An introduction to R Markdown

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Last update

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The text is under development and updates are constant

Chapter 1

R Markdown Basics

Here is a brief introduction into using *R Markdown*. *Markdown* is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. *R Markdown* provides the flexibility of *Markdown* with the implementation of **R** input and output. For more details on using *R Markdown* see https://bookdown. org/yihui/rmarkdown/.

Be careful with your spacing in *Markdown* documents. While whitespace largely is ignored, it does at times give *Markdown* signals as to how to proceed. As a habit, try to keep everything left aligned whenever possible, especially as you type a new paragraph. In other words, there is no need to indent basic text in the Rmd document (in fact, it might cause your text to do funny things if you do).

1.1 Lists

It's easy to create a list. It can be unordered like

- Item 1
- Item 2

or it can be ordered like

1. Item 1
2. Item 2

Notice that I intentionally mislabeled Item 2 as number 4. *Markdown* automatically figures this out! You can put any numbers in the list and it will create the list. Check it out below.

To create a sublist, just indent the values a bit (at least four spaces or a tab). (Here's one case where indentation is key!)

1. Item 1
2. Item 2
3. Item 3
     - Item 3a
     - Item 3b

1.2   Line breaks

Make sure to add white space between lines if you'd like to start a new paragraph. Look at what happens below in the outputted document if you don't:

Here is the first sentence. Here is another sentence. Here is the last sentence to end the paragraph. This should be a new paragraph.

Now for the correct way:

Here is the first sentence. Here is another sentence. Here is the last sentence to end the paragraph.

This should be a new paragraph.

1.3   Font syntax

italics or *italics*

```
*italics* or _italics_
```

bold or **bold**

```
**bold** or __bold__
```

superscript^2

```
superscript^2^
```

subscript$_2$

```
superscript~2~
```

~~strikethrough~~

```
~~strikethrough~~
```

1.4   R chunks

When you click the **Knit** button above 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 (`cars` is a built-in **R** dataset):

The basic R chunk is:

```
```{r cars}
summary(cars)
```
```

The result is:

```
##      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
```

1.4.1 Chunk options

You can define chunk options globally or individually. A global definition can be inserted into your file by calling the `knitr::opts_chunk$set` function. A global definition can be modified by individual definitions.

1.4.1.1 Global options

```
```{r}
knitr::opts_chunk$set(options)
```
```

1.4.1.2 Individual options

```
```{r, options}
R code
```
```

1.4.1.3 Some chunk options

- Text output

    echo:(TRUE or FALSE) Whether to display the source code in the output document.

collapse: (TRUE or FALSE) Collapse all the source and output blocks created by the chunk into a single block.

warning: (TRUE or FALSE) Whether to preserve warnings (produced by warning()) in the output.

error: (TRUE or FALSE) Whether to preserve errors (from stop()).

eval: (TRUE or FALSE) Defines whether R code should be run or not.

For a detailed list of options, see:

[link] https://yihui.org/knitr/options/

[link] https://rstudio.com/wp-content/uploads/2015/03/rmarkdown-reference.pdf

1.5   Inline code

If you'd like to put the results of your analysis directly into your discussion, add inline code like this:

```
> The `cos` of $2 \pi$ is `r cos(2*pi)`.
```

> The cos of 2π is 1.

Another example would be the direct calculation of the standard deviation:

```
> The standard deviation of `speed` in `cars` is `r sd(cars$speed)`.
```

> The standard deviation of speed in cars is 5.2876444.

One last neat feature is the use of the `ifelse` conditional statement which can be used to output text depending on the result of an **R** calculation:

```
> `r ifelse(sd(cars$speed) < 6, "The standard deviation is less than 6.", "The standard
```

> The standard deviation is less than 6.

Note the use of `>` here, which signifies a quotation environment that will be indented.

Chapter 2

Math expressions

Mathematical expressions are written using **LaTeX** code.

Equations must be written between `$ $` or `$$ $$`. For inline equations you must use `$<equation>$`.

2.1 Inline equations

My first inline equation: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.

```
My first inline equation: $x = \frac{-b \pm \sqrt{b^{2} - 4ac}}{2a}$.
```

2.2 Math environments

2.2.1 Equation

Equation (2.1)

$$\theta^*|L^*, \delta^2, Y, \sigma_u^2 \sim N\left(B^{-1}W'L^*, \delta^2 B^{-1}\right) \tag{2.1}$$

The equation reference is defined by `\@ref(eq:name)` which must defined in equation as `(\#eq:name)`

```
Equation \@ref(eq:ncrep)

\begin{equation}
    \theta^{*}|L^{*}, \delta^{2},Y,\sigma^{2}_{u} \sim
```

```
    N\left(B^{-1}W'L^{*},\delta^{2}B^{-1} \right)
    (\#eq:ncrep)
\end{equation}
```

2.2.2   Matrix

Matrix (2.2)

$$X_{m,n} = \begin{pmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,n} \\ x_{2,1} & x_{2,2} & \cdots & x_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m,1} & x_{m,2} & \cdots & x_{m,n} \end{pmatrix} \tag{2.2}$$

```
Matrix \@ref(eq:matex)


\begin{equation}
X_{m,n} =
\begin{pmatrix}
  x_{1,1} & x_{1,2} & \cdots & x_{1,n} \\
  x_{2,1} & x_{2,2} & \cdots & x_{2,n} \\
  \vdots  & \vdots  & \ddots & \vdots  \\
  x_{m,1} & x_{m,2} & \cdots & x_{m,n}
\end{pmatrix}
(\#eq:matex)
\end{equation}
```

An extensive list of examples and mathematical symbols can be viewed in the references.

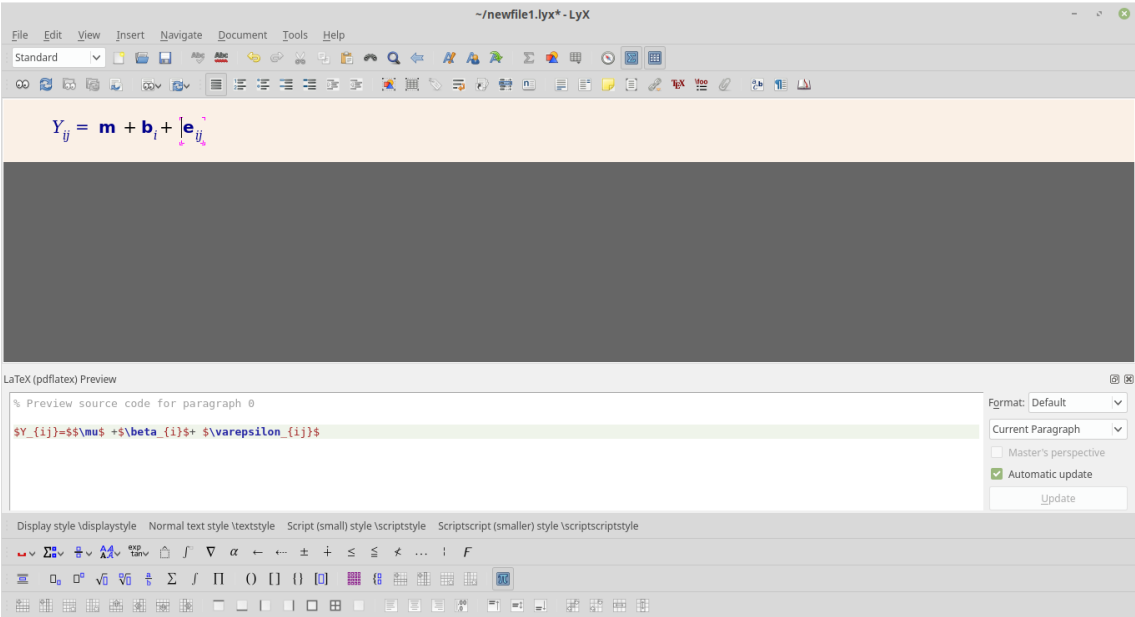## 2.3   LyX for mathematical expressions

We can use LyX to insert any equation or matrix in your report. Just copy and paste the LyX code (Figure **??** into your R Markdown file.
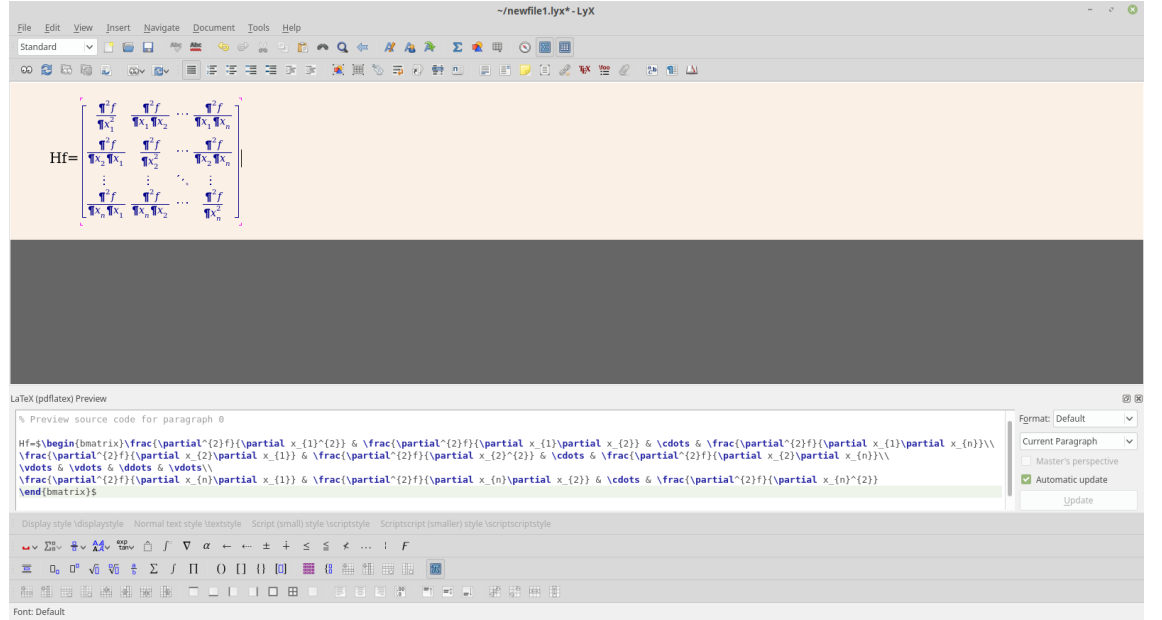
To view your LyX code, follow these steps after open the LyX: View > Source Pane.

My LyX code is $Y_{ij} = \mu + \beta_i + \varepsilon_{ij}$

```
My LyX code is $Y_{ij}=$$\mu$ +$\beta_{i}$+ $\varepsilon_{ij}$
```

For matrices or equations with references, just add the equation environment.

My Hessian matrix (Figure (2.3))

$$Hf = \begin{bmatrix} \frac{\partial^2 f}{\partial x_1^2} & \frac{\partial^2 f}{\partial x_1 \partial x_2} & \cdots & \frac{\partial^2 f}{\partial x_1 \partial x_n} \\ \frac{\partial^2 f}{\partial x_2 \partial x_1} & \frac{\partial^2 f}{\partial x_2^2} & \cdots & \frac{\partial^2 f}{\partial x_2 \partial x_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial^2 f}{\partial x_n \partial x_1} & \frac{\partial^2 f}{\partial x_n \partial x_2} & \cdots & \frac{\partial^2 f}{\partial x_n^2} \end{bmatrix} \tag{2.3}$$

```
My Hessian matrix (Figure \@ref(eq:lyxmat))

\begin{equation}
Hf=\begin{bmatrix}\frac{\partial^{2}f}{\partial x_{1}^{2}} &
\frac{\partial^{2}f}{\partial x_{1}\partial x_{2}} & \cdots &
\frac{\partial^{2}f}{\partial x_{1}\partial x_{n}}\\
\frac{\partial^{2}f}{\partial x_{2}\partial x_{1}} &
\frac{\partial^{2}f}{\partial x_{2}^{2}} & \cdots &
\frac{\partial^{2}f}{\partial x_{2}\partial x_{n}}\\
\vdots & \vdots & \ddots & \vdots\\
\frac{\partial^{2}f}{\partial x_{n}\partial x_{1}} &
\frac{\partial^{2}f}{\partial x_{n}\partial x_{2}} &
\cdots & \frac{\partial^{2}f}{\partial x_{n}^{2}}
\end{bmatrix}
\end{equation}
```

```
(\#eq:lyxmat)
\end{equation}
```

2.4 References

- https://bookdown.org/yihui/bookdown/markdown-extensions-by-bookdown.html
- https://en.wikibooks.org/wiki/LaTeX/Mathematics
- https://en.wikibooks.org/wiki/LaTeX/Advanced_Mathematics

Chapter 3

Tables

The insertion of tables in the text can be performed with the aid of the kable and kable extra and xtable package, or by writing the latex code directly in your file with LyX assistance. I will not define what is the best package for building tables. I believe that the choice are personal.

3.0.1 Package kable

My kable table (3.1)

Table 3.1: My table using kable package

	mpg	cyl	disp	hp	drat	wt
Mazda RX4	21.0	6	160	110	3.90	2.620
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875
Datsun 710	22.8	4	108	93	3.85	2.320
Hornet 4 Drive	21.4	6	258	110	3.08	3.215
Hornet Sportabout	18.7	8	360	175	3.15	3.440

```
My kable table (\@ref(kabletable))

``{r, message=FALSE}
library(kableExtra)

dat <- mtcars[1:5, 1:6]
kab <- knitr::kable(dat, caption="My table using kable package",
                    booktabs=T, label="kabletable")
```

```
kable_classic_2(kab, full_width=F, latex_options="hold_position")
```
```

See references for other examples.

### 3.0.2 Package xtable

My table in xtable (3.2)

Table 3.2: My table using xtable package

|                   | mpg   | cyl  | disp   | hp     | drat | wt   |
|-------------------|-------|------|--------|--------|------|------|
| Mazda RX4         | 21.00 | 6.00 | 160.00 | 110.00 | 3.90 | 2.62 |
| Mazda RX4 Wag     | 21.00 | 6.00 | 160.00 | 110.00 | 3.90 | 2.88 |
| Datsun 710        | 22.80 | 4.00 | 108.00 | 93.00  | 3.85 | 2.32 |
| Hornet 4 Drive    | 21.40 | 6.00 | 258.00 | 110.00 | 3.08 | 3.21 |
| Hornet Sportabout | 18.70 | 8.00 | 360.00 | 175.00 | 3.15 | 3.44 |

For a HTML file, change type="latex" to type="html".

```
My table in xtable (\@ref(xtabletab))

``{r, results='asis', message=FALSE, warning=FALSE}
library(xtable)

print(xtable(dat, caption="My table using xtable package",
      label="xtabletab"), comment=FALSE,
            caption.placement="top", type="latex")
```
```

See references for other examples.

3.0.3 LyX for table

You can insert Latex code directly into your R markdown code. The LyX code must be within the table environment.

My LyX table (3.3)

'

```
My LyX table (\ref{lyxtab2})

\begin{table}[!h]
\centering
\caption{My LyX table}
```

Table 3.3: My LyX table

Car	mpg	cyl	disp	hp	drat	wt
Mazda RX4	21.00	6.00	160.00	110.00	3.90	2.62
Mazda RX4 Wag	21.00	6.00	160.00	110.00	3.90	2.88
Datsun 710	22.80	4.00	108.00	93.00	3.85	2.32
Hornet 4 Drive	21.40	6.00	258.00	110.00	3.08	3.21
Hornet Sportabout	18.70	8.00	306.00	175.00	3.15	3.44

```
\begin{tabular}{ccccccc}
\hline
Car & mpg & cyl & disp & hp & drat & wt\tabularnewline
\hline
Mazda RX4 & 21.00 & 6.00 & 160.00 & 110.00 & 3.90 & 2.62\tabularnewline
Mazda RX4 Wag & 21.00 & 6.00 & 160.00 & 110.00 & 3.90 & 2.88\tabularnewline
Datsun 710 & 22.80 & 4.00 & 108.00 & 93.00 & 3.85 & 2.32\tabularnewline
Hornet 4 Drive & 21.40 & 6.00 & 258.00 & 110.00 & 3.08 & 3.21\tabularnewline
Hornet Sportabout & 18.70 & 8.00 & 306.00 & 175.00 & 3.15 & 3.44\tabularnewline
\hline
\end{tabular}
\label{lyxtab2}
\end{table}
```

3.0.4   References

- https://cran.r-project.org/web/packages/kableExtra/vignettes/awesome_table_in_html.html#Overview

- https://cran.r-project.org/web/packages/xtable/vignettes/xtableGallery.pdf

Chapter 4

Figure

You can include **R** plots using your favorite graphics packages (graphics, lattice or ggplot2) and their extensions.

4.0.1 Graphics with R code

A simple graph with function `plot` (Figure 4.1)

Changes to the behavior of the graph in the final file can be made by changing the options in the chunk.

In the current example, the size of the graph is being changed with the commands `fig.width` and `fig.height`.

See the references for more options.

```
A simple graph with function `plot` (Figure \@ref(fig:grafplot))


``{r grafplot, fig.cap="Plot example", fig.width=5, fig.height=5, fig.align='center'}
data(pressure)
plot(pressure, col="red", pch=18, xlab="Temperature", ylab="Pressure")
```
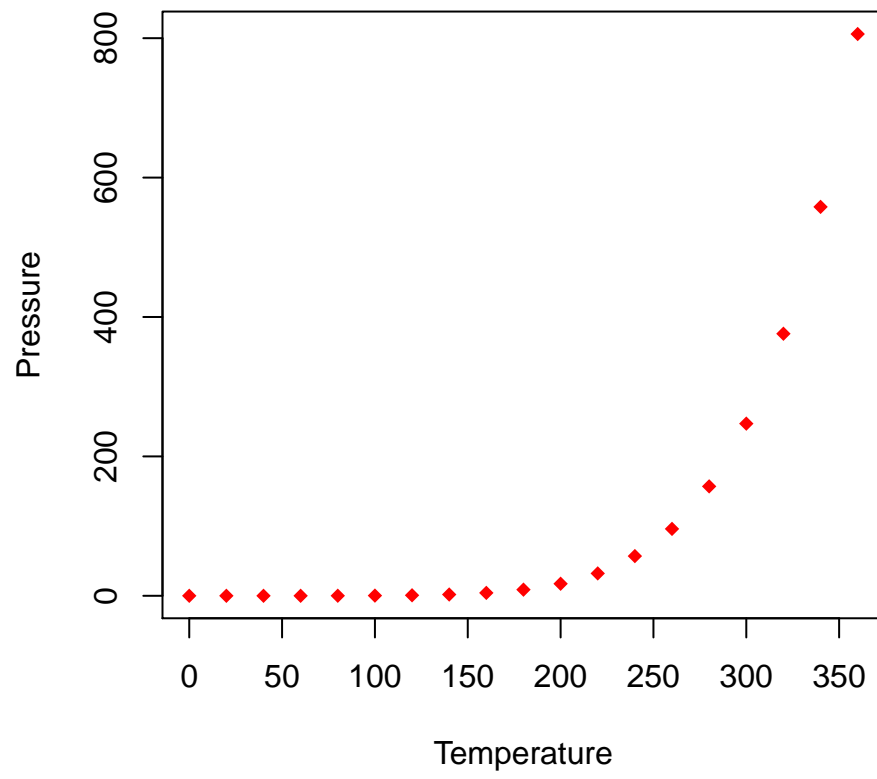
Figure 4.1: Plot example

4.0.2 Inserting figures external to R

External figures can be inserted using R chunk or by inserting latex code directly into the text.
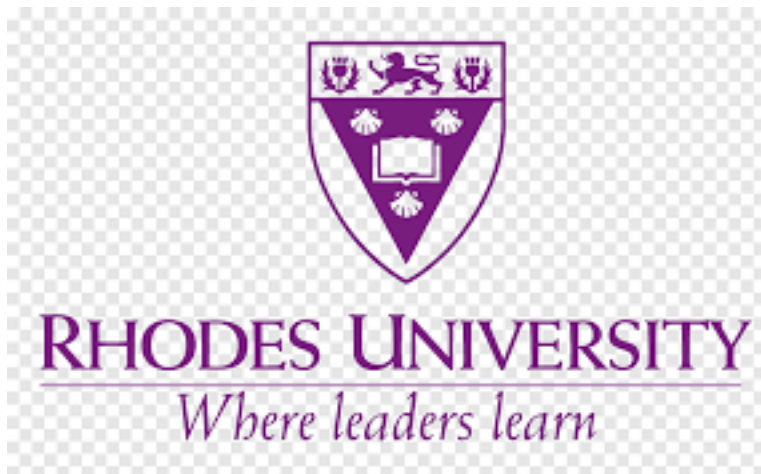
4.0.2.1 R chunk

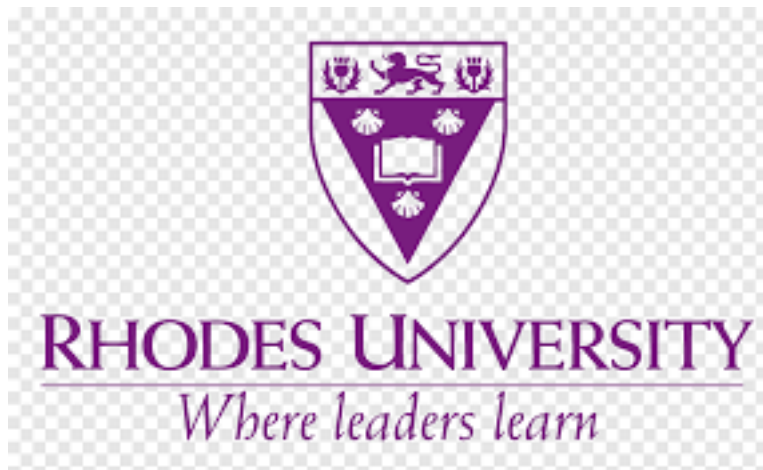Rhodes symbol (4.2)

Figure 4.2: Rhodes symbol

```
Rhodes symbol (\@ref(fig:rhodes))

``{r rhodes, fig.cap="Rhodes symbol", fig.align='center'}
knitr::include_graphics("rhodes.png")
```
```

For more details see references

#### 4.0.2.2   Latex code

Rhodes symbol (4.0.2.2)



```
Rhodes symbol (\ref{figrhodes})

\begin{figure}
\centering
\includegraphics[rhodes.png]
\label{figrhodes}
\end{figure}
```

For more details see references

4.1   References

- https://rstudio.com/wp-content/uploads/2015/03/rmarkdown-reference.pdf
- https://en.wikibooks.org/wiki/LaTeX/Floats,_Figures_and_Captions

Chapter 5

Bibliographies

5.1 File format

The best way to insert citations in your text is with an auxiliary file. The .bib (BibLaTeX) and .bibtex (BibTeX) formats are the most commonly used. Other formats can be viewed in the references.

The input format in .bib or .bibtex files occurs as shown in the examples below.

- Article

```
@article{Xarticle,
    author   = "",
    title    = "",
    journal  = "",
    volume   = "",
    number   = "",
    pages    = "",
    year     = "XXXX",
    month    = "",
    note     = "",
}
```

```
@article{correa_2009,
    title = {Comparison of three diagrammatic keys for the
            quantification of late blight in tomato leaves},
    volume = {58},
    copyright = {© 2009 The Authors. Journal compilation © 2009 BSPP},
    issn = {1365-3059},
    url = {http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3059.2009.02140.x/abstract},
    doi = {10.1111/j.1365-3059.2009.02140.x},
```

```
    language = {en},
    number = {6},
    urldate = {2015-08-27},
    journal = {Plant Pathology},
    author = {Corrêa, F. M. and Bueno Filho, J. S. S. and Carmo, M. G. F.},
    year = {2009},
    keywords = {Phytophthora infestans, Solanum lycopersicum,
                disease assessment, disease severity},
    pages = {1128--1133},
}
```

- Book

```
@book{Xbook,
    author    = "",
    title     = "",
    publisher = "",
    ?_volume   = "",
    ?_number   = "",
    ?_series   = "",
    ?_address  = "",
    ?_edition  = "",
    year       = "XXXX",
    ?_month    = "",
    ?_note     = "",
}
```

```
@book{grolemund_r_nodate,
    title = {R Markdown: The Definitive Guide},
    shorttitle = {R Markdown},
    url = {https://bookdown.org/yihui/rmarkdown/},
    urldate = {2021-02-17},
    author = {Yihui, X. and Allaire, G. and Grolemund, J.J.}
}
```

Other types of references can be included, such as: booklet, conference, proceedings, manual, mastersthesis, phdthesis and, technical report.

See references for more details.

5.2   Citations and references

In order for the document to be rendered correctly, it is necessary to include the following line in your YAML header.

```
---

bibliography: references.bib

---
```

5.2.1 Citations

Citations must be enclosed in square brackets must be accompanied by @ followed by the name of the reference.

- Single case

See (Ryan and Woodall 2005)

```
See [@ryan_most_cited_2005]
```

- Multiple cases

For multiples references, names must be separated by comma.

See (Ryan and Woodall 2005; Grolemund 2021)

```
See [@ryan_most_cited_2005; @grolemund_r_nodate]
```

- Beginning of paragraph

Ryan and Woodall (2005) blablabla

```
@ryan_most_cited_2005 blablabla
```

By default, references are inserted at the end of the text.

5.2.2 References

Grolemund, Garrett, J. J. Allaire. 2021. *R Markdown: The Definitive Guide.* https://bookdown.org/yihui/rmarkdown/.

Ryan, Thomas P., and William H. Woodall. 2005. "The Most-Cited Statistical Papers." *Journal of Applied Statistics* 32 (5): 461–74. doi:10.1080/02664760500079373.

5.3 Managing bibliographies

Insert references in BibTeX format is easy. There are several bibliography managers available. The most popular are Zotero (free), Mendeley (free/premium) and, EndNote (basic/premium). For a comparison between the bibliography managers, click here.

- **Zotero** www.zotero.org : It can be installed on Linux, Windows, and Mac. It integrates with Google Chrome and Firefox. It's free.

- **Mendeley** www.mendeley.com : Available in the free version and premium version.

- **EndNote** endnote.com : Available in the basic version and premium version.

5.4   References

- https://rmarkdown.rstudio.com/authoring_bibliographies_and_citations.html)

- https://en.wikibooks.org/wiki/LaTeX/Bibliography_Management

- https://bookdown.org/yihui/rmarkdown-cookbook/bibliography.html