Chapter 1: Reporting with R Markdown

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June 3, 2019

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1 Introduction to R Markdown

According to R Markdown from R Studio, R Markdown documents are fully reproducible. Use a productive notebook interface to weave together narrative text and code to produce elegantly formatted output. Use multiple languages including R, Python, and SQL.

R Markdown supports dozens of static and dynamic output formats including HTML,PDF,MS Word Beamer, HTML5 slides, Tufte-style handouts books, dashboards, shiny applications, scientific articles, websites, and more.

This chapter mainly focuses on producing document using HTML.

2 My First R Markdown File

2.1 Installing R Markdown

To start, We can download and install R Markdown package from CRAN, as R Markdown is a free and open source package, like R and the other packages in CRAN.

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

2.2 Creating R Markdown file

To Create a new R markdown file, we click as below.

File -> New File -> R Markdown (Fig. 1).

We choose HTML as default output in this chapter. Some specific issues in generating PDF, Word or others may discuss in the future.

2.3 Generating HTML, pdf, and docx files

After an R Markdown file with *.rmd* extension has been created, the file with template code is included for references

(Fig. 2).

For example, we click `knit to HTML` and the html content is displayed in Viewer (Fig. 3).

Let's explore this file. See what we have found.

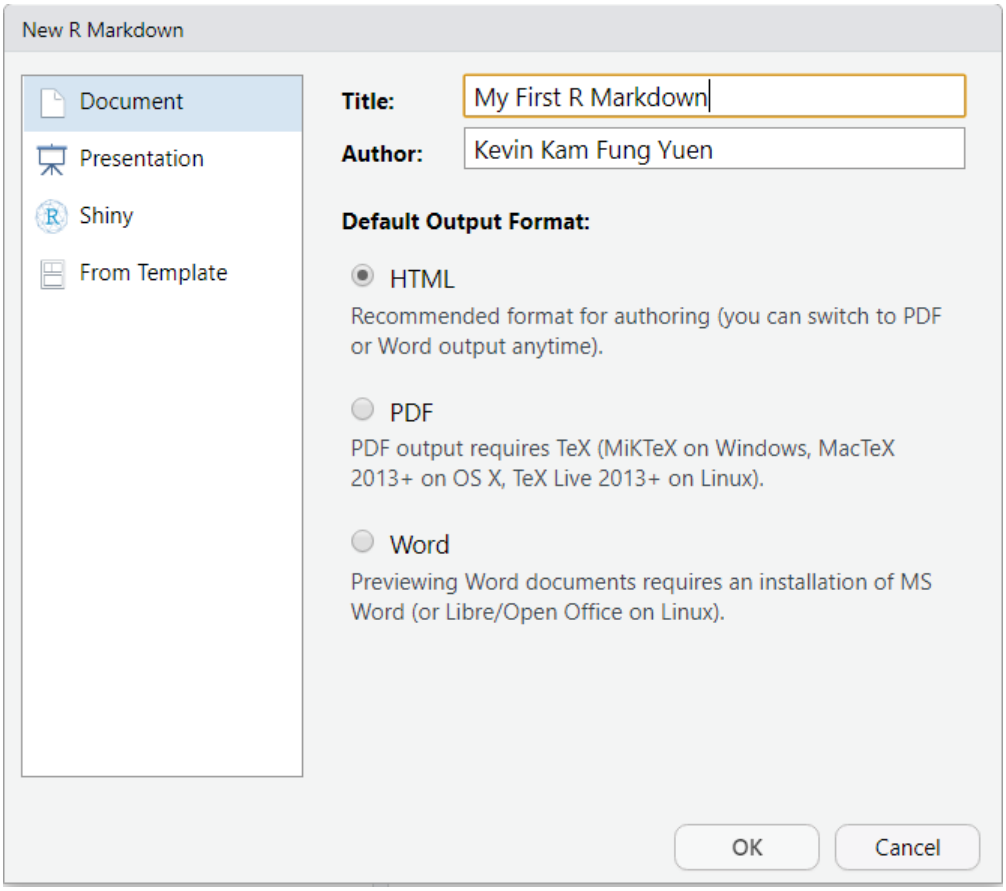


Figure 1: create a new R markdown file

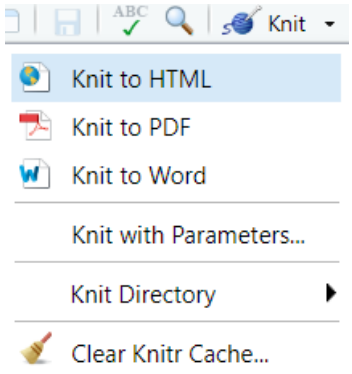


Figure 2: knit to HTML, pdf, and docx files

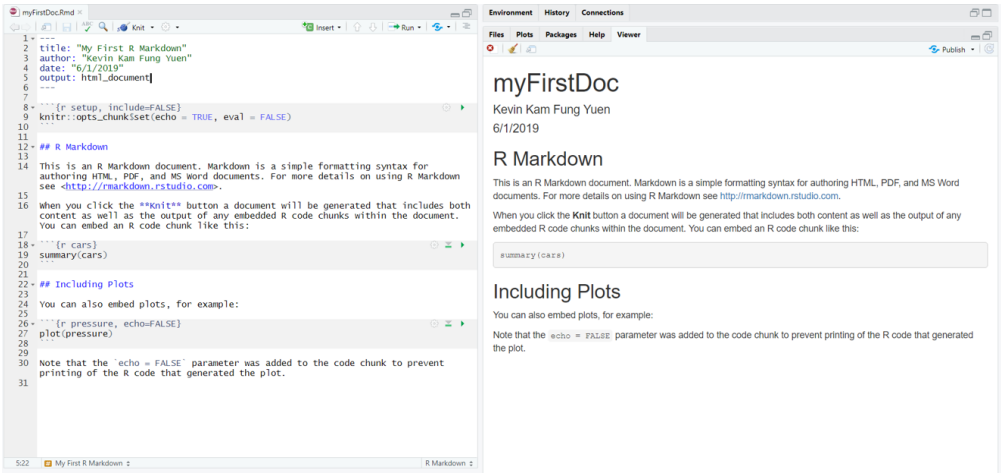


Figure 3: knit to a HTML file from template Rmd

2.4 Components of R Markdown

According to the sample code of the initial Rmd file, we observe three components, YAML header, R code chunk and syntax/code inside the text.

2.4.1 YAML header

YAML header is embraced by starting `---` and ending `---`.

```
---
title: "My First R Markdown"
author: "Kevin Kam Fung Yuen"
date: "6/1/2019"
output: html_document
---
```

2.4.2 R code Chunk

A chunk of R code surrounded by starting 3 backticks ``` {r} and ending 3 backticks ``` .

````
```{r plotPressure, echo=FALSE, eval=FALSE}
    plot(pressure)
```
````

Change the logical value to observe what happen.

2.4.3 Syntax and inline R code within text

Text can be mixed with Syntax and Inline R Code, for example, `# heading` and `_italics_`.

Source Code in Rmd:

```
When you _click_ the **Knit** button...
```

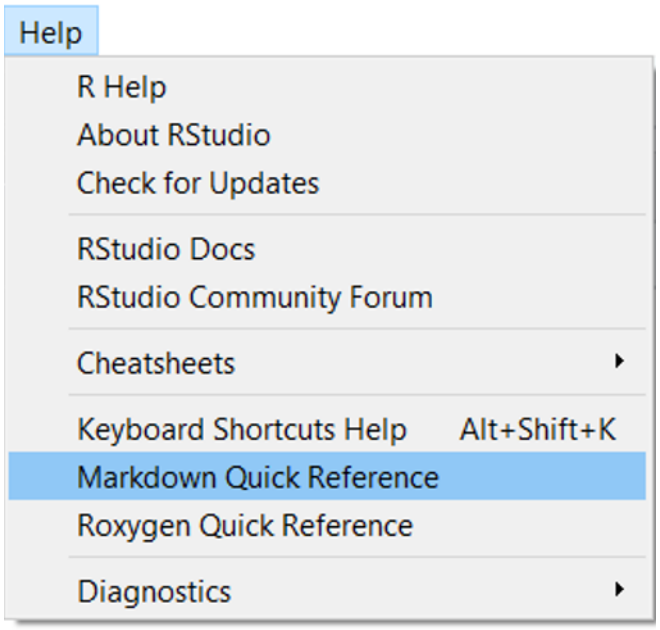


Figure 4: A list of Cheatsheets

We use the format below to display the inline R code.

There are `` `r nrow(iris)` `` rows and `` `r ncol(iris)` `` columns of iris data set.

Output result:
There are 150 rows and 150 columns of iris data set.

3 Quick Reference and Cheatsheets in RStudio

3.1 R Markdown Quick Reference

To open the `markdown quick reference`, we select `Help -> Markdown Quick Reference` (Fig. 4).

3.2 Markdown Cheatsheet

To open the `R markdown Cheat Sheet`, we select

`Help -> Cheatsheet -> R Markdown Cheat Sheet` (Fig. 5).

Some syntax and specific functions are shared to all files, whilst some are not. This chapter only focuses on creating a html file, which is especially good for the beginner.

4 External Learning resources

The free learning resources to learn R Markdown are recommended.

1. R Markdown from RStudio, https://rmarkdown.rstudio.com/
2. R Markdown: The Definitive Guide (Y.Xie, J. J. Allaire, G. Grolemund,2019), https://bookdown.org/yihui/rmarkdown/

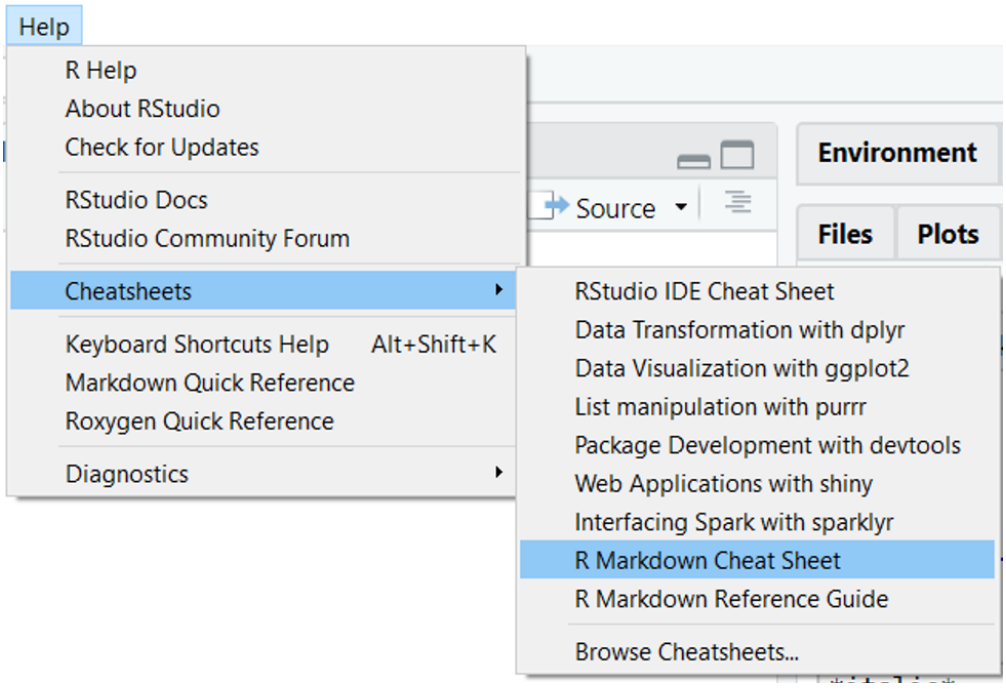


Figure 5: Open RMarkdown Cheatsheets

Figure 6: Youtube Share

5 Syntax

5.1 iframe

5.1.1 Embed Your First Video

Sometime, we would like to embed a youtube video in our webpage. The `iframe` tag can be used to embed a video from the youtube or other source.

For example, here is a link of youtube. We use web browser to open it. https://www.youtube.com/watch?v=_LpAAPBNtaI

After we go to the youtube, we will find the youtube 'share' icon (Fig. 6).

After clicking the 'share' icon, we choose `Embed` sharing option. Youtube will provide the Embed code as shown in (Fig. 7). Simply click the `copy` icon and then paste into the space where you would like to insert in your R Markdown document.

```
<iframe width="560" height="315" src="https://www.youtube.com/embed/_LpAAPBNtaI"   frameborder="0" allo
</iframe>
```

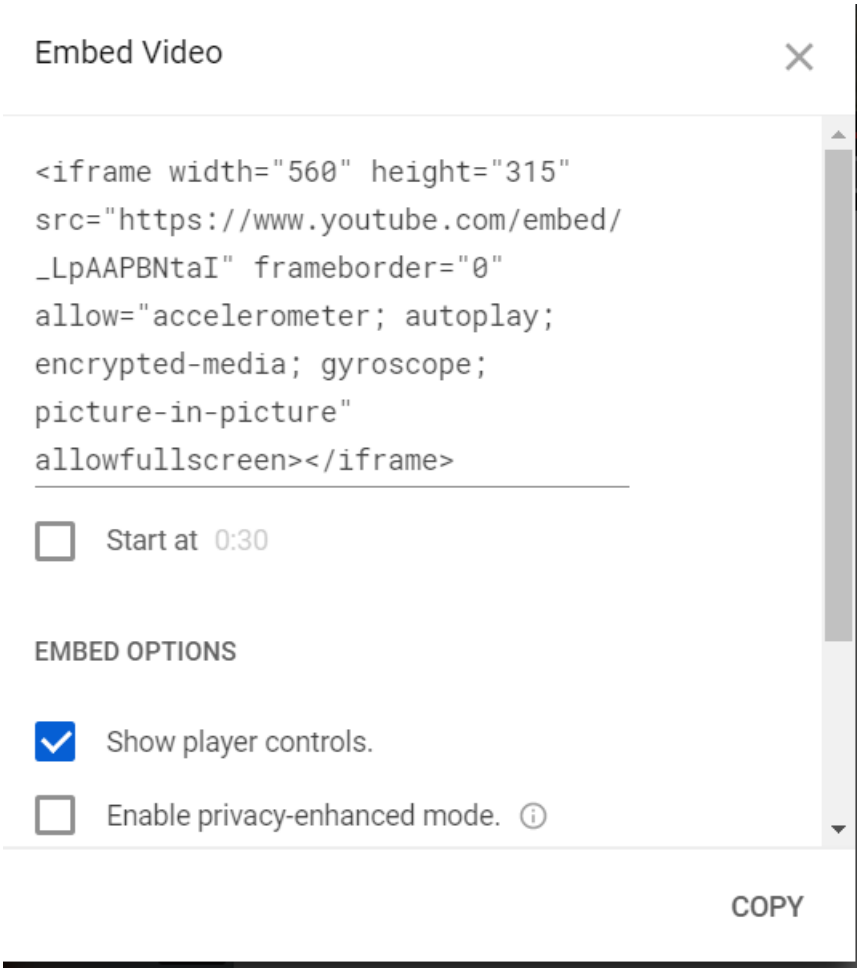


Figure 7: Youtube Embed Code for Sharing

5.1.2 Embed Your Second Video

Sometimes, we may find the advertisement video may have further impact. Let's discuss its impact by embeding the following video together with the previous video.

Go to youtube by the link below:

https://www.youtube.com/watch?v=UCSSddh8N5U

Repeat the same procedure from the previous example, you find the code below.

```
<iframe width="560" height="315" src="https://www.youtube.com/embed/UCSSddh8N5U" frameborder="0" allow=
```

Render the webpage by clicking the `knit` button. Then we can watch the video in our web page.

5.1.3 Other cases

Please embed these two videos in your R markdown file. What will you observe?

- https://youtu.be/qaE6xyxIMM4
- https://www.youtube.com/watch?v=NWCMefYuTh8
- https://www.youtube.com/watch?v=6hn3znbkTzE

After we watch these four videos, what kind of concepts could we conclude in marketing?

5.2 Embed google map

The `iframe` tag is not just for embedding a video. Similarly, we can embed the google map. We can find the Embed code in google map with the link below.

https://www.google.com/maps

For example, we can find the code to embed the map of Singapore.

5.3 Headers

Source Code in Rmd:

```
# This is the first level of Header

## This is the second level of Header

### This is the third level of Header
```

5.4 Comment

We may require to write some comments for our code, and such comments may not be suitable to share with the others. We can use the syntax as below.

Source Code in Rmd:

```
<!-- This is the comments for code,
it will not display after click of Knit. -->
```

5.5 Emphasis

We may emphasize the words with *italic* and **bold**.

Source code in Rmd:

```
*italic 1*      **bold 1**

_italic 2_      __bold 2__
```

Knit Output:

italic 1 **bold 1**

italic 2 **bold 2**

5.6 superscript, subscript, and strikethrough

The syntaxes of superscript, subscript, and strikethrough are as below.

```
superscript
A^2^
subscript
A~2~
strikethrough
~~Hi,something is wrong here. Please delete me~~
```

5.7 Line Break

See the example as below for the line breaks problem.

Source Code in Rmd:

```
I hear so I forget;
I see so I remember;
I do so I understand.
```

However, the **Knit Output** is not what we expected:

I hear so I forget; I see so I remember; I do so I understand.

In order to start a new line for the rest of words, we insert **two or more spaces** to the last character where is intended to start the break. Therefore, the Knit output is what we expected as below.

I hear so I forget;
I see so I remember;
I do so I understand.

5.8 List

5.8.1 Unordered List

The format of unordered list is as below.

Source code in Rmd:

```
* List 1
* List 2
    + List 2a
    + List 2b
    + List 2c
* List 3
    + List 3a
    + List 3b
```

Knit output:

- List 1
- List 2
    - List 2a
    - List 2b
    - List 2c
- List 3
    - List 3a
    - List 3b

5.8.2 Ordered List

The format of ordered list is as below.

Source code in Rmd:

```
1. List 1
2. List 2
    + List 2a
    + List 2b
    + List 2c
3. List 3
    + List 3a
6. List 6
5. List 5
```

Knit output:

1. List 1
2. List 2
    - List 2a
    - List 2b
    - List 2c
3. List 3
    - List 3a
4. List 6
5. List 5

Pay attention to the source code and the rendered content.

5.9 Link

Use a plain http(s) address or add a link to a phrase:

Source Code in Rmd:

```
plain http(s) address
https://github.com/kkfyuen/SMAH2018Guide

a link to a phrase
[Introduction and Tutorial Guide on SUSS-Microsoft Analytics Hackathon 2018](https://github.com/kkfyuen/
```

Knit Output:

plain http(s) address
https://github.com/kkfyuen/SMAH2018Guide

a link to a phrase
Introduction and Tutorial Guide on SUSS-Microsoft Analytics Hackathon 2018

5.10 Image

Images on local files in the same directory:

```
![text your the image (optional)](fig/imagefile.png)
```

Images on the web:

```
![text your the image (optional)](http://webaddress/image.png)
```

For example, Here is the link for a jpg image file. https://i2.wp.com/dailynewsgh.com/wp-content/uploads/2019/05/img_5572.jpg

Alternatively, we can save the file locally in case that the photo may be removed from the link in the future.

we can use the code format above to display the image as below.

5.11 Reference Styles

5.11.1 Reference by link

We first define `[phrase][id]` in the text, and then define the `[id]` at the end of the document, which format is as below. `[id]: http(s)://hyperlink "Description Title"`

for example,

```
For more information, please refer to [this link][mdRS].

Put this code at the end of the Rmd document
[mdRS]: https://rmarkdown.rstudio.com/ "R Markdown from RStudio"
```

*** Output *** For more information, please refer to this link.

When we click `this link`, the browse will go to the web address.

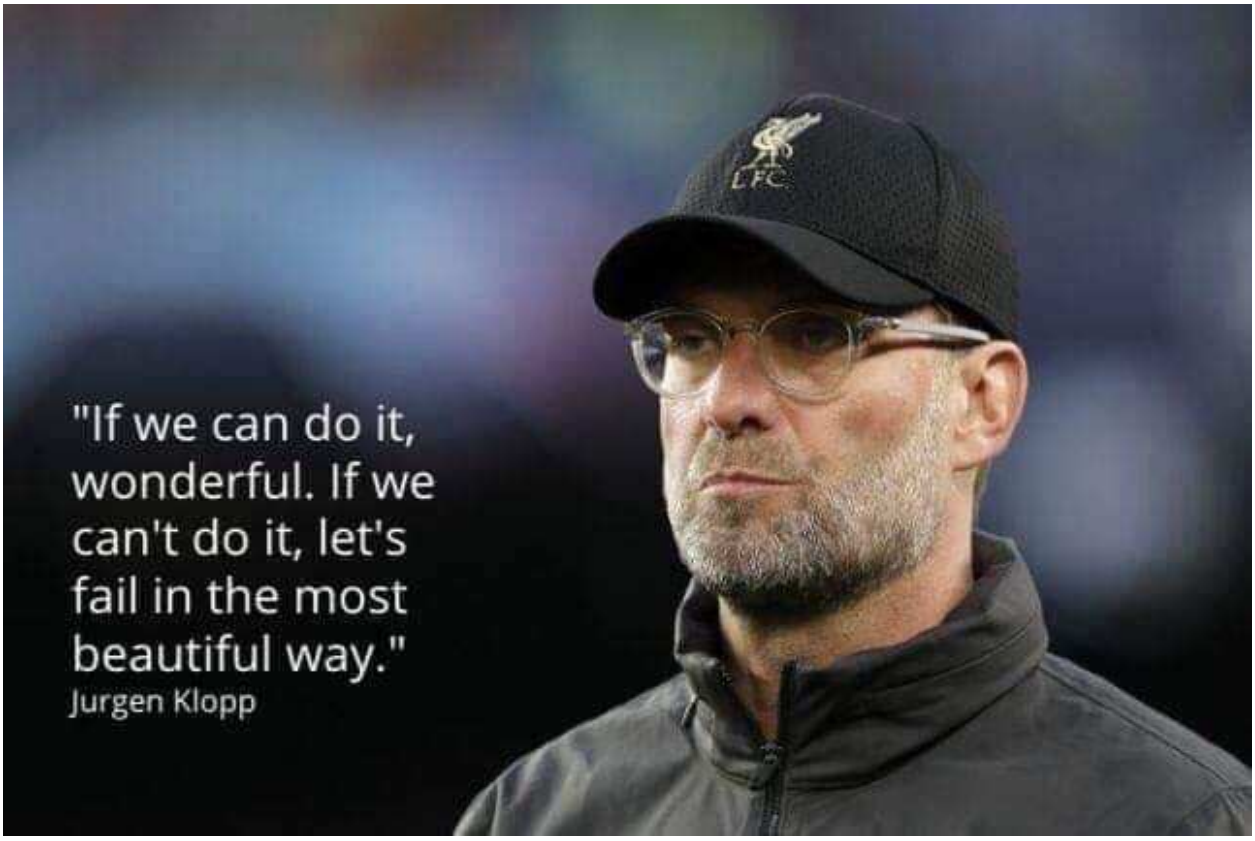


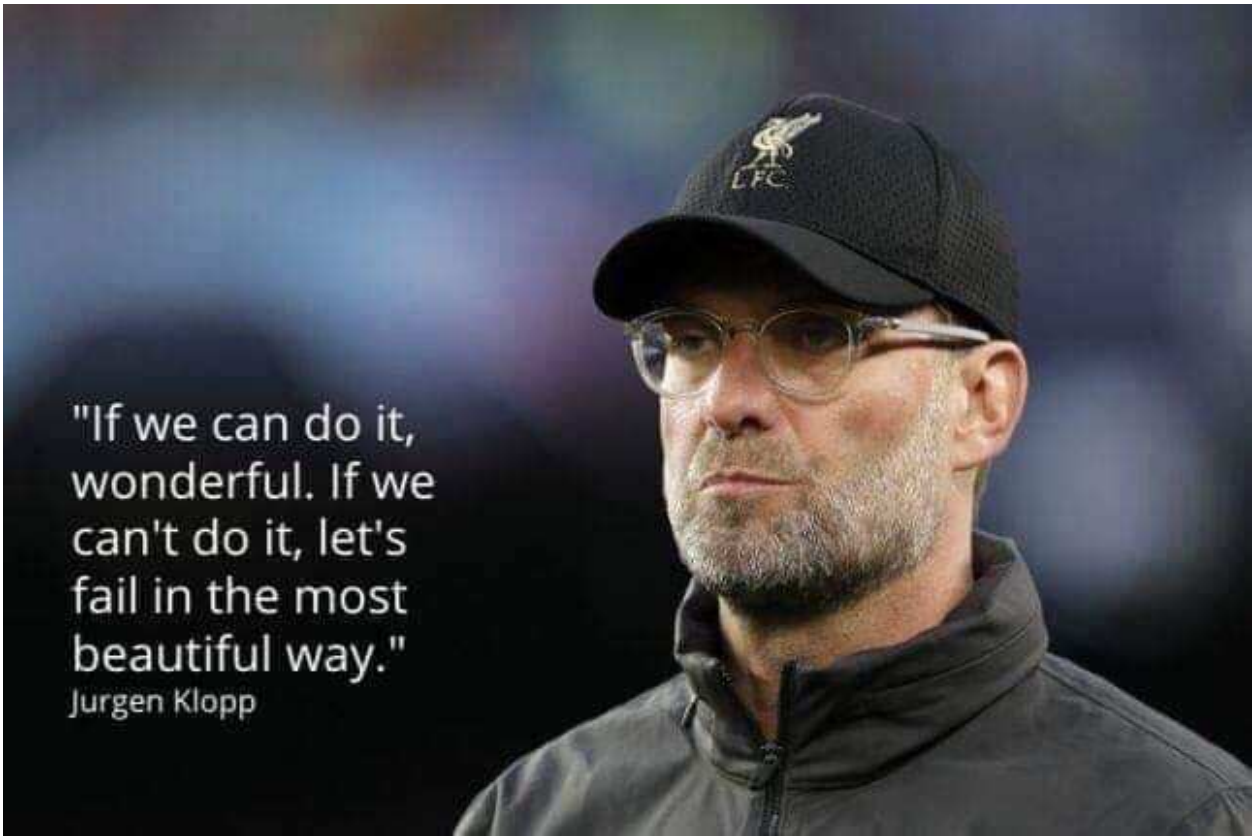
Figure 8: Liverpool Boss Jurgen Klopp

5.11.2 Reference by image

Similarly we can manage image like in this way.

```
Please refer to ![What Liverpool Boss Jurgen Klopp][JurgenKlopp]
Put this code at the end of the Rmd document
[JurgenKlopp]: https://i2.wp.com/dailynewsgh.com/wp-content/uploads/2019/05/img_5572.jpg "can and can't
```

** Output **

Please refer to 

5.12 Blockquotes

we use > at the beginning to cite the quote

```
> "Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces
> Albert Einstein, What Life Means to Einstein (1929)
```

5.13 Table

The format of a table is defined in the way below.

```
Table Header 1  | Table Header...| Table Header n |
:-------------- | :-------------:| --------------:|
Table Cell 11   | Table Cell 1.. | Table Cell 1n  |
Table Cell ...  | Table Cell ... | Table Cell ... |
Table Cell 1m   | Table Cell ... | Table Cell mn  |
```

Output will be like in this way

Table Header 1	Table Header…	Table Header n
Table Cell 11	Table Cell 1..	Table Cell 1n
Table Cell …	Table Cell …	Table Cell …
Table Cell 1m	Table Cell …	Table Cell mn

According to the syntax above, we could produce a table like in this way.

Notation	Explanation
-	Minus, can be unary or binary
+	Plus, can be unary or binary
!	Unary not
~	Tilde, used for model formulae, can be either unary or binary
|	Or, binary, vectorized
||	Or, binary, not vectorized

Pay attention to the `|` notation in the table above. we need to add `\` before `|`. That's `\|`.

5.14 LaTeX Equations

5.14.1 Inline and Display Equations

We insert equations by two ways: Inline Equation and Display Equation. Inline Equation is surrounded by `$` whilst Display Equation is surrounded by `$$`.

```
The The mass-energy equivalence equation is $E=mc^2$ (Inline Equation). Alternatively, the equation is
$$E=mc^2$$
```

The output:
Inline Equation
The mass-energy equivalence equation is $E = mc^2$. Display Equation in a new line.

$$E = mc^2$$

For more details of the syntax, please refer to the link below.

- http://joshua.smcvt.edu/undergradmath/undergradmath.pdf
- https://en.wikibooks.org/wiki/LaTeX/Mathematics

Some examples are introduces as followings.

5.14.2 Matrix

We can create a matrix with squared brackets by defining latex in Rmd in this way.

```
$$[
\begin{matrix}
1 & 2\\
```

```
3 & 4
\end{matrix}
]$$
```

** Output **

$$\left[\begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix}\right]$$

or

```
$$\left[
\begin{matrix}
1 & 2\\
3 & 4
\end{matrix}
\right]$$
```

Test what happen for the code above. or what happen for Type `\left(` and `\right)`.

5.14.3 Fraction

Example 1

```
f(y) = {{y - 1} \over {y + 2}}
```

$$f(y) = \frac{y - 1}{y + 2}$$

Example 2

```
\Delta  = {{ - b \pm \sqrt {{b^2} - 4ac} } \over {2a}}
```

$$\Delta = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Example 3

```
c = \sqrt {{a^2} + {b^2}}
```

$$c = \sqrt{a^2 + b^2}$$

Example 4

Sometimes, $ could be omitted.

```
\begin{align*}
  f(x) &= x^3+x^2+x+1\\
  g(x) &= \frac{1}{x} + \frac{1}{y}\\
  G(x) &= \int^a_b \frac{1}{4}x^4
\end{align*}
```

Output

$$f(x) = x^3 + x^2 + x + 1$$
$$g(x) = \frac{1}{x} + \frac{1}{y}$$
$$G(x) = \int_b^a \frac{1}{4}x^4$$

5.15 Horizontal Rule / Page Break

When we generate a docx or pdf file, we can break the page by inserting Three or more asterisks or dashes into the right position.

```
page 1
******
page 2
------
page 3
****
page 4
---
```

6 Spelling Check in R Studio

Unlike word document, R Markdown document does not has real time spelling checking function. However, after we finish typing, we can use the clicks as below to check spelling.

Edit -> Check Spelling

The short key for `Check Spelling` is to simply click `F7`

7 References

1. R Markdown from RStudio, https://rmarkdown.rstudio.com/
2. Y.Xie, J. J. Allaire, G. Grolemund,2019, R Markdown: The Definitive Guide, https://bookdown.org/yihui/rmarkdown/

8 Exercises

8.1 Exercise 1

Create a table as below in an Rmd file .

Description	Code	Notations
Greek letters	`\alpha \beta \epsilon`	$\alpha\beta\epsilon$
Function operators	`\int \sum \prod`	$\int \sum \prod$
Binary operators	`\cup \cap`	$\cup \cap$
Set operators 1	`\subset \supset`	$\subset \supset$
Set operators 2	`\subseteq \supseteq`	$\subseteq \supseteq$

8.2 Exercise 2

Reproduce some sections in the documentation in https://github.com/kkfyuen/SMAH2018Guide. Make a better look if necessary.