse)
3
4 ## Load data
5 library(nycflights13)
6
7 ## Make graph
8 ggplot(aes(x = dep_delay),
9         data = flights) +
10     geom_histogram()
```

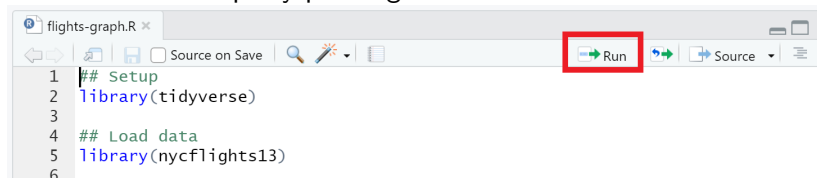
The status bar at the bottom indicates the current position is '1:1' and the context is '(Top Level)'. The file type is identified as 'R Script'.



# R Scripts

## Running the code

Run the entire script by pressing Run



Run the command where your cursor is located by pressing  
Cmd/Ctrl + Enter

Run a section of commands by highlighting them and pressing  
Cmd/Ctrl + Enter

# R Scripts

## Diagnostics

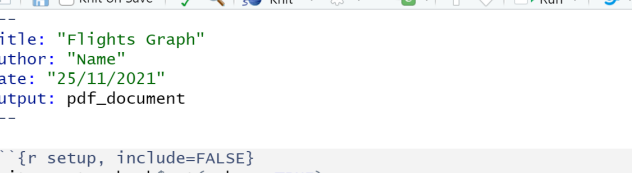
When working in a script, RStudio will mark syntax errors. If you hover over the red x, you can see what the problem is.

```
7  ## Make graph
8  ggplot(aes(x = dep_delay),
9          data = flights) +
10  geom_histogram(
```

unexpected end of document  
unmatched opening bracket '('

# R Markdown

R Markdown files combine code chunks with the results of those chunks and text and support formats like PDF, HTML, word files and slideshows.



The screenshot shows an R Markdown editor window titled "flights-graph.Rmd". The code is as follows:

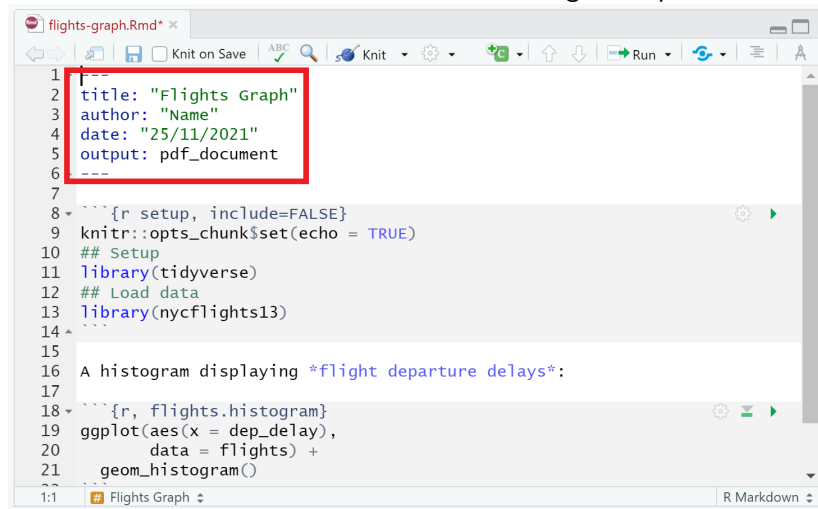
```
1 |---
2 |title: "Flights Graph"
3 |author: "Name"
4 |date: "25/11/2021"
5 |output: pdf_document
6 |---
7 |
8 |```{r setup, include=FALSE}
9 |knitr::opts_chunk$set(echo = TRUE)
10 |## Setup
11 |library(tidyverse)
12 |## Load data
13 |library(nycflights13)
14 |```
15 |
16 |A histogram displaying *flight departure delays*:
17 |
18 |```{r, flights.histogram}
19 |ggplot(aes(x = dep_delay,
20 |          data = flights) +
21 |  geom_histogram()
22 |```
```

The status bar at the bottom indicates the current line is 1:1 and the document is titled "Flights Graph". The R Markdown logo is visible in the bottom right corner.

# R Markdown

## YAML header

contains the document information and settings are specified



The screenshot shows an R Markdown editor window titled "flights-graph.Rmd". The editor contains a YAML header and R code. The YAML header is highlighted with a red box and contains the following text:

```
1 ---
2 title: "Flights Graph"
3 author: "Name"
4 date: "25/11/2021"
5 output: pdf_document
6 ---
```

The R code block follows the YAML header and contains the following text:

```
7
8 {r setup, include=FALSE}
9 knitr::opts_chunk$set(echo = TRUE)
10 ## Setup
11 library(tidyverse)
12 ## Load data
13 library(nycflights13)
14
15
16 A histogram displaying flight departure delays:
17
18 {r, flights.histogram}
19 ggplot(aes(x = dep_delay,
20           data = flights) +
21       geom_histogram()
```

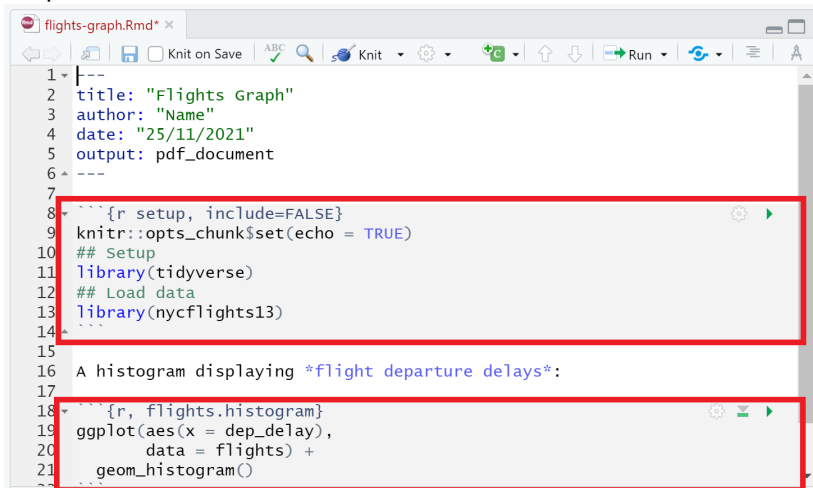
The editor interface includes a toolbar with icons for navigation, saving, and running the document. The status bar at the bottom shows the current line and column (1:1) and the document title (R Markdown).

# R Markdown

## Chunks

Text goes in between the code chunks. This text can be formatted with basic markdown syntax.

You can write in code chunks the same way you would write in a script



The screenshot shows an R Markdown editor window titled "flights-graph.Rmd". The editor displays a code chunk starting at line 8, which is highlighted with a red rectangular box. The code within the chunk is as follows:

```
1 |---
2 |title: "Flights Graph"
3 |author: "Name"
4 |date: "25/11/2021"
5 |output: pdf_document
6 |---
7 |
8 |```{r setup, include=FALSE}
9 |knitr::opts_chunk$set(echo = TRUE)
10 |## Setup
11 |library(tidyverse)
12 |## Load data
13 |library(nycflights13)
14 |```
15 |
16 |A histogram displaying *flight departure delays*:
17 |
18 |```{r, flights.histogram}
19 |ggplot(aes(x = dep_delay),
20 |       data = flights) +
21 |  geom_histogram()
22 |```
```

The code chunk is enclosed in triple backticks and includes a title, author, date, and output format. It also contains R code for setting up the environment and plotting a histogram of flight departure delays. The code is formatted with syntax highlighting, and the chunk is highlighted with a red rectangular box.

# R Markdown

## Running the code

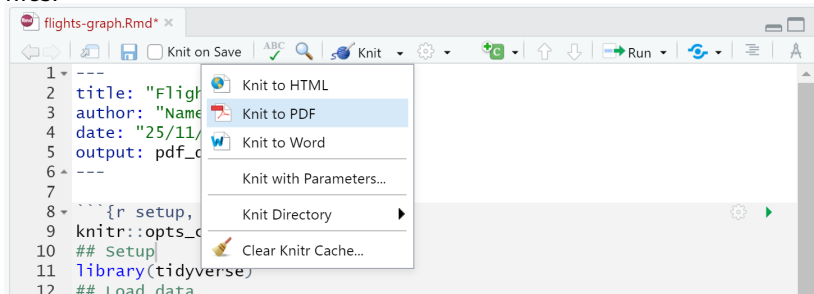
Like with a script, you can use the Run button `Cmd/Ctrl + Enter`. Each chunk also has an arrow you can press to run the code in that chunk.

The output will display below the code chunk rather than in the console or the Plots section.

# R Markdown

## Knitting to .Rmd file

To present your work, you can knit your R Markdown file to a more common file type, including PDFs, Word documents, and html files.



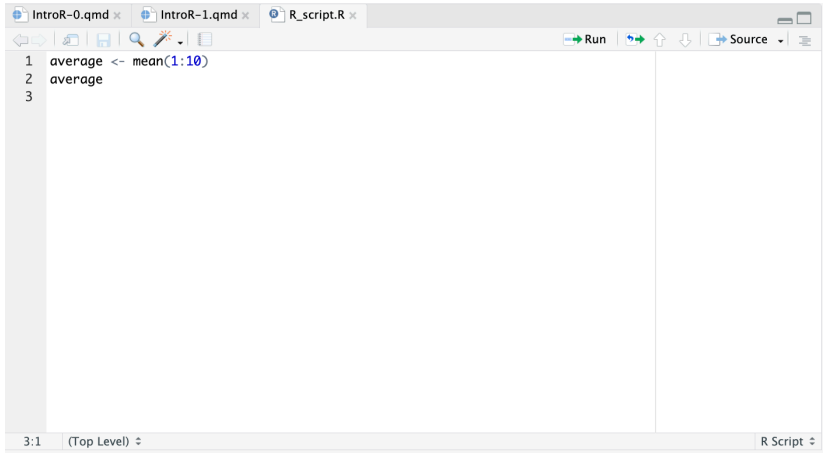
In class exercise



# R Script

1. Create a new R script.
2. Write code to calculate the average of numbers 1 to 10.
3. Run the script.
4. Save the script.

# R Script



The image shows a screenshot of an R Studio editor window. The title bar at the top displays three open files: 'IntroR-0.qmd', 'IntroR-1.qmd', and 'R\_script.R'. The 'R\_script.R' file is the active one. The editor area contains three lines of R code:

```
1 average <- mean(1:10)
2 average
3
```

The code is line-numbered on the left. The first line assigns the mean of the integers from 1 to 10 to a variable named 'average'. The second line prints the value of 'average'. The third line is empty. The right side of the editor is a blank console area. The bottom status bar shows the cursor position '3:1' and the scope '(Top Level)'. The file type is identified as 'R Script'.

# R Markdown

1. Create a new R Markdown file.
2. Load the tidyverse and faraway libraries.
3. Load the dataset “broccoli” by calling the function `data()`
4. Print out the broccoli dataset in the R Markdown file.
5. Save the file.
6. Knit the R Markdown file to PDF.

# R Markdown

```
---  
title: "R_markdown"  
output: html_document  
date: "2023-05-19"  
---
```

```
```{r}  
#install.packages("tidyverse")  
#install.packages("faraway")  
library(tidyverse)  
library(faraway)  
```
```

```
```{r}  
data("broccoli")  
broccoli  
```
```

Description: df [36 × 4]

|    | wt<br><dbl> | grower<br><fctr> | box<br><fctr> | cluster<br><fctr> |
|----|-------------|------------------|---------------|-------------------|
| 1  | 352         | 1                | 1             | 1                 |
| 2  | 369         | 1                | 1             | 2                 |
| 3  | 383         | 1                | 1             | 3                 |
| 4  | 339         | 2                | 1             | 1                 |
| 5  | 367         | 2                | 1             | 2                 |
| 6  | 328         | 2                | 1             | 3                 |
| 7  | 376         | 3                | 1             | 1                 |
| 8  | 359         | 3                | 1             | 2                 |
| 9  | 388         | 3                | 1             | 3                 |
| 10 | 365         | 1                | 2             | 1                 |

1–10 of 36 rows

Previous 1 2 3 4 Next

Chunk 2 ↕

R Markdown ↕

Questions?

# Outline of Topics

Getting Set up



R



RStudio

R basics

File types



Scripts



R markdown

**Hello, world!** (*Live coding*)