New technologies in R

Laurent DELSOL

14 octobre 2026

Introduction

Chapter 1: Discovering RMarkdown

- Markdown Syntax
- Including R code
- Usage examples
- Exercise A. Linear Regression
- Exercise B. Dog or Wolf?
- Exercise C. Mountain Hike
- Bibliography (among others)

Introduction

Prerequisites and Organization

- Prerequisites
  - Basic knowledge of **R**
  - Ability to handle Word, HTML, LaTeX, and similar file formats
  - Basic knowledge of statistics
- 2 half day lectures and practical sessions
  - **7h30 am - 11h am** Introduction to RMarkdown
  - **12h30 am - 4h30 pm** Introduction to Shiny web app

Course Outline

- Chapter 1: Discovering RMarkdown
  - Markdown syntax
  - Including **R** code
  - Usage examples
- Chapter 2: Interactive documents with Shiny
  - Overview
  - Syntax and formatting
  - Usage examples

Why use R?

- free and open-source software
- easy to use, modify, and implement
- implementation of the latest statistical methods
- numerous and varied tools dedicated to:
  - statistics
  - code parallelization
  - big data
  - signal and image processing
- extensions enabling the creation of, for example:
  - automated reports (rmarkdown), internship thesis (bookdown)
  - interactive web applications (shiny)
  - dashboards (dashbord)

Installing R

To install on Windows, go to this page: http://cran.r-project.org/bin/windows/base/ and follow the first link to download the installer. Once the installer is launched, simply install R using the default options.

For Mac OS X, installation files are available at http://cran.r-project.org/bin/macosx/.

If you are working on Linux, you should be able to find **R** via your package manager, though this may vary depending on the specific Linux distribution.

Installing RStudio and the rmarkdown, shiny, and dashboard packages

Once R is correctly installed, go to http://www.rstudio.com/products/rstudio/download/ to download the latest stable version of RStudio. Specifically, you should download the Open Source edition of RStudio Desktop (as there is also a server version available).

You can then install the **rmarkdown**, **shiny**, and **dashboard** packages from **CRAN** using the following commands:

```
install.packages("rmarkdown")
install.packages("bookdown")
install.packages("shiny")
```

Chapter 1: Discovering RMarkdown

Why use RMarkdown?

RMarkdown syntax enables the creation of statistical reports that:

- feature a polished layout without being overly complex to set up
- can include graphs, mathematical formulas (LaTeX), the R commands used, etc
- are automated and thus very easy to update
- come in a wide variety of formats (HTML, PDF, Word, presentations, etc) generated from the same code

Markdown Syntax

The Basics

Result	*Syntax*
Standard text	`Standard text`
italics	`*italics* and _italics_`
bold	`**bold** and __bold__`
superscript^2 or subscript$_0$	`superscript^2^ or subscript~0~`
~~strikethrough~~	`~~strikethrough~~`
`[link](www.rstudio.com)`	link
$A = \pi \times r^2$	`$A = \pi\times r^{2}$`
Note[1]	`Note^[footnote]`

[1] footnote

Basics (continued)

You can combine ***bold and italics*** by typing `*__ ... __*`

You get a **level-p heading** by starting the line with the # symbol repeated p times. For example, `##### Title 5` produces

Title 5

Note:

```
A line break is not recognized...
unless you leave two spaces
before moving to the next line.
```

A line break is not recognized... unless you leave two spaces before moving to the next line.

Blocks, bulleted, numbered, and nested lists

Result

- step...

1. idea 1
2. idea 2
    a. first point
    b. second point
3. idea 3
    - another idea
    - another idea
    - another idea

Syntax

```
>- step...
```

```
 1. idea 1
 1. idea 2
a. first point
 a. second point
 1. idea 3
      - another idea
      * another idea
      + another idea
```

Blocks, bulleted, numbered, and nested lists

Result

- step...
- step

1. idea 1
2. idea 2
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    - another idea
    - another idea
    - another idea

Syntax

```
>- step...
 >- step

 1. idea 1
 1. idea 2
a. first point
 a. second point
 1. idea 3
      - another idea
      * another idea
      + another idea
```

Additional notes:

- To prevent a section title from being numbered (e.g., when using *bookdown*), add `{-}` or `{.unnumbered}` after it.
- A blockquote is created using the > symbol.

```
> "Statistics have shown that mortality in the
army increases significantly during wartime."
*Alphonse Allais*, **Le Chat noir**, January 11,
1890.
```

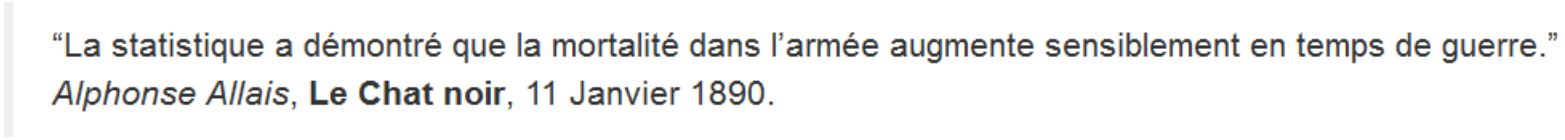


Figure 1: Example of a quote rendered in HTML format

Include a table

Works only for certain output formats

```
|  Tables   |      Are      |  Cool  |
|:----------|:-------------:|-------:|
| col 1 is  |  left-aligned | $1600  |
| col 2 is  |    centered   |   $12  |
| col 3 is  | right-aligned |    $1  |
```

Tables	Are	Cool
col 1 is	left-aligned	$1600
col 2 is	centered	$12
col 3 is	right-aligned	$1

Figure 2: Example of a table generated in ioslides_presentation format

Including an image

Image

```
![Burren, Ireland](images/Burren.jpg){width=2cm}
```

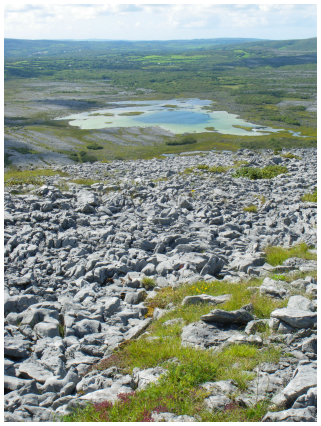


Figure 3: Burren, Ireland

Including a link to a local file or folder

- For a local file

Syntax: `[Link to video](videos/VideoB.mp4)`

Result: Link to video

- For a local folder

Syntax: `[Link to folder](videos/.)`

Result: Link to folder

Entête

```
---
title: "New technologies in R"
author: "Laurent DELSOL"
date: '14 octobre 2026'
output:
```

Output formats: Documents

- **html_notebook** - Interactive R Notebooks
- **html_document** - HTML document w/ Bootstrap CSS
- **pdf_document** - PDF document (via LaTeX template)
- **word_document** - Microsoft Word document (docx)
- **odt_document** - OpenDocument Text document
- **rtf_document** - Rich Text Document format
- **md_document** - Markdown document (various flavors)

Output formats: Presentations (transparencies)

- **ioslides_presentation** - HTML presentation with ioslides
- **revealjs::revealjs_presentation** - HTML presentation with reveal.js
- **slidy_presentation** - HTML presentation with W3C Slidy
- **beamer_presentation** - PDF presentation with LaTeX Beamer
- **powerpoint_presentation** - PowerPoint presentation

Output formats: Others

- **flexdashboard::flex_dashboard** - Interactive dashboards
- **tufte::tufte_handout** - PDF handouts in the style of Edward Tufte
- **tufte::tufte_html** - HTML handouts in the style of Edward Tufte
- **tufte::tufte_book** - PDF books in the style of Edward Tufte
- **html_vignette** - R package vignette (HTML)
- **github_document** - GitHub Flavored Markdown document

Add-on packages: **bookdown**, **blogdown**, **shiny**

Some customizations and options

- adding a table of contents:
  toc : yes
- automatic date update:
  ‘`r format(Sys.time(), “%d %B %Y”)`’
- using parameters

```
params:
  year: 2018
  region: Europe
  printcode: TRUE
  data: file.csv
```

Interactive parameter selection (via the **shiny** package)

```
params:

  year:
    label: "Year"
    value: 2017
    input: slider
    min: 2010
    max: 2018
    step: 1
    sep: ""

  printcode:
    label: "Display Code:"
    value: TRUE
```

Interactive parameter selection (via the **shiny** package)

```
params:

  region:
    label: "Region:"
    value: Europe
    input: select
    choices: [North America, Europe, Asia, Africa]

  data:
    label: "Input dataset:"
    value: results.csv
    input: file
```

Including R code

General syntax

To include an R code block, use the syntax

```
```{r}
R_Commands
```
```

Within the text, simply use `r R_Commands `

A first example

```
```{r sim, prompt=TRUE, comment='Result obtained:'}
a=runif(1,0,10); x=rexp(100,a); a.e=1/mean(x); a.e
```
```

Exponential distribution parameter: `r a`.

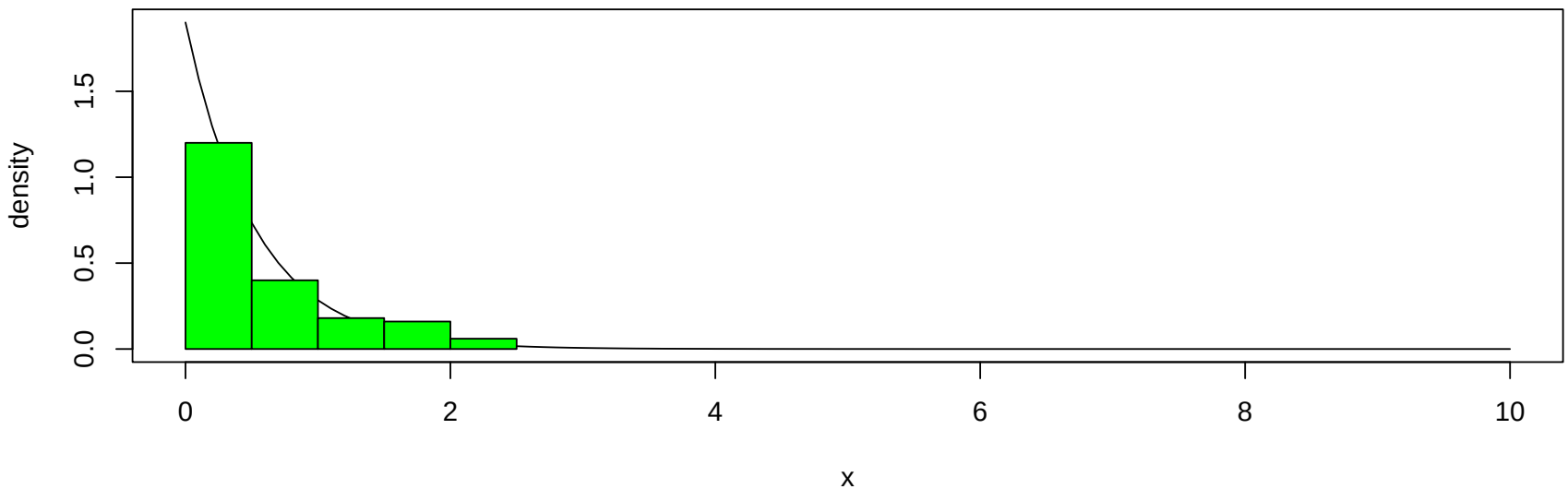
```
```{r hist, fig.height=4, echo=FALSE}
plot(function(x) dexp(x,a),0,10,ylab="density")
hist(x,freq=FALSE,add=TRUE,col='green')
```
```

Result

```
> a=runif(1,0,10); x=rexp(100,a); a.e=1/mean(x); a.e
```

```
Result obtained: [1] 1.618185
```

Exponential distribution parameter: 1.9007971.



Options (some examples)

- **eval** (boolean) indicates whether the block code should be evaluated
- **echo** (boolean) indicates whether the block code should be displayed
- **include** (boolean) indicates whether the block should be included
- **results** ('markup', 'hide', 'hold', 'asis') indicates how the results should appear
- **error** (boolean) indicates whether error messages should be included
- **message** (boolean) indicates whether messages should be included
- **warning** (boolean) indicates whether warnings should be included
- **cache** (boolean) indicates whether the block should be cached (and thus executed only if its content changes)
- **fig.show** ('asis', 'hide', 'hold', 'animate') indicates how figures should appear

Setting default options

```
```{r include=FALSE}
knitr::opts_chunk$set(
echo = TRUE,
include=TRUE,
warning=FALSE,
fig.height=3,
fig.show='hold',
results='hold',
comment='',
fig.align='center'
)
```
```

Displaying a table with **kable** (knitr package)

```
data(HairEyeColor);library(knitr)
HairEyeColor_c=HairEyeColor[,,1]+HairEyeColor[,,2]
kable(HairEyeColor_c,'latex',caption="An example table")
```

Table 1: An example table

	Brown	Blue	Hazel	Green
Black	68	20	15	5
Brown	119	84	54	29
Red	26	17	14	14
Blond	7	94	10	16

Displaying a dataset with **kable** (knitr and kableExtra)

```
data(mtcars);library(kableExtra)
kable(mtcars,'html',caption="mtcars data") %>%
  kable_styling() %>%
  scroll_box(width = "100%", height = "10cm")
```

Données mtcars

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2

```

Figure 4: Example of HTML output
```

Usage examples

Usage examples

Finally, here are a few illustrations of what can be achieved with RMarkdown:

- **Report** (PDF, Word, HTML) on the simulation and analysis of a time series [Reproducibility, Adaptability]
- **HTML Page** presenting simulations ("Fortnite" duels) and their statistical analysis [Reproducibility, Interactivity]
- **Slideshow Presentation** (HTML or PDF) on linear regression [Interactivity]
- **Article** (HTML or PDF) discussing a magic trick based on the Fibonacci sequence [Reproducibility]

Exercise A. Linear Regression

Exercise A. Linear Regression

Write an RMarkdown report to automatically perform a linear regression analysis (scatter plot, correlation, regression line, and model quality) on data generated by the following commands:

```
a=rnorm(1)
b=rnorm(1,2,1)
sigma_b=runif(1)
x=runif(100)
y=a*x+b+rnorm(100,0,sigma_b)
```

R Code 1/3

```r
# Scatter plot
plot(x,y)

# Correlation
(r=cor(x,y))

# Regression line
res=lm(y~x)
summary(res)
a0=res$coefficients[2]
b0=res$coefficients[1]

# Coefficient of determination
R2=cor(x,y)^2
```

R Code 2/3

```r
# Regression line
plot(x,y,main='Regression line')
abline(b,a,col='orange')
abline(b0,a0,col='blue')

# Estimation
x0=.7
r=predict(res,data.frame(x=x0))
segments(x0,min(y),x0,r,col='green',lty=2)
segments(min(x),r,x0,r,col='green',lty=2)
```

R Code 3/3

```
# Interactive plot
library(plotly)
p=plot_ly(x=~x,y=~y, name='data',type = 'scatter',
          mode='markers')
p=add_lines(p,x=~x,y=~a*x+b,name='y=ax+b',
            color=I('orange'))
p=add_lines(p,x=~x,y=~a0*x+b0,name='y=a0+b0',
            color=I('blue'))
p=add_segments(p,x0,min(y),x0,r,name='y=a0x0+b0',
               color=I('green'),linetype = I("dash"))
add_segments(p,min(x),r,x0,r,name='x=x0',
             color=I('green'),linetype = I("dash"))
```

Your turn!

Reproduce the following automated documents:

- Word document
- HTML document
- PDF document, only if you have LaTeX installed

You can use the command

`outputFormat <- knitr:::pandoc_to()` to adjust the graph display to the output format.

Exercise B. Dog or Wolf?

Exercise B. Dog or Wolf?

Canid skeletal remains were found at Jussac. Create a presentation explaining—in two or three slides—the analysis of the `Jussac.data` dataset and the results of the supervised classification using Linear Discriminant Analysis (LDA).

LAM	LBM	LCB	LM	LMS	LP	Type
13.8	95	129	11.2	64	17.5	Dog
16.5	76	154	14.2	74	20.0	Dog
15.9	71	170	12.3	87	17.9	Dog
14.8	73	188	13.3	94	19.5	Dog
13.0	55	161	12.1	81	17.1	Dog
14.7	58	164	12.7	90	17.5	Dog

R Code 1/2

```r
library(MASS) # load the MASS library for LDA
load('Jussac.RData') # load the observations

# Linear Discriminant Analysis
Type.lda <- lda(Type~., data=Jussac.learn)
LD1 <- Type.lda$scaling[,1] # Axis 1

# Calculate projections onto Axis 1
proj=as.matrix(Jussac.learn[,-7])%*%LD1

# Plot the resulting projections
plot(proj,Type=='Chien',xlab='LD1',ylab='Type',
     col=(Type=='Chien')+1,yaxt="n")
axis(2,at=c(0,1),c('Loup','Chien'))
```

R Code 2/2

```r
# Classification quality
CV=lda(Type~., data=Jussac.learn,CV=TRUE)
Classe_est=CV$class
# Confusion matrix
table(Type,Classe_est)
# Error rate
mean(Classe_est!=Type)
# ROC curve
Prob=CV$posterior[,1]
ROC(Type=='Chien',Prob,plot=TRUE)
# Results for Jussac
predict(Type.lda,Jussac)$class # Class
predict(Type.lda,Jussac)$posterior # Posterior probabiliti
```

Your turn!

Recreate the ioslides document.

You can use the following commands

```
<div class="columns-2">
<div>
<p>...</p>
</div>
<div>
<p>...</p>
</div>
</div>
```

to set up a two-column layout.

Exercise C. Mountain Hike

Exercise C. Mountain Hike

The **Mountain_Hike.RData** dataset describes the terrain of a mountainous area. Create a 3D plot of the hiking landscape in an HTML document. Then, plot the elevation profile of the chosen route (you may use kernel estimation and the provided coordinates).

long	lat	alti
99.062468	53.307663	1503.552
-6.870042	28.219049	1565.064
-3.991788	92.239441	1523.288
31.888710	-9.171035	1495.187
20.895597	25.186065	1612.269
15.368273	80.504487	1511.161

R Code 1/3

```
load('Mountain_Hike.RData')
library(plotly)
library(sm)
# Discretization
longitude=seq(min(long),max(long),length=100)
latitude=seq(min(lat),max(lat),length=100)
# Estimation
RES=sm.regression(cbind(long,lat),alti,
                  eval.points=cbind(longitude,latitude),
                  eval.grid=TRUE,method='cv',
                  display='none',nbins=0)$estimate
Est_altitude=matrix(RES,100,100)
```

R Code 2/3

```r
# Data frame with estimated altitudes on the grid
DT=data.frame(longitude,latitude,Est_altitude)
# Plot
plot_ly(DT,x=~latitude,y=~longitude,z = ~Est_altitude,
        type = "surface")

# Altitude estimation for the route
Alti_est=sm.regression(cbind(long,lat),alti,
                       eval.points=Position,
                       eval.grid=FALSE,method='cv',
                       display='none',nbins=0)$estimate
```

R Code 3/3

```
# Data frame with estimated altitudes along the route
lo=Position[,1]
la=Position[,2]
DT2=data.frame(Time,lo,la,Alti_est)

# Plot
plot_ly(DT,x=~latitude,y=~longitude,z = ~Est_altitude,
        type = "surface")%>%
add_trace(x=~la,y=~lo,z = ~Alti_est, type = "scatter3d")
plot_ly(DT2,x=~Time,y=~Alti_est, type = 'scatter',
        mode = 'lines')
```

Your turn!

Recreate the HTML document.

You can use the commands

```
output:
  html_document:
    code_folding: "hide"
```

and

```
# Title 1 {.tabset .tabset-fade .tabset-pills}
## Tab 1
## Tab 2
```

to hide/show the code and set up the tabs.

Bibliography (among others)

Bibliography (among others)

- Tutorial RMarkdown
- The RMarkdown Cheasheet
- The RMarkdown Reference guide
- R Markdown: The Definitive Guide, Yihui Xie, J. J. Allaire,Garrett Grolemund