

R Markdown Cookbook

Michael Harper, Yihui Xie

2018-09-23

Contents

Preface	5
How to read this book	5
Structure of the book	6
Software information and conventions	6
Acknowledgements	6
About the Authors	7
I Get Started	1
1 Installation	3
2 Basics	5
2.1 R Markdown components	5
3 Basics	7
3.1 Quick Tips	7
4 Multi-format projects	9
4.1 Control Output	9
4.2 Output-specific functions	9
4.3 Designing output	9
5 Knitr Hooks	11
6 Tables	13
7 Managing Big Projects	15
7.1 Sourcing Files	15
7.2 Caching	15
7.3 Notifications	15
II Additional Packages	17
8 Diagrams	19
8.1 Basic Diagrams	19
8.2 Adding parameters to plots	20
9 References	23

III Recipes	25
10 Document Elements	27
10.1 Set Date to Current Date	27
10.2 Adding Multiple Authors	27
11 LaTeX	29
11.1 Inserting Commands	29
11.2 LaTeX preamble	29
11.3 Multi-figure plots	29
11.4 Cross-output	29
11.5 LaTeX subfigures	29
12 HTML Output	33
12.1 Tabbed headings	33
12.2 Altering Citation Style	33
12.3 Automatically Generate Package Citations	33

Preface

This book is in a **very** early stage of development. If you have any suggestions on what should be included within this book, please get in touch via GitHub

R Markdown is a powerful tool for combining analysis and reporting into the same document. Since the development of the **rmarkdown** package (Allaire et al., 2018), it has grown to become a diverse ecosystem of code, and reports, books and websites can all easily be generated directly from R code.

There is a wealth of guidance which has grown over the past few years. *R Markdown: The Definitive Guide* (Yihui Xie, 2018). However, as noted by Yihui, it was commented by the publisher that it would be beneficial to provide more practical examples of the use of R Markdown. And so, the idea of this book was born.

To fill the gap for official documentation, users often seek for help on StackOverflow. At the time of writing, there were almost 4,000 different questions with the **r-markdown** tag. However, the use of the website is relatively difficult if you do not have a specific problem you are trying to search for, and therefore it is hard to be able to tell what is possible with R Markdown unless you have the insight to search for a specific question. This book aims to draw together much existing literature from StackOverflow, and provide up-to-date solutions for everyday queries that users commonly face.

This book is designed to provide a range of examples of how to extend the functionality of your R Markdown documents. As a cookbook, this guide is recommended to new or intermediate R Markdown users who are looking for practical examples of how R Markdown documents can be effectively updated.

How to read this book

The book is designed to highlight the many ways in which your R Markdown documents can be customized. Users are encouraged to try using the concepts within their own documents. The code detailed in the book should be sufficient, but the full source code and examples are provided on GitHub.

It is recommended that readers have a basic understanding of R Markdown. Chapter 2 of *R Markdown: The Definitive Guide* (Yihui Xie, 2018) provides a great overview of the basics of R Markdown and is recommended background reading for any new users of R Markdown.

It should be noted that this guide does not intend to provide a full technical reference for R Markdown, and there is already extensive literature available on these topics. This book aims to supplement, not replace, this existing literature, and it is therefore recommended that readers explore the following books if they seek further information:

- *R Markdown: The Definitive guide* (Yihui Xie, 2018): provides an overview of the R Markdown package and the wide range of ways it can be used.
- *Dynamic documents and knitr*: provides more detailed technical guidance on the inner workings of **rmarkdown** and **knitr** (Xie, 2018b).
- *Authoring books with bookdown* (Xie, 2016): a short book which provides details on the **bookdown** package (Xie, 2018a), which is designed to simplify the creation of long-format documents in R Markdown.

- *blogdown: Creating Websites with R Markdown* (Xie et al., 2017): provides details of the **blogdown** package (?) package.

Where relevant, this book provides references to these existing resources.

Structure of the book

The book is broken down into small “recipes” which aim to demonstrate a single concept at a time.

Chapter content to be finalised once recipes created.

Software information and conventions

The R session information used when compiling this book is as follows:

```
xfun::session_info(c(
  'blogdown', 'bookdown', 'knitr', 'rmarkdown'), dependencies = FALSE)
```

```
## R version 3.5.0 (2017-01-27)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 14.04.5 LTS
##
## Locale:
##   LC_CTYPE=en_US.UTF-8      LC_NUMERIC=C
##   LC_TIME=en_US.UTF-8      LC_COLLATE=en_US.UTF-8
##   LC_MONETARY=en_US.UTF-8   LC_MESSAGES=en_US.UTF-8
##   LC_PAPER=en_US.UTF-8      LC_NAME=C
##   LC_ADDRESS=C              LC_TELEPHONE=C
##   LC_MEASUREMENT=en_US.UTF-8 LC_IDENTIFICATION=C
##
## Package version:
##   blogdown_0.8    bookdown_0.7.19 knitr_1.20    rmarkdown_1.10
```

We do not add prompts (`>` and `+`) to R source code in this book, and we comment out the text output with two hashes `##` by default, as you can see from the R session information above. This is for your convenience when you want to copy and run the code (the text output will be ignored since it is commented out). Package names are in bold text (e.g., **rmarkdown**), and inline code and filenames are formatted in a typewriter font (e.g., `knitr::knit('foo.Rmd')`). Function names are followed by parentheses (e.g., `blogdown::serve_site()`). The double-colon operator `::` means accessing an object from a package.

“Rmd” is the filename extension of R Markdown files, and also an abbreviation of R Markdown in this book.

Acknowledgements

About the Authors

Part I

Get Started

Chapter 1

Installation

We assume you have already installed R (<https://www.r-project.org>) (R Core Team, 2017) and the RStudio IDE (<https://www.rstudio.com>). RStudio is not required but recommended, because it makes it easier for an average user to work with R Markdown. If you do not have RStudio IDE installed, you will have to install Pandoc (<http://pandoc.org>), otherwise there is no need to install Pandoc separately because RStudio has bundled it. Next you can install the **rmarkdown** package in R:

```
# Install from CRAN
install.packages('rmarkdown')

# Or if you want to test the development version,
# install from GitHub
if (!requireNamespace("devtools"))
  install.packages('devtools')
devtools::install_github('rstudio/rmarkdown')
```


Chapter 2

Basics

This book by no means intends to be a comprehensive guide to R Markdown, however before we start, it is important to provide an overview of the key challenges which users often face when they attempt to customise their R Markdown documents.

This chapter aims to clarify frequently confused concepts for users wishing to extend

2.1 R Markdown components

A common source of confusion is understanding which component does what within the R markdown workflow. Figure X highlights the components of the R Markdown workflow.

We focus on `.Rmd` files within this book. `.Rnw` and `.Rhtml` are available but less frequently used formats.

knitr is responsible for the first stage of the conversion process. This processes all the embedded code chunks.

The conversion process used by **knitr** is output format dependent.

pandoc is responsible for converting the raw markdown file into the required output format (PDF/HTML/Word).

If PDF format is selected, there is one additional dependency of LaTeX.

Chapter 3

Basics

- What should be known before reading this book
- Assumed knowledge of the basics of R Markdown

3.1 Quick Tips

- Short index of some basic ideas on how to improve R Markdown documents
- Include current date in R Markdown <https://stackoverflow.com/questions/23449319/yaml-current-date-in-rmarkdown/23529410#23529410>

Chapter 4

Multi-format projects

One of the main benefits of R Markdown can create multiple output formats from a single source document. This book example is available in all three formats, with PDF, ebook and online versions all being available.

Project should therefore ideally be designed to be flexible for the multiple outputs. However, users will often find themselves wanting to fine-tune the output, and doing so will often require

This chapter aims to provide several examples on how a document can be customised with output specific features, whilst also retaining the ability to export documents to multiple formats.

4.1 Control Output

Designing custom behavior which can respond to change in outputs using `is_latex_output` etc. For example, you may want to have interactive tables using `DT::datatable` in the HTML output but print static versions in the PDF.

4.2 Output-specific functions

HTML documents have the capacity to contain. The `webshot` package is available to take screenshots of HTML elements for non-interactive output formats (ebooks, PDF).

```
library(ggplot2)
library(plotly)
p <- ggplot(data = diamonds, aes(x = cut, fill = clarity)) +
  geom_bar(position = "dodge")
ggplotly(p)
```

4.3 Designing output

If we wish to design our own format-specific function we can use the functions `knitr::is_latex_output()` and `knitr::is_html_output()`. These function will return a TRUE/FALSE action

```
knitr::is_html_output()
```

This can be used to control the output of statements.

Chapter 5

Knitr Hooks

- Knitr hooks: these are explained within previous R Markdown book
- Include practical examples could be very useful for readers to see the power of it.
- Use some of these: <https://gist.github.com/yihui/2629886>

Chapter 6

Tables

- provide more detailed documentation on kable
- Using kableExtra to style tables

Chapter 7

Managing Big Projects

- Practical tips on how a big project should be managed
- `source` is particularly useful for loading external scripts so that the R Markdown project isn't too bloated with code.

Ideas: - Use `(ref:tag)` to store page formatting options which might need to be reused. For example a page break

7.1 Sourcing Files

A benefit of using R Markdown is that it is easy

```
source("yourScript.R")
```

7.2 Caching

- Caching
- Ways it can be tailored to suit analysis. This cache invalidation is a great example: <https://stackoverflow.com/questions/18376008/invalidate-a-chunks-cache-when-uncached-chunk-changes>

7.3 Notifications

- Can link R Markdown with notifications if have long analysis
- Working with non R users
- Use HTML outputs and interactive graphics

Part II

Additional Packages

Chapter 8

Diagrams

It is often useful to express analysis using flowcharts and diagrams within reports. Although there are many separate programs which can be used to produce these, it can be beneficial to create these within our analysis directly. This makes it easier to update and edit the graph if we need to edit it in the future, and allows us to use the results from our analysis directly within the diagrams, making them more information.

While there are several different packages available for R, we will focus on the package **DiagrammeR** (Iannone, 2018). We also recommend that you read at <http://rich-iannone.github.io/DiagrammeR/index.html>. In this chapter we will explain some of the basic usages of the package.

8.1 Basic Diagrams

DiagrammeR provides methods to build graphs for a number of different graphing languages.

R Studio provides native support for Graphviz (.gv) and mermaid (.mmd) files. Using files of these types in RStudio provides the advantage of syntax coloring and allowing a quick preview of the diagram. For example, we can make a simple flowchart with the following code:

```
DiagrammeR::grViz("digraph {  
  
  graph [layout = dot, rankdir = LR]  
  
  node [shape = rectangle]  
  rec1 [label = 'Step 1']  
  rec2 [label = 'Step 2']  
  rec3 [label = 'Step 3']  
  rec4 [label = 'Step 4']  
  
  # edge definitions with the node IDs  
  rec1 -> rec2 -> rec3 -> rec4  
  }",  
  height = 200)
```

There are extensive controls which can be used to control the shape of nodes, colours, line types and add additional parameters.

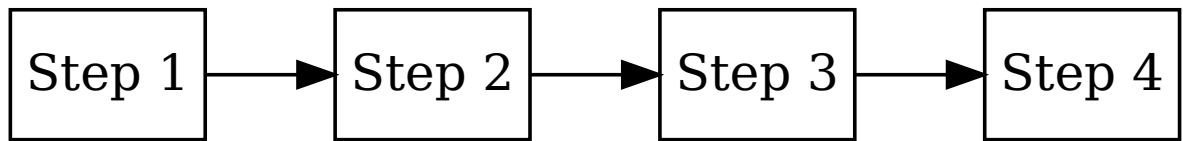


Figure 8.1: A basic graphic using DiagrammeR

8.2 Adding parameters to plots

We can allow

Graphviz substitution allows for mixing in R expressions into a Graphviz graph specification without sacrificing readability.

If you specify a substitution with `@@`, you must ensure there is a valid expression for that substitution. The expressions are placed as footnotes and their evaluations must result in an R vector object (i.e., not a data frame, list, or matrix). Because there is the possibility to have multiple substitutions, numbering is required. Thus, the `@@` notation is immediately followed by a number and that number should correspond to the number of the footnoted R expression.

For example, suppose we have a dataset which is being analysed, and we would like to identify how many values are removed at each stage of a process.

```

DiagrammeR::grViz("
digraph graph2 {

graph [layout = dot, rankdir = LR]

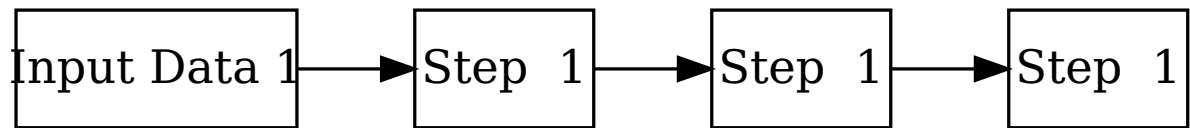
# node definitions with substituted label text
node [shape = rectangle]
a [label = '@@1']
b [label = '@@2']
c [label = '@@3']
d [label = '@@4']

a -> b -> c -> d

}

[1]: paste('Input Data', 1)
[2]: paste('Step ', 1)
[3]: paste('Step ', 1)
[4]: paste('Step ', 1)
")

```



Chapter 9

References

Part III

Recipes

Chapter 10

Document Elements

There are lots of small tips and tricks that can be used to customize the content of R Markdown documents. This chapter provides short recipes which are useful for tweaking the behaviour of your own R Markdown documents.

10.1 Set Date to Current Date

It is useful for the date of the knitted R Markdown document to automatically update each time we rerun the file. To do this, we can add R code directly to the `date` field in the YAML, and use the `Sys.time()` function to extract the current date. As this function will by default provide the date and time, we must format it as shown below:

```
---
title: Your title
date: "23 September, 2018"
---
```

This will automatically update each time you Knit your document i.e. 23 September, 2018. If we wish to customize the format of the dates, we can alter the time format by providing our own text string. Some examples are shown as follows:

- `%B %Y`: "September 2018"
- `%d/%m/%y`: "23/09/18"
- `%d/%m/%y`: "Sun 23 Sep"

A full table of POSIXct formats is shown in Table 10.1, with

10.2 Adding Multiple Authors

We can add multiple authors to a R Markdown document within the YAML in a number of ways

```
---
title: "Untitled"
author: "John Doe, John Smith"
output: html_document
---
```

If you would prefer a linebreak between the two authors, we can add

Table 10.1: Date Time Formats within R

Code	Meaning	Code	Meaning
%a	Abbreviated weekday	%A	Full weekday
%b	Abbreviated month	%B	Full month
%c	Locale-specific date and time	%d	Decimal date
%H	Decimal hours (24 hour)	%I	Decimal hours (12 hour)
%j	Decimal day of the year	%m	Decimal month
%M	Decimal minute	%p	Locale-specific AM/PM
%S	Decimal second	%U	Decimal week of the year (starting on Sunday)
%w	Decimal Weekday (0=Sunday)	%W	Decimal week of the year (starting on Monday)
%x	Locale-specific Date	%X	Locale-specific Time
%y	2-digit year	%Y	4-digit year
%z	Offset from GMT	%Z	Time zone (character)

```

---
author:
- John Doe^[Their institution]
- John Doe 2^[Their institution]
output:
  pdf_document: default
  html_document: default
---
```

Chapter 11

LaTeX

For many authors, the main of long reports or books, the primary output will be LaTeX. In this chapter, we discuss approaches which can be used to customise the output of PDF reports.

Users should approach with a note of caution. One of the major benefits of R Markdown is the fact that a single source document can create documents with multiple formats. By tailoring your work to a single output format (PDF/Word/HTML), you may improve the appearance and performance of a single output but at the expense of this transferability.

11.1 Inserting Commands

11.2 LaTeX preamble

11.3 Multi-figure plots

If we need to print multiple output graphs or figures, there are several ways this can be achieved.

11.4 Cross-output

As explained in <https://bookdown.org/yihui/rmarkdown/r-code.html#figures> of Yihui Xie (2018), we can place multiple figures side-by-side using the `fig.hold='hold'` along with the `out.width` option. As an example below, we have set the `out.width="50%"`:

```
plot(1:10)
plot(rnorm(10), pch=19)
```

The main benefits of this approach is that it is easily achieved, and also works for both PDF and HTML outputs.

11.5 LaTeX subfigures

When writing a document you may want to include some slightly more complicated figures with multiple images. Subfigures are a useful LaTeX feature which allows us to achieve this by plotting multiple figures within a single plot and providing each with their own subcaption.

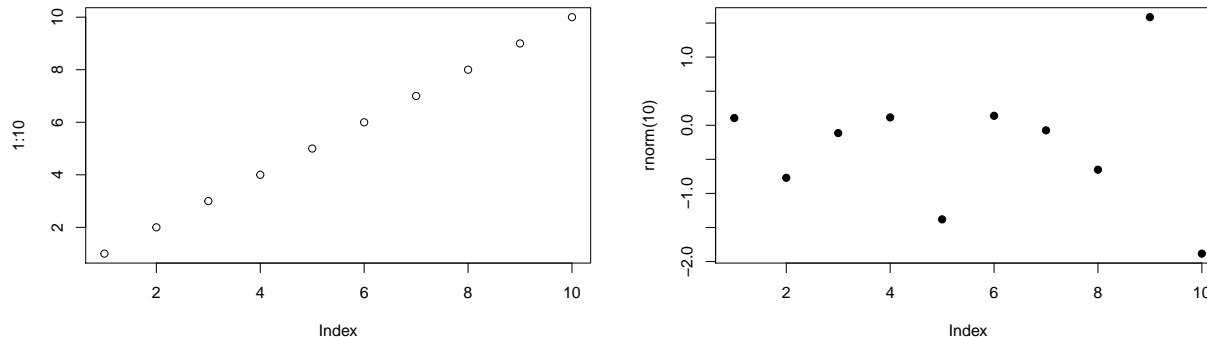


Figure 11.1: Side-by-side figures

Subfigures require the LaTeX package `subfig`. The line `\usepackage{subfig}` must therefore be included within the YAML, or if you are using an external tex template you can add this to that file. For example:

As listed within the knitr chunk options, subfigures require a few additional settings to be set in the chunk header:

- `fig.subcap` is a list of the captions for subfigures
- `fig.ncol`: the number of columns of subfigures
- `out.width`: the output width of the figures. You will normally set this 100% divided by the number of sub columns.

An example is demonstrated below:

```
``yaml
output: pdf_document
header-includes:
  - \usepackage{subfig}
...

```{r fig-sub, fig.cap='two plots', fig.subcap=c('one plot', 'the other one'), out.width='.49\\linewidth}
plot(1:10)
plot(rnorm(10), pch=19)
```
```

The output is shown in Figure 11.2.

```
knitr::include_graphics("images/subfigure.png", dpi = NA)
```

11.5.1 Using with list

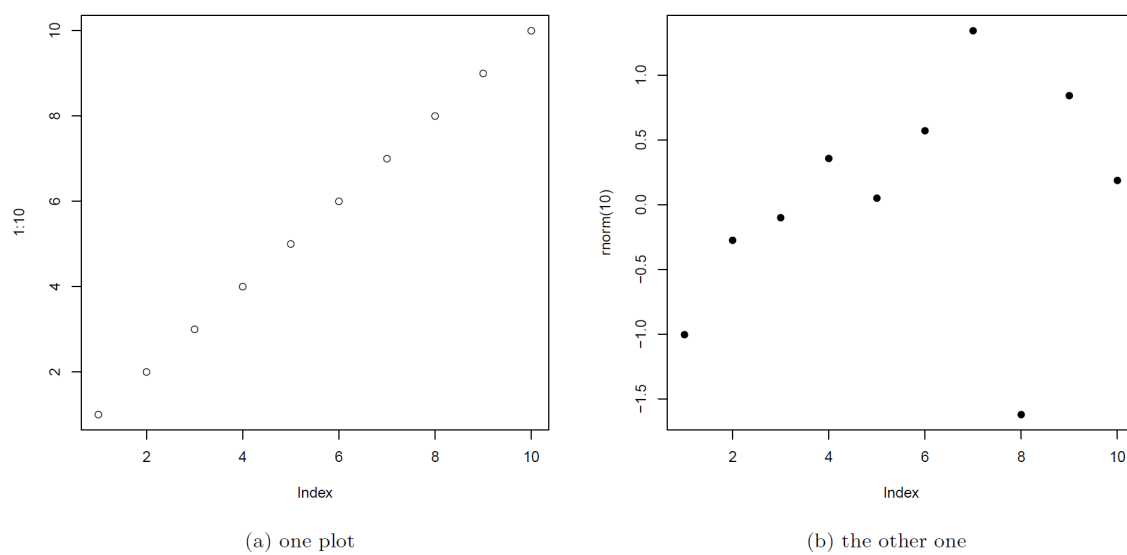


Figure 1: two plots

Figure 11.2: An example subcaption

Chapter 12

HTML Output

How to customise the appearance of HTML documents:

- CSS styles
- Adapt some of the details from here: https://rmarkdown.rstudio.com/html_document_format.html

12.1 Tabbed headings

https://stackoverflow.com/questions/38062706/rmarkdown-tabbed-and-untabbed-headings?utm_medium=organic&utm_source=google_rich_qa&utm_campaign=google_rich_qa

12.2 Altering Citation Style

- Using short author citations: https://stackoverflow.com/questions/48303890/using-short-author-citations-in-bookdown?utm_medium=organic&utm_source=google_rich_qa&utm_campaign=google_rich_qa

12.3 Automatically Generate Package Citations

It is important to that an acknowledgements is provided within your work to authors of any literature or software referenced. Within a typical workflow, this can be a frustrating experience if you are required to manually identify the correctly formatted citations, load them into a referencing software and then refer to them within the text. However, R Markdown makes it easy to streamline this process.

We can generate a BibTex file for packages used within your analysis using the `write_bib` function within R Markdown.

```
# automatically create a bib database for R packages
knitr::write_bib(c(
  .packages(), 'bookdown', 'knitr', 'rmarkdown', 'DiagrammeR'
), 'packages.bib')
```

Once the bibliography has been generated, we can reference the packages, we can reference the package directly from within the text by

```
---
bibliography: packages.bib
---
```

rmarkdown

If in addition to your packages

```
---  
bibliography: [packages.bib. references.bib]  
---
```

A complete example of the elements above is provided below:

Bibliography

- Allaire, J., Xie, Y., McPherson, J., Luraschi, J., Ushey, K., Atkins, A., Wickham, H., Cheng, J., and Chang, W. (2018). *rmarkdown: Dynamic Documents for R*. R package version 1.10.
- Iannone, R. (2018). *DiagrammeR: Graph/Network Visualization*. R package version 1.0.0.
- R Core Team (2017). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.
- Xie, Y. (2016). *bookdown: Authoring Books and Technical Documents with R Markdown*. Chapman & Hall/CRC The R Series. CRC Press.
- Xie, Y. (2018a). *bookdown: Authoring Books and Technical Documents with R Markdown*. R package version 0.7.19.
- Xie, Y. (2018b). *knitr: A General-Purpose Package for Dynamic Report Generation in R*. R package version 1.20.
- Xie, Y., Hill, A., and Thomas, A. (2017). *blogdown: Creating Websites with R Markdown*. Chapman & Hall/CRC The R Series. CRC Press.
- Yihui Xie, J.J. Allaire, G. G. (2018). *R Markdown: The Definitive Guide*. Chapman and Hall/CRC, Boca Raton, Florida, 1st edition. ISBN 978-1138359338.