Stat545

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Contents

Welcome

___“Stat545.com”___ .

http://stat545.com/index.html

Chapter 1

cm001 - introduction

1.1 Intro to course; S/W install; acct sign-ups

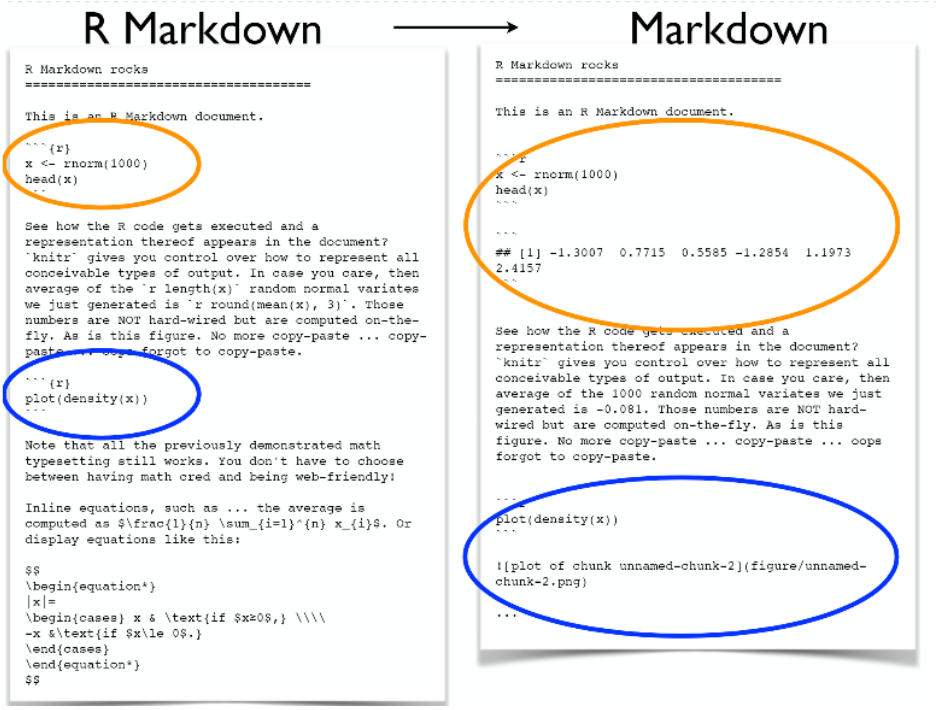
1.1.1 Data Domination

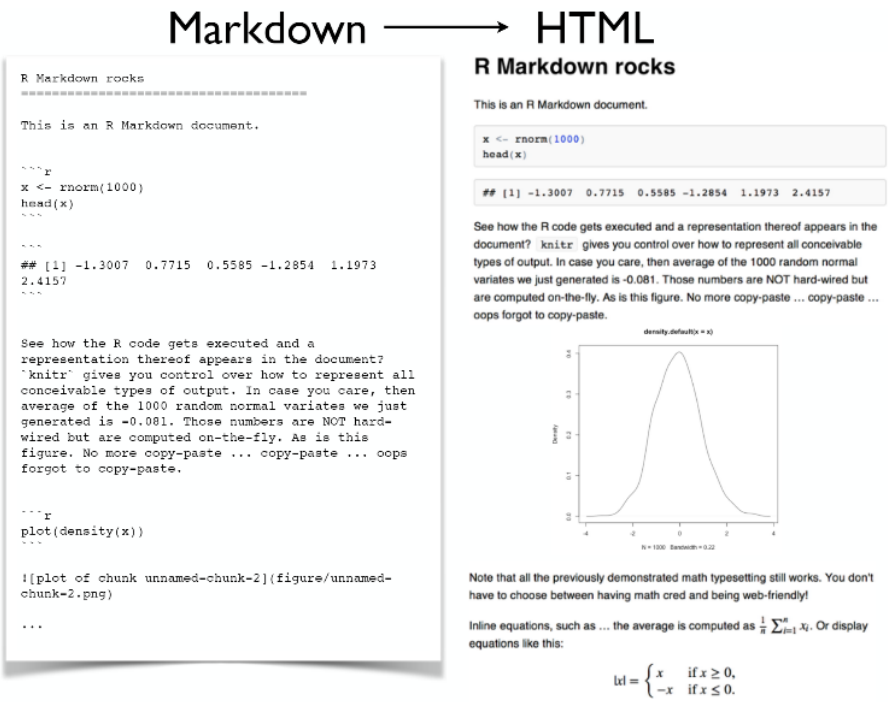
> "Software programming, algorithm development and other technological skills can give scientists an edge in their fields." — Careers,31 August 2017

> "A picture is worth a thousand words."

1.1.2 Data Science Tool :

- R
- Rstudio : an integrated development enviroment(IDE) for R
- Rmarkdown


R Markdown
Markdown
R Markdown rocks
This is an R Markdown document.
```{r}
x <- rnorm(1000)
head(x)
```
See how the R code gets executed and a representation thereof appears in the document? `knitr` gives you control over how to represent all conceivable types of output. In case you care, then average of the `r length(x)` random normal variates we just generated is `r round(mean(x), 3)`. Those numbers are NOT hard-wired but are computed on-the-fly. As is this figure. No more copy-paste ... copy-paste ... oops forgot to copy-paste.
```{r}
plot(density(x))
```
Note that all the previously demonstrated math typesetting still works. You don't have to choose between having math cred and being web-friendly!
Inline equations, such as ... the average is computed as $\frac{1}{n} \sum_{i=1}^{n} x_{i}$. Or display equations like this:
$$
\begin{equation*}
|x|=
\begin{cases} x & \text{if $x\ge0$,} \\\\
-x &\text{if $x\le 0$.}
\end{cases}
\end{equation*}
$$
R Markdown rocks
This is an R Markdown document.
```r
x <- rnorm(1000)
head(x)
```
```
## [1] -1.3007 0.7715 0.5585 -1.2854 1.1973
2.4157
```
See how the R code gets executed and a representation thereof appears in the document? `knitr` gives you control over how to represent all conceivable types of output. In case you care, then average of the 1000 random normal variates we just generated is -0.081. Those numbers are NOT hard-wired but are computed on-the-fly. As is this figure. No more copy-paste ... copy-paste ... oops forgot to copy-paste.
```r
plot(density(x))
```
![plot of chunk unnamed-chunk-2](figure/unnamed-chunk-2.png)
...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HTML
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density.default(x = x)
Density
Note that all the previously demonstrated math typesetting still works. You don't have to choose between having math cred and being web-friendly!
Inline equations, such as ... the average is computed as $\frac{1}{n}\sum_{i=1}^{n} x_i$. Or display equations like this:
$$|x| = \begin{cases} x & \text{if } x \geq 0, \\ -x & \text{if } x \leq 0. \end{cases}$$

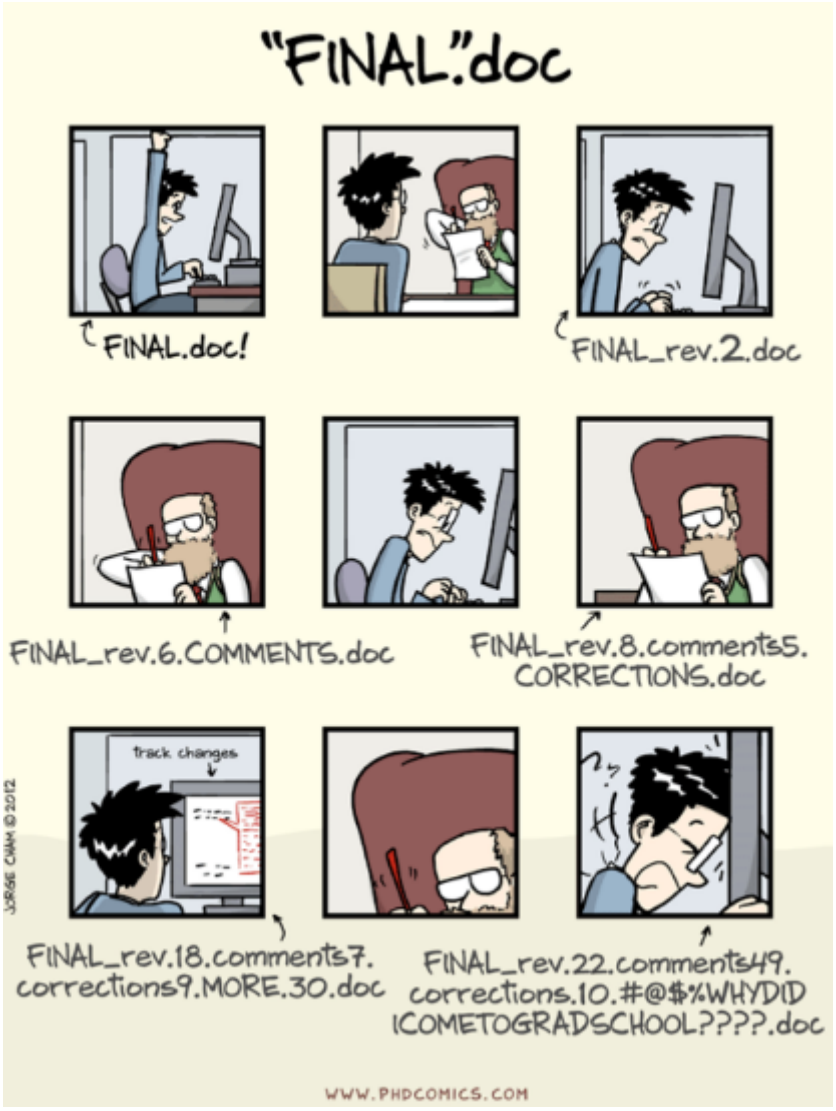
R Markdown → Markdown → HTML

foo.rmd → foo.md → foo.html

easy to write
(and read!)

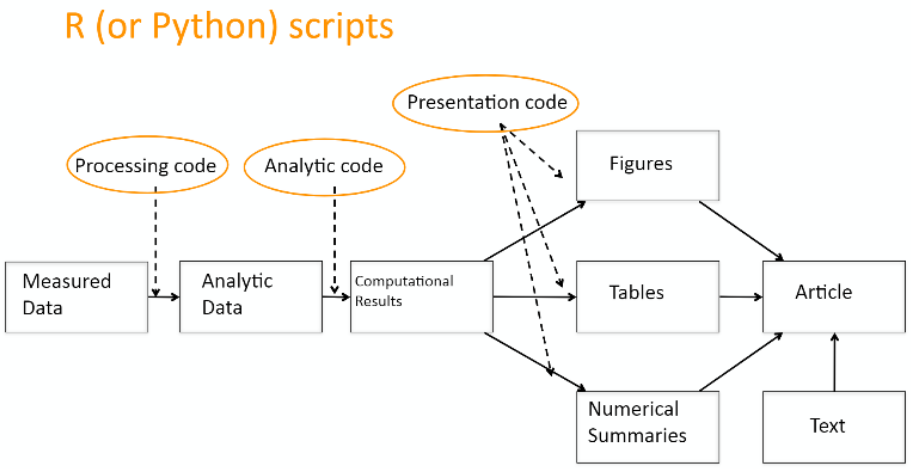
easy to publish
easy to read in
browser

- git and github : Version control systems(VCS) and collaboration tools.



- GNU Make

  - How to make end products more integrated and more reproducible?
  - How to keep everything up-to-date?
  - if the data changes, how do we remember to remake the figure 2B and 4?



Like Git,
GNU Make is another old school tool that is being repurposed to meet a need in data-intensive workflows.

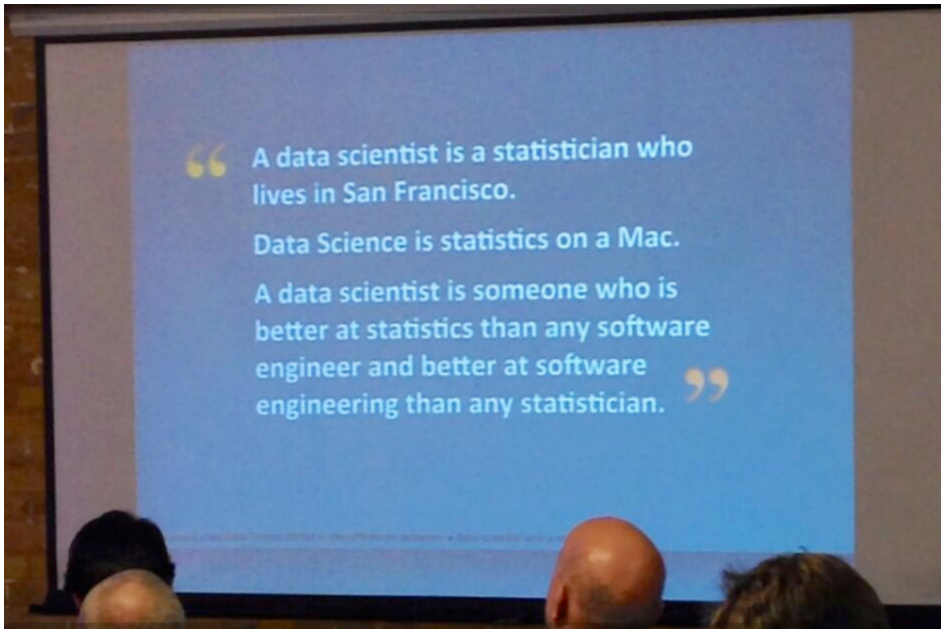
Originally intended to orchestrate compiling complicated software, it's now used to express what depends on what and keep everything "in sync".

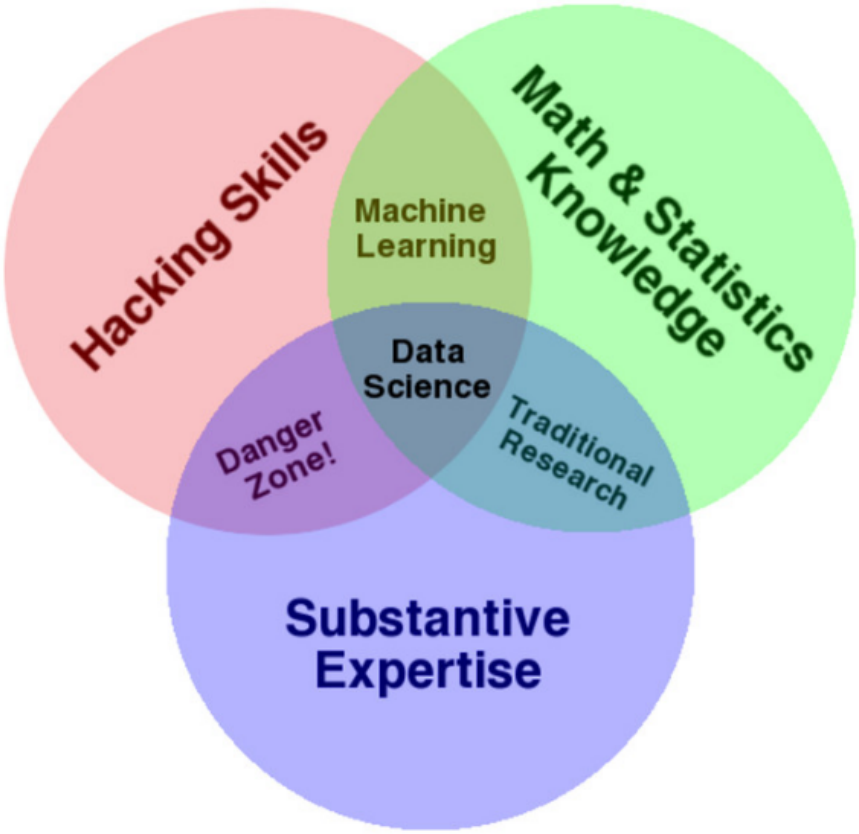
Makefile

```
all: data model paper
data: raw.csv
model: model.Rout
paper: plot.Rout paper.pdf

raw.csv: get_data.py
    python get_data.py

clean.csv: clean.sh raw.csv
    source clean.sh

model.Rout: model.R clean.csv
    R CMD BATCH model.R

plot.Rout: plot.R model.Rout
    R CMD BATCH plot.R

paper.pdf: paper.tex
    $(TEXCMD) $<
    $(TEXCMD) $<
    bibtex *.aux
    $(TEXCMD) $<
```

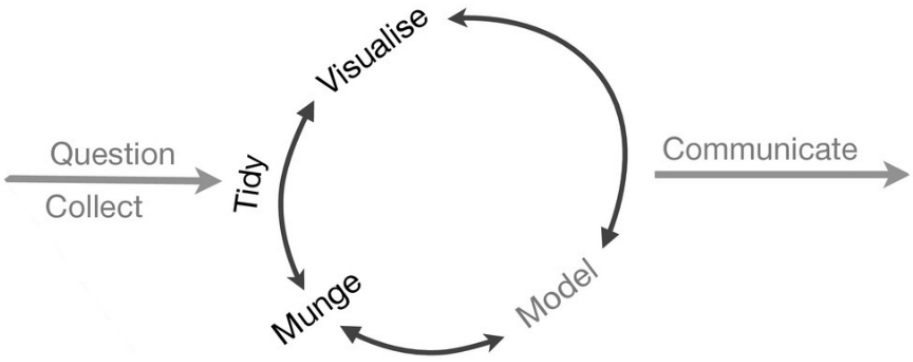
http://zmjones.com/make.html

1.1.3 What is Data Science?





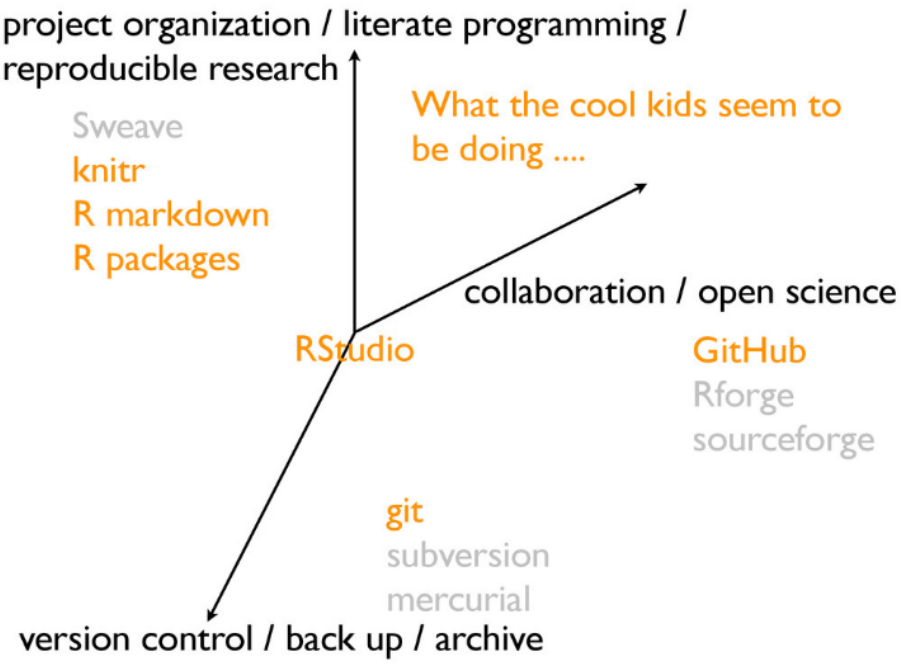
a horizontal data science workflow



Slides from Hadley Wickham's talk in the Simply Statistics Unconference http://t.co/D931Og8mq3

big data ≠ data science

big data ⊂ data science



1.2 Deep Thoughts about data analytic work; intro to R and RStudio

1.2.1 To do before next class:

- swirl: "a software package for the R programming language that turns the R console into an interactive learning environment"

1.2.2 Basics of working with R at the command line and RStudio goodies

- Launch RStudio/R and notice the default panes:
- Console (entire left)
- Environment/History (tabbed in upper right)
- Files/Plots/Packages/Help (tabbed in lower right)

Customizing RStudio.

- Make an assignment.

```
x <- 3 * 4
x
#> [1] 12
```

"assignments" form:

```
objectName <- value
```

- Keyboard shortcut for assignment operator <- is Alt + - (the minus sign).
- RStudio offers many handy keyboard shortcuts.
- Alt+Shift+K brings up a keyboard shortcut reference card.
- Object names

```
i_use_snake_case
other.people.use.periods
evenOthersUseCamelCase
```

Make another assignment

```
this_is_a_really_long_name <- 2.5
```

To inspect this, try out RStudio's completion facility: type the first few characters, press TAB, add characters until you disambiguate, then press return.

Make another assignment

```
jenny_rocks <- 2 ^ 3
```

R has a mind-blowing collection of built-in functions that are accessed like so

```
functionName(arg1 = val1, arg2 = val2, and so on)
```

- `seq()` which makes regular sequences of numbers
  - Type `se` and hit TAB.

```
seq(1,10)
#>  [1]  1  2  3  4  5  6  7  8  9 10
```

```
yo <- "hello world"
```

```
y <- seq(1, 10)
y
#>  [1]  1  2  3  4  5  6  7  8  9 10
```

Surrounding the assignment with parentheses, which causes assignment and "print to screen" to happen.

```
(y <- seq(1, 10))
#>  [1]  1  2  3  4  5  6  7  8  9 10
```

Not all functions have (or require) arguments:

```
date()
#> [1] "Fri Jul  6 21:00:12 2018"
```

- The workspace is where user-defined objects accumulate. You can also get a listing of these objects with commands:

```
objects()
#> [1] "jenny_rocks"                "this_is_a_really_long_name"
#> [3] "x"                          "y"
#> [5] "yo"
ls()
#> [1] "jenny_rocks"                "this_is_a_really_long_name"
#> [3] "x"                          "y"
#> [5] "yo"
```

remove the object named `y`

```
rm(y)
```

To remove everything:

```
rm(list = ls())
```

or click the broom in RStudio's Environment pane.

1.2.3 Workspace and working directory

1.2.3.1 Workspace, .RData

1.2.3.2 Working directory

You can explicitly check your working directory with:

```
getwd()
```

Although I do not recommend it, in case you're curious, you can set R's working directory at the command line like so:

```
setwd("~/myCoolProject")
```

Although I do not recommend it, you can also use RStudio's Files pane to navigate to a directory and then set it as working directory from the menu: Session –> Set Working Directory –> To Files Pane Location. (You'll see even more options there). Or within the Files pane, choose **More** and **Set As Working Directory**.

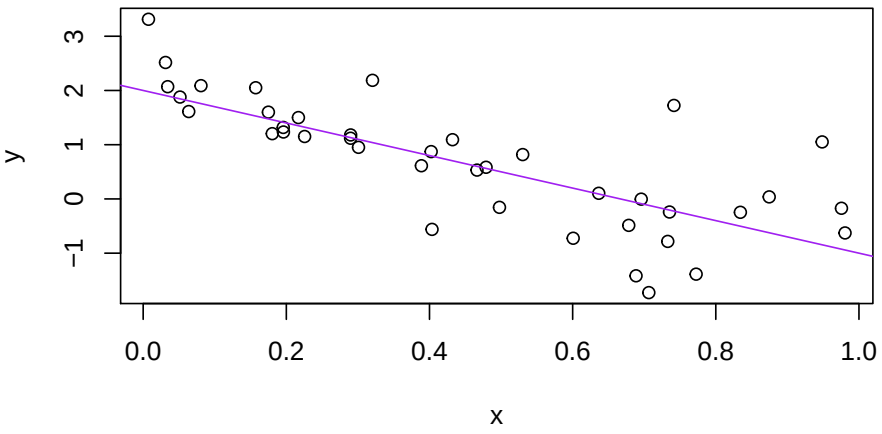
1.2.4 RStudio projects

Keeping all the files associated with a project organized together – input data, R scripts, analytical results, figures – is such a wise and common practice that RStudio has built-in support for this via its *projects*.

Using Projects

Let's enter a few commands in the Console, as if we are just beginning a project:

```
a <- 2
b <- -3
sig_sq <- 0.5
x <- runif(40)
y <- a + b * x + rnorm(40, sd = sqrt(sig_sq))
(avg_x <- mean(x))
#> [1] 0.45
write(avg_x, "avg_x.txt")
plot(x, y)
abline(a, b, col = "purple")
```




```
dev.print(pdf, "toy_line_plot.pdf")
#> pdf
#>   2
```

```
source(file.r)
```

In your favorite OS-specific way, search your files for `toy_line_plot.pdf` and presumably you will find the PDF itself (no surprise) but *also the script that created it (`toy-line.r`)*. This latter phenomenon is a huge win. One day you will want to remake a figure or just simply understand where it came from. If you rigorously save figures to file **with R code and not ever ever ever the mouse or the clipboard**, you will sing my praises one day. Trust me.

1.2.5 stuff

It is traditional to save R scripts with a `.R` or `.r` suffix.

Comments symbol : `#`
de(comment) : Ctrl+Shift+C

This workflow will serve you well in the future:

- Create an RStudio project for an analytical project
- Keep inputs there
- Keep scripts there; edit them, run them in bits or as a whole from there
- Keep outputs there (like the PDF written above)

Many long-time users never save the workspace, never save `.RData` files (I'm one of them), never save or consult the history.

Option to disable the loading of .RData and permanently suppress the prompt on exit to save the workspace (go to Tools->Options->General).