Gov 50: 2. R, RStudio, and Rmarkdown

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Roadmap

1. Working in Plain Text
2. Let's take a touR
3. Using Rmarkdown
4. Getting R bearings
5. Our first visualizations

1/ Working in Plain Text

The two computer revolutions

The frontier of computing

- Touch-based interfaces

Where statistical computing lives

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- Single app at a time

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- Windows and pointers
- Multi-tasking, multiple windows

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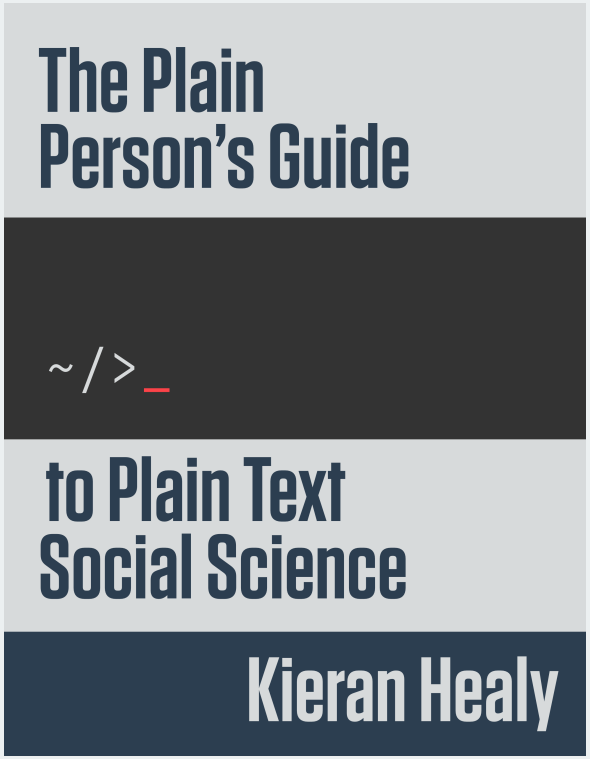
Where statistical computing lives

- Windows and pointers
- Multi-tasking, multiple windows
- Works heavily with the file system
- Underneath it's UNIX and the command line

Plain-text tools for data analysis



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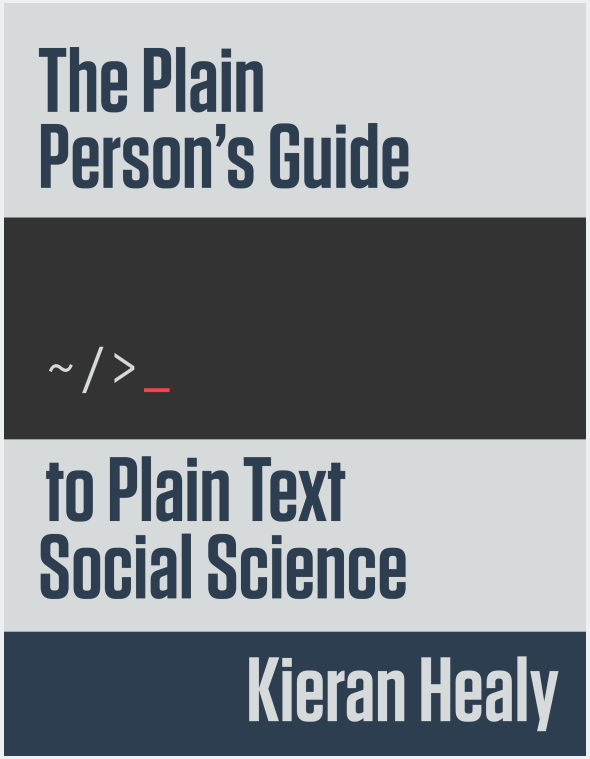

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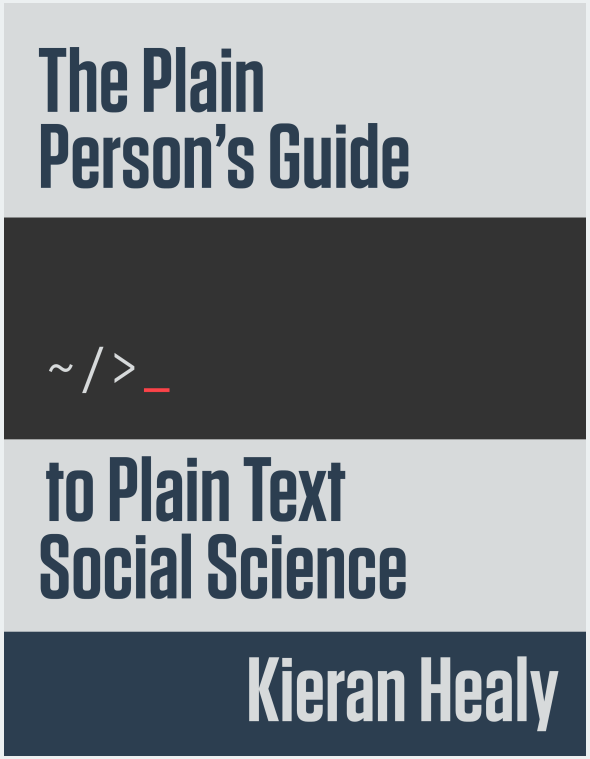

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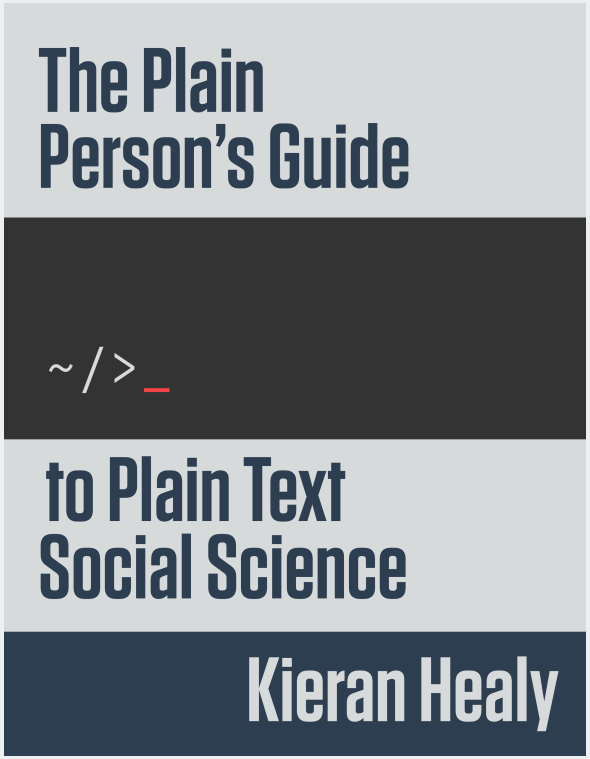

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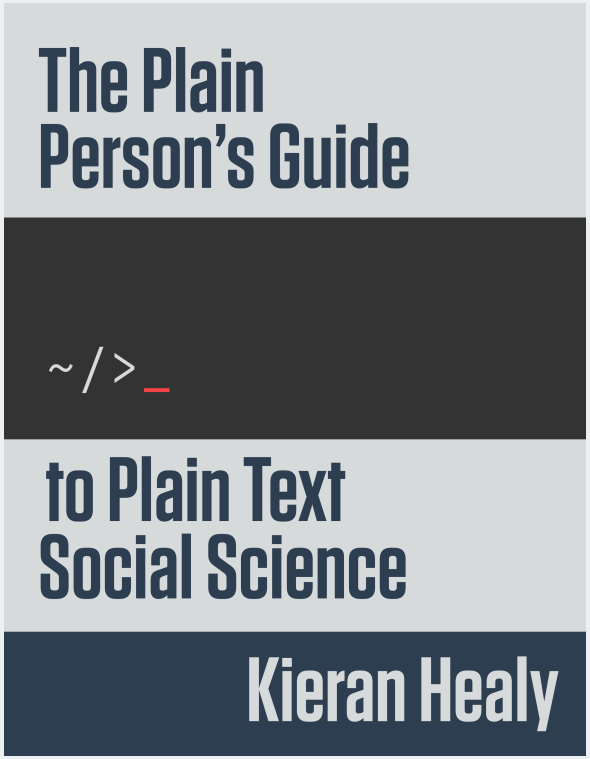

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- But... far from the touch-based paradigm of modern computing
- So why use them?

The process of data science is instrinsically messy

Office vs engineering model of computing

What's real in the project? How are changes managed?

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In the Office model

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We’ll tend toward the Engineering model because it’s better suited to keep the mess in check.

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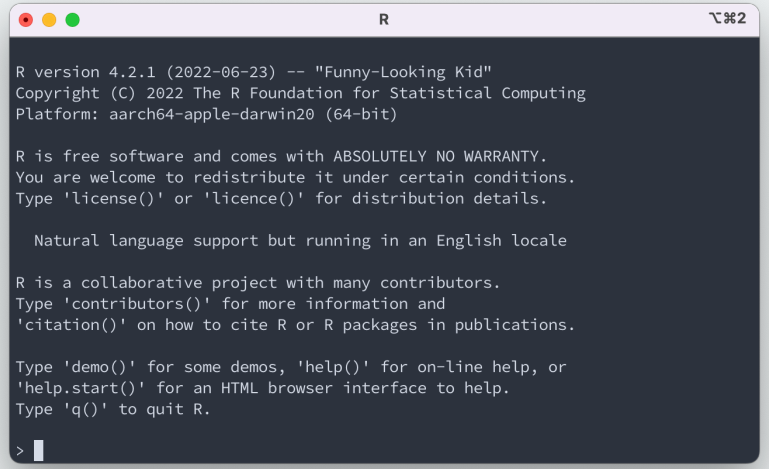
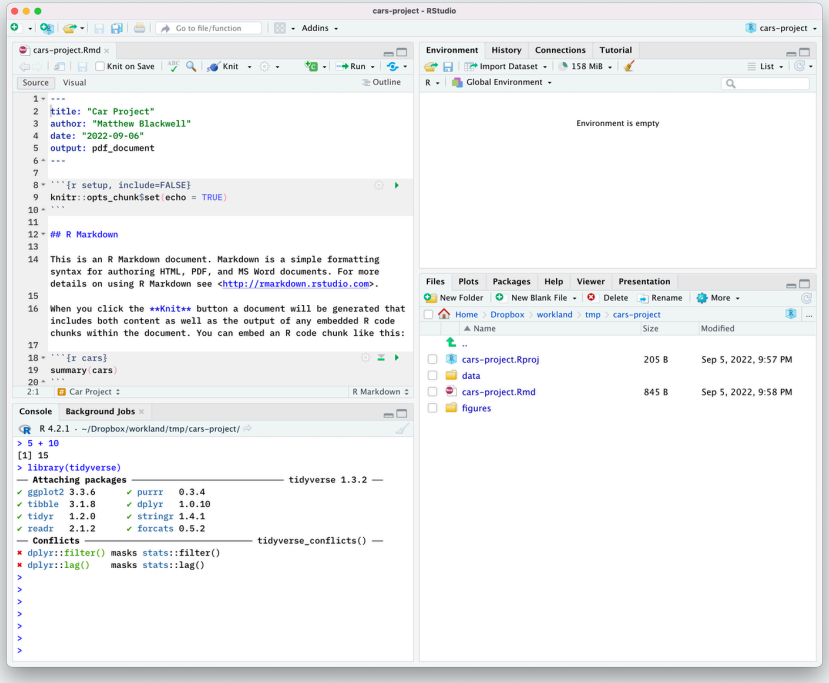
R versus RStudio





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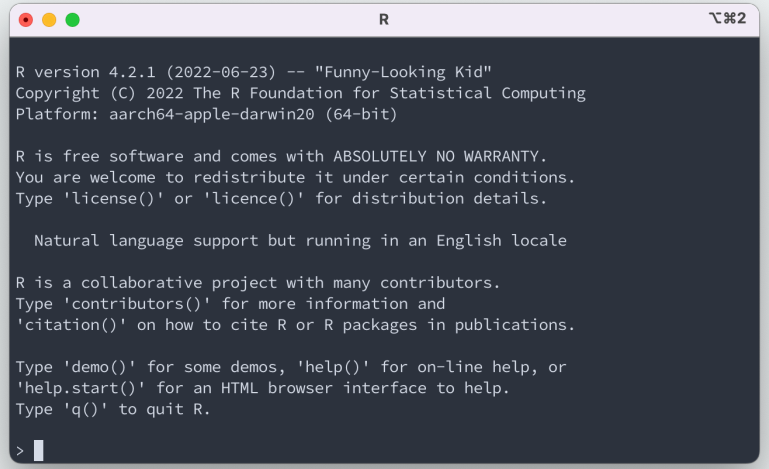

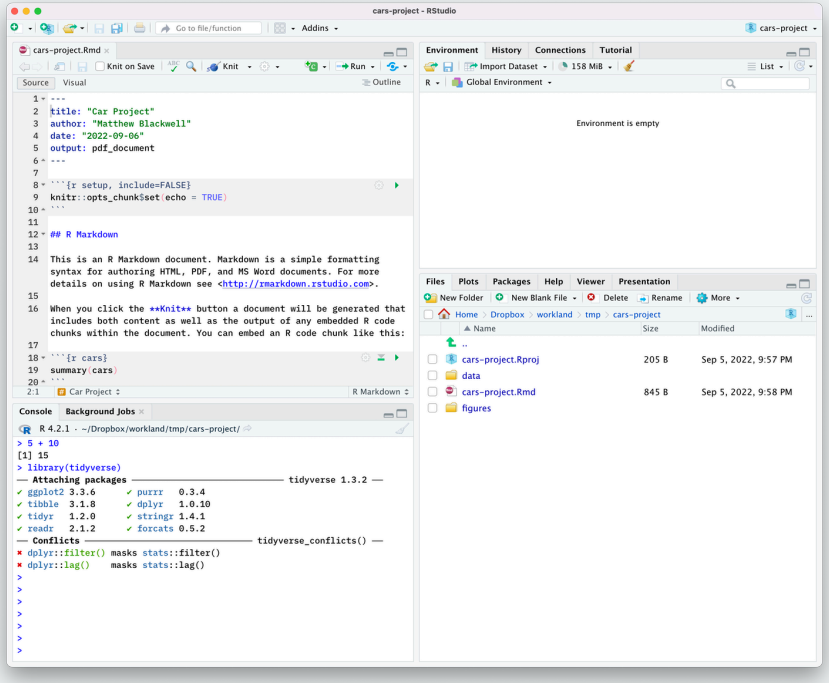

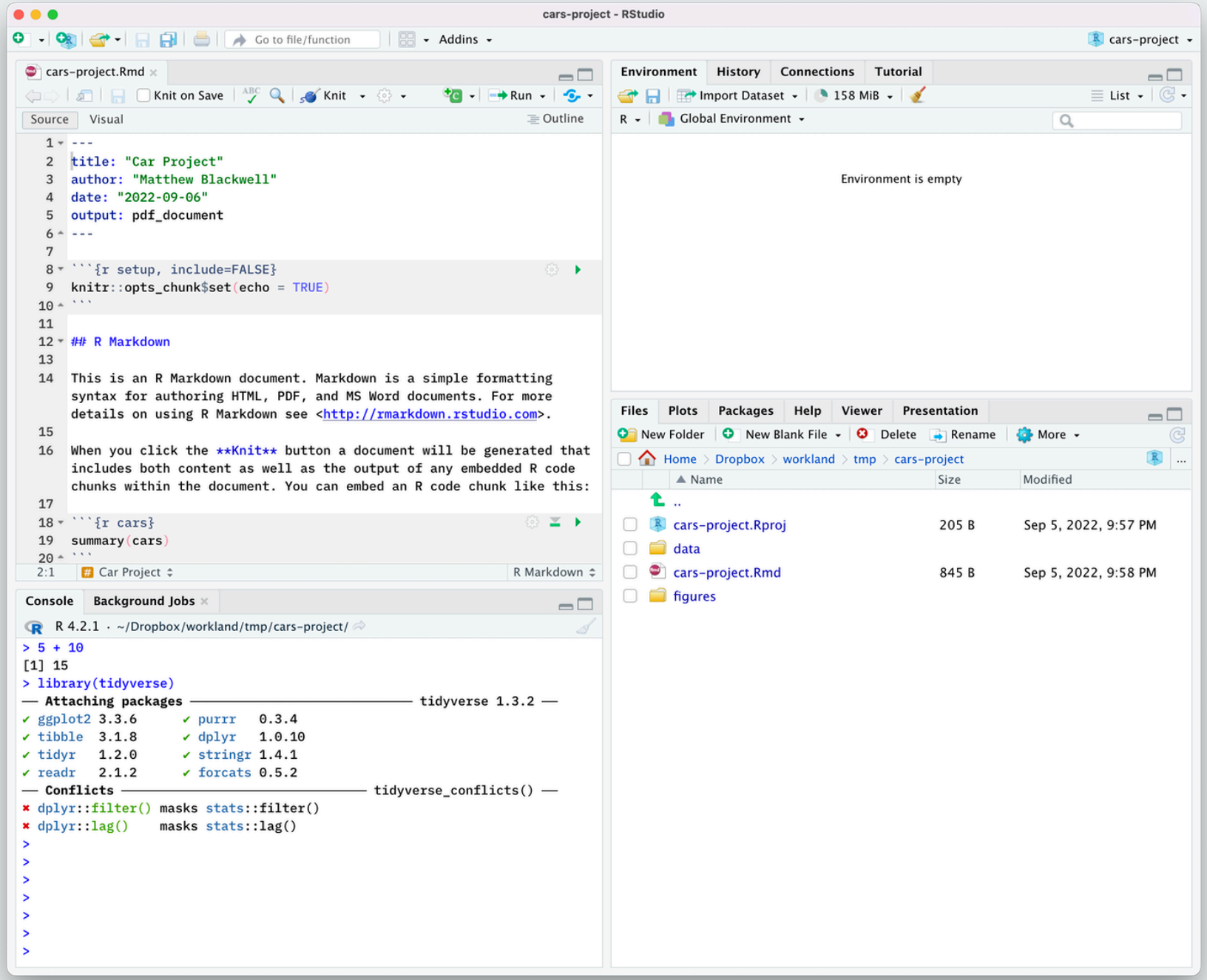
cars-project - RStudio
Go to file/function
Addins
cars-project
cars-project.Rmd
Knit on Save
Knit
Run
Source
Visual
Outline
1 ---
2 title: "Car Project"
3 author: "Matthew Blackwell"
4 date: "2022-09-06"
5 output: pdf_document
6 ---
7
8 ```{r setup, include=FALSE}
9 knitr::opts_chunk$set(echo = TRUE)
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12 ## R Markdown
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16 When you click the **Knit** button 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:
17
18 ```{r cars}
19 summary(cars)
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2:1
Car Project
R Markdown
Console
Background Jobs
R 4.2.1 · ~/Dropbox/workland/tmp/cars-project/
> 5 + 10
[1] 15
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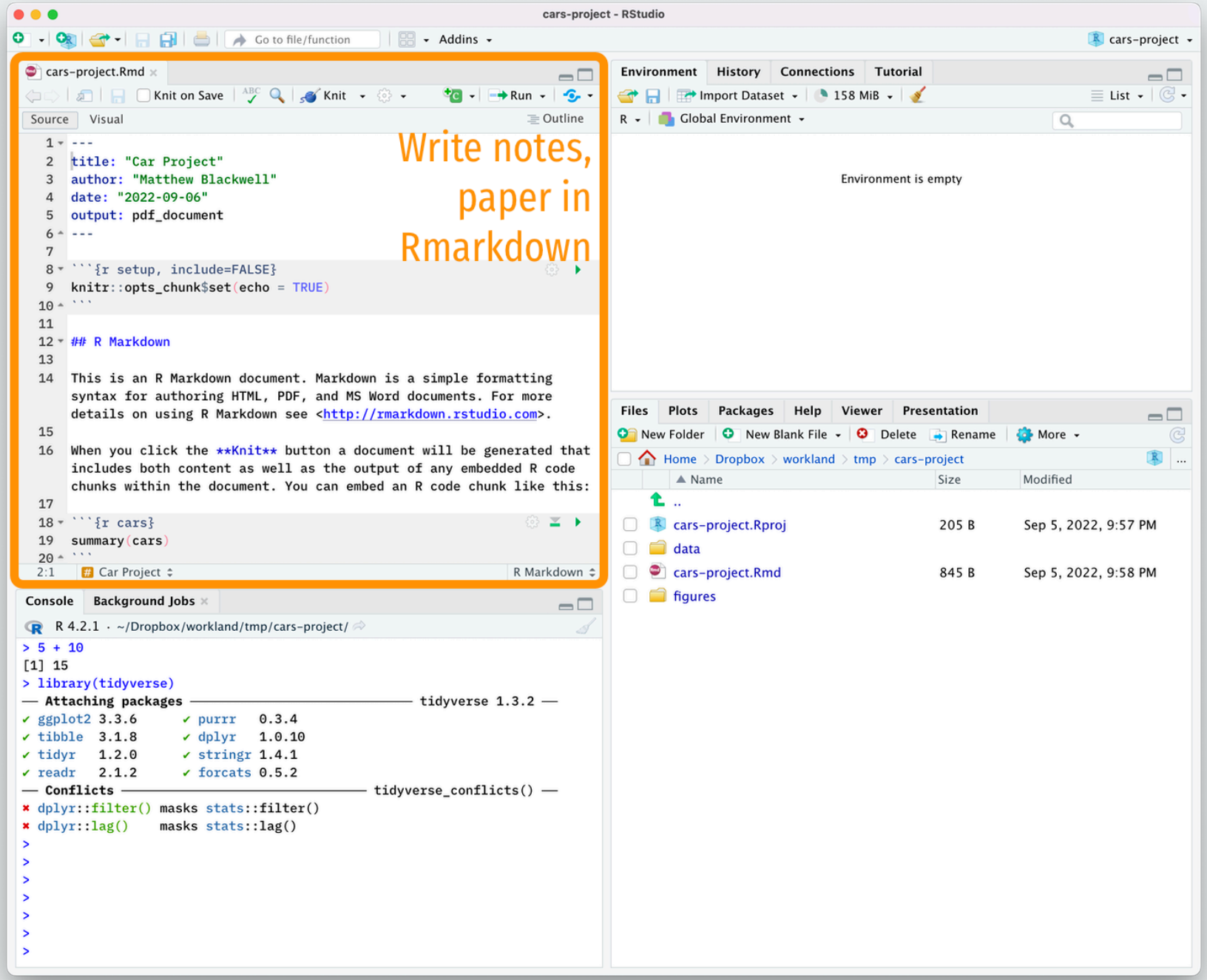
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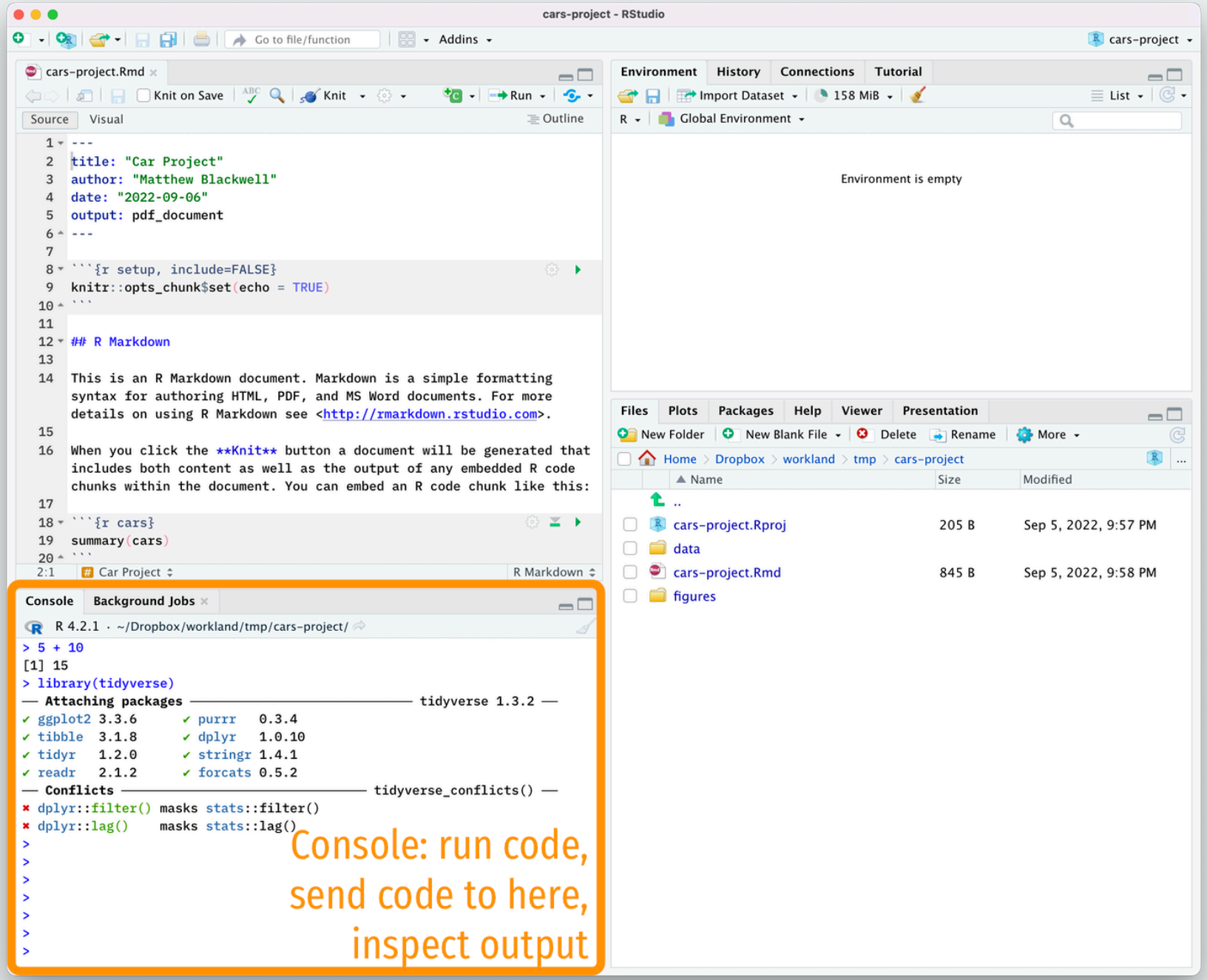
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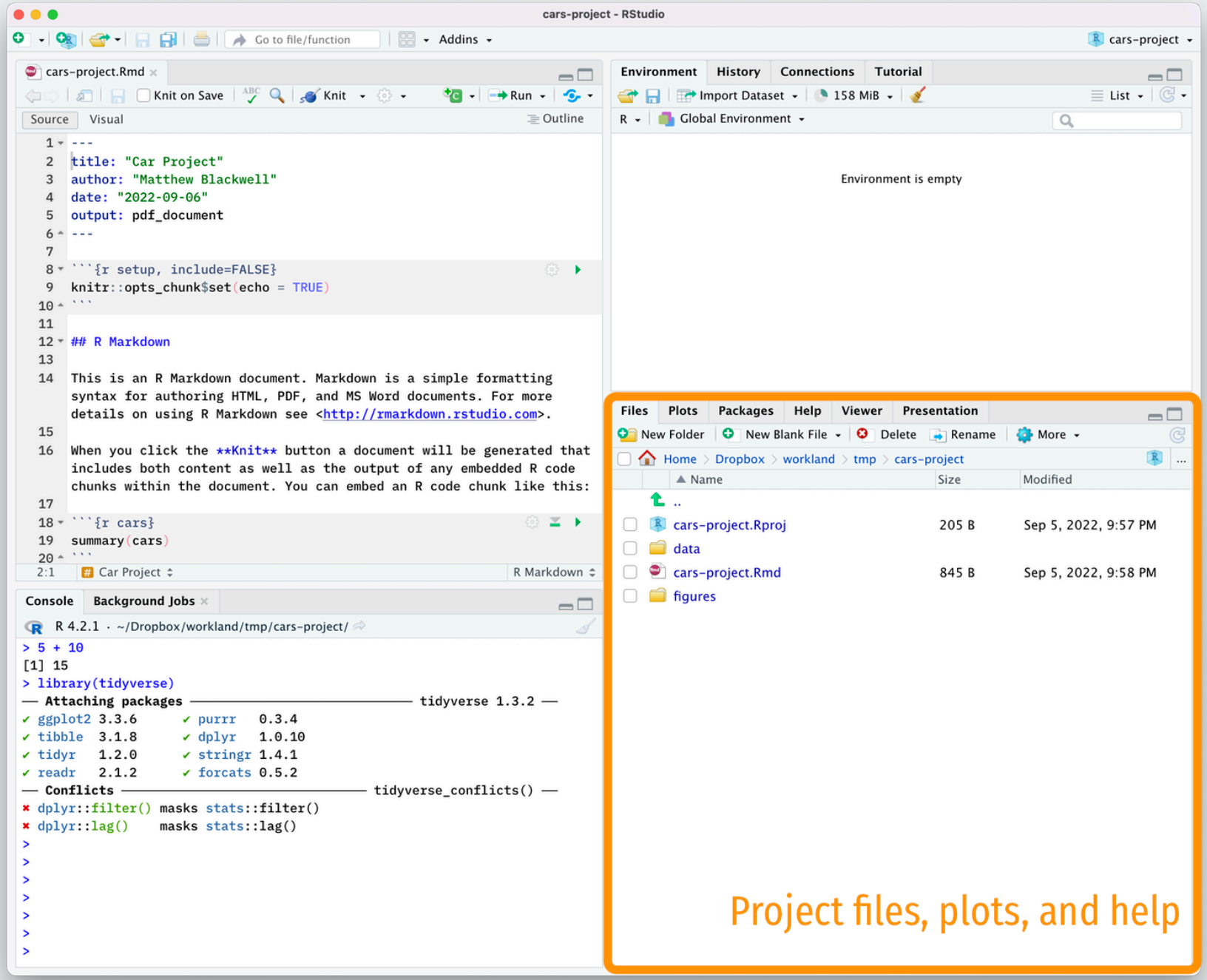
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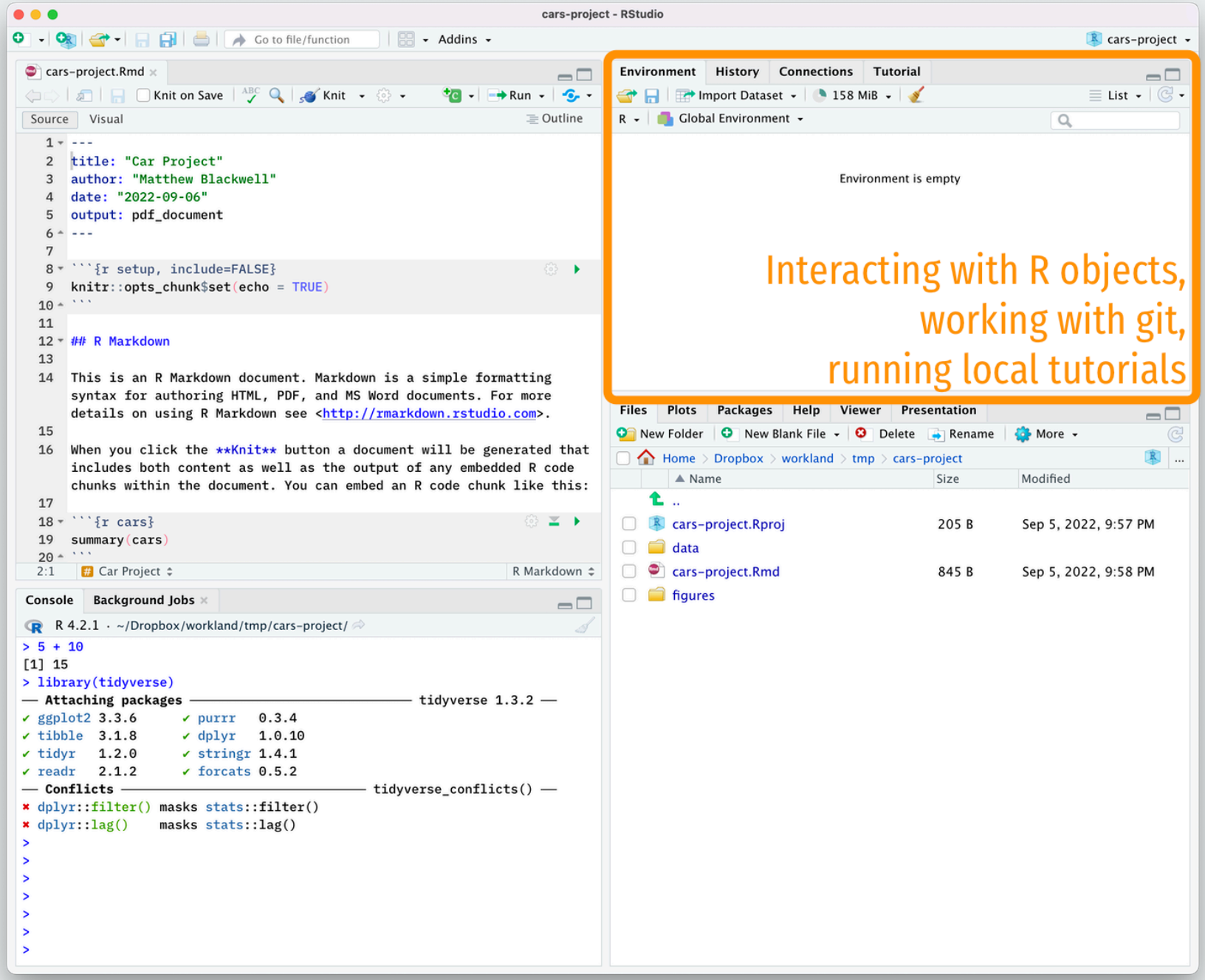
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3/ Using Rmarkdown

The acts of coding

```r
library(ggplot2)
ggplot(mtcars, aes(x = wt, y = mpg)) +
  geom_point()
```

Figure: 1. Writing code

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ggplot(mtcars, aes(x = wt, y = mpg)) +
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```

Figure: 1. Writing code

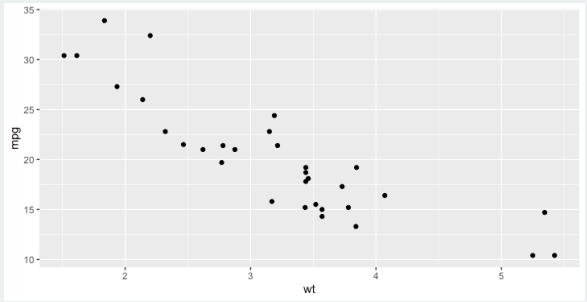

Figure: 2. Looking at output

The acts of coding

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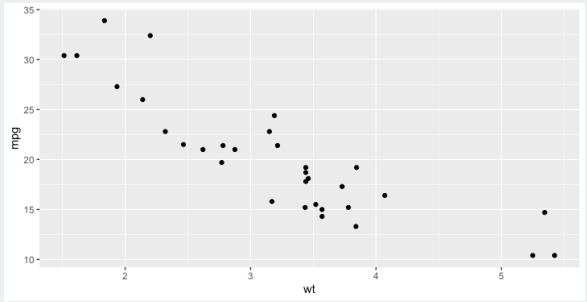

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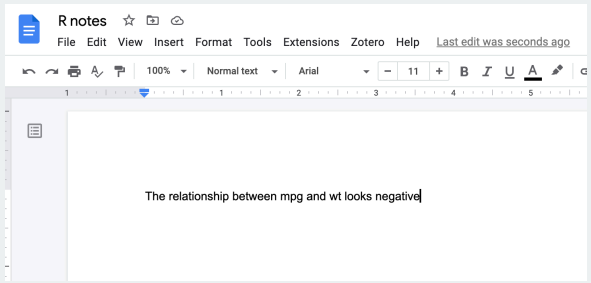

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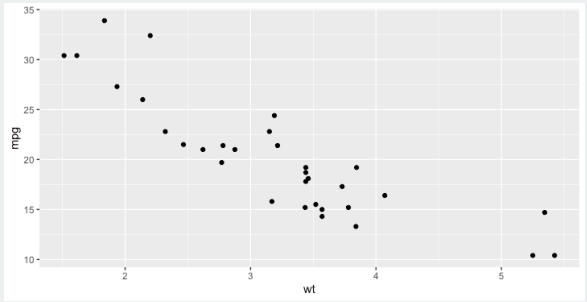

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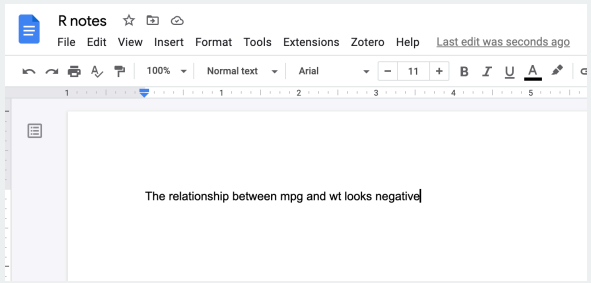

Figure: 3. Taking notes

How to do all of these efficiently?

Rmarkdown files to the rescue

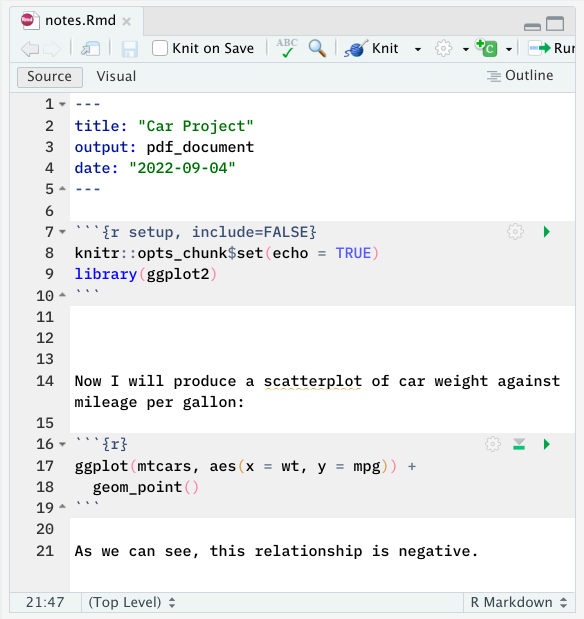

Figure: Rmarkdown file

Keep code and notes together in plain text

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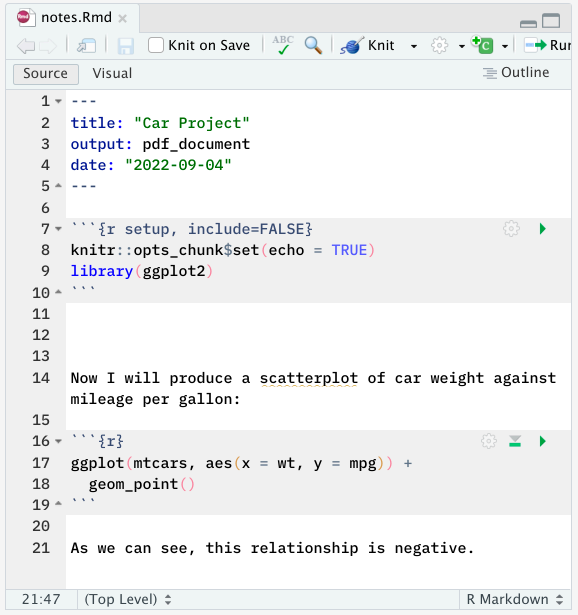

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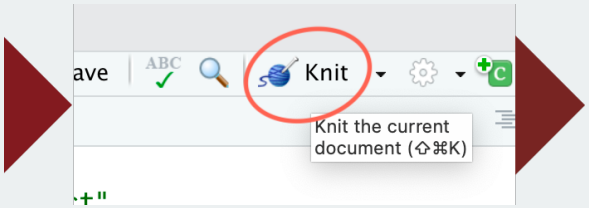

Figure: Knit in R

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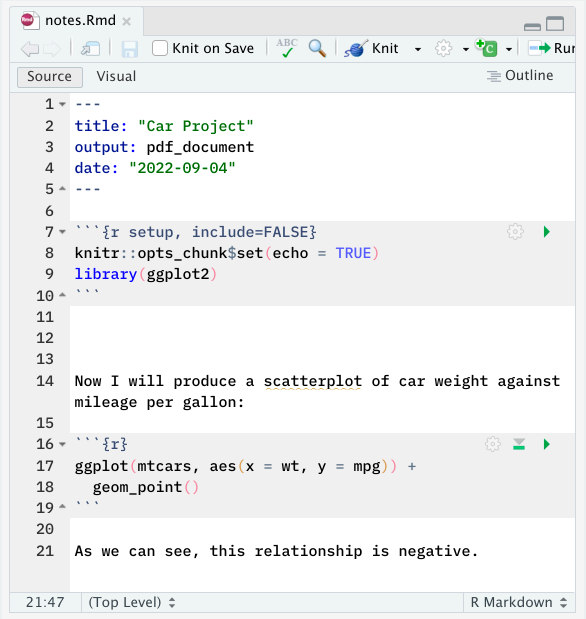

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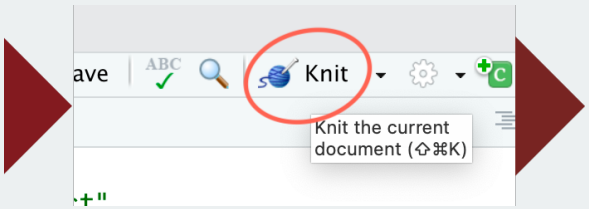

Figure: Knit in R

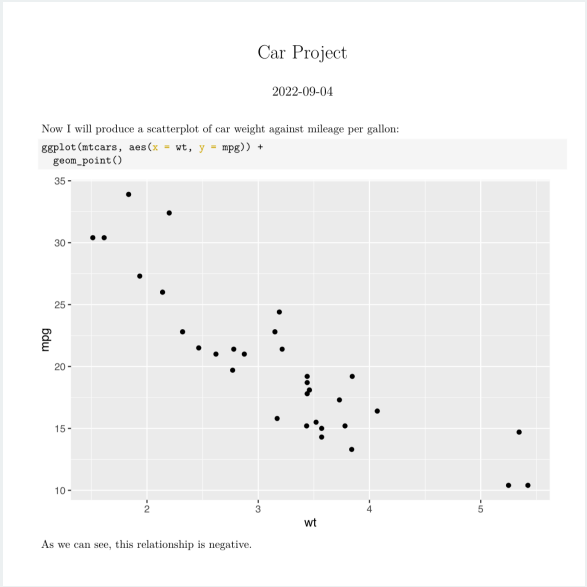

Figure: PDF output

Produce nice-looking outputs in different formats

Markdown: formatting in plain text

Non-code text in Rmd files is plain text with formatting instructions

syntax

```
Plain text
End a line with two spaces to start a new paragraph.
*italics* and _italics_
**bold** and __bold__
superscript^2^
~~strikethrough~~
[link](www.rstudio.com)

# Header 1

## Header 2

### Header 3

#### Header 4

##### Header 5

###### Header 6

endash: --
emdash: ---
ellipsis: ...
inline equation: $A = \pi*r^{2}$
image: ![](path/to/smallorb.png)

horizontal rule (or slide break):

***

> block quote

* unordered list
* item 2
    + sub-item 1
    + sub-item 2

1. ordered list
2. item 2
    + sub-item 1
    + sub-item 2
```

becomes

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Header 2
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    - sub-item 1
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1. ordered list
2. item 2
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    - sub-item 2

```
---
title: "Car Project"
author: "Matthew Blackwell"
date: "2022-09-06"
output: pdf_document
---
```

Header contains metadata and sets options about the whole document

```
```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)
```
```

Code Chunk

```
## R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for
authoring HTML, PDF, and MS Word documents. For more details on using R
Markdown see <http://rmarkdown.rstudio.com>.

When you click the **Knit** button 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:
```

Plain text with markdown formatting

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

Can "play" chunks interactively

```
## Including Plots

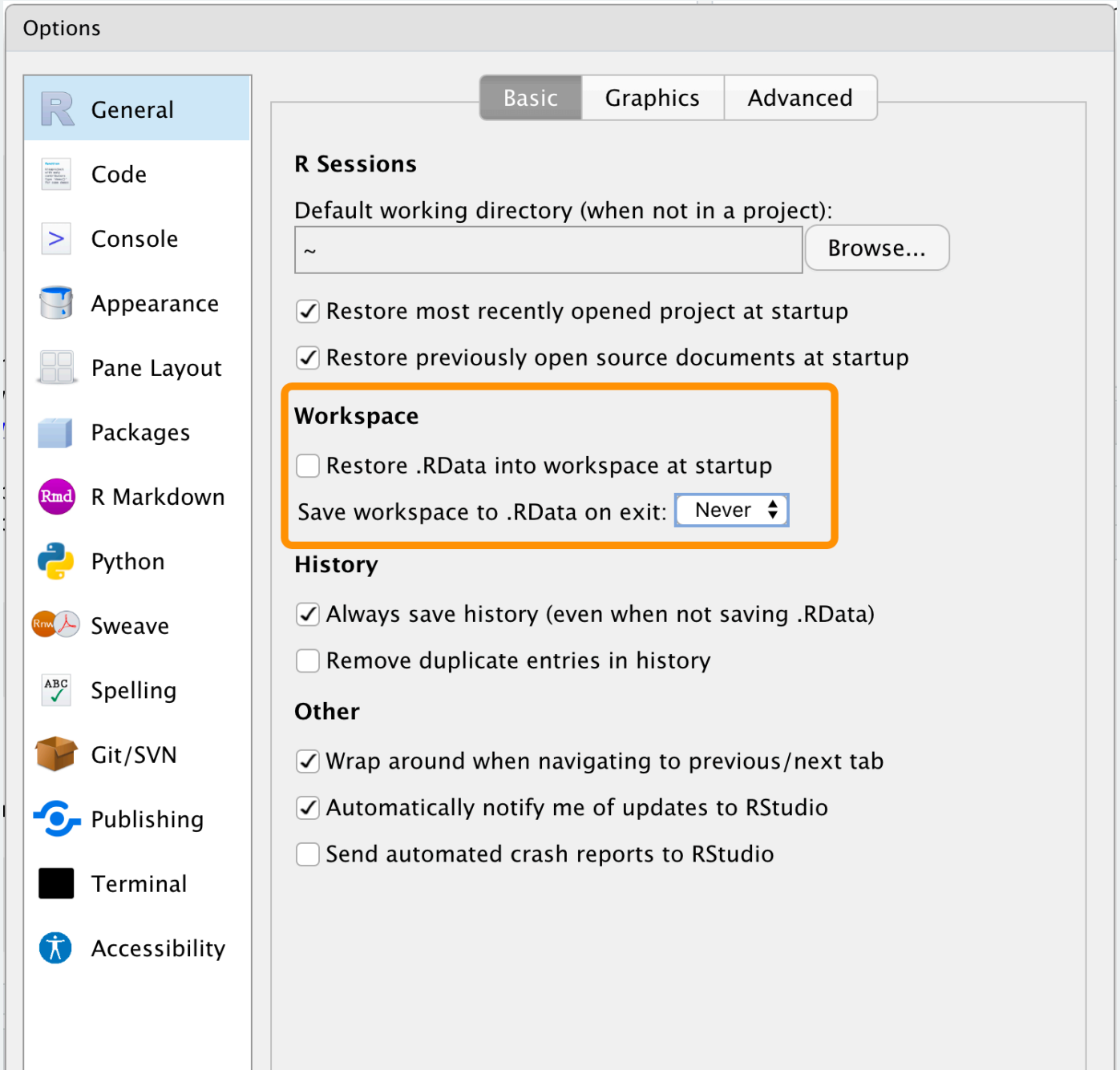
You can also embed plots, for example:
```

Chunks can have names and options

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

Code chunks replaced with output when Knitted

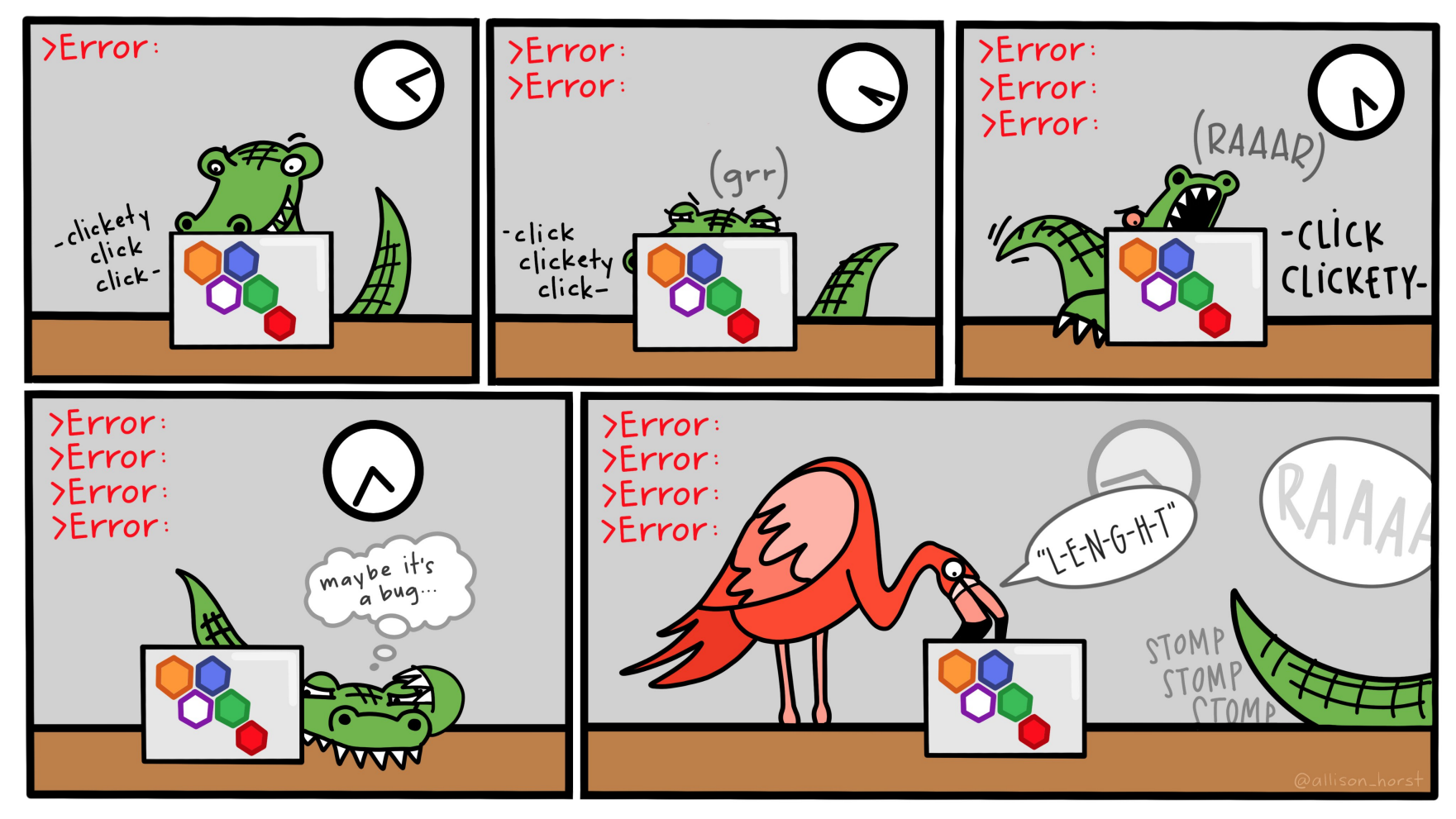
Remember what's real



4/ Getting R bearings

Try to type your code by hand

Typing speeds up the try-fail cycle



Physically typing the code is best way to familiarize yourself with R and the try-fail-try-fail-try-succeed cycle

Credit: Allison Horst

What R looks like

Code that you can type and run:

```
## Any R code that begins with the # character is a comment
## Comments are ignored by R

my_numbers <- c(4, 8, 15, 16, 23, 42) # Anything after # is also a comment
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Output from code prefixed by ## by convention:

```
my_numbers
```

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Output from code prefixed by ## by convention:

```
my_numbers
```

```
## [1]  4  8 15 16 23 42
```

Output also has a counter in brackets when over one line:

```
letters
```

```
##  [1] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l"
## [13] "m" "n" "o" "p" "q" "r" "s" "t" "u" "v" "w" "x"
## [25] "y" "z"
```

Everything in R has a name

```
my_numbers # just created this
```

```
## [1]  4  8 15 16 23 42
```

```
letters # this is built into R
```

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## [13] "m" "n" "o" "p" "q" "r" "s" "t" "u" "v" "w" "x"
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```

```
pi # also built in
```

```
## [1] 3.14
```

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```
pi # also built in
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```
## [1] 3.14
```

Some names are forbidden (NA, TRUE, FALSE, etc) or strongly not recommended (c, mean, table)

We do things in R with functions

Functions take in objects, perform actions, and return outputs:

```
mean(x = my_numbers)
```

```
## [1] 18
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```
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```

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## [1] 18
```

- x is the argument name,
- my_numbers is what we're passing to the that argument

If you omit the argument name, R will assume the default order:

```
mean(my_numbers)
```

```
## [1] 18
```

Getting help with R

How do we know the default argument order? Look to help files:

```
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- Get help **early** before becoming too frustrated!
  - Easy to overlook small issues like missing commas, etc.

Functions live in packages

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```

Load them into your R session with `library()`:

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library(ggplot2)
```

Now we can use any function provided by `ggplot2`.

Functions live in packages

We can also use the `mypackage::` prefix to access package functions without loading:

```
knitr::kable(head(mtcars))
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160	110	3.90	2.62	16.5	0	1	4	4
Mazda RX4 Wag	21.0	6	160	110	3.90	2.88	17.0	0	1	4	4
Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1
Hornet 4 Drive	21.4	6	258	110	3.08	3.21	19.4	1	0	3	1
Hornet Sportabout	18.7	8	360	175	3.15	3.44	17.0	0	0	3	2
Valiant	18.1	6	225	105	2.76	3.46	20.2	1	0	3	1

5/ Our first visualizations

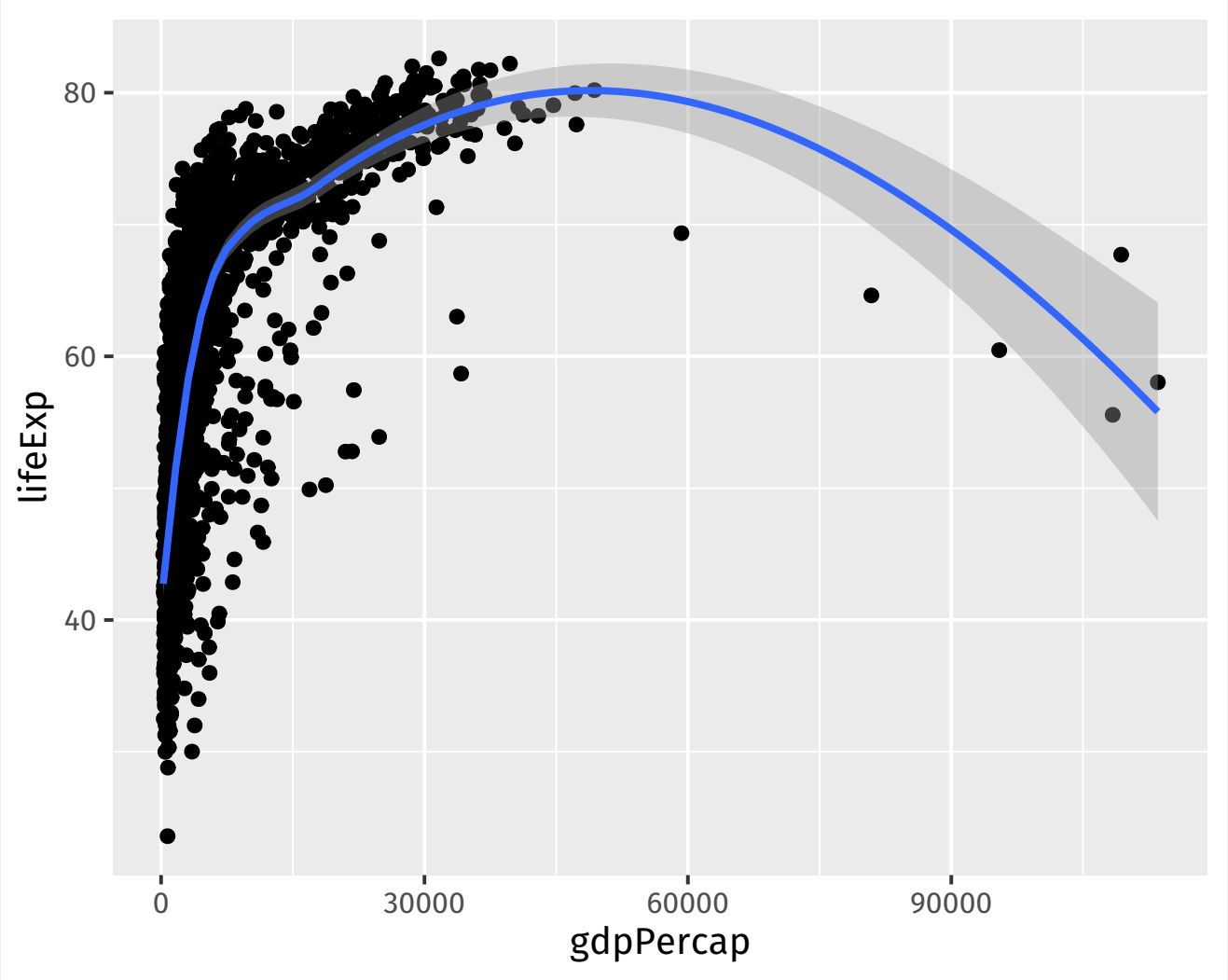
Gapminder data

```
library(gapminder)
gapminder
```

```
## # A tibble: 1,704 x 6
##    country     continent  year lifeExp      pop gdpPe~1
##    <fct>       <fct>     <int>   <dbl>    <int>   <dbl>
##  1 Afghanistan Asia       1952    28.8  8425333    779.
##  2 Afghanistan Asia       1957    30.3  9240934    821.
##  3 Afghanistan Asia       1962    32.0 10267083    853.
##  4 Afghanistan Asia       1967    34.0 11537966    836.
##  5 Afghanistan Asia       1972    36.1 13079460    740.
##  6 Afghanistan Asia       1977    38.4 14880372    786.
##  7 Afghanistan Asia       1982    39.9 12881816    978.
##  8 Afghanistan Asia       1987    40.8 13867957    852.
##  9 Afghanistan Asia       1992    41.7 16317921    649.
## 10 Afghanistan Asia       1997    41.8 22227415    635.
## # ... with 1,694 more rows, and abbreviated variable
## #   name 1: gdpPercap
```

Plotting life expectancy over time

```
ggplot(gapminder, mapping = aes(x = gdpPercap, y = lifeExp)) +
  geom_point() + geom_smooth(method = "loess")
```



A histogram of GDP per capita

```
ggplot(gapminder, mapping = aes(x = gdpPercap)) +
  geom_histogram()
```