

# **An introduction to**



# **and RStudio**

Tiago A. Marques

Modelação Ecológica 2018/2019

# LEARNING GOALS

- OBTAIN A WORKING KNOWLEDGE ABOUT THE R SOFTWARE AND ENVIRONMENT, TO BE ABLE TO IMPLEMENT BASIC DATA ANALYSIS
- INTEGRATION OF R AND RSTUDIO, AN HELPFUL R INTERFACE, VIA A SHORT INTRODUCTION TO R AND RSTUDIO FOLLOWED BY A HANDS ON ASSISTED TUTORIAL

# THE R ENVIRONMENT

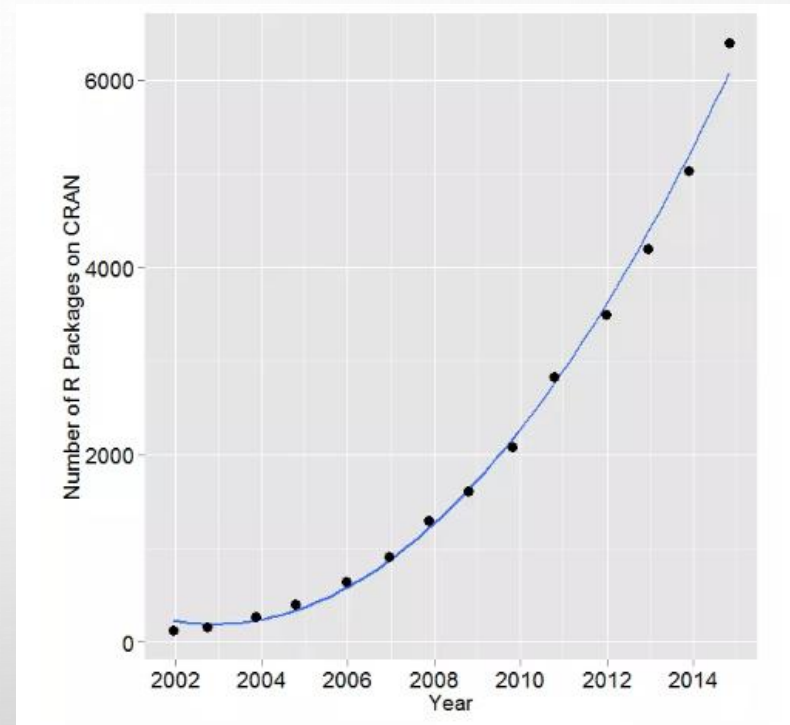
- R IS BOTH A PROGRAMMING LANGUAGE AND AN ENVIRONMENT FOR STATISTICAL COMPUTATION
- R IS FREE OPEN SOURCE SOFTWARE
- CREATED IN 1995 BY ROSS IHAKA AND ROBERT GENTLEMAN, DEPARTMENT OF STATISTICS OF THE UNIVERSITY OF AUCKLAND, AUCKLAND, NEW ZEALAND (GETS ITS NAME FROM ANOTHER FAMOUS PROGRAMMING LANGUAGE FOR DATA ANALYSIS, S)
- PROJECT IS RUN BY THE APPROPRIATELY NAMED “R CORE DEVELOPMENT TEAM”
- SOFTWARE AND EXTENSIVE RESOURCES AVAILABLE AT

[HTTP://WWW.R-PROJECT.ORG](http://www.r-project.org)

LATEST VERSION WAS **R VERSION 3.4.3** (THOSE GUYS ARE FAST...THIS MIGHT BE OUTDATED TODAY!)

# THE R BASE + PACKAGES

- R BASE INSTALLATION COMES WITH A NUMBER OF LIBRARIES WHICH PROVIDE ACCESS TO A LARGE NUMBER OF COMMONLY USED FEATURES (E.G. LINEAR MODELS, SURVIVAL ANALYSIS, BASIC STATISTICAL DISTRIBUTIONS, ETC)
- HOWEVER, ONE OF ITS STRENGTHS COMES FROM THE FACT THAT MANY MORE PACKAGES ARE AVAILABLE ONLINE

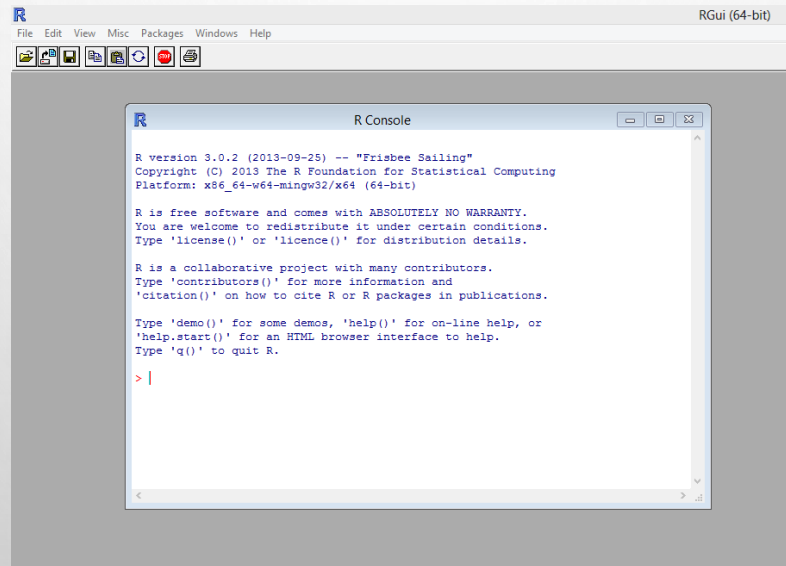


SOURCE:

[HTTP://R4STATS.COM/ARTICLES/POPULARITY/](http://R4STATS.COM/ARTICLES/POPULARITY/)

# THE R ENVIRONMENT

- R WAS TRADITIONALLY ACCESSED SOLELY VIA THE COMMAND LINE, MAKING THE LEARNING CURVE RATHER STEEP FOR BEGINNERS



```
R version 3.0.2 (2013-09-25) -- "Frisbee Sailing"
Copyright (C) 2013 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.

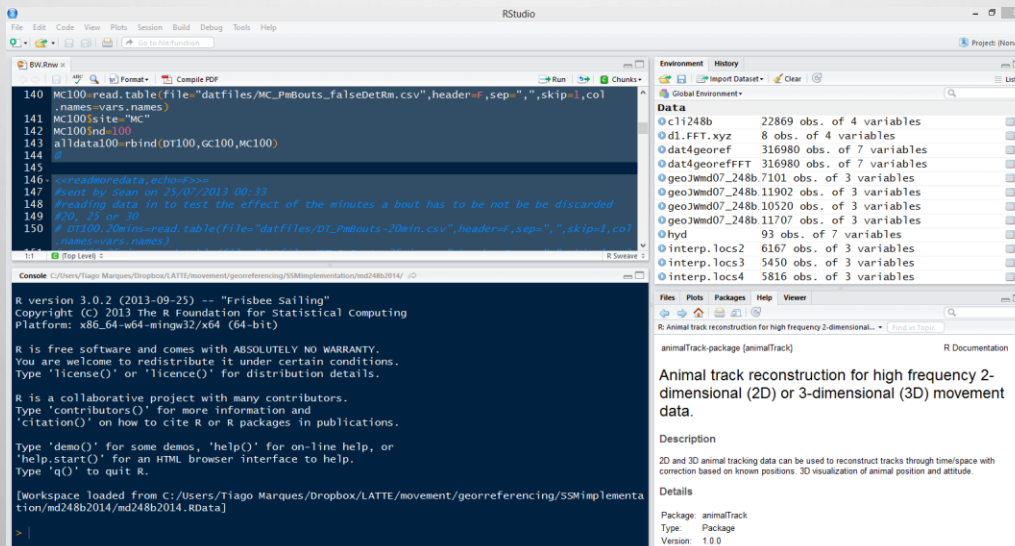
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> |
```

- HERE WE FOCUS ON RSTUDIO, A PROGRAM TO INTERFACE WITH R, MAKING MANY OF THE MOST COMMON TASKS SIMPLER. LET'S OPEN RSTUDIO SHALL WE? <sup>5</sup>

# RSTUDIO

- (AS R) FREE AND OPEN SOURCE
- AN INTEGRATED DEVELOPMENT ENVIRONMENT FOR DATA ANALYSIS
- SIMPLIFIES THE USER INTERACTION WITH R
- IN A SINGLE APPLICATION YOU HAVE ACCESS TO A NUMBER OF WINDOWS CONTAINING THE CODE, THE COMMAND LINE, THE FIGURES, THE HELP, A WINDOWS EXPLORER, ETC.



# 4 WINDOWS, 4 WAYS TO INTERACT WITH R

code

The screenshot shows the RStudio interface with four main windows:

- Source Editor (code):** Contains R code: 

```
1 temp=rnorm(50)
2 plot(temp)
3
```
- Environment (workspace):** Shows the Global Environment with a Data table:

Data	Values
dat4fhsmm	num [1:6292, 1:3] 26.1 39.4 52.6 65.6 79.4 ...
temp	num [1:50] -0.518 0.0561 -0.7382 -0.2479 0.620...
- Console (command line):** Shows the R startup message and the execution of the code from the Source Editor:

```
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 C:/Users/Tiago Marques/Dropbox/LATTE/movement/sim3Dtracks/DTAGissues/dat4fhsmm.Rdata]

> plot(temp)
Error in plot(temp) : object 'temp' not found
> temp=rnorm(50)
> plot(temp)
>
```
- Plots:** Shows a scatter plot of 'temp' vs 'Index' with data points ranging from approximately -1.5 to 1.5 on the y-axis and 0 to 50 on the x-axis.

command line

workspace

plots

# THE CODE AND PLOTS TABS

Sends and executes current line or selected text to console

Move back and forth in a figure log

Export figures as pdf or jpeg

The screenshot displays the RStudio interface with several key components:

- Code Editor:** Contains R code for generating random numbers and plotting them. The 'Run' button is highlighted with a blue circle and an arrow pointing to the console.
- Environment:** Shows the current workspace with variables 'temp' and 'temp2' of type 'num'.
- Console:** Displays the execution output, including error messages for 'plot(temp)' and 'plot(temp2)' because the objects do not exist in the environment. The 'Export' button in the console toolbar is highlighted with a blue circle and an arrow pointing to the 'Export' option in the 'Plots' tab.
- Plots:** Shows a scatter plot of 'temp2' versus 'Index'. The 'Export' button in the plot toolbar is highlighted with a blue circle and an arrow pointing to the 'Export' option in the 'Plots' tab.

```
1 temp=rnorm(50)
2 plot(temp)
3
4
5 temp2=rnorm(50)
6 plot(temp2)
```

```
S.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in pub
lications.

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

[workspace loaded from C:/Users/Tiago Marques/Drop
box/LATTE/movement/sim3Dtracks/DTAGissues/dat4fhs
m.Rdata]

> plot(temp)
Error in plot(temp) : object 'temp' not found
> temp=rnorm(50)
> plot(temp)
> temp2=rnorm(50)
> plot(temp2)
>
```

Data	
dat4fhsmm	num [1:6292, 1:3] 26.1 39.4 52.6 65.6 79.4 ...
Values	
temp	num [1:50] -0.518 0.0561 -0.7382 -0.2479 0.620...
temp2	num [1:50] -1.562 -0.356 -1.489 1.309 -0.792 ...

temp2

Index



# THE ENVIRONMENT TAB

Shortcut for data import

The screenshot shows the RStudio interface with the Environment tab selected. The Environment pane displays the following objects:

Object	Class	Dimensions	Values
dat4fhsmm	num	[1:6292, 1:3]	26.1 39.4 52.6 65.6 79.4 ...
temp	num	[1:50]	-0.518 0.0561 -0.7382 -0.2479 0.620...
temp2	num	[1:50]	-1.562 -0.356 -1.489 1.309 -0.792 ...

The Environment pane also includes a search bar, 'Import Dataset', and 'Clear' buttons. The Data Viewer pane shows a table with 6292 observations of 3 variables (V1, V2, V3). The Console pane shows the following R code and output:

```
> plot(temp)
Error in plot(temp) : object 'temp' not found
> temp=rnorm(50)
> plot(temp)
> temp2=rnorm(50)
> plot(temp2)
> View(dat4fhsmm)
> View(dat4fhsmm)
> |
```

The Plots pane shows a scatter plot of temp2 versus Index, with the x-axis labeled 'Index' and the y-axis labeled 'temp2'. The plot shows a positive correlation between the two variables.

Objects available in workspace (+ details)

Pressing most objects names gives you a preview of what they are

# THE PACKAGES TAB

The screenshot displays the RStudio interface with the following components:

- Environment pane:** Shows the loaded data environment with variables: `dat4fhsmm` (numeric, 6292 observations), `temp` (numeric, 1:50), and `temp2` (numeric, 1:50).
- Console:** Contains R help text and a series of commands and error messages:

```
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 C:/Users/Tiago Marques/Dropbox/LA
TTE/movement/sim3Dtracks/DTAGissues/dat4fhsmm.Rdata]

> plot(temp)
Error in plot(temp) : object 'temp' not found
> temp=rnorm(50)
> plot(temp)
> temp2=rnorm(50)
> plot(temp2)
> View(dat4fhsmm)
> View(dat4fhsmm)
>
```
- Packages pane:** Lists installed and available packages. The `datsets` package is highlighted with a blue box, and its name is also highlighted in the console output.

install a package

an installed package

an installed and loaded package

click the name for package description

# THE HISTORY AND “WINDOWS EXPLORER” TABS

The screenshot displays the RStudio interface with four main windows:

- Environment:** Shows the current workspace with 6292 observations of 3 variables (V1, V2, V3).
- History:** Lists the commands executed in the console, including Sweave, par, plot, temp=rnorm, and View.
- Console:** Shows the R prompt and the execution of the commands from the History window, including an error message for the first plot command.
- Files:** Shows the file explorer for the current project directory, listing various files and folders.

Blue arrows point from the History window to the Console window, and from the Files window to the History window, indicating the flow of information and actions.

The command history (with shortcuts to send commands to source or console)

To see the files in your working directory (select a file to load or open it)

# THE HELP TAB

The screenshot shows the RStudio interface with the following components:

- Environment/History:** Shows the execution history: `temp=rnorm(50)`, `plot(temp)`, `temp2=rnorm(50)`, `plot(temp2)`, `View(dat4fhsmm)`, `View(dat4fhsmm)`, and `?mean`.
- Help Pane:** Displays the documentation for the `mean` function. The title is "Arithmetic Mean". The description is "Generic function for the (trimmed) arithmetic mean." The usage is `mean(x, ...)`. The arguments section lists `x` (An R object), `trim` (the fraction of observations to be trimmed), and `na.rm` (a logical value indicating whether NA values should be stripped).
- Console:** Shows the execution of the following R code:

```
> plot(temp)
Error in plot(temp) : object 'temp' not found
> temp=rnorm(50)
> plot(temp)
> temp2=rnorm(50)
> plot(temp2)
> View(dat4fhsmm)
> View(dat4fhsmm)
> ?mean
```
- Data Viewer:** Shows a data frame with 12 rows and 3 columns (V1, V2, V3).

If you call for help...

This is where it will show up

With hyperlinks for easy navigation

# R HAS AMAZING (ENDLESS) ONLINE RESOURCES

Modelação Ecológica

- Modelação Ecológica(Biologia da Conservação)
- Modelação Ecológica(Ecologia Marinha)
- Teóricas
- Teorico-Práticas
  - Aula 1
  - Aula 2
  - Aula 3
  - R Cheat Sheets**
- Material Suplementar

+ Criar

## R Cheat Sheets

Página **Ficheiros 7** Permissões Link

Adicionar Ficheiro

#	Nome	Permissões
1	advancedR.pdf	Público
2	base-r.pdf	Público
3	how-big-is-your-graph.pdf	Público
4	regex.pdf	Público
5	rmarkdown-reference.pdf	Público
6	rmarkdown-2.0.pdf	Público
7	rstudio-ide.pdf	Público

And I have added a few cheat sheets (“cábulas”) in Fenix

# R MARKDOWN AND DYNAMIC REPORTS

O'REILLY®

Safari

Search...

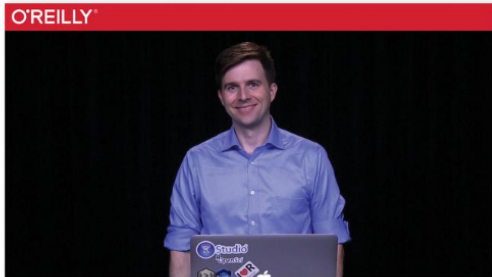


Enterprise

Pricing

Sign In

START FREE TRIAL



## Reproducible Research and Reports with R Markdown

★★★★★ 2 reviews

by Garrett Grolemond

Publisher: O'Reilly Media, Inc.

Release Date: May 2016

ISBN: 9781491959534

START WATCHING

[View table of contents](#)

### Video Description

R Markdown does three main things pretty close to magic. First, it lets you make a completely reproducible, parameter-set and automatable R report. Second, it lets you export that report into a multitude of formats (HTML, Word, .js slide show, interactive web app, etc.). Third, it does the first two things really fast. Wishing for a way to document your code so it still makes sense to you or somebody else six months down the road? Presto! R Markdown does that. Hoping for a button you could click to reproduce your entire analysis with a new data set or parameter? Shazaam! R Markdown does that. Sick of having to copy and paste your results? Poof! R Markdown takes the pain away. If you're an analyst, scientist, actuary, statistician, or a programmer familiar with R, you should add this package to your bag of tricks.

14

# VAMOS CRIAR UM RELATÓRIO DINÂMICO

The screenshot shows the RStudio application window. The 'File' menu is open, and the 'R Markdown...' option is highlighted. The 'Environment' pane on the right shows the Global Environment with variables 'd', 'docs', 'dtm', and 'm'. The 'Files' pane is empty. The console at the bottom shows the workspace loaded from ~/.RData.

**File** Edit Code View Plots Session Build Debug Profile Tools Help

- New File
  - R Script Ctrl+Shift+N
  - R Notebook
  - R Markdown...**
  - Shiny Web App...
  - Text File
  - C++ File
  - R Sweave
  - R HTML
  - R Presentation
  - R Documentation
- New Project...
- Open File... Ctrl+O
- Reopen with Encoding...
- Recent Files
- Open Project...
- Open Project in New Session...
- Recent Projects
- Import Dataset
- Save Ctrl+S
- Save As...
- Save with Encoding...
- Save All Ctrl+Alt+S
- Knit Document Ctrl+Shift+K
- Publish...
- Print...
- Close Ctrl+W
- Close All Ctrl+Shift+W
- Close All Except Current Ctrl+Alt+Shift+W
- Close Project
- Quit Session... Ctrl+Q

**Environment** History Connections

Global Environment

Data

d	8551 obs. of 2 variables
docs	Large SimpleCorpus (4998 elements, 662.2 Kb)
dtm	Large TermDocumentMatrix (6 elements, 1.6 Mb)
m	Large matrix (47456010 elements, 362.9 Mb)

**Files** Plots Packages Help Viewer

R Markdown

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]

> |

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins Project: (None)

```
404 mydata<-iris
405 mydata$total<-mydata$Sepal.Length+mydata$Sepal.Width+
406 mydata$Petal.Length+mydata$Petal.Width
407
408
409 Now, we are going to export this data set as a txt, named
mydatafile.txt
410
411 {r}
412 write.table(mydata,file="mydatafile.txt",row.names=F
413
414
415 Note the use of the optional argument `row.names=FALSE`
otherwise some arbitrary row names would be added to
you look in the folder you are working in, you should
new file there. Open it and check that it looks as you
expect. Next, we are going to import it back into R,
object named `indat`.
416
417 {r}
418 indat<-read.table(file="mydatafile.txt",header=TRUE)
419
420
421 So now we have our data back in R.
```

632:165 Programing tricks

Console Terminal

C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/

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 C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/.RData]

> |

Environment History Connections

Global Environment

Data	
dfmat	3 obs. of 4 variables
mat	num [1:3, 1:4] 10 25 36 45 42 41 98 56 32 5 ...
nomes	List of 2

New R Markdown

Document

Presentation

Shiny

From Template

Title: O meu primeiro relatório dinâmico

Author: Tiago A. Marques

Default Output Format:

HTML  
Recommended format for authoring (you can switch to PDF or Word output anytime).

PDF  
PDF output requires TeX (MiKTeX on Windows, MacTeX 2013+ on OS X, TeX Live 2013+ on Linux).

Word  
Previewing Word documents requires an installation of MS Word (or Libre/Open Office on Linux).

OK Cancel



# R MARKDOWN AND DYNAMIC REPORTS

Não tocar neste "code chunk"!

The image shows the RStudio interface with an R Markdown document open in the editor and the Environment pane on the right. A blue arrow points from the text 'Não tocar neste "code chunk"!' to a code chunk in the document.

**Environment Pane:**

Object	Value
dfmat	3 obs. of 4 variables
mat	num [1:3, 1:4] 10 25 36 45 42 41 98 56 32 5 ...
nomes	List of 2

**Code Editor (R Markdown Document):**

```
1 ---
2 title: "O meu primeiro relatório dinâmico"
3 author: "Tiago A. Marques"
4 date: "October 17, 2018"
5 output: html_document
6 ---
7
8 {r setup, include=FALSE}
9 knitr::opts_chunk$set(echo = TRUE)
10
11
12 ## R Markdown
13
14 This is an R Markdown document. Markdown is a simple formatting
15 syntax for authoring HTML, PDF, and MS Word documents. For more
16 details on using R Markdown see <http://rmarkdown.rstudio.com>.
17
18 When you click the Knit button a document will be generated
19 that includes both content as well as the output of any embedded R
20 code chunks within the document. You can embed an R code chunk
21 like this:
22
23 {r cars}
24 summary(cars)
```

**Console:**

```
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 c:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/.RData]
> |
```

The image shows the RStudio interface. The code editor contains R Markdown code for a document titled "O meu primeiro relatório dinâmico" by Tiago A. Marques, dated October 17, 2018. The code includes a setup block, a heading for R Markdown, a paragraph of text, and an R code chunk for the 'cars' dataset. The Environment pane shows the 'Data' environment with variables 'dfmat', 'mat', and 'nomes'. A 'Choose Encoding' dialog box is open, with 'UTF-8' selected. A blue arrow points from the dialog box to the text on the right.

```
1 ---
2 title: "O meu primeiro relatório dinâmico"
3 author: "Tiago A. Marques"
4 date: "October 17, 2018"
5 output: html_document
6 ---
7
8 {r setup, include=FALSE}
9 knitr::opts_chunk$set(echo = TRUE)
10
11
12 ## R Markdown
13
14 This is an R Markdown document. Markdown is a simple formatting
15 syntax for authoring HTML, PDF, and MS word documents. For more
16 details on using R Markdown see <http://rmarkdown.rstudio.com>.
17
18 When you click the Knit button a document will be generated
19 that includes both content as well as the output of any embedded
20 R code chunks within the document. You can embed an R code chunk
21 like this:
22
23 {r cars}
24 summary(cars)
```

Variable	Value
dfmat	3 obs. of 4 variables
mat	num [1:3, 1:4] 10 25 36 45 42 41 98 56 32 5 ...
nomes	List of 2

Choose Encoding

- ISO-8859-1 (System default)
- ASCII
- BIG5
- GB18030
- GB2312
- ISO-2022-JP
- ISO-2022-KR
- ISO-8859-2
- ISO-8859-7
- SHIFT\_JIS
- UTF-8**
- WINDOWS-1252

Show all encodings  
 Set as default encoding for source files

OK Cancel

Para poderem  
usar caracteres  
portugueses (tipo  
~ç,õ)

The image shows the RStudio interface with a 'Save File - Untitled1' dialog box open. The dialog displays the current directory path: '2018 > TPs > TP1 > Rtutorial'. The file name field contains 'omeurelatorio'. The 'Save as type' dropdown is set to 'RData'. The background code editor shows R Markdown code for a dynamic report.

```
1 ---
2 title: "O meu primeiro relatório dinâmico"
3 author: "Tiago A. Marques"
4 date: "October 17, 2018"
5 output: html_document
6 ---
7
8 {r setup, include=FALSE}
9 knitr::opts_chunk$set(echo = TRUE)
10
11
12 ## R Markdown
13
14 This is an R Markdown document. Markdown
15 syntax for authoring HTML, PDF, and MS
16 details on using R Markdown see <http://
17
18 when you click the Knit button a
19 code chunks within the document. You
20 like this:
21
22 {r cars}
23 summary(cars)
24
```

Console output:

```
C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/
R is a collaborative project with many contributors.
Type 'contributors()' for more information.
'citation()' on how to cite R or R packages.
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 C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/.RData]
> |
```

Definir o nome e onde querem guardar o vosso relatório

```
RStudio
File Edit Code View Plots Session Build
ProblemsInWilcoxon.R FT2.R
1 ---
2 title: "O meu primei
3 author: "Tiago A. Ma
4 date: "October 17, 2
5 output: html_documen
6 ---
7
8 {r setup, include
9 knitr::opts_chunk$se
10
11
12 ## R Markdown
13
14 This is an R Markdow
15 syntax for authoring
16 details on using R M
17
18 When you click the *
19 that includes both c
20 code chunks within t
21 like this:
22
23 {r cars}
24 summary(cars)
25
26 O meu primeiro relatório dinâmico
27
28 Console Terminal R Markdown
29 C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/omeurelatorio.html
30 R is a collaborative proje
31 Type 'contributors()' for
32 'citation()' on how to cit
33
34 Type 'demo()' for some den
35 'help.start()' for an HTML
36 Type 'q()' to quit R.
37
38 [workspace loaded from C:/
39 gica/2018/TPs/TP1/Rtutorial
40
41 > |
```

C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/omeurelatorio.html

# O meu primeiro relatório dinâmico

Tiago A. Marques  
October 17, 2018

## 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:

```
summary(cars)
```

##	speed	dist
##	Min. : 4.0	Min. : 2.00
##	1st Qu.: 12.0	1st Qu.: 26.00
##	Median : 15.0	Median : 36.00
##	Mean : 15.4	Mean : 42.98
##	3rd Qu.: 19.0	3rd Qu.: 56.00
##	Max. : 25.0	Max. : 120.00

## Including Plots

You can also embed plots, for example:



Project: (None)

List

Search

Knit

E cá está ele! O vosso primeiro HTML criado automaticamente ao compilarem o ficheiro omeurelatorio.Rmd. Na realidade, é possível criar outputs em pdf e word (mas o pdf implica software adicional – latex - e o word às vezes não corre bem – usar por vossa conta e risco!)

# IMPORTANTE

The screenshot displays the RStudio interface with the following components:

- Code Editor:** Shows an R Markdown document with a title "O meu primeiro relatório dinâmico", author "Tiago A. Marques", and date "October 17, 2018". The document includes a header, a code chunk for setting options, and a main text block explaining R Markdown.
- Environment:** Shows the global environment with three objects: `dfmat` (3 observations of 4 variables), `mat` (a numeric matrix), and `nomes` (a list of 2 elements).
- Files:** A file explorer showing the current directory structure, including files like `.RData`, `.Rhistory`, `biblio.bib`, `dados1.csv`, `figs`, `mee.csl`, `my1stR.Rdata`, `mydatafile.txt`, `omeuralatorio.html`, `omeuralatorio.Rmd`, `omeurelat.html`, `omeurelat.Rmd`, `omeurelatorio.html`, `omeurelatorio.Rmd`, `Rplots.pdf`, `Rtut4ME.pdf`, and `Rtut4ME.Rmd`.
- Console:** Shows the R version (3.4.3), copyright information, and the standard R startup message regarding warranty and documentation.

O que é executado na linha de comandos é independente do que está no relatório dinâmico (no .Rmd). Um .RMD não é um script usual, tem código e texto. O Código está sempre, sempre, sempre dentro de um code chunk!

# Como inserir um novo "code chunk"

The screenshot shows the RStudio interface with the 'Insert Chunk' menu open. The menu items and their shortcuts are:

- Jump To... Alt+Shift+J
- Go To File/Function... Ctrl+.
- Show Document Outline Ctrl+Shift+O
- Show Diagnostics
- Go To Help
- Go To Function Definition
- Extract Function Ctrl+Alt+X
- Extract Variable Ctrl+Alt+V
- Rename in Scope Ctrl+Alt+Shift+M
- Reflow Comment Ctrl+Shift+/  
Comment/Uncomment Lines Ctrl+Shift+C
- Insert Roxygen Skeleton Ctrl+Alt+Shift+R
- Reindent Lines Ctrl+I
- Reformat Code Ctrl+Shift+A
- Run Selected Line(s) Ctrl+Enter
- Re-Run Previous Ctrl+Shift+P
- Run Region
- Send to Terminal Ctrl+Alt+Enter
- Source Ctrl+Shift+S
- Source File... Ctrl+Alt+G

The background code editor shows an R code chunk with the following content:

```
example:  
  
parameter was added to the code chunk  
code that generated the plot.  
  
"The Dining Table"  
for Statistical Computing  
(-bit)  
  
ABSOLUTELY NO WARRANTY.  
under certain conditions.  
distribution details.  
  
any contributors.  
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 C:/Users/tam2/Dropbox/Trabalho/DBA/ModelacaoEcologica/2018/TPs/TP1/Rtutorial/.RData]
```

The console shows the output of the R code, including the message: "ABSOLUTELY NO WARRANTY. under certain conditions. distribution details." and the workspace path.

The file explorer shows the following files and folders:

Name	Size	Modified
..		
.RData	2.9 KB	Oct 3, 2018, 12:28 PM
.Rhistory	14.5 KB	Oct 17, 2018, 10:56 AM
biblio.bib	2.9 KB	Sep 13, 2018, 4:43 PM
biblio.bib.bak	3 KB	Sep 13, 2018, 4:43 PM
dados1.csv	454 B	Jan 31, 2014, 4:39 PM
figs		
mee.csl	6.6 KB	Mar 18, 2015, 11:29 PM
my1stR.Rdata	239 B	Oct 16, 2018, 1:41 PM
mydatafile.txt	4.8 KB	Oct 16, 2018, 1:41 PM
omeuralatorio.html	719.9 KB	Oct 17, 2018, 10:54 AM
omeuralatorio.Rmd	878 B	Oct 17, 2018, 10:52 AM
omeurelat.html	733 KB	Oct 17, 2018, 10:51 AM
omeurelat.Rmd	905 B	Oct 17, 2018, 10:51 AM
omeuralatorio.html	733 KB	Oct 17, 2018, 10:57 AM
omeuralatorio.Rmd	905 B	Oct 17, 2018, 10:57 AM
Rplots.pdf	180.2 KB	Sep 13, 2018, 2:52 PM
Rtut4ME.pdf	594.4 KB	Oct 16, 2018, 1:41 PM
Rtut4ME.Rmd	36 KB	Oct 16, 2018, 1:41 PM

# NOW... OPEN THE HANDS ON TUTORIAL

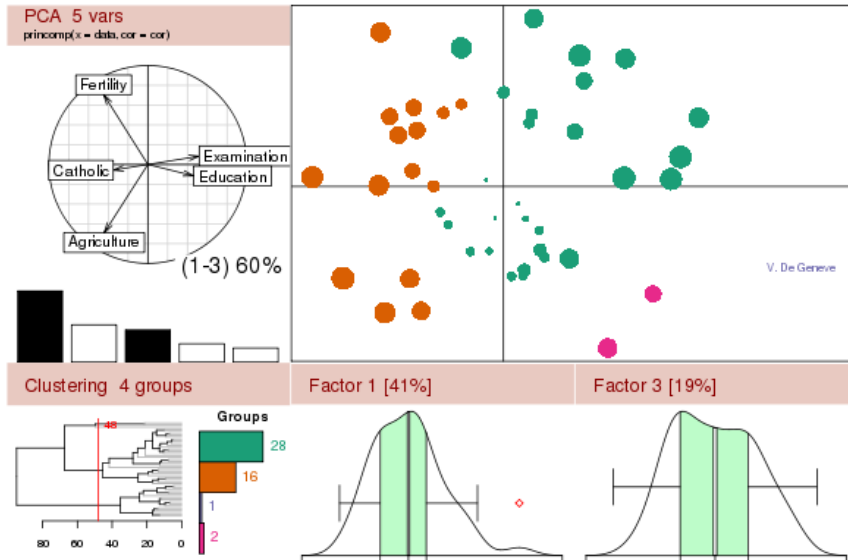
## A hands-on tutorial on R and R Studio

Modelação Ecológica 2019/2020

Tiago A. Marques

September 18, 2019

### The R Project for Statistical Computing



### Contents

Introduction	2
Introduction to R Studio	2
Dynamic reports and reproducible research	3
A first quick session in R Studio	3
Working through R via a dynamic report	5
Types and classes of objects	7
Subsetting data	9
Mathematical functions and simple data calculations	10
Importing and exporting data	11
Graphics	12
Extending basic capabilities via packages	16
Linear regression	17
Simulation and random number generation	21
Programing tricks	22
Writing your own functions	23
A final task integrating all of the above	23
Wrap up	24
References	24