KateRMarkdown

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05/03/2021

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Figure 1: A Non Reproducible workflow - 'https://www.youtube.com/watch?v=s3JldKoA0zw&t=5s'

2 Introducing RMarkdown

That's why we are playing around wit `RMarkdown` today.
Clearly, there's no best way of doing so than throwing in a bunch of *Cats*.

2.1 Why RMarkdown

RMarkdown is the easiest way to create interactive documents integrating text, code and output from your code. It is fairly versatile, has a shallow learning curve and, as it often happens in R, there is a bunch of people continuously expanding its functionalities and possibilities.

For instance, you can:

- Compile a single R Markdown document to a report in different formats, such as PDF, HTML, or Word.
- Create notebooks in which you can directly run code chunks interactively.
- Make slides for presentations (HTML5, LaTeX Beamer, or PowerPoint).
- Produce dashboards with flexible, interactive, and attractive layouts.
- Build interactive applications based on Shiny.
- Write journal articles.
- Author books of multiple chapters.
- Generate websites and blogs.

Yes, you guessed that. This very document has been generated using `RMarkdown`.
Not all that glitters is gold, though. Expect headaches when setting up your (especially Windows) machine to work if interested in knitting pdfs or more advanced stuff.

2.2 Briefest history on RMarkdown ever

Source: https://bookdown.org/yihui/rmarkdown/
The document format "R Markdown" was first introduced in the knitr package (Xie 2015, 2020c) in early 2012. The idea was to embed code chunks (of R or other languages) in Markdown documents.

However, the original version of Markdown invented by John Gruber was often found overly simple and not suitable to write highly technical documents. For example, there was no syntax for tables, footnotes, math expressions, or citations. Fortunately, John MacFarlane created a wonderful package named Pandoc (http://pandoc.org) to convert Markdown documents (and many other types of documents) to a large variety of output formats. More importantly, the Markdown syntax was significantly enriched. Now we can write more types of elements with Markdown while still enjoying its simplicity.

In a nutshell, R Markdown stands on the shoulders of knitr and Pandoc. The former executes the computer code embedded in Markdown, and converts R Markdown to Markdown. The latter renders Markdown to the output format you want (such as PDF, HTML, Word, and so on).

The rmarkdown package (Allaire, Xie, McPherson, et al. 2020) was first created in early 2014.

2.3 What's Markdown

Markdown is a lightweight markup language that you can use to add formatting elements to plaintext text documents. Created by John Gruber in 2004, Markdown is now one of the world's most popular markup languages.

It's the language used to create README's and Project descriptions in GitHub

2.4 What's Latex

Latex which is pronounced «Lah-tech» or «Lay-tech» (to rhyme with «blech» or «Bertolt Brecht»), is a document preparation system for high-quality typesetting. It is most often used for medium-to-large technical or scientific documents but it can be used for almost any form of publishing.

LaTeX is not a word processor! Instead, LaTeX encourages authors not to worry too much about the appearance of their documents but to concentrate on getting the right content.

You need LaTex only for knitting to pdf documents. If you're happy with html notebooks, there's no need of installing it.

2.5 What's Pandoc

If you need to convert files from one markup format into another, pandoc is your swiss-army knife.

The good news is that your RStudio IDE has already a Pandoc installation embedded! Maybe it's not the latest, but it will work just fine most of the times.

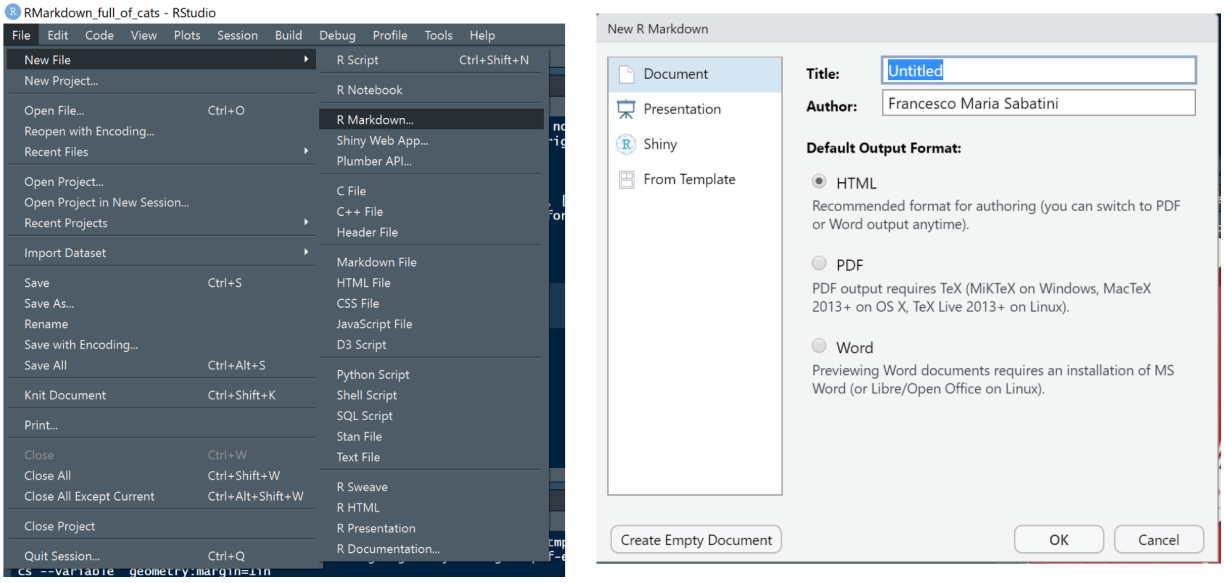
3 Can we look at cats now?

Almost. Fire up your RStudio and install `RMarkdown` first.

```
install.packages("RMardown")
```

Time to start your first `RMarkdown` document.

File -> New File -> R Markdown



We'll stick to html today. Knitting documents to pdf is undoubtedly cooler, but requires installing Latex, which might be tricky, depending on the machine one is using.

Congratulations - You've just created your first `RMarkdown` document.

3.1 What am I seeing?

You should be seeing something like this:

The first part is called the metadata.
The metadata is written between the pair of three dashes — The syntax for the metadata is YAML (YAML Ain't Markup Language, https://en.wikipedia.org/wiki/YAML), so sometimes it is also called the YAML metadata or the YAML frontmatter. Before it bites you hard, we want to warn you in advance that indentation matters in YAML, so do not forget to indent the sub-fields of a top field properly.
(Source - https://bookdown.org/yihui/rmarkdown/basics.html).
It sounds intimidating. However, you won't have to do much with your metadata most of the time, besides copy pasting it from a template. Pheeeewww!

In the rest of the script you can distinguish between text and *chunks* of code. Note how chunks of code are enclosed by three **backtick** signs.
```

If you can't find the backtick sign in your keyboard, try with the ASCI code: `Alt+96`.
```

Look at the two buttons highlighted by the arrows.

- *Insert* — allows you to add a new chunk of code.
- *Knit* — renders your document to the preferred file type.

3.2 What happens when I `knit` my notebook?

`Knitting` your `RMarkdown` script means rendering it to your chosen output (html in this case). There is quite a lot of machinery (=dark magic) happening behind the scenes. Fortunately, for most applications we don't have to understand how these happen. Just enjoy the result.

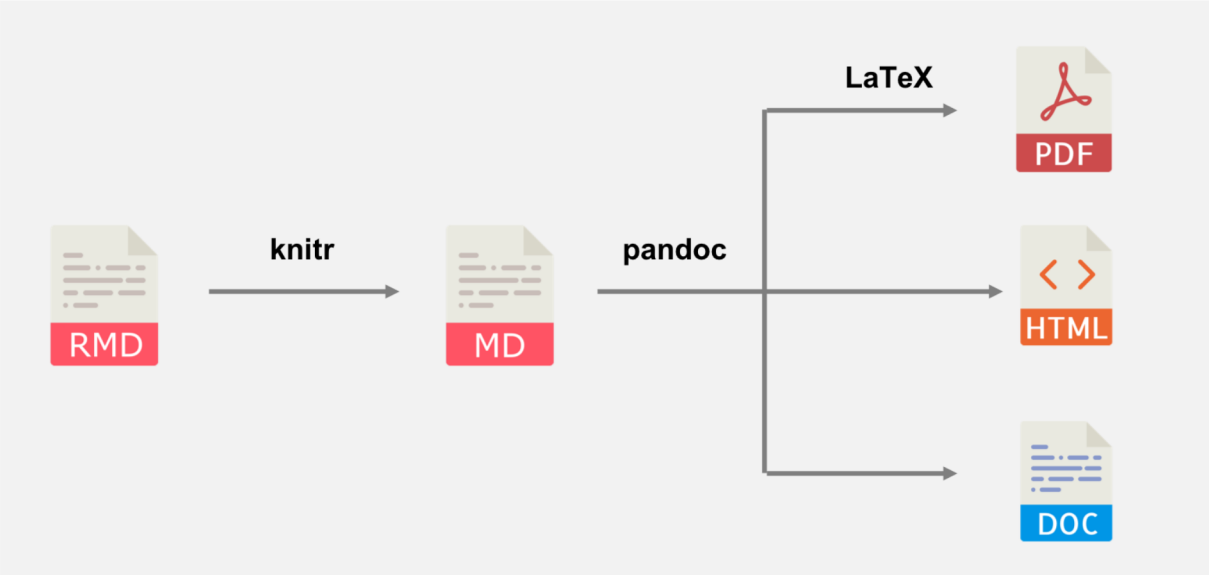


Figure 2: Workflow - Source: 'https://bookdown.org/yihui/rmarkdown-cookbook'

3.3 How to create a beautiful `RMarkdown` document?

3.3.1 Playing around with Text

Let's start with the easiest. How to add text (=**narrative**), to my `RMarkdown`. Easy-peasy. Just type!

You just need to know a couple of things:
Going to new line -> Need to add *two whitespaces* at the end of a block of text.
Leaving an empty line -> Two ways: 1. `<br>`, 2.`\newline` (followed by an empty line).

Titles and Headers:
`# Header` - Header 1
`## Header` - Header 2
`### Header` - Header 3

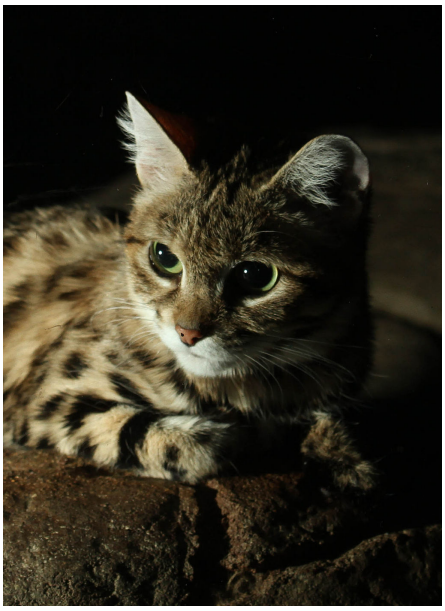
Basic formatting. You can use some basic markdown formatting to make your text:
Italic: *Felis catus* –> *Felis catus*
Italic: _Felis catus_ –> *Felis catus*
Bold: **Felis catus** –> **Felis catus**

Bold: ___Felis catus___ –> **Felis catus**
Both: ***Felis catus*** –> ***Felis catus***
Both: _____Felis catus_____ –> ***Felis catus***

Adding Lynx:
`[Eurasian Lynx - Wikipedia](https://en.wikipedia.org/wiki/Eurasian_lynx)`
Renders as:
Eurasian Lynx - Wikipedia

Embed cat from url/file:
```
<center> ![Black Footed Cat](https://en.wikipedia.org/wiki/Black-footed_cat#/media/File:Black_Footed_Cat
</center>
```

Renders as:



Create numbered lists of cats (don't forget to leave an empty line before starting the list). E.g.,
My favourite wildcats:

```
1. Andean Cat (*Leopardus Jacobita*)
2. Rusty Spotted Cat (*Prionailurus Rubiginosus*)
3. Chinese Mountain Cat (*Felis Bieti*)
4. Kodkod (*Leopardus Guigna*)
```

Renders as:

1. Andean Cat (*Leopardus Jacobita*)
2. Rusty Spotted Cat (*Prionailurus Rubiginosus*)
3. Chinese Mountain Cat (*Felis Bieti*)
4. Kodkod (*Leopardus Guigna*)

Create unordered lists of cats:

Where small cats live:

```
* Small Cats of South America
```

```
 + Andean Cat
 + Geoffroy's Cat
 + Jaguarundi
 + ...
* Small Cats of SE Asia
 + Leopard Cat
 + Marbled Cat
 + Fishing Cat
 + ...
```

Renders as:

- Small Cats of South America
  - Andean Cat
  - Geoffroy's Cat
  - Jaguarundi
  - ...
- Small Cats of SE Asia
  - Leopard Cat
  - Marbled Cat
  - Fishing Cat
  - ...

Do Yourself a Favour - and download the catsheet (=cheatsheet)
Catsheet - https://rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf

3.3.2 Playing around with Code

To insert a chunk of code, just enclose it between three backticks, followed by {r}:

````
```{r}


4+4


```
````

Let's make some practice. We need to import some cat-related data, first.

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.0 --
## v ggplot2 3.3.3     v purrr   0.3.4
## v tibble  3.0.6     v dplyr   1.0.4
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.1
## Warning: package 'ggplot2' was built under R version 4.0.3
## Warning: package 'tibble' was built under R version 4.0.3
## Warning: package 'tidyr' was built under R version 4.0.3
## Warning: package 'readr' was built under R version 4.0.3
## Warning: package 'dplyr' was built under R version 4.0.3
## Warning: package 'forcats' was built under R version 4.0.3
```

```
## -- Conflicts ---------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
big.cats <- read.table("data/Wikipedia_LargestCats.txt", header = T, sep="\t")
big.cats
```

```
##    Rank           Common.name   Scientific.name Weight.range.kg
## 1     1                 Tiger   Panthera tigris          90-300
## 2     2                  Lion      Panthera leo         160-270
## 3     3                Jaguar     Panthera onca          56-120
## 4     4                Cougar     Puma concolor          53-100
## 5     5               Leopard   Panthera pardus           17-90
## 6     6               Cheetah  Acinonyx jubatus           20-60
## 7     7          Snow leopard    Panthera uncia           22-55
## 8     8         Eurasian lynx         Lynx lynx           15-45
## 9     9 Sunda clouded leopard   Neofelis diardi           12-26
## 10   10       Clouded leopard Neofelis nebulosa         11.5-23
##    Maximum.weight.kg Maximum.length.m Native.range.by.continent
## 1             388.78             4.17                      Asia
## 2             375.00             3.64      Asia, Africa, Europe
## 3             160.00             2.60   North and South America
## 4             125.20             2.80   North and South America
## 5              96.50             2.75      Asia, Africa, Europe
## 6              72.00             2.10      Africa, Asia, Europe
## 7              75.00             2.50                      Asia
## 8              38.00             1.50              Asia, Europe
## 9              27.00             1.30                      Asia
## 10             23.00             1.08                      Asia
```

This data.frame contains the weight range, and the maximum observed weights and lengths of the ten largest wildcats. (Source: Wikipedia).

When knitting this code, we are getting a bunch of messages related to the tidyverse package. Not so nice in a report. You can deactivated them by opening your chunk with `{r, warning=F, message=F}`.

Let's do some real R code. In the chunk below, we split the weight range field into min and max using some fancy `dplyr` code.

```
big.cats <- big.cats %>%
  separate(Weight.range.kg, into=c("Weight.min", "Weight.max"), sep = "-", remove = T) %>%
  mutate(Weight.min=as.numeric(Weight.min),
         Weight.max=as.numeric(Weight.max)) %>%
  mutate(Common.name=factor(Common.name, levels=big.cats$Common.name))
```

Maybe in your report you want to automatically include a value which you calculate in your r script. This can be done with some *inline code*. This can be done enclosing some code by backticks and specifying the code is in r. For instnce the code:
`The cat having the highest weight is` `` `r big.cats[1,'Common.name']` `` . `It weights up to` `` `r big.cats[1,'Maximum.weight.kg']` `` .

Renders as:
The cat having the highest weight is Tiger.
It weights up to 388.78.

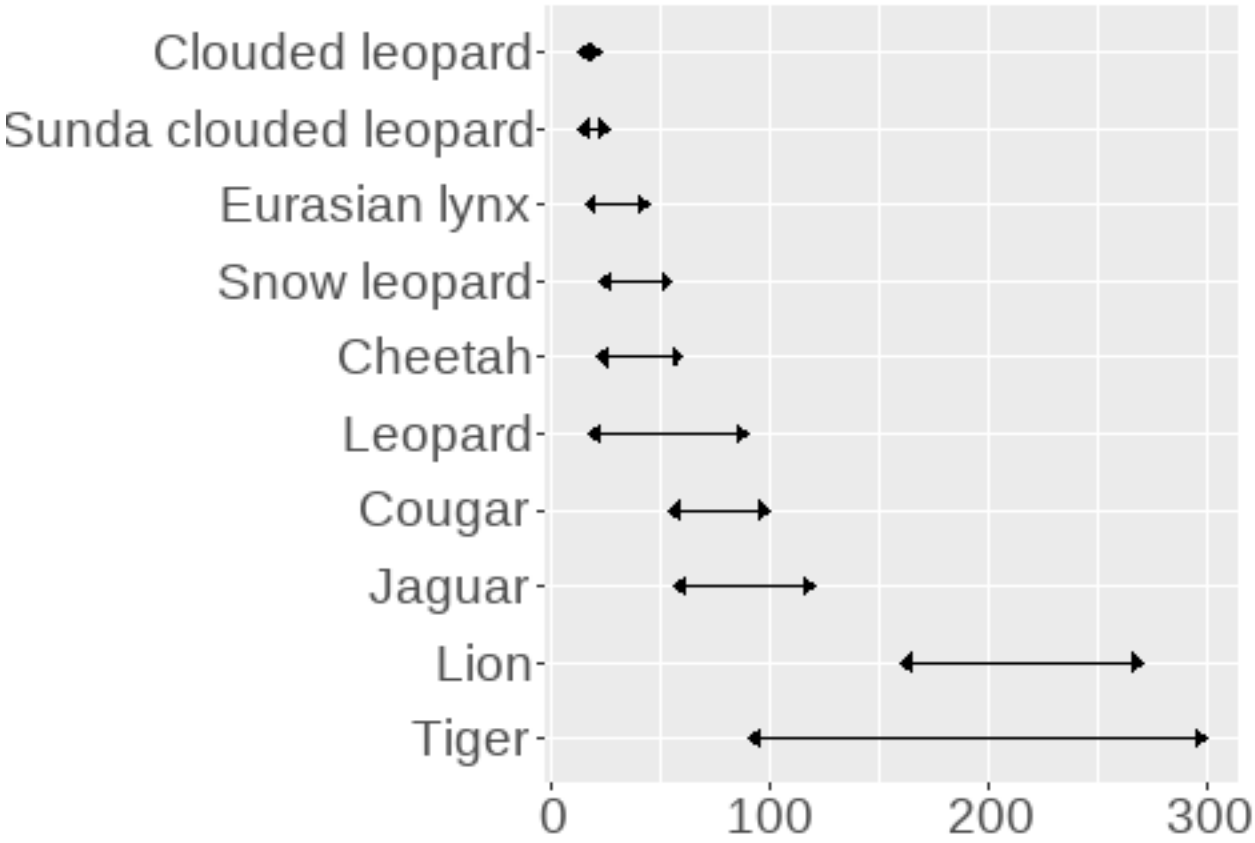
A couple of useful arguments when you start your chunk:
`{r echo=F}` — For running your code in the background, without showing the code itself.
`{r eval=F}` — Opposite. For showing your code, but without actually running it.

3.3.3 Playing around with Pictures

THE THING about `RMarkdown` is that it allows embedding graphs directly to your document. Input changed? Just re-knit and you'll have all your graphs updated. It's as easy as simply running a chunk of code.

Let's make a graph to see the differences in cat size more easily.

```
# create spider plot
ggcats <- ggplot(data=big.cats) +
  geom_segment(aes(y=Common.name, yend=Common.name, x=Weight.min, xend=Weight.max),
               arrow = arrow(length = unit(5, "points"),
                             ends="both", type = "closed", angle = 40)) +
  ylab(NULL) +
  xlab(NULL) +
  theme(axis.text = element_text(size=14))
ggcats
```



Some useful figure related arguments here:
`{r fig.height=3}` - picture height in inches
`{r fig.width=3}` - picture width in inches

`{r fig.cap="add caption here"}` - Add a caption
`{r fig.align="center"}` - Horizontal alignment of your graph
`{r dpi=150}` - Change resolution of output image (mostly relevant for pdf)

You can also combine them altogether in a single line. For instance, if I rerun the chunk above specifying:
`{r, fig.height=3, fig.width=4, fig.cap="Weight (kg) of the 10 largest wild cats", fig.align="center", dpi=150, echo=F}`

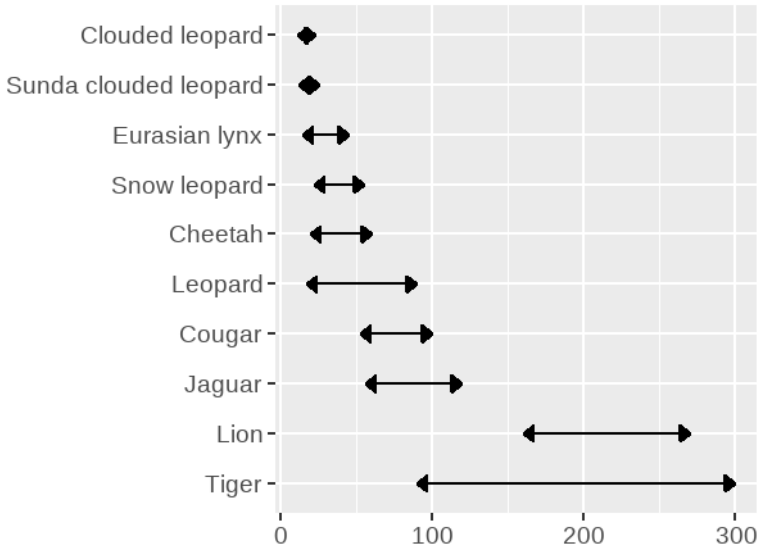


Figure 3: Weight (kg) of the 10 largest wild cats

Note how the code isn't visible anymore, having set `echo=F`. I swear it's there, though.

3.3.4 Playing around with Tables

If you just print an R object on the console as we did above, `RMarkdown`, will show it in the rendered document as well. It won't look that good, though.

The entry level way of rendering tables is the `knitr::kable` function.

```
knitr::kable(head(big.cats[1:4,1:5]), caption="The largest cats!")
```

Table 1: The largest cats!

Rank	Common.name	Scientific.name	Weight.min	Weight.max
1	Tiger	Panthera tigris	90	300
2	Lion	Panthera leo	160	270
3	Jaguar	Panthera onca	56	120
4	Cougar	Puma concolor	53	100

An even nicer way is using the `kableExtra` package. For instance, when rendering to html, `kableExtra` allows the creation of responsive tables. This is extremely useful for tables larger than a A4 format.

```
library(kableExtra)
knitr::kable(big.cats, caption="The largest cats!") %>%
  kable_styling(
    bootstrap_options = c("striped", "hover", "condensed", "responsive"),
    position = "center")
```

I won't look good that good on a pdf, but on an html report it's just as good as it can possibly be.

4 Slightly more advanced stuff

4.1 Long computing times

Whenever you knit your `RMarkdown` report, R will re-run all the code contained in your .Rmd script. It's therefore not the best idea to include a chunk of code taking 3 hours to run. If you do so, even just correcting a typo in the text will require you to wait three hours before the corrected version of your report is rendered!

There are a couple of workarounds, though.

1) add the argument `{r cache=T}` to your chunk:
   Adding this argument to the slowest chunks of code will save the intermediate results of these chunks in a dedicated folder. `RMarkdown` will *only* rerun these chunks when changed. Otherwise, it will skip the chunk, and get directly the cached results.

2) `{r eval=F}` + save and load
   Sometimes, it might be more convenient to run slow chunks of code in a dedicated, interactive session (maybe even on a different machine), save the results in a `.RData` file, and reload this saved data in your report. For transparency, you might still show the code you used to produce these intermediate outputs, but setting eval=F, you'll tell RMarkdown not to run this code.

Something like this.
Chunk 1 with slow code I ran elsewhere:

```
```{r eval=F}
```
```

```
output <- function(input) # A real SLOW chunk of code

save(output, filename='output.slow.RData')

```
```

Chunk 2 reimporting the output of chunk 1:

```
```{r}

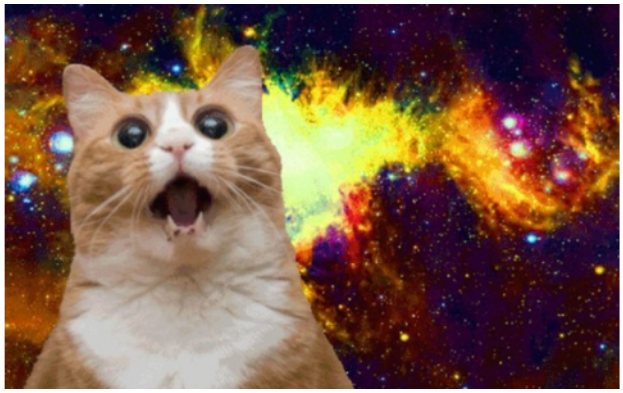
load(filename='output.slow.RData')

```
```

4.2 Alternative ways of knitting

Clicking on the `knit` button is convenient. The keyboard shortcut `Ctrl``Alt``k` is even more.
Sometimes, you might want to knit multiple documents (Yes, you might loop across several `.Rmd` scripts, and knit hundreds of reports in parallel). To do so, you might want to knit an `.Rmd` file from console as:

```
knitr::knit("KateRMarkdown.Rmd")
```



4.3 PDFs and paper templates

I know. You you can't wait to produce your fantastic pdf reports, and write your next paper directly in R. Good news - is possible - There are many templates out there, and you just have to reach out to them. See for instance: https://t.co/uJBqWER5h6?amp=1
Yes, these templates will format bibliographic reference as well

Bad news - you'll need to setup your machine first, and it might be tricky sometimes. You find some guidance at: https://bookdown.org/yihui/rmarkdown-cookbook/install-latex.html.

5 Resources

Many good resources out there. I only cite two:

1) Bookdown - https://bookdown.org/yihui/rmarkdown/

2) RMarkdown Cookboo - https://bookdown.org/yihui/rmarkdown-cookbook/
```