R for Infectious Disease Modelling

Yang Liu, PhD
yang.liu@lshtm.ac.uk
Shanghai, China

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LONDON SCHOOL of HYGIENE & TROPICAL MEDICINE

Outline

- Have a brief overview of the fundamentals of R
- R in your work flow
    - Import and export
    - Tidy and transform
    - Visualization
- Finding Solutions/ Self-learning

“`Lecture_CodeAlong.R`” is useful during this lecture.

Brief Review of R

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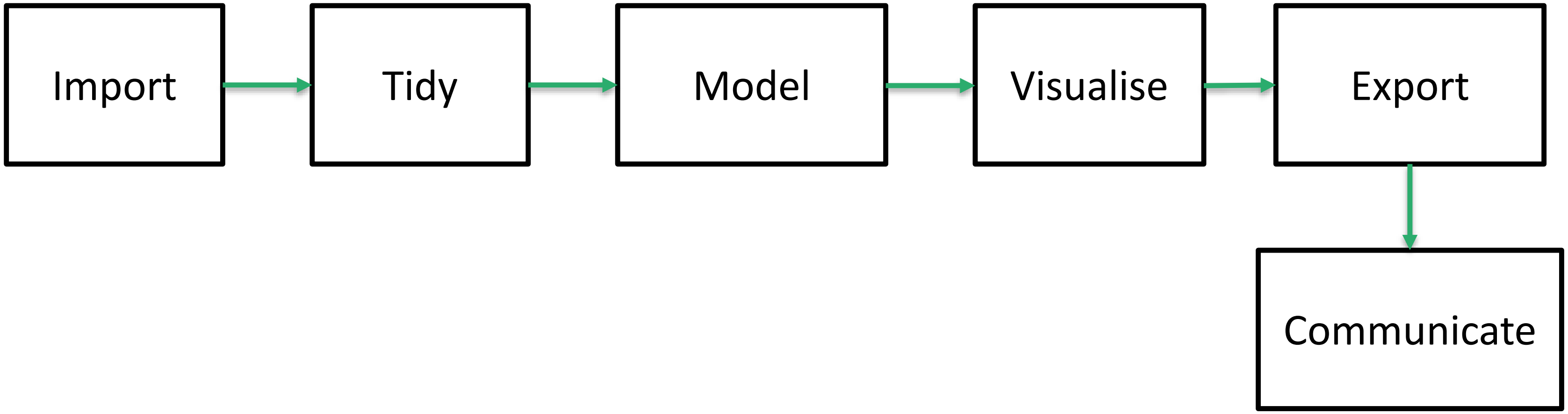
What is R all about?

Why though?

1. R can do a lot of things:
    - Read and process different data and file types
    - Data cleaning
    - Web-scraping; interacting with websites
    - Statistical analysis
    - Mathematical modelling
    - Data visualization
    - Document processing, e.g. Markdown
    - Dashboards and reports generation
    - Mapping and spatial modelling

Why though?

1. R can do a lot of things:



Why though?

2. R plays well with other software/ programming languages/ systems/ platforms:
   - Python
   - C++
   - Jags (Just another Gibbs sampler)
   - OpenBUGS
   - git

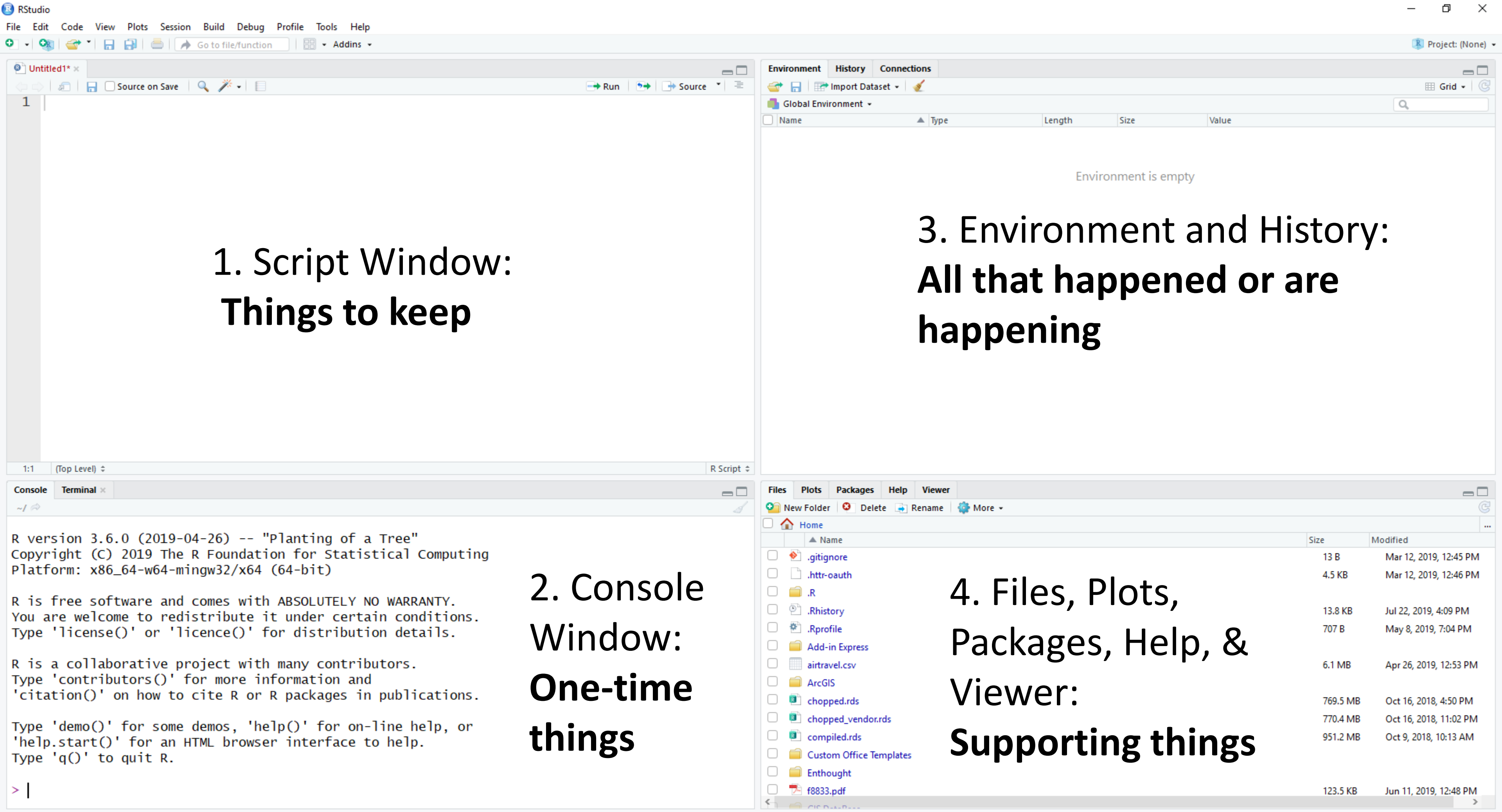
Why though?

3. R is a community driven project:
   - Open source
   - Constantly evolving
   - Channels to interact

What & Why?

4. Last but not the least:

What does it look like?



1. Script Window:

Things to keep

3. Environment and History:

All that happened or are happening

```
R version 3.6.0 (2019-04-26) -- "Planting of a Tree"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> 
```

2. Console Window:

One-time things

Name	Size	Modified
.gitignore	13 B	Mar 12, 2019, 12:45 PM
.httr-oauth	4.5 KB	Mar 12, 2019, 12:46 PM
.R		
.Rhistory	13.8 KB	Jul 22, 2019, 4:09 PM
.Rprofile	707 B	May 8, 2019, 7:04 PM
Add-in Express		
airtravel.csv	6.1 MB	Apr 26, 2019, 12:53 PM
ArcGIS		
chopped.rds	769.5 MB	Oct 16, 2018, 4:50 PM
chopped_vendor.rds	770.4 MB	Oct 16, 2018, 11:02 PM
compiled.rds	951.2 MB	Oct 9, 2018, 10:13 AM
Custom Office Templates		
Enthought		
f8833.pdf	123.5 KB	Jun 11, 2019, 12:48 PM

4. Files, Plots, Packages, Help, & Viewer:

Supporting things

Let’s run a line now!

To run codes, you can:

(1) Type it/ copy & paste it in the console window and press enter;

(2) Type it in the script window, either a. put the cursor on the target line or b. highlight the target code with your jouse, and then press ctrl + enter;

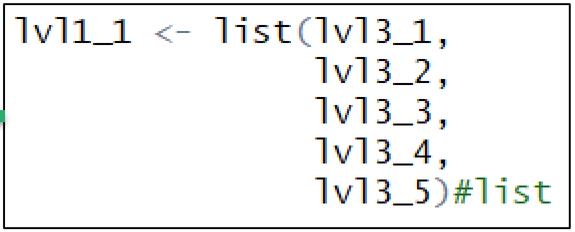
(3) Type it in the script window, select it using your mouse, and then click the “Run” button top right;

(4) Click the “Source” button on top right, which will run the whole script.

Starting from objects

Level 1 (Highest)

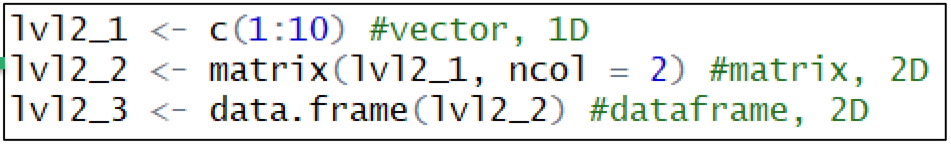
- List



```
lvl1_1 <- list(lvl3_1,
               lvl3_2,
               lvl3_3,
               lvl3_4,
               lvl3_5)#list
```

Level 2

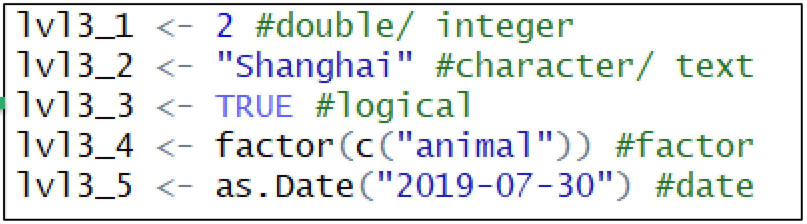
- Vector, matrix, data frame…



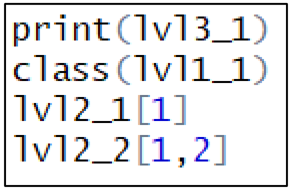
```
lvl2_1 <- c(1:10) #vector, 1D
lvl2_2 <- matrix(lvl2_1, ncol = 2) #matrix, 2D
lvl2_3 <- data.frame(lvl2_2) #dataframe, 2D
```

Level 3 (Lowest)

- Double/ integer (numeric), text (character), Logical, Factor (categorical), Date…

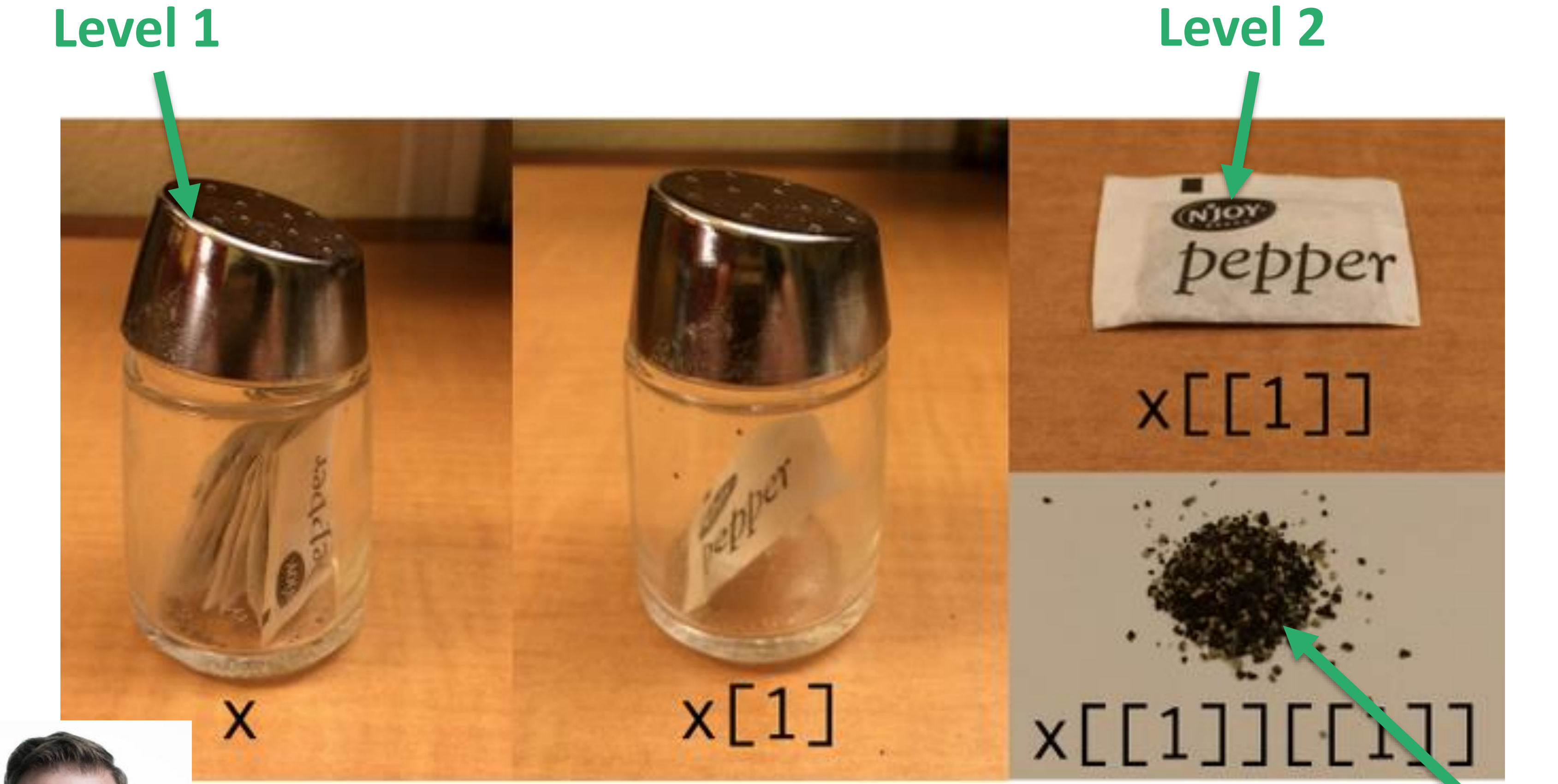


```
lvl3_1 <- 2 #double/ integer
lvl3_2 <- "Shanghai" #character/ text
lvl3_3 <- TRUE #logical
lvl3_4 <- factor(c("animal")) #factor
lvl3_5 <- as.Date("2019-07-30") #date
```



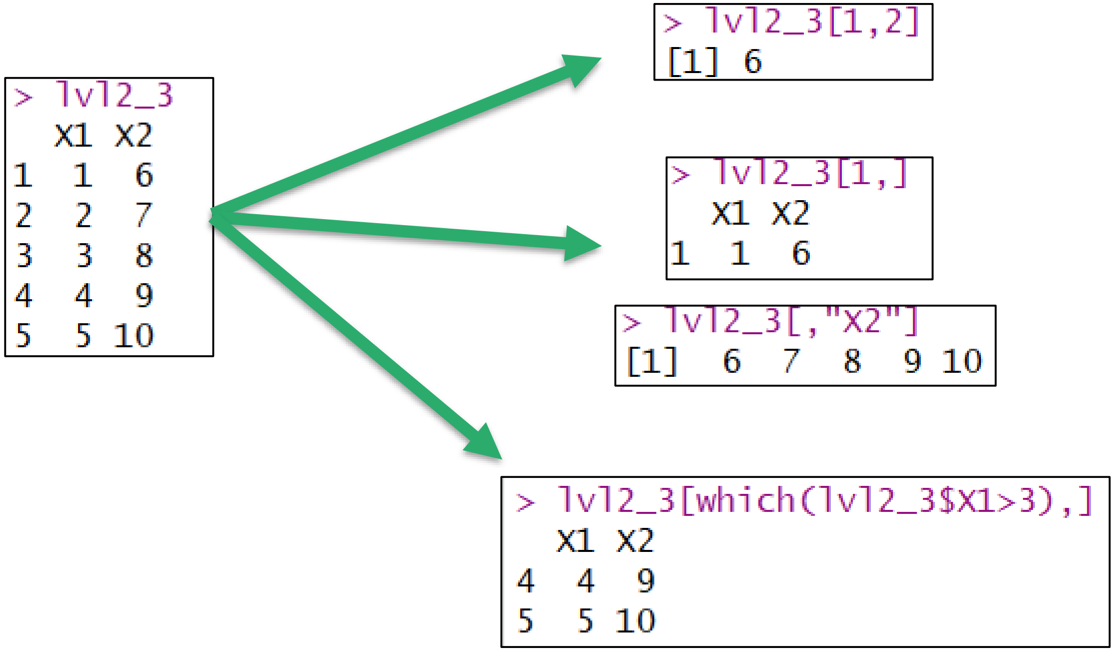
```
print(lvl3_1)
class(lvl1_1)
lvl2_1[1]
lvl2_2[1,2]
```

Overall Indexing



Subsetting

Subsetting can be done in many different ways depending on your needs. To name a few:



```
> lvl2_3
  X1 X2
1  1  6
2  2  7
3  3  8
4  4  9
5  5 10
```

```
> lvl2_3[1,2]
[1] 6
```

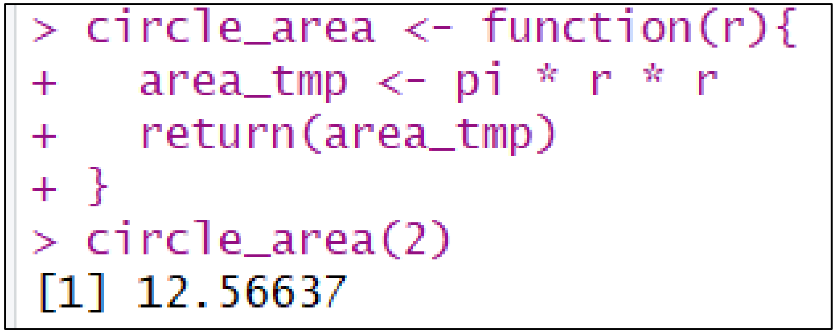
```
> lvl2_3[1,]
  X1 X2
1  1  6
```

```
> lvl2_3[,"X2"]
[1]  6  7  8  9 10
```

```
> lvl2_3[which(lvl2_3$X1>3),]
  X1 X2
4  4  9
5  5 10
```

Functions

There is an additional type of object we did not talk about – functions. Instead of storing data in various formats, functions store “rules”:

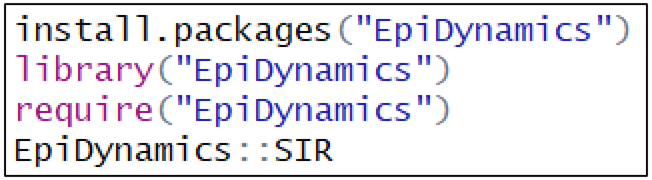


```
> circle_area <- function(r){
+   area_tmp <- pi * r * r
+   return(area_tmp)
+ }
> circle_area(2)
[1] 12.56637
```

Generally there are three sources of functions: (1) base R; (2) specific packages; and (3) write your own!

R relies on packages, what about that?

Base R contains a large number of functions already that can meet simple needs. But for more advanced techniques, you sometimes need to rely on packages.



```
install.packages("EpiDynamics")
library("EpiDynamics")
require("EpiDynamics")
EpiDynamics::SIR
```

```
Advanced options:
(1) pacman
(2)
   devtools::install_gi
   thub
```

Line 1: Install a package from Internet

Line 2 and 3: Both are used to activate a package. “Require” is more commonly used within a function. “Library” is the right way to go in most cases.

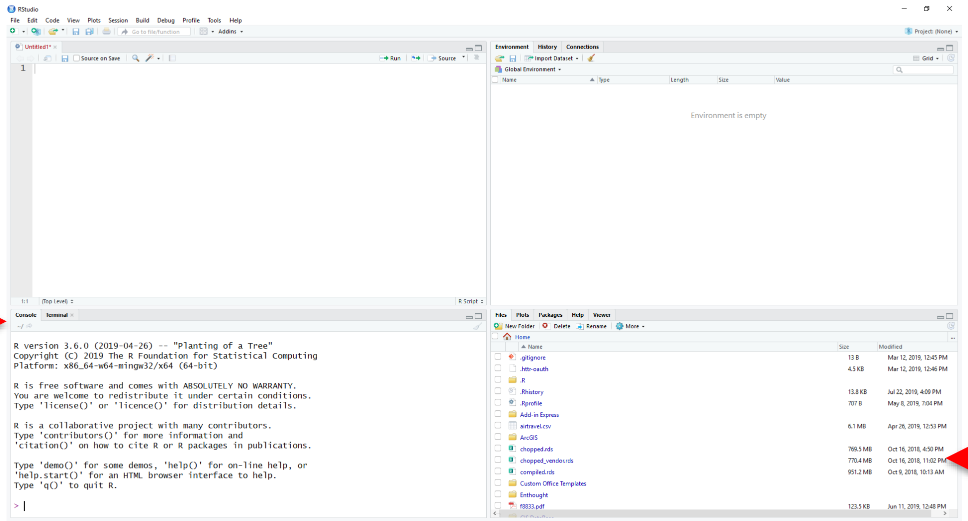
Line 4: Here, you are calling the function SIR from the package EpiDynamics. This is very useful when you have the same function names in different packages.

Interacting with R

R is a piece of software. It only looks at where you tell it to look. These commands will help you get an idea of where R is looking, or tell R where to look at.

```
getwd()
list.files()
setwd("~/SOMWHERE ELSE")
```

Alternatively:



RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Project: (None)
Untitled1*
Source on Save
Run
Source
1:1
(Top Level)
R Script
Environment History Connections
Import Dataset
Global Environment
Grid
Name Type Length Size Value
Environment is empty
Console Terminal
~/
Files Plots Packages Help Viewer
New Folder Delete Rename More
Home

```
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compiled.rds	951.2 MB	Oct 9, 2018, 10:13 AM
Custom Office Templates		
Enthought		
f8833.pdf	123.5 KB	Jun 11, 2019, 12:48 PM

File tab

RECAP: What else just happened?

Symbol	Implication

Questions?

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R in your workflow

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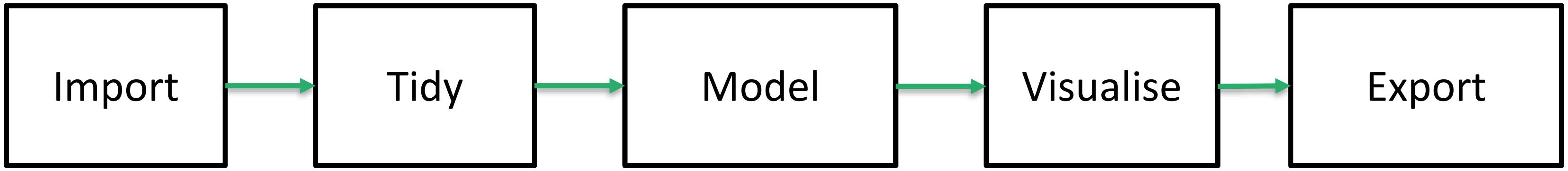
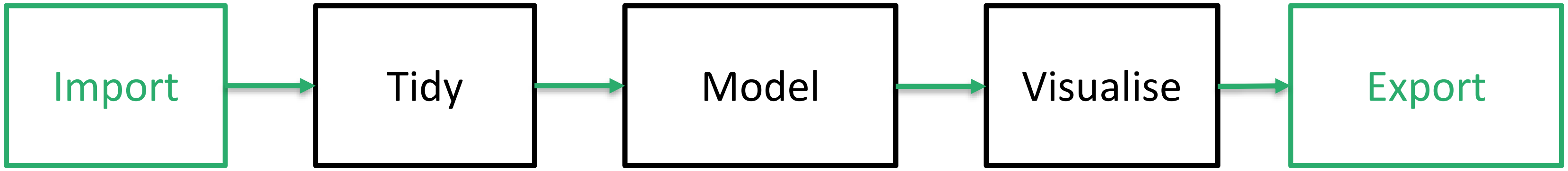
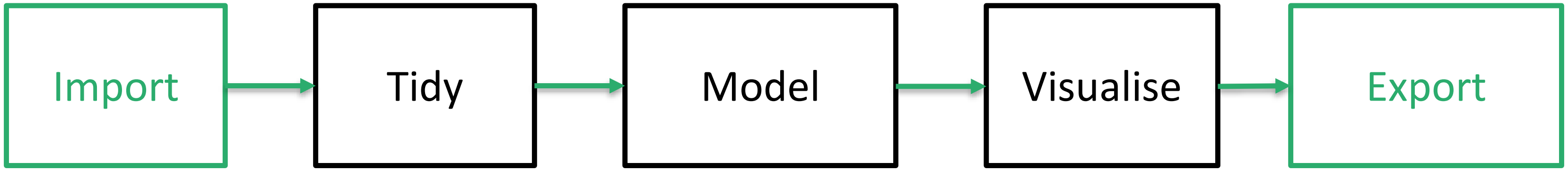
Your flow of work



Import & Export



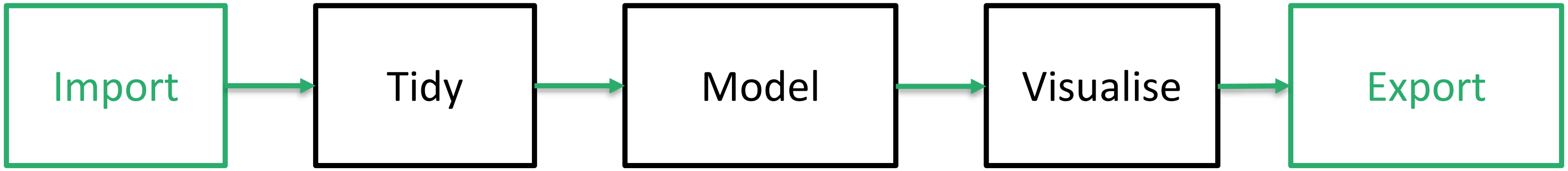
Import & Export



R is capable of working with many different file types. In my personal experience, I have worked with:

- Regular Documents: *. txt, *.csv, *.xlsx, *.pdf;
- Geographic Information: *.shp, *.tif;
- R code: *.r, *.rmd;
- R objects: *.rds, *.rdata;
- Images: *.png, *.jpeg;
- Large data files: *.ncdf4;
- Web content: *.html, *.xml.

Import & Export


Import
Tidy
Model
Visualise
Export

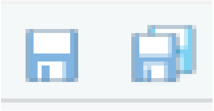
R is capable of working with many different file types. In my personal experience, I have worked with:

- Regular Documents: *. txt, *.xlsx ;
- Geographic Information: *.shp
- R code: *.r
- R objects: *.rds, *.rdata;
- Images:
- Large data files:
- Web content:

.r / .rData / .rds

These three are file types unique to R.

- `.r` files contain **r scripts**. These are the files where you codes will be saved. →

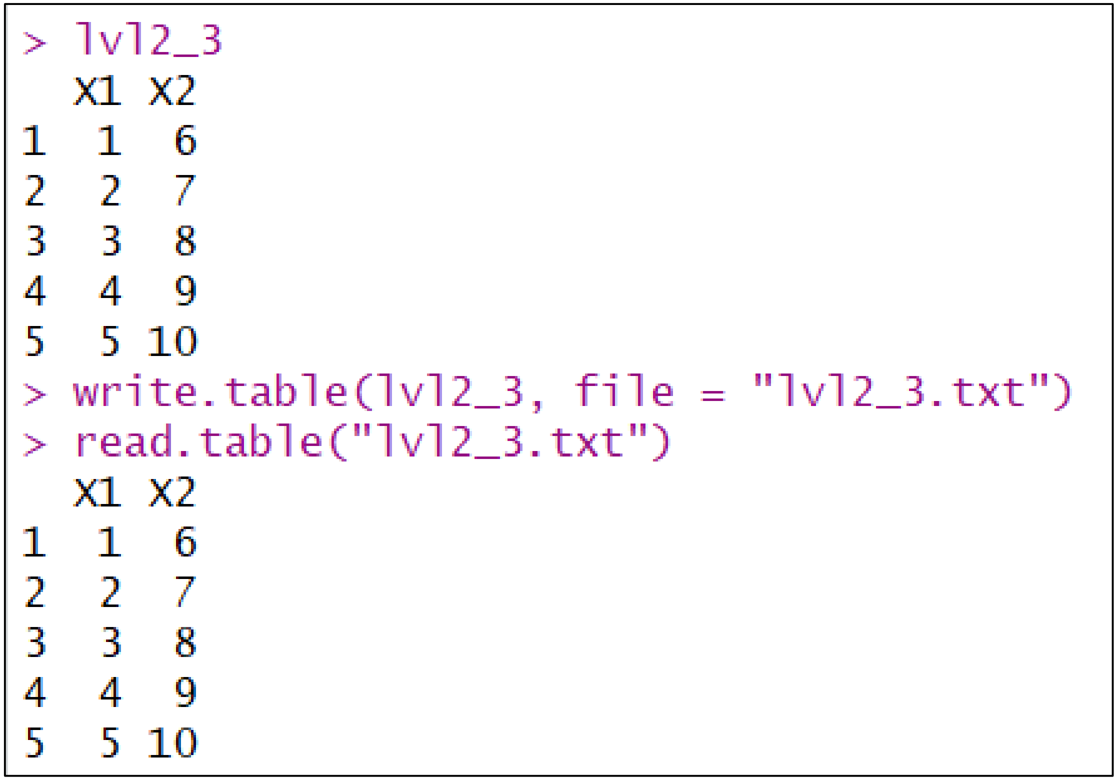


- `.rdata` can save **multiple r objects**. Before you close R, sometimes the software will ask you if you'd like to the current workspace to an `.rdata` file. Proceed with caution. → `save()`

- `.rds` can only save **a single r object**. The advantage is that it can maintain the object class. It's also good at compressing file size. → `write_rds(); saveRDS(); read_rds(); readRDS()`

.txt and .xlsx

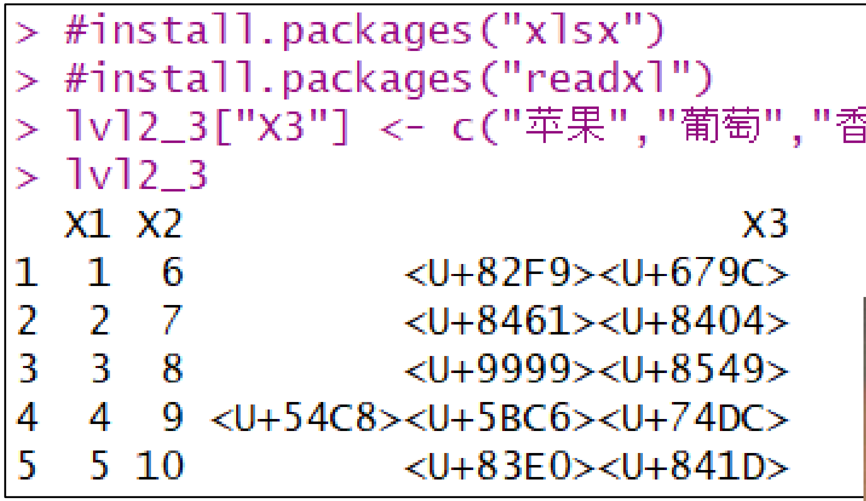
These two are probably the most common file types to import and export. You might have worked with them via **Notepad** or **Excel**.



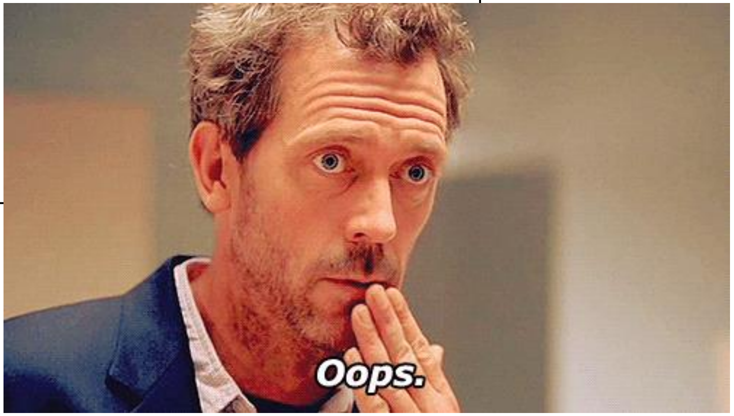
```
> lvl2_3
  X1 X2
1  1  6
2  2  7
3  3  8
4  4  9
5  5 10
> write.table(lvl2_3, file = "lvl2_3.txt")
> read.table("lvl2_3.txt")
  X1 X2
1  1  6
2  2  7
3  3  8
4  4  9
5  5 10
```

.txt and .xlsx

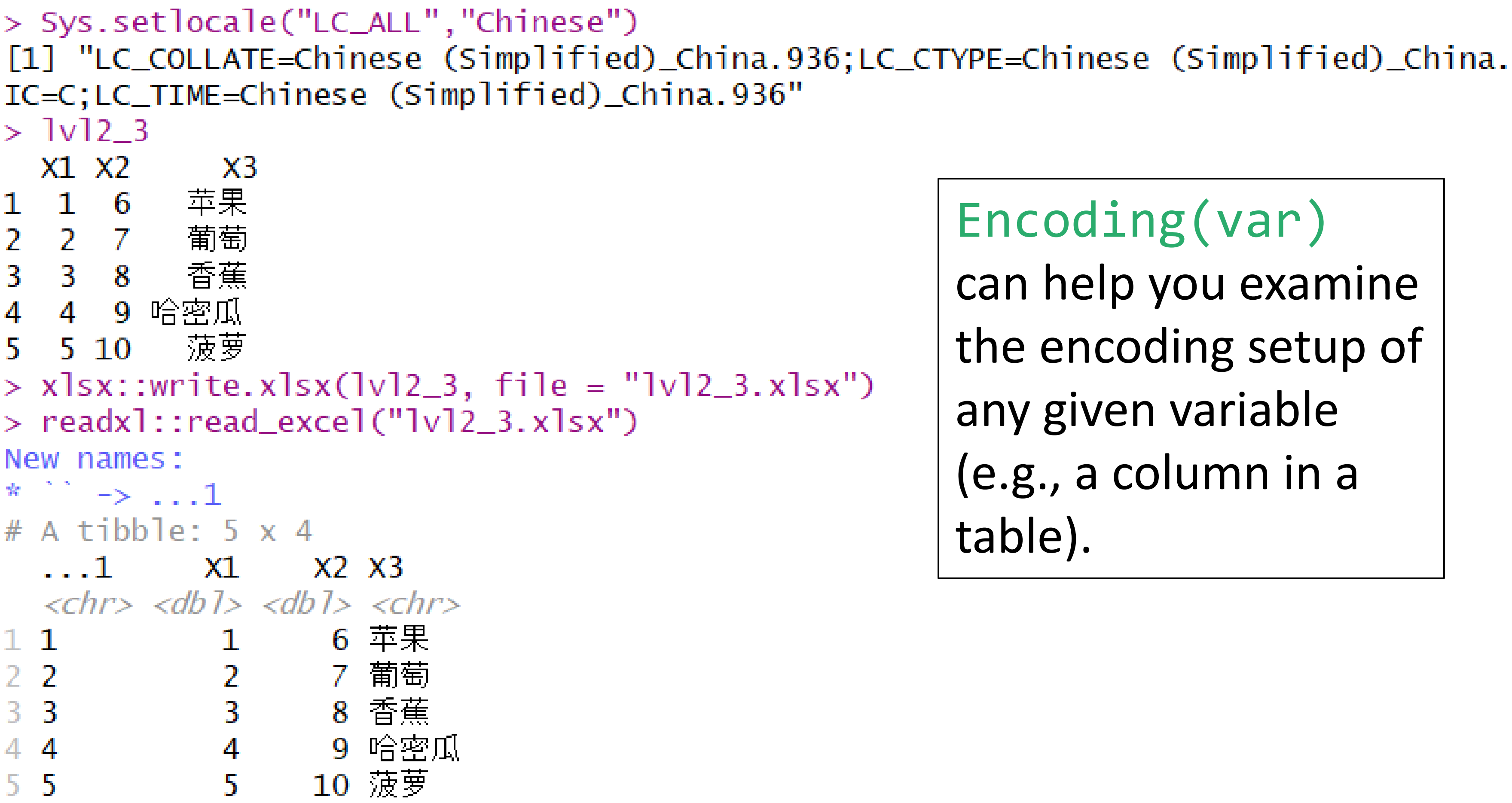
These two are probably the model common types of file type import. You might have worked with them via **Notepad** or **Excel**.



```
> #install.packages("xlsx")
> #install.packages("readxl")
> lvl2_3["X3"] <- c("苹果","葡萄","香蕉","哈密瓜","菠萝")
> lvl2_3
  X1 X2                         X3
1  1  6         <U+82F9><U+679C>
2  2  7         <U+8461><U+8404>
3  3  8         <U+9999><U+8549>
4  4  9 <U+54C8><U+5BC6><U+74DC>
5  5 10         <U+83E0><U+841D>
```



.txt and .xlsx

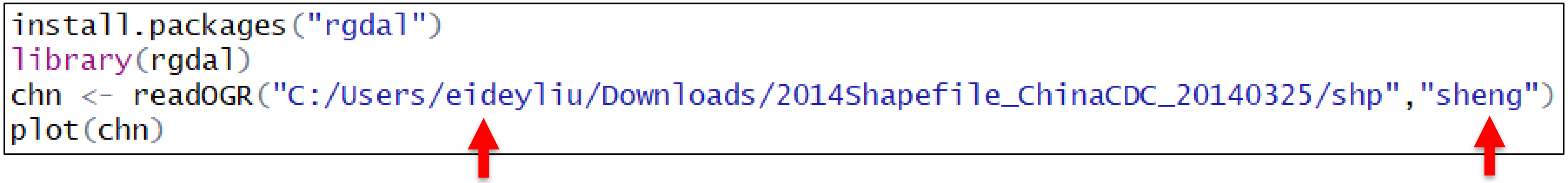


```
> Sys.setlocale("LC_ALL","Chinese")
[1] "LC_COLLATE=Chinese (Simplified)_China.936;LC_CTYPE=Chinese (Simplified)_China.
IC=C;LC_TIME=Chinese (Simplified)_China.936"
> lvl2_3
  X1 X2     X3
1  1  6   苹果
2  2  7   葡萄
3  3  8   香蕉
4  4  9 哈密瓜
5  5 10   菠萝
> xlsx::write.xlsx(lvl2_3, file = "lvl2_3.xlsx")
> readxl::read_excel("lvl2_3.xlsx")
New names:
* `` -> ...1
# A tibble: 5 x 4
  ...1     X1    X2 X3
  <chr> <dbl> <dbl> <chr>
1 1         1     6 苹果
2 2         2     7 葡萄
3 3         3     8 香蕉
4 4         4     9 哈密瓜
5 5         5    10 菠萝
```

`Encoding(var)` can help you examine the encoding setup of any given variable (e.g., a column in a table).

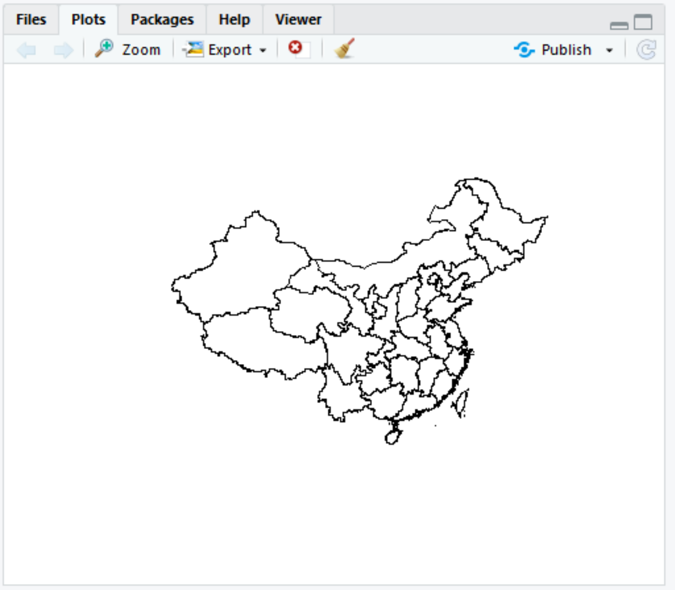
.shp

Shape files contains geographic information about locations in the format of polygon (area), point, or raster (grid-based).



```
install.packages("rgdal")
library(rgdal)
chn <- readOGR("C:/Users/eideyliu/Downloads/2014Shapefile_ChinaCDC_20140325/shp","sheng")
plot(chn)
```

Advanced options:
(1) sf
(2) Mapview
(3) Leaflet



RECAP: Useful Packages

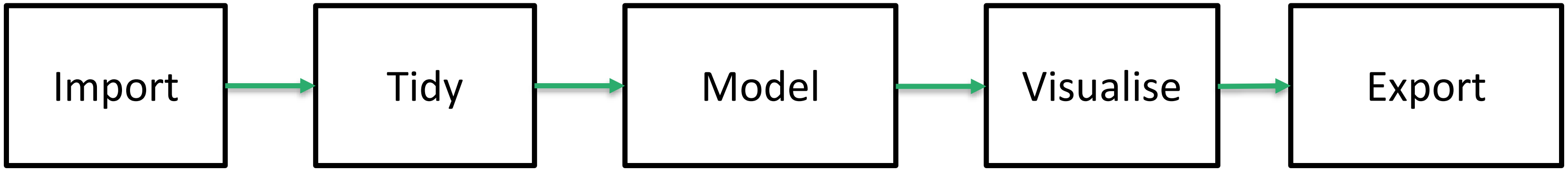
Regular Documents

- `readxl`
- `writexl`
- `xlsx`

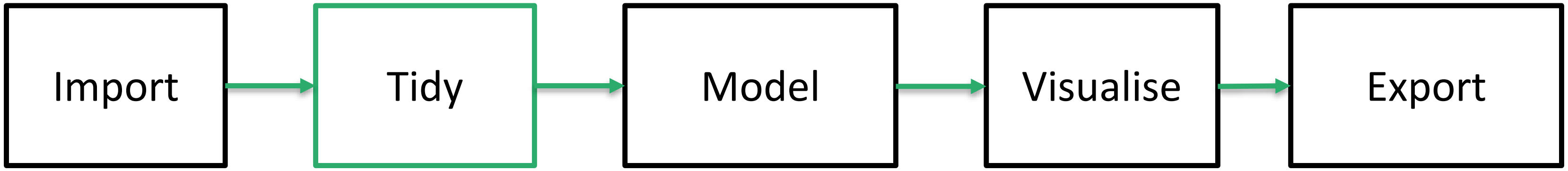
Geographic Information

- `rgdal`
- `sf`

Your flow of work


Import → Tidy → Model → Visualise → Export

Your flow of work



Import

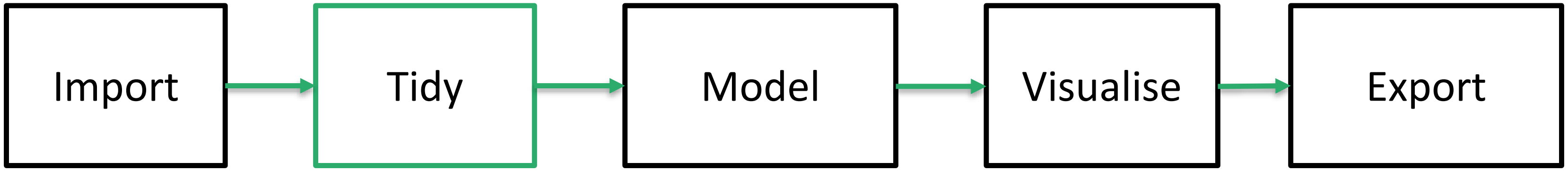
Tidy

Model

Visualise

Export

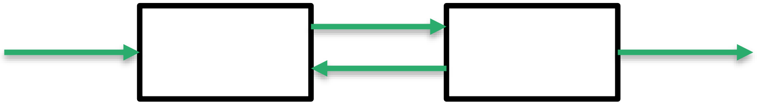
Import & Export



Import → Tidy → Model → Visualise → Export

Tidying your data entails:

- **Convert/ generate** new data from raw data so that they become meaningful to your analysis.
- **Organize** your data in a way that is well structured, consistent, and easy to work with for the Modelling and Visualization steps;



Converting between classes

Level 1 (Highest)

- List

Level 2

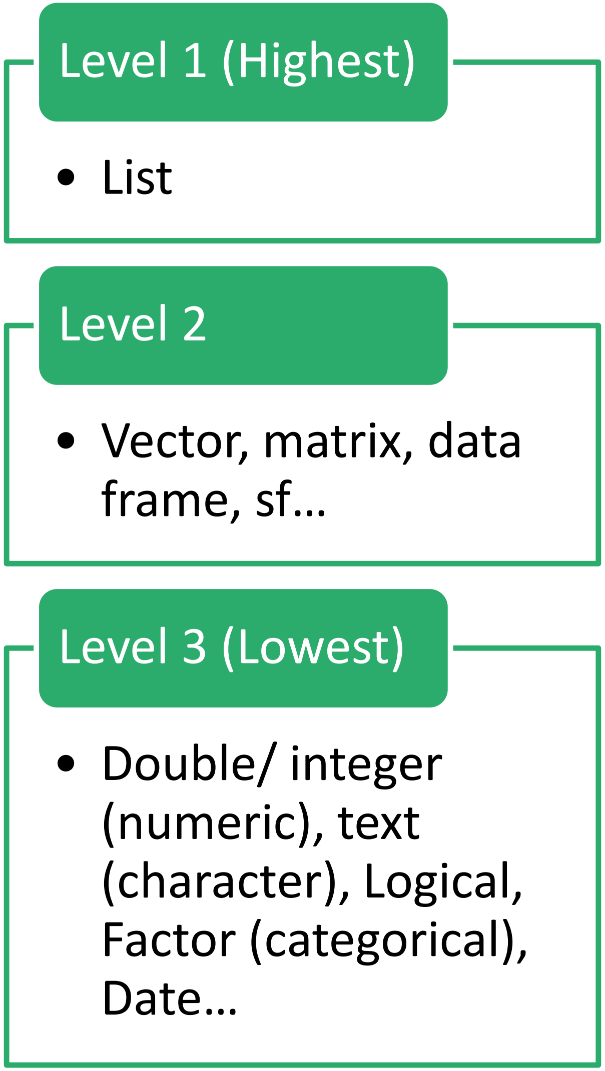
- Vector, matrix, data frame, sf…

Level 3 (Lowest)

- Double/ integer (numeric), text (character), Logical, Factor (categorical), Date…

The general rule is if you are trying to **convert into objects that allows for the same or higher dimensions**, you can convert between classes using functions with the `as.CLASSNAME()`, e.g., `as.numeric(); as.matrix()`.

Converting between classes



Level 1 (Highest)

- List

Level 2

- Vector, matrix, data frame, sf…

Level 3 (Lowest)

- Double/ integer (numeric), text (character), Logical, Factor (categorical), Date…

However, it will need to depend on specific cases:

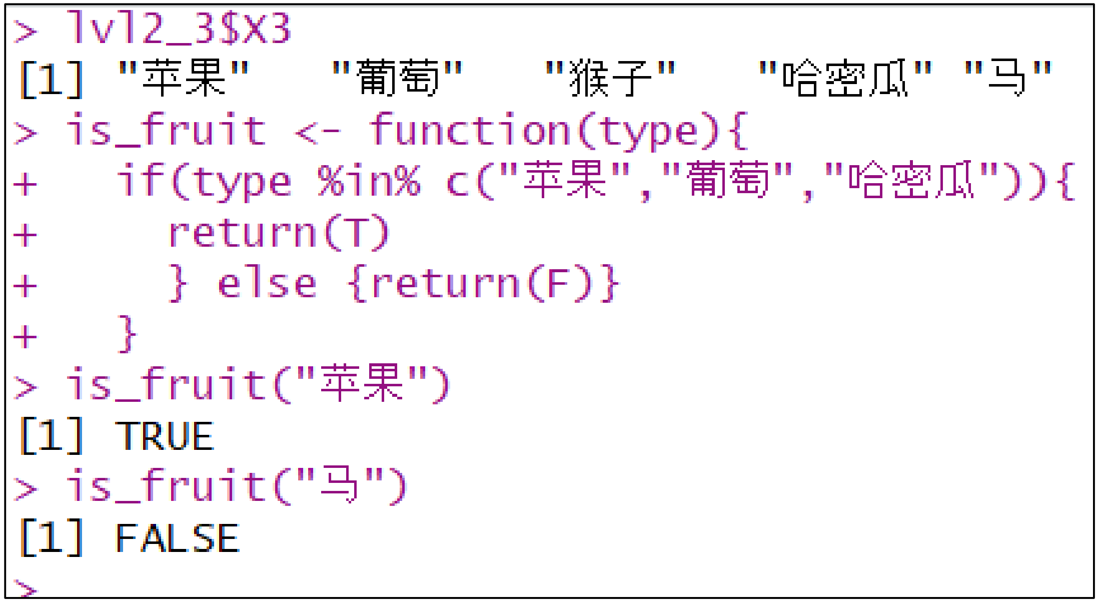
- Integer → text?
- Text → Integer?
- Integer → Logical?
- Logical → Integer?
- Vector → Matrix?
- Matrix → Vector?

It's important to keep an on if conversion processes are doing what you want them to do.

IF statements

IF statements are a one-time thing:

- a **IF** statement means something will happen for all when certain conditions are met.



```
> lvl2_3$X3
[1] "苹果"    "葡萄"    "猴子"    "哈密瓜"  "马"
> is_fruit <- function(type){
+   if(type %in% c("苹果","葡萄","哈密瓜")){
+     return(T)
+     } else {return(F)}
+   }
> is_fruit("苹果")
[1] TRUE
> is_fruit("马")
[1] FALSE
>
```

Loops

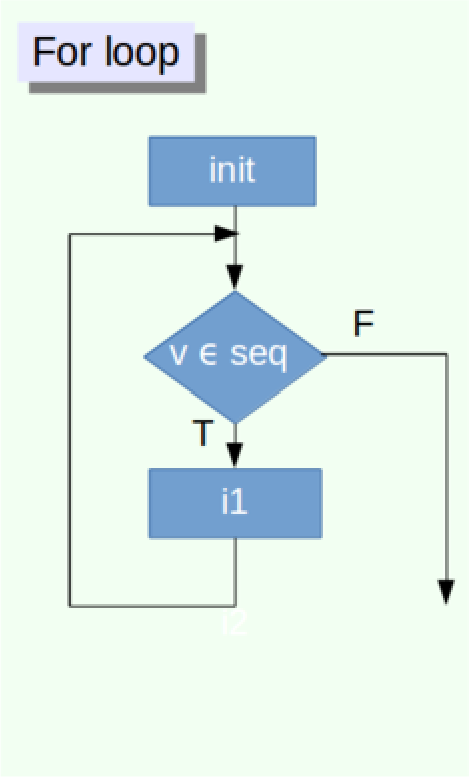
There are three basic types of loops in R:

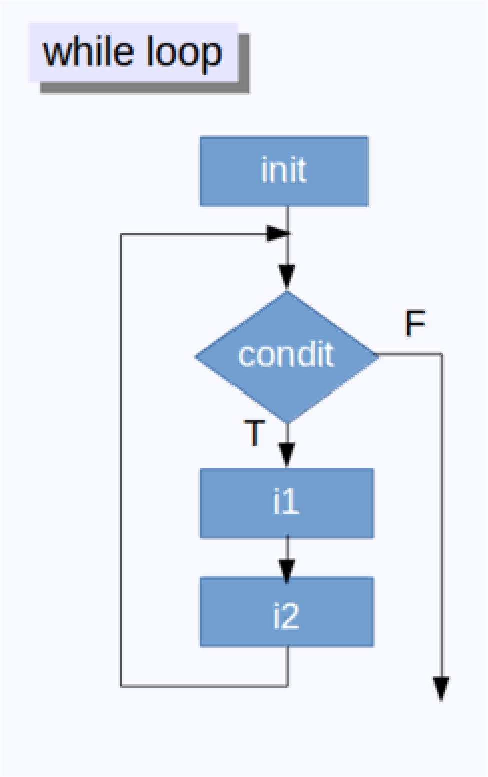
- a **FOR** loop is used when you want SOMETHING to happen for a range of conditions;

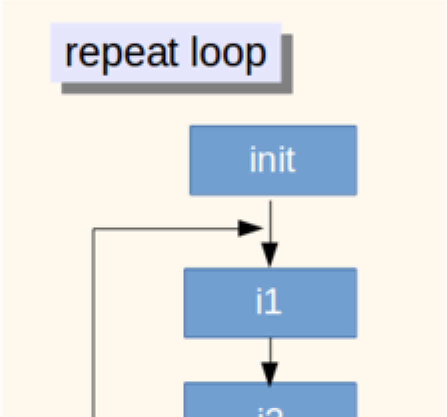
- a **REPEAT** loop is used when you want SOMETHING to happen for as long as certain conditions are met;

- a **WHILE** loop is used when you want SOMETHING to happen for as long as certain conditions are not met.

Loops

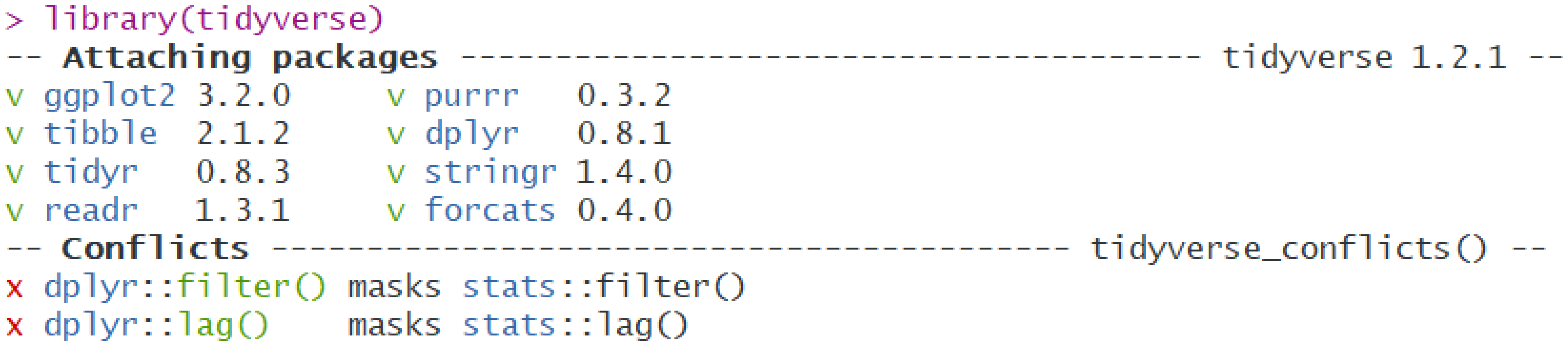






https://www.datacamp.com/community/tutorials/tutorial-on-loops-in-r
Carlo Fanara, 2018

Tidyverse



```
> library(tidyverse)
-- Attaching packages --------------------------------------- tidyverse 1.2.1 --
v ggplot2 3.2.0     v purrr   0.3.2
v tibble  2.1.2     v dplyr   0.8.1
v tidyr   0.8.3     v stringr 1.4.0
v readr   1.3.1     v forcats 0.4.0
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
```

Tidyverse

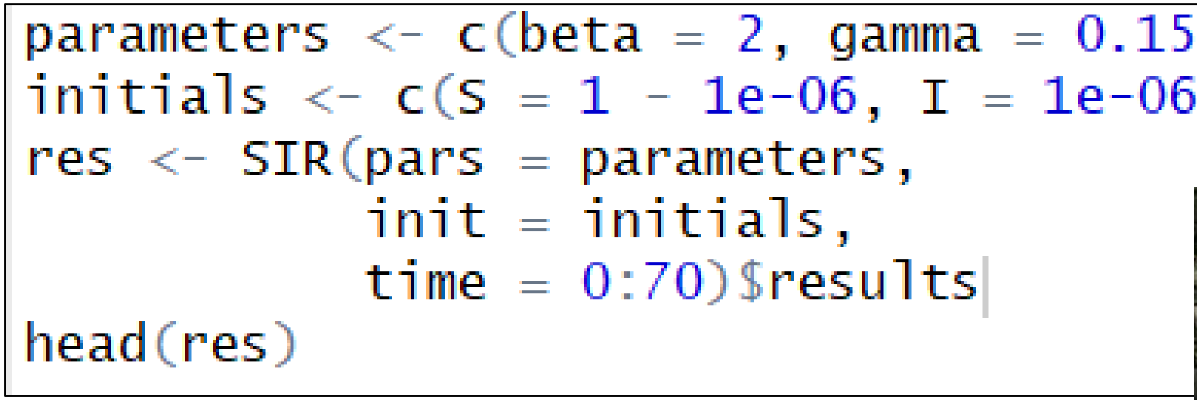
Package	Usage
ggplot2	Visualization
tibble	Data storage
tidyr	Data cleaning
readr	Import data
purrr	Application of functions to lists of objects; advance conversion
dplyr	Data wrangling
stringr	Work with texts
forcats	For categorical variables

Useful Commands in Tidyverse

- `select`
- `mutate`
- `filter`
- `gather`
- `spread`
- `join`

Let’s try it out with a toy model!

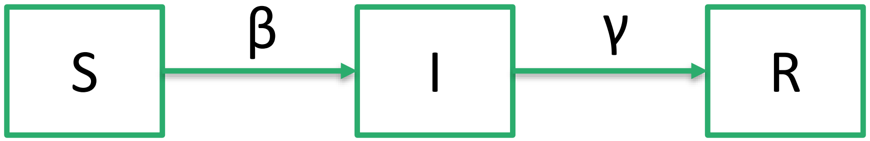
Disease ***Birdy Pox*** is a (fictional) infectious disease with a transmission rate (Beta) of 2 and a recovery rate (Gamma) of 0.15. This outbreak within a population of 1,000,000 is a result of 1 infectious individual (initial condition). We observe the outbreak progression for 70 days.



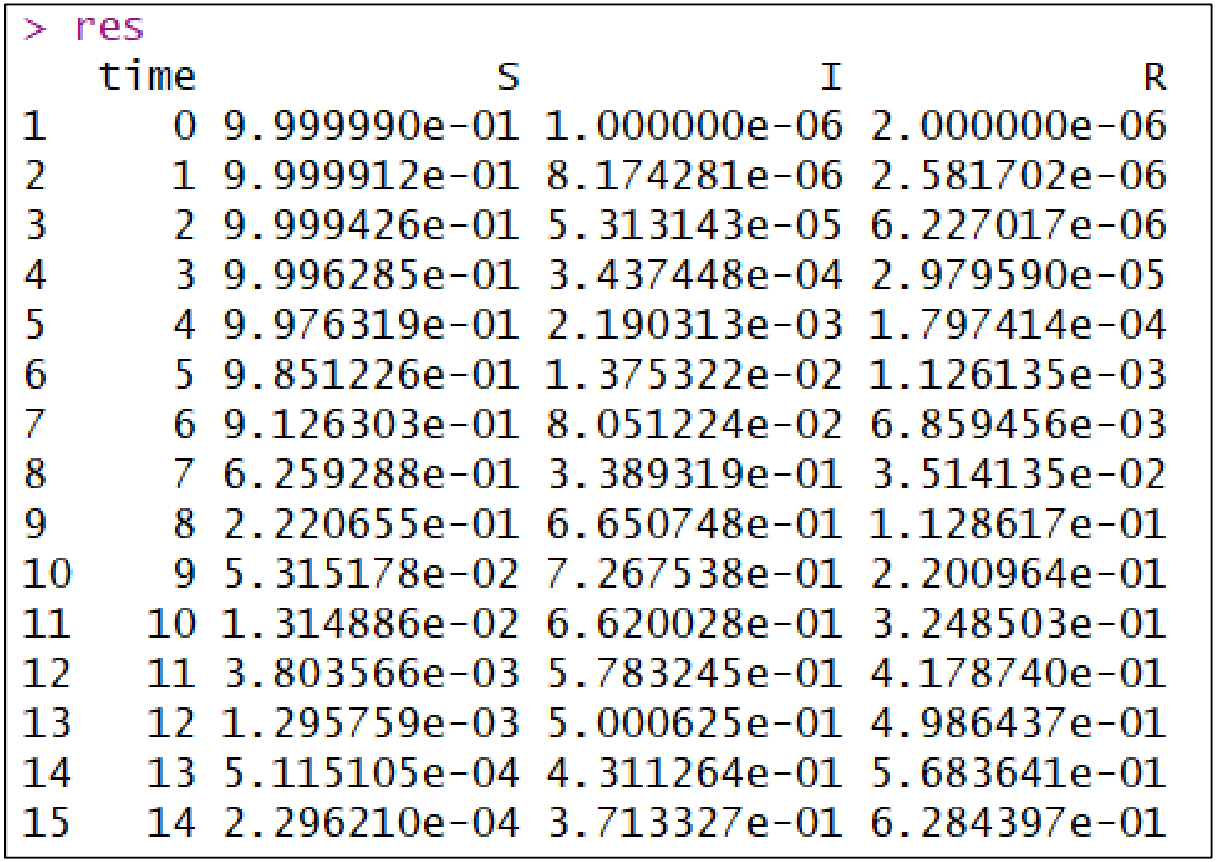
```
parameters <- c(beta = 2, gamma = 0.15)
initials <- c(S = 1 - 1e-06, I = 1e-06, R = 0)
res <- SIR(pars = parameters,
           init = initials,
           time = 0:70)$results
head(res)
```

Let's try it out with a toy model!

Disease ***Birdy Pox*** is a (fictional) infectious disease with a transmission rate (Beta) of 2 and a recovery rate (Gamma) of 0.15. This outbreak within a population of 1,000,000 is a result of 1 infectious individual (initial condition). We observe the outbreak progression for 70 days.



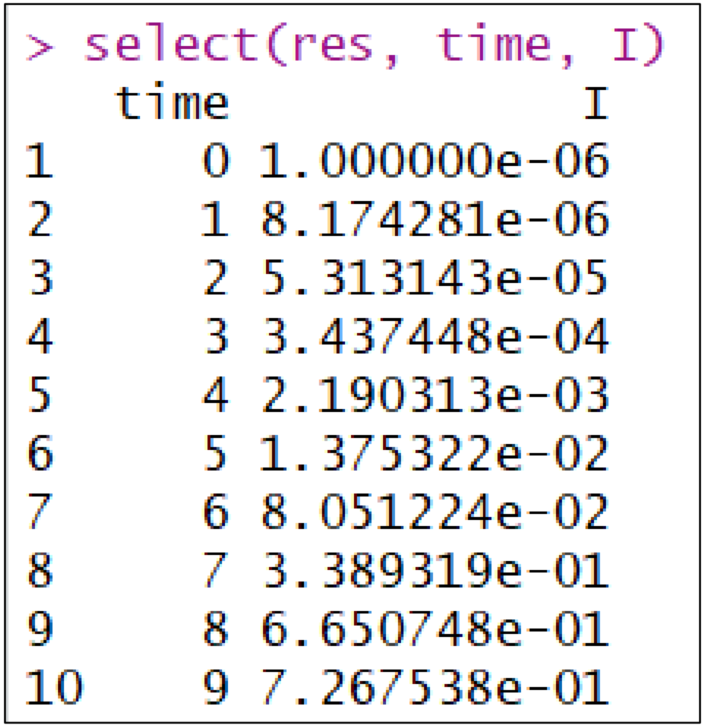
Let’s try it out with a toy model!



```
> res
   time            S            I            R
1     0 9.999990e-01 1.000000e-06 2.000000e-06
2     1 9.999912e-01 8.174281e-06 2.581702e-06
3     2 9.999426e-01 5.313143e-05 6.227017e-06
4     3 9.996285e-01 3.437448e-04 2.979590e-05
5     4 9.976319e-01 2.190313e-03 1.797414e-04
6     5 9.851226e-01 1.375322e-02 1.126135e-03
7     6 9.126303e-01 8.051224e-02 6.859456e-03
8     7 6.259288e-01 3.389319e-01 3.514135e-02
9     8 2.220655e-01 6.650748e-01 1.128617e-01
10    9 5.315178e-02 7.267538e-01 2.200964e-01
11   10 1.314886e-02 6.620028e-01 3.248503e-01
12   11 3.803566e-03 5.783245e-01 4.178740e-01
13   12 1.295759e-03 5.000625e-01 4.986437e-01
14   13 5.115105e-04 4.311264e-01 5.683641e-01
15   14 2.296210e-04 3.713327e-01 6.284397e-01
```

select

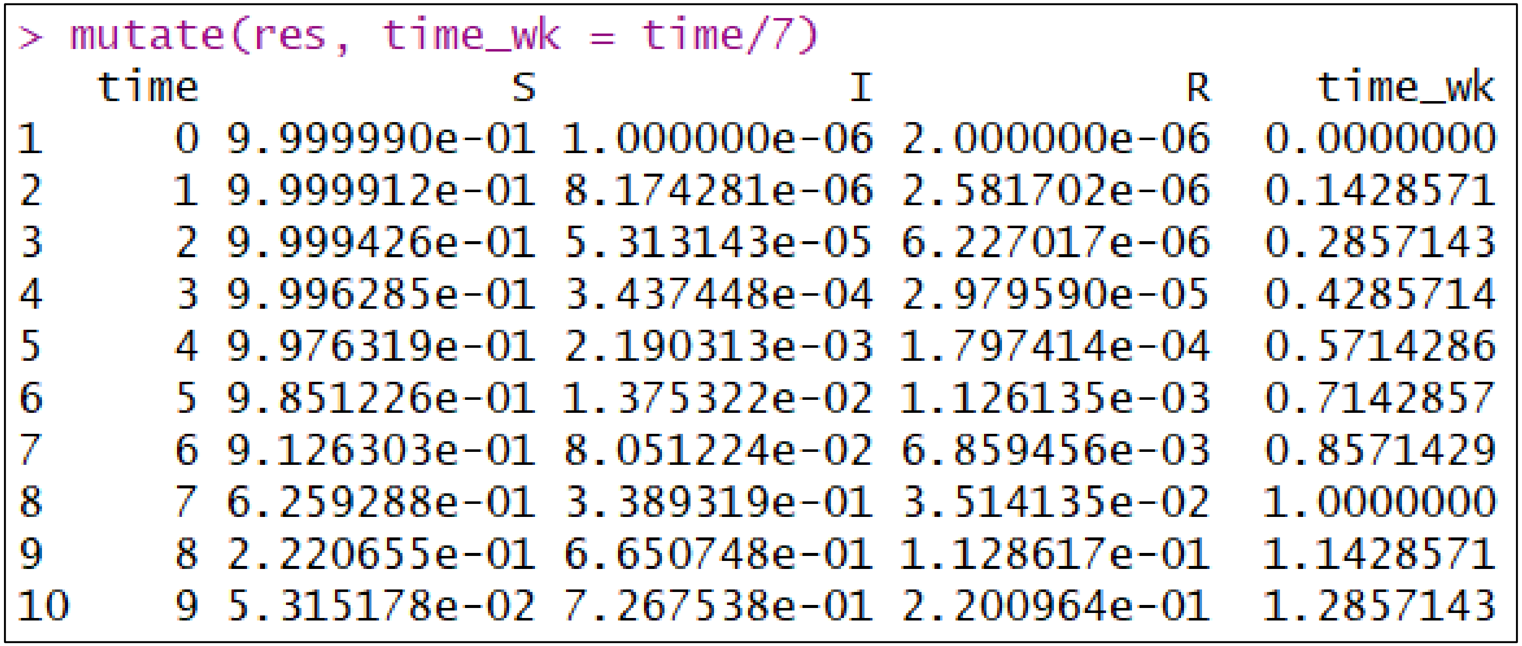
The function select helps you trim your working table based on needs: keeping the relevant variables, getting rid of the ones that are not needed. **What if we are only interested in I?**



```
> select(res, time, I)
   time            I
1     0 1.000000e-06
2     1 8.174281e-06
3     2 5.313143e-05
4     3 3.437448e-04
5     4 2.190313e-03
6     5 1.375322e-02
7     6 8.051224e-02
8     7 3.389319e-01
9     8 6.650748e-01
10    9 7.267538e-01
```

mutate

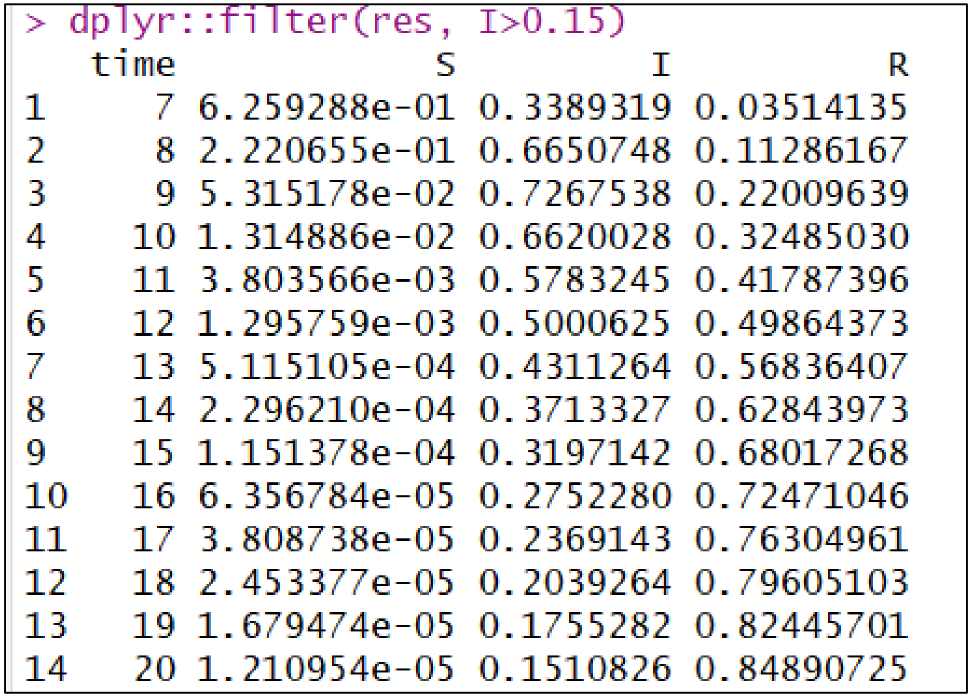
The function mutate helps you convert/ compute based on variables that already exist in the table provided. **What if we want to convert the unit from time from days to weeks?**



```
> mutate(res, time_wk = time/7)
   time            S            I            R   time_wk
1     0 9.999990e-01 1.000000e-06 2.000000e-06 0.0000000
2     1 9.999912e-01 8.174281e-06 2.581702e-06 0.1428571
3     2 9.999426e-01 5.313143e-05 6.227017e-06 0.2857143
4     3 9.996285e-01 3.437448e-04 2.979590e-05 0.4285714
5     4 9.976319e-01 2.190313e-03 1.797414e-04 0.5714286
6     5 9.851226e-01 1.375322e-02 1.126135e-03 0.7142857
7     6 9.126303e-01 8.051224e-02 6.859456e-03 0.8571429
8     7 6.259288e-01 3.389319e-01 3.514135e-02 1.0000000
9     8 2.220655e-01 6.650748e-01 1.128617e-01 1.1428571
10    9 5.315178e-02 7.267538e-01 2.200964e-01 1.2857143
```

filter

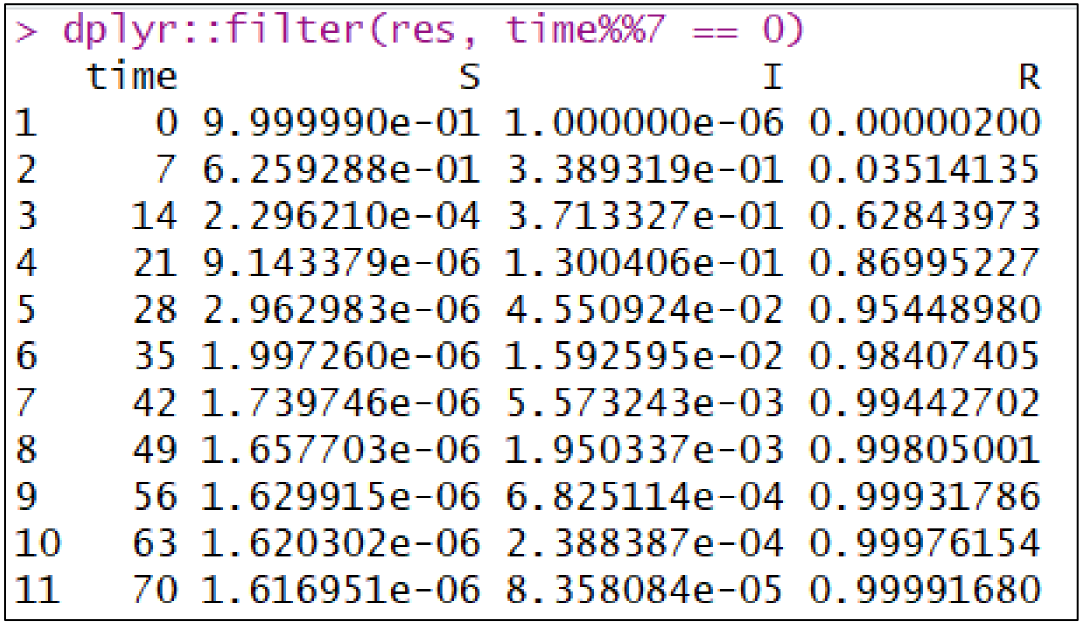
The function `filter` is a form of subsetting. It is capable of processing multiple filter based on multiple conditions. <u>**What if we are only interested in looking at the time when proportion of I is greater than 0.15?**</u>



```
> dplyr::filter(res, I>0.15)
   time            S         I          R
1     7 6.259288e-01 0.3389319 0.03514135
2     8 2.220655e-01 0.6650748 0.11286167
3     9 5.315178e-02 0.7267538 0.22009639
4    10 1.314886e-02 0.6620028 0.32485030
5    11 3.803566e-03 0.5783245 0.41787396
6    12 1.295759e-03 0.5000625 0.49864373
7    13 5.115105e-04 0.4311264 0.56836407
8    14 2.296210e-04 0.3713327 0.62843973
9    15 1.151378e-04 0.3197142 0.68017268
10   16 6.356784e-05 0.2752280 0.72471046
11   17 3.808738e-05 0.2369143 0.76304961
12   18 2.453377e-05 0.2039264 0.79605103
13   19 1.679474e-05 0.1755282 0.82445701
14   20 1.210954e-05 0.1510826 0.84890725
```

filter

The function `filter` is a form of subsetting. It is capable of processing multiple filter based on multiple conditions. **What if we are only interested in looking at this same table but only at the end of each week?**



```
> dplyr::filter(res, time%%7 == 0)
   time            S            I          R
1     0 9.999990e-01 1.000000e-06 0.00000200
2     7 6.259288e-01 3.389319e-01 0.03514135
3    14 2.296210e-04 3.713327e-01 0.62843973
4    21 9.143379e-06 1.300406e-01 0.86995227
5    28 2.962983e-06 4.550924e-02 0.95448980
6    35 1.997260e-06 1.592595e-02 0.98407405
7    42 1.739746e-06 5.573243e-03 0.99442702
8    49 1.657703e-06 1.950337e-03 0.99805001
9    56 1.629915e-06 6.825114e-04 0.99931786
10   63 1.620302e-06 2.388387e-04 0.99976154
11   70 1.616951e-06 8.358084e-05 0.99991680
```

`gather and spread`

The function `gather` changes tables from wide to long form.

- A wide table looks like the following:

Time	S	I	R
0	a	c	e
1	b	d	f

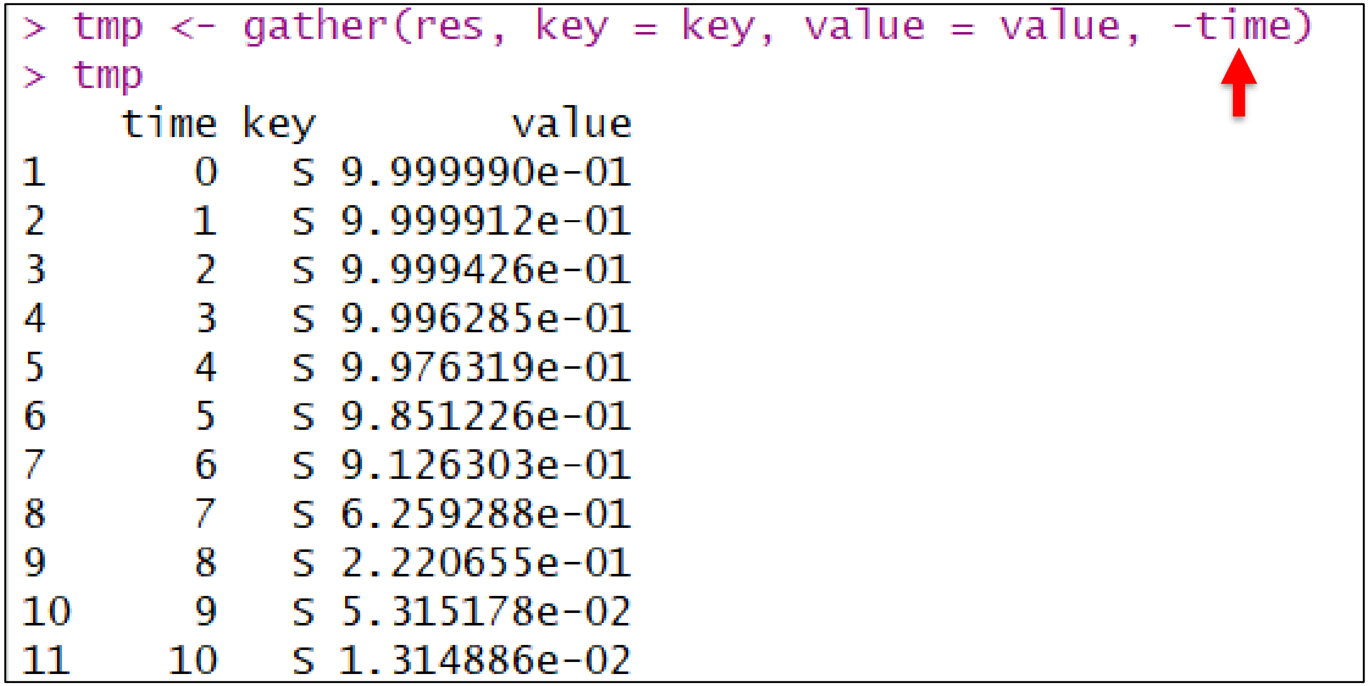
gather and spread

The function gather changes tables from wide to long form. Using the same example, a long table would look like something like this:

Time	key	value
0	S	a
1	S	b
0	I	c
1	I	d
0	R	e
1	R	f

gather and spread

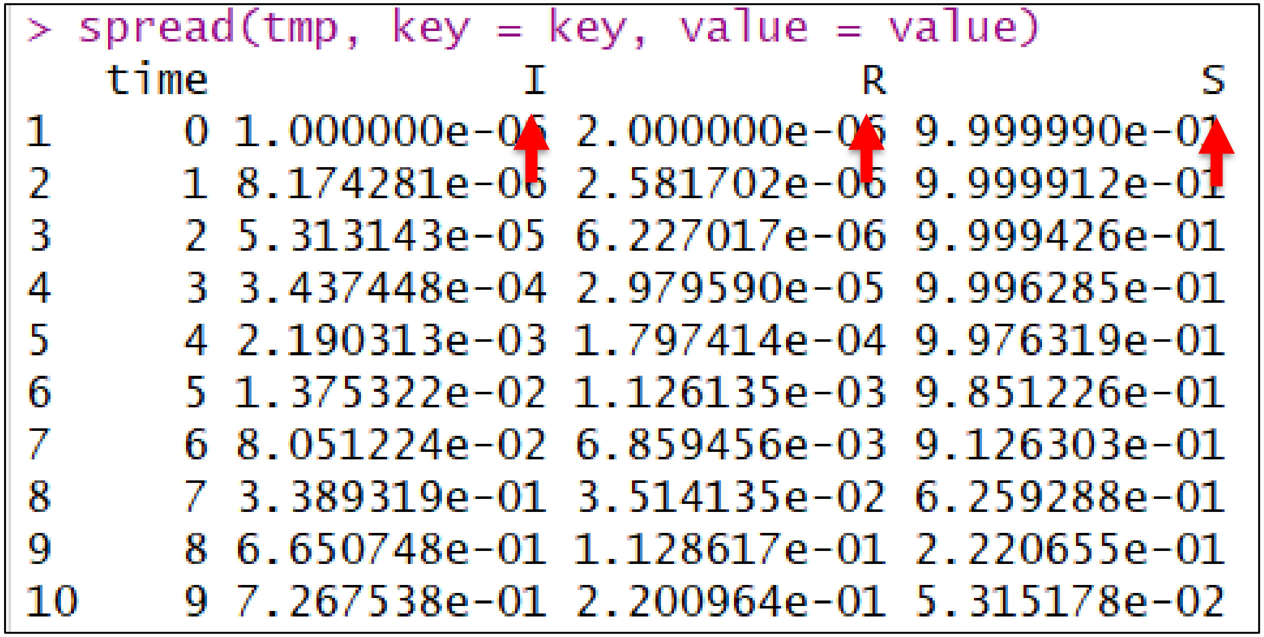
The function gather changes tables from wide to long form. To implement:



```
> tmp <- gather(res, key = key, value = value, -time)
> tmp
   time key        value
1     0   S 9.999990e-01
2     1   S 9.999912e-01
3     2   S 9.999426e-01
4     3   S 9.996285e-01
5     4   S 9.976319e-01
6     5   S 9.851226e-01
7     6   S 9.126303e-01
8     7   S 6.259288e-01
9     8   S 2.220655e-01
10    9   S 5.315178e-02
11   10   S 1.314886e-02
```

gather and spread

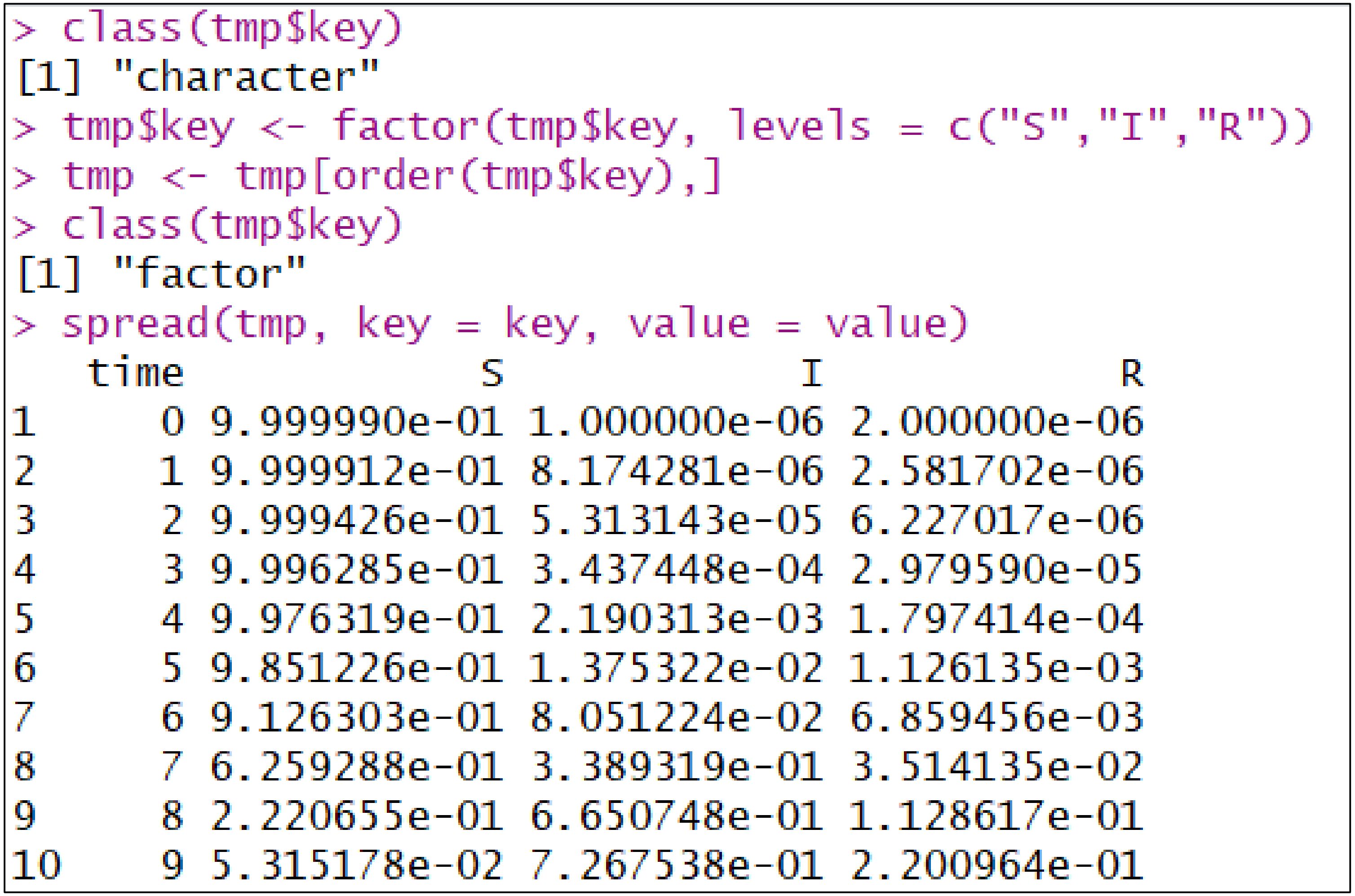
The function spread changes tables from long to wide form. To implement:



```
> spread(tmp, key = key, value = value)
   time            I            R            S
1     0 1.000000e-05 2.000000e-05 9.999990e-01
2     1 8.174281e-06 2.581702e-06 9.999912e-01
3     2 5.313143e-05 6.227017e-06 9.999426e-01
4     3 3.437448e-04 2.979590e-05 9.996285e-01
5     4 2.190313e-03 1.797414e-04 9.976319e-01
6     5 1.375322e-02 1.126135e-03 9.851226e-01
7     6 8.051224e-02 6.859456e-03 9.126303e-01
8     7 3.389319e-01 3.514135e-02 6.259288e-01
9     8 6.650748e-01 1.128617e-01 2.220655e-01
10    9 7.267538e-01 2.200964e-01 5.315178e-02
```

gather and spread

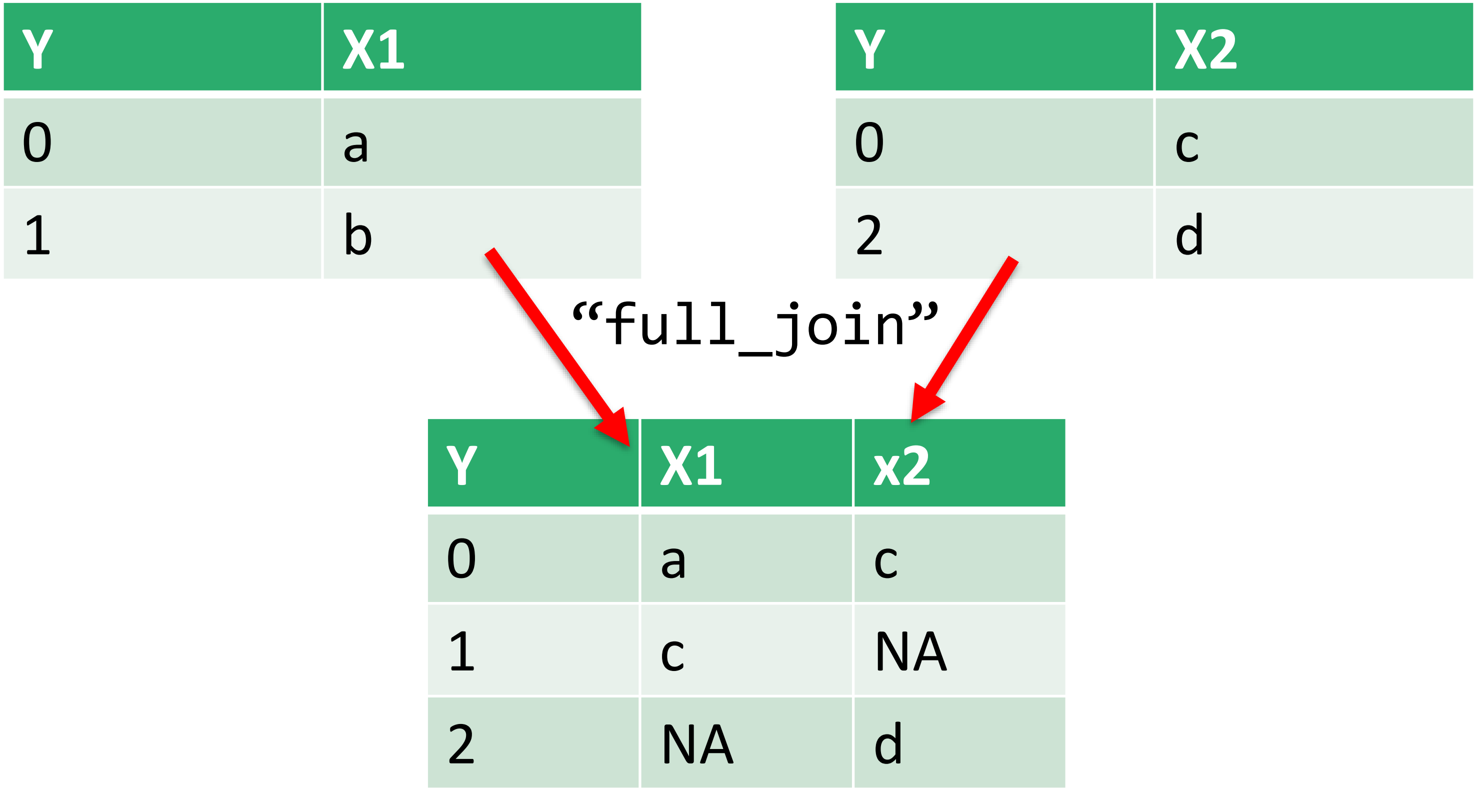
A fix:



```
> class(tmp$key)
[1] "character"
> tmp$key <- factor(tmp$key, levels = c("S","I","R"))
> tmp <- tmp[order(tmp$key),]
> class(tmp$key)
[1] "factor"
> spread(tmp, key = key, value = value)
   time            S            I            R
1     0 9.999990e-01 1.000000e-06 2.000000e-06
2     1 9.999912e-01 8.174281e-06 2.581702e-06
3     2 9.999426e-01 5.313143e-05 6.227017e-06
4     3 9.996285e-01 3.437448e-04 2.979590e-05
5     4 9.976319e-01 2.190313e-03 1.797414e-04
6     5 9.851226e-01 1.375322e-02 1.126135e-03
7     6 9.126303e-01 8.051224e-02 6.859456e-03
8     7 6.259288e-01 3.389319e-01 3.514135e-02
9     8 2.220655e-01 6.650748e-01 1.128617e-01
10    9 5.315178e-02 7.267538e-01 2.200964e-01
```

join

The function join is merges two tables based on certain column.



Y	X1
0	a
1	b

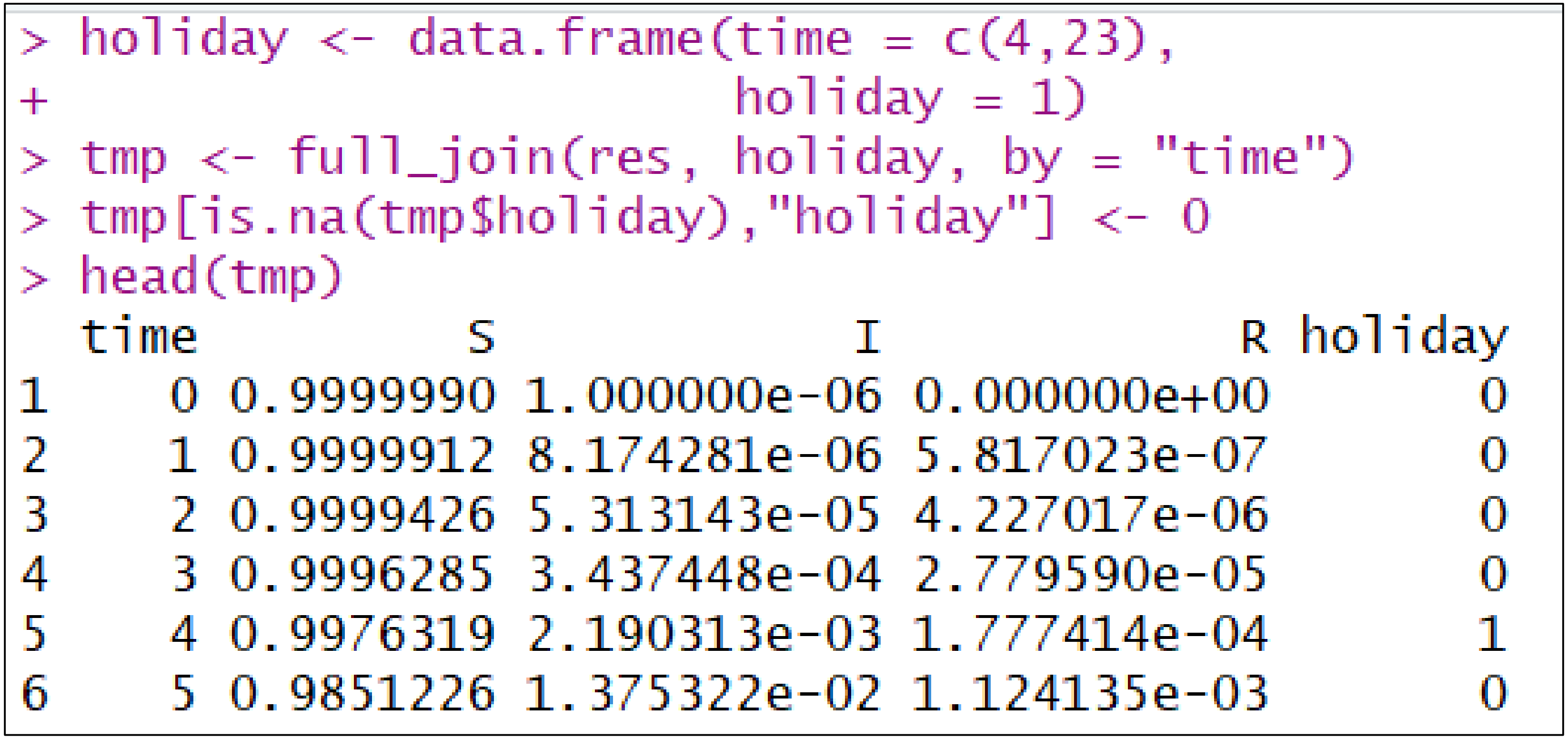
Y	X2
0	c
2	d

“full_join”

Y	X1	x2
0	a	c
1	c	NA
2	NA	d

join

The function `join` is merges two tables based on certain column.



```
> holiday <- data.frame(time = c(4,23),
+                       holiday = 1)
> tmp <- full_join(res, holiday, by = "time")
> tmp[is.na(tmp$holiday),"holiday"] <- 0
> head(tmp)
  time         S            I            R holiday
1    0 0.9999990 1.000000e-06 0.000000e+00       0
2    1 0.9999912 8.174281e-06 5.817023e-07       0
3    2 0.9999426 5.313143e-05 4.227017e-06       0
4    3 0.9996285 3.437448e-04 2.779590e-05       0
5    4 0.9976319 2.190313e-03 1.777414e-04       1
6    5 0.9851226 1.375322e-02 1.124135e-03       0
```

Advance option: %>%

These are read as **“pipes”**. You can think of these as “and then”. It chains functions together. While doing data cleaning, you may want to do multiple things to the same object – this is when pipes become particularly useful.

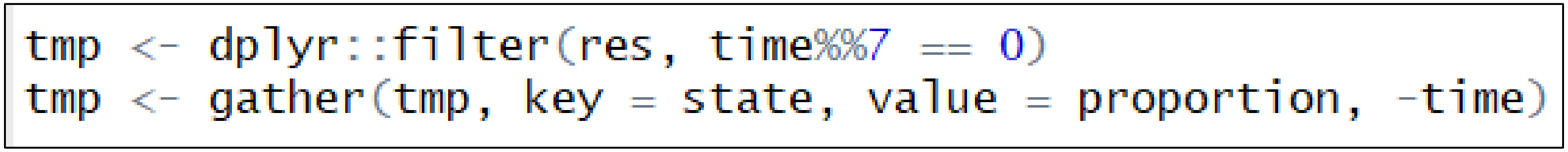
If f() and g() are both functions:

- g(f(x))
- x %>% f %>% g

These two expressions mean the exact same things.

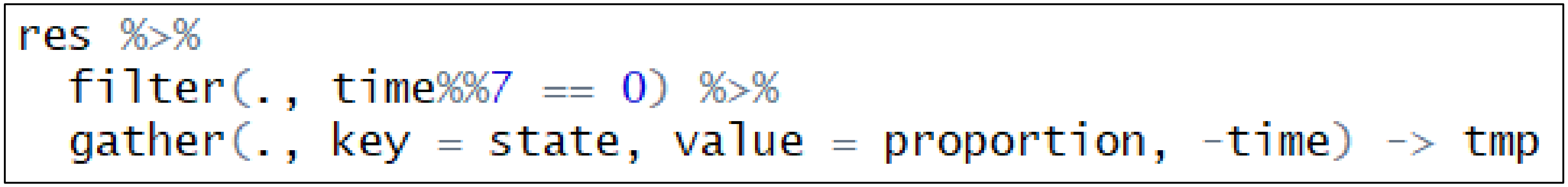
Advance option: %>%

We want to first filter the original table to only look at the estimates at every week-end, and then we want to convert the table to a long table:



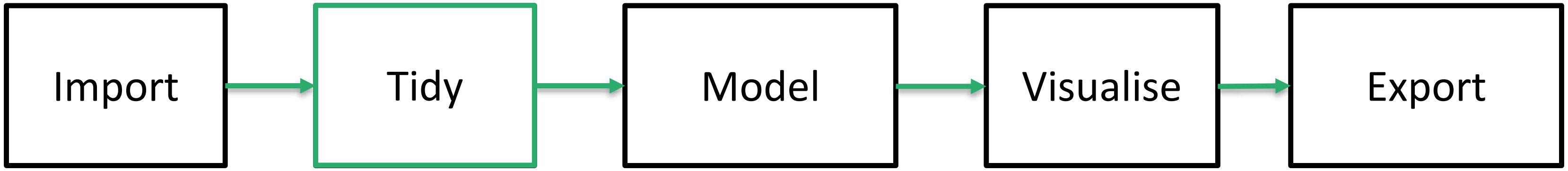
```
tmp <- dplyr::filter(res, time%%7 == 0)
tmp <- gather(tmp, key = state, value = proportion, -time)
```

VS



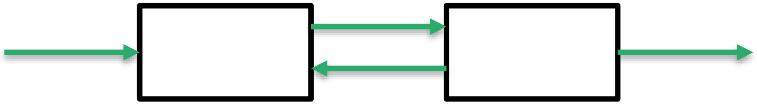
```
res %>%
  filter(., time%%7 == 0) %>%
  gather(., key = state, value = proportion, -time) -> tmp
```

RECAP: Import & Export



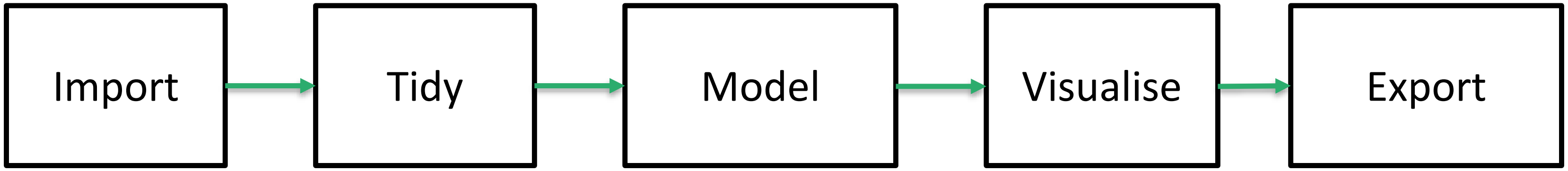
Tidying your data entails:

- **Convert/ generate** new data from raw data so that they become meaningful to your analysis.
- **Organize** your data in a way that is well structured, consistent, and easy to work with for the Modelling and Visualization steps;



tidyverse

Your flow of work


Import

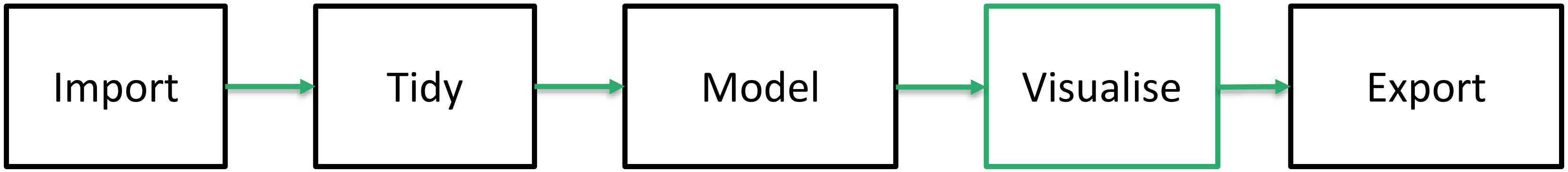
Tidy

Model

Visualise

Export

Your flow of work


Import

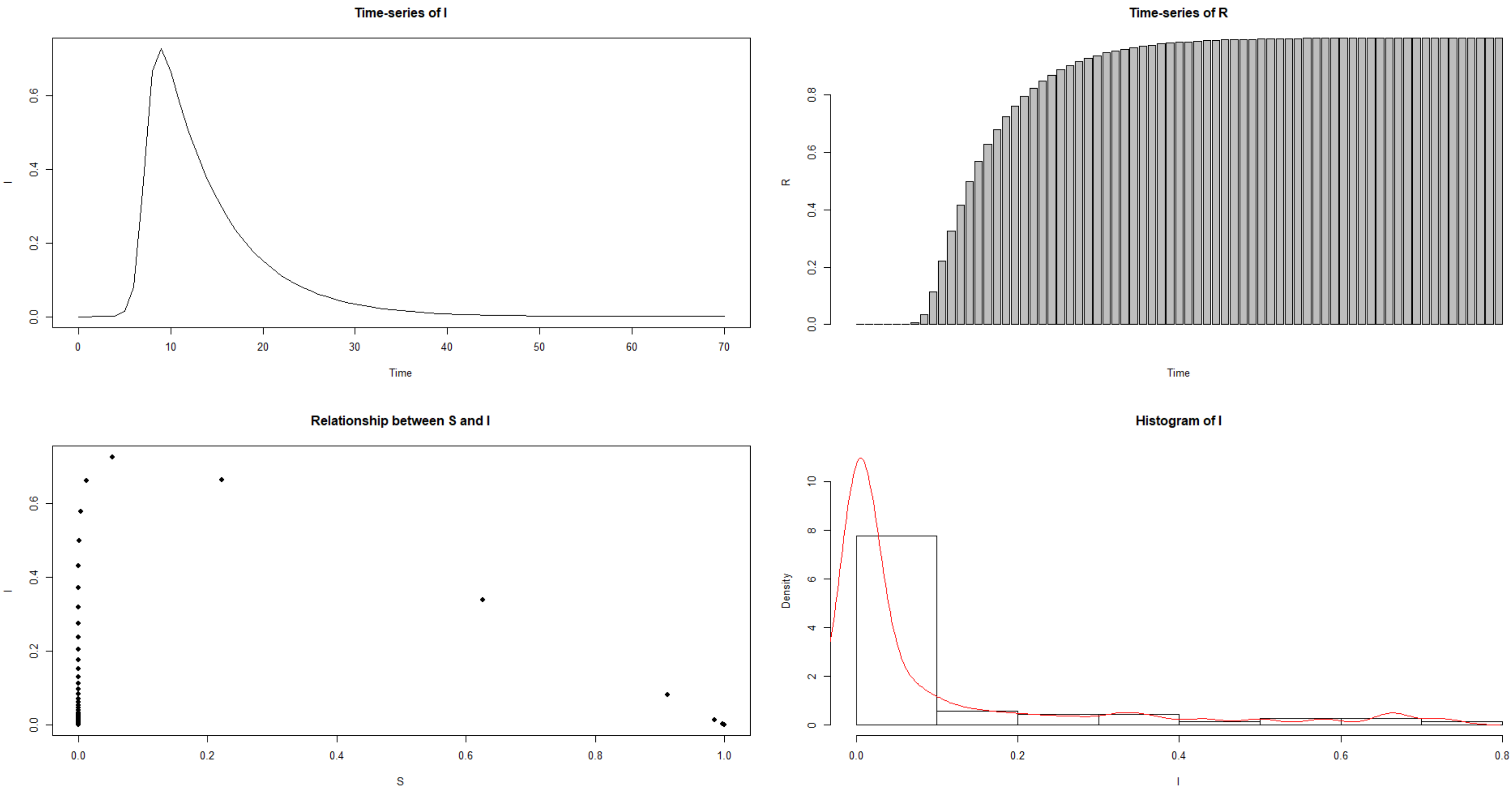
Tidy

Model

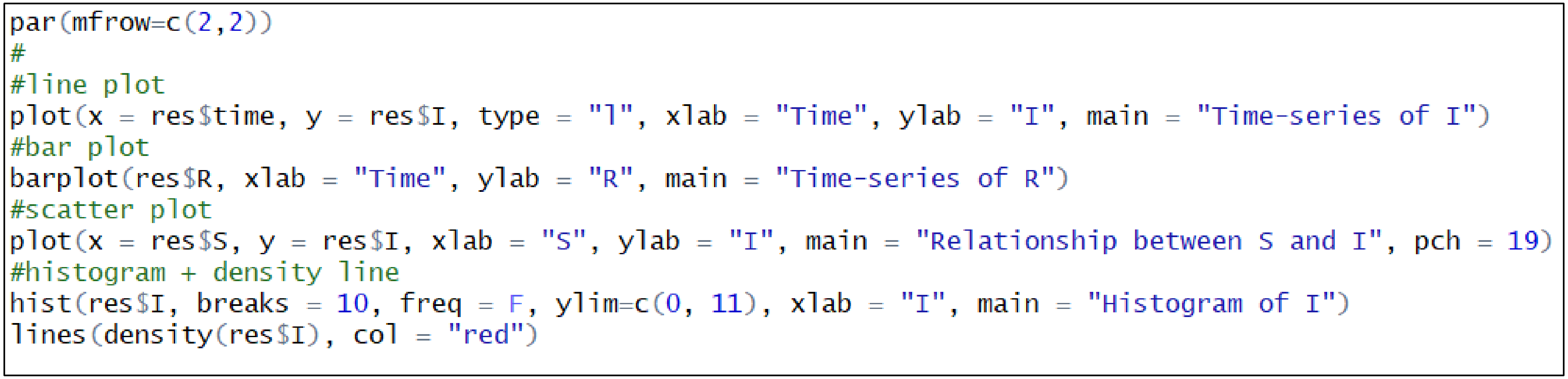
Visualise

Export

Base R plots


Time-series of I
I
0.0
0.2
0.4
0.6
0
10
20
30
40
50
60
70
Time
Time-series of R
R
0.0
0.2
0.4
0.6
0.8
Time
Relationship between S and I
I
0.0
0.2
0.4
0.6
0.0
0.2
0.4
0.6
0.8
1.0
S
Histogram of I
Density
0
2
4
6
8
10
0.0
0.2
0.4
0.6
0.8
I

Base R plots

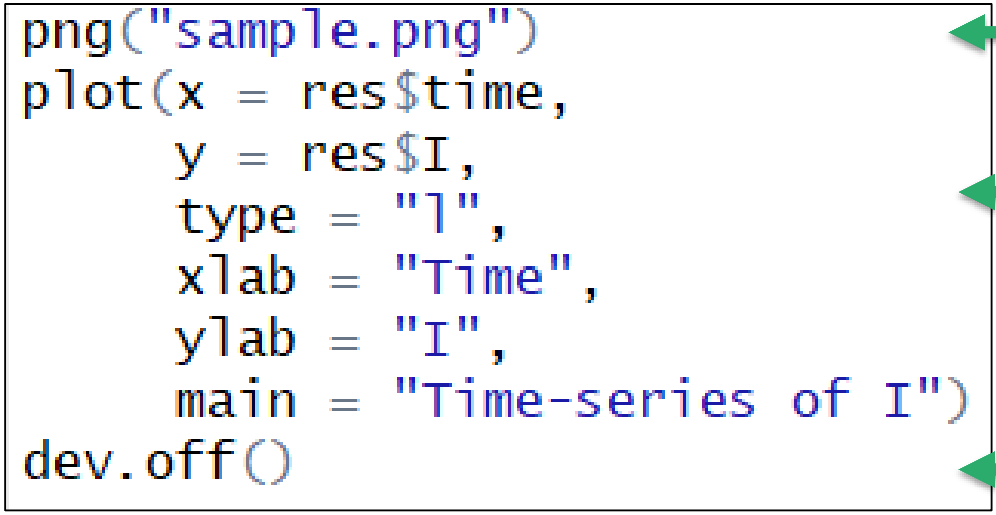


```
par(mfrow=c(2,2))
#
#line plot
plot(x = res$time, y = res$I, type = "l", xlab = "Time", ylab = "I", main = "Time-series of I")
#bar plot
barplot(res$R, xlab = "Time", ylab = "R", main = "Time-series of R")
#scatter plot
plot(x = res$S, y = res$I, xlab = "S", ylab = "I", main = "Relationship between S and I", pch = 19)
#histogram + density line
hist(res$I, breaks = 10, freq = F, ylim=c(0, 11), xlab = "I", main = "Histogram of I")
lines(density(res$I), col = "red")
```

Base R plots: export

Method 1: Use your mouse. In the bottom right panel, in the ”plot” label, the drop down menu “Export” will lead the users to an interface that does the job.

Method 2: Use code.



```
png("sample.png")
plot(x = res$time,
     y = res$I,
     type = "l",
     xlab = "Time",
     ylab = "I",
     main = "Time-series of I")
dev.off()
```

Part 1: Create an empty “container”

Part 2: Plot

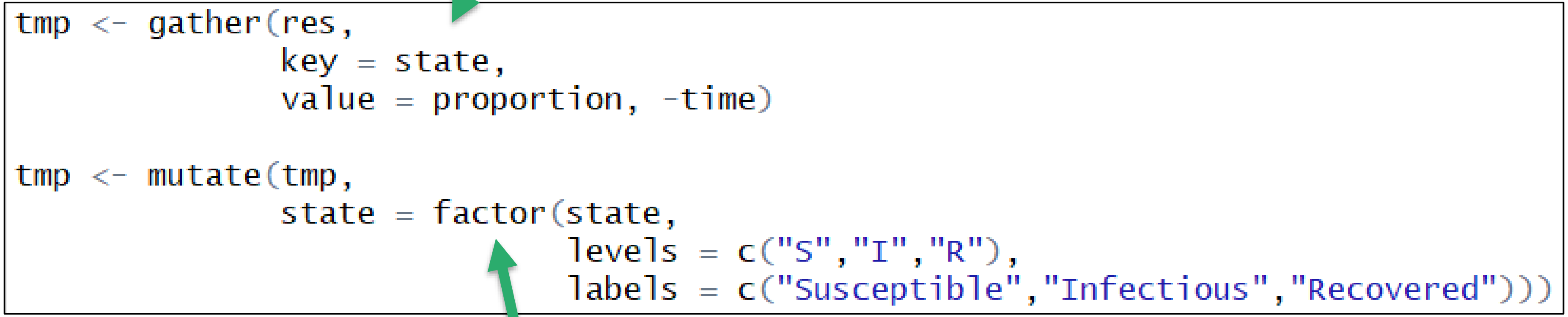
Part 3: Tell R you are done

ggplot

The function `ggplot()` uses grammar of graphics. Essentially, it uses code to make pictures. Let’s go back to ***Birdy Pox*** and see what we can do.

ggplot: preparation

ggplot works with long-form dataset.

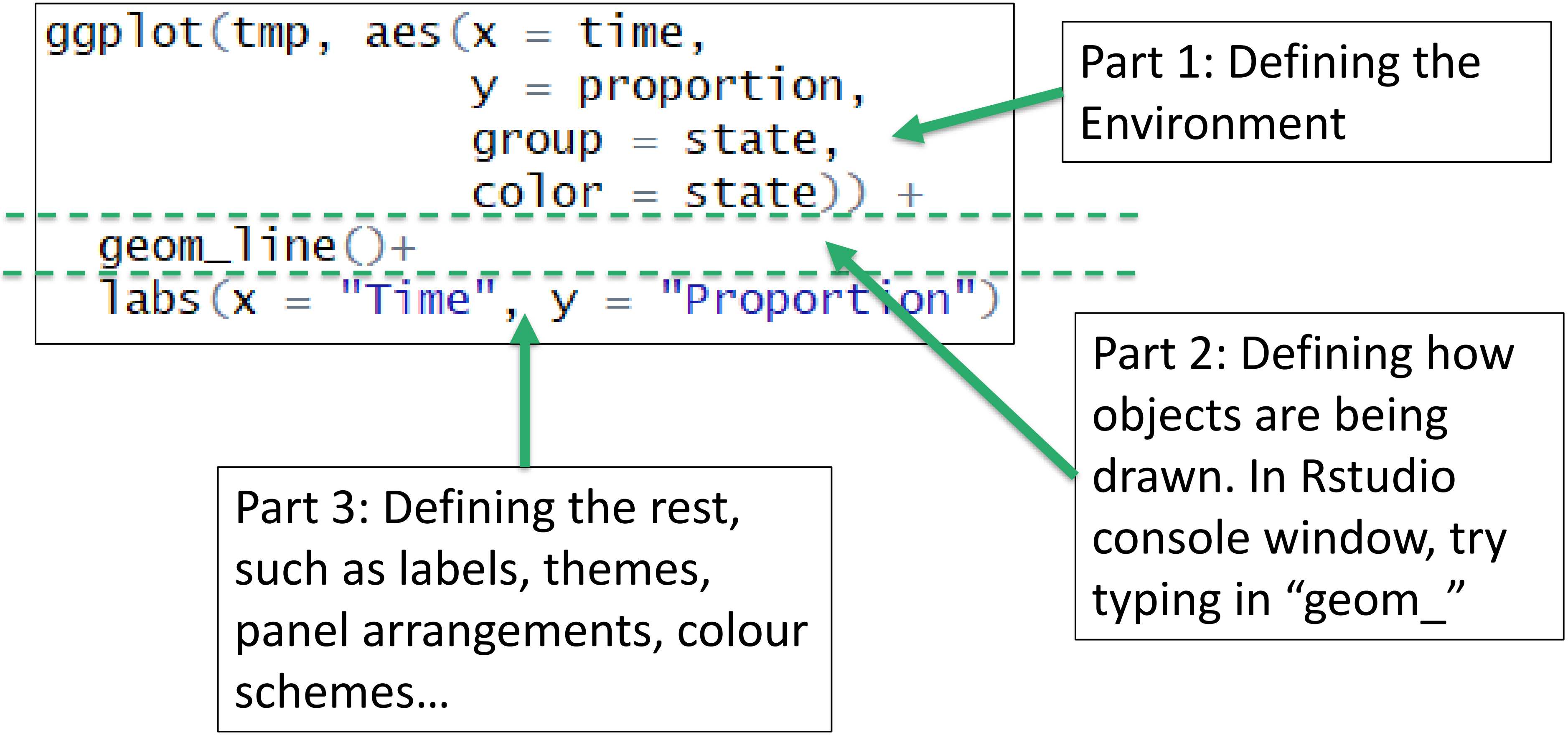


```
tmp <- gather(res,
              key = state,
              value = proportion, -time)

tmp <- mutate(tmp,
              state = factor(state,
                             levels = c("S","I","R"),
                             labels = c("Susceptible","Infectious","Recovered")))
```

Again, we need to make sure object classes are correct.

ggplot: structure



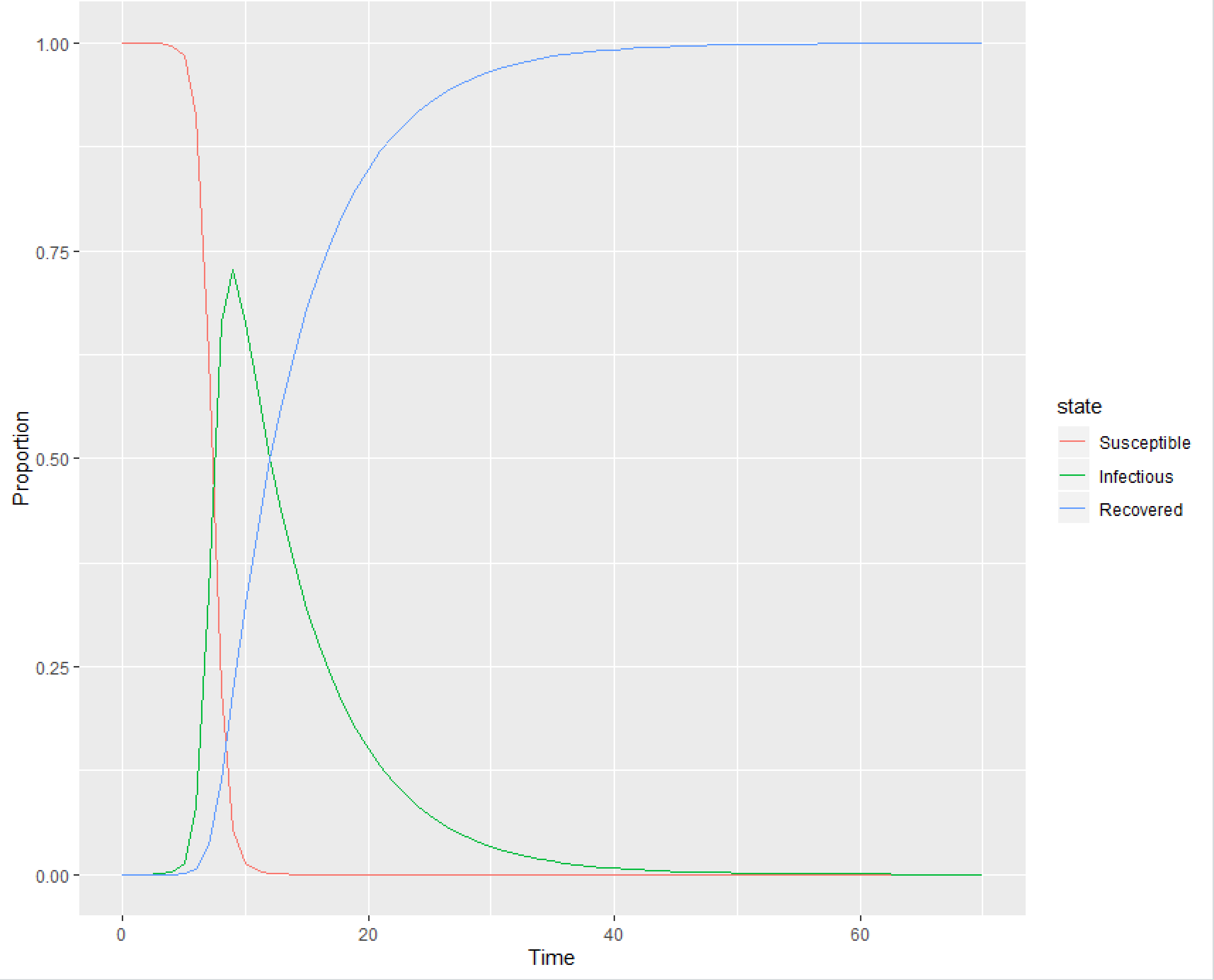
```
ggplot(tmp, aes(x = time,
                y = proportion,
                group = state,
                color = state)) +
  geom_line()+
  labs(x = "Time", y = "Proportion")
```

Part 1: Defining the Environment

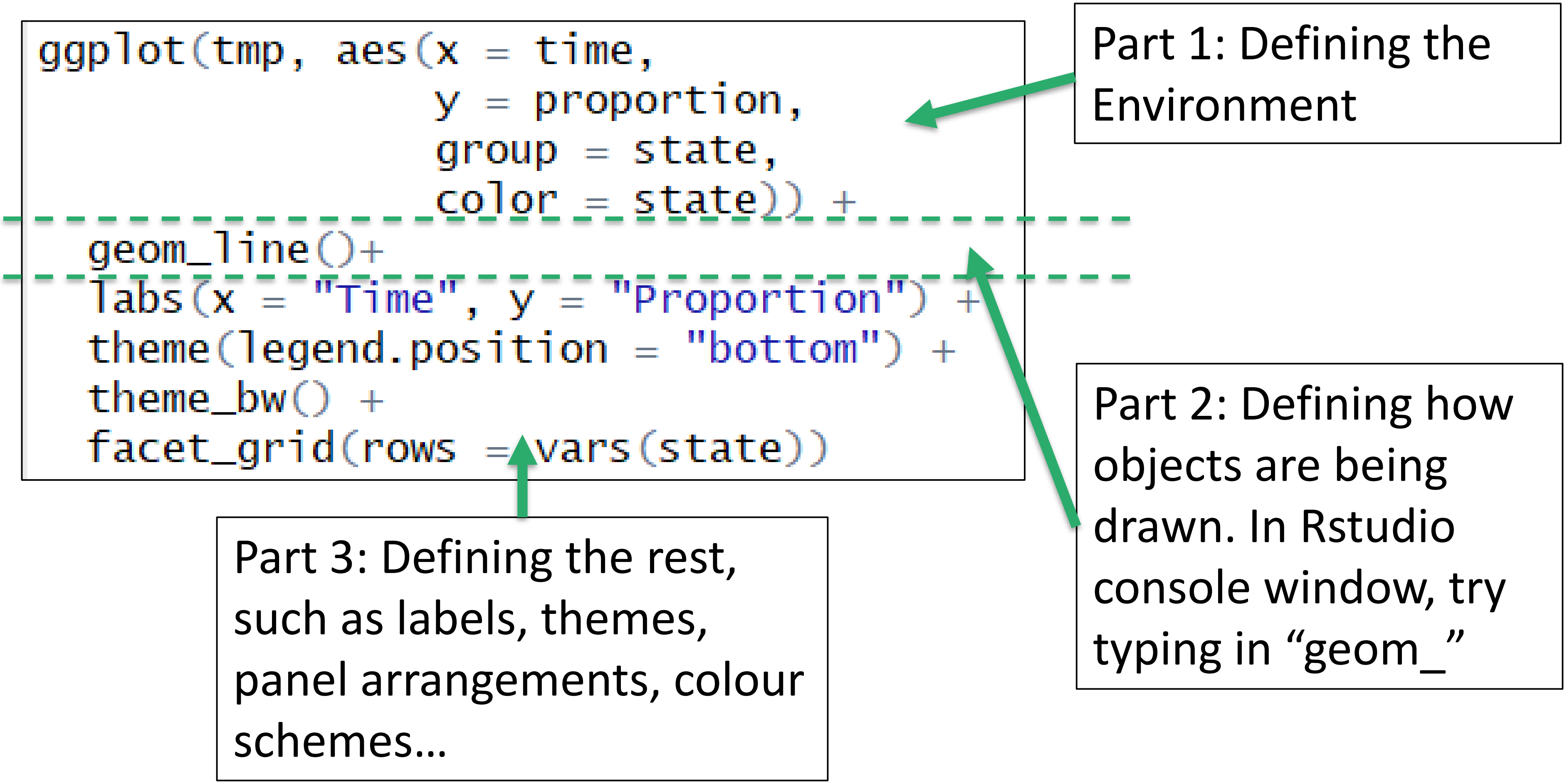
Part 2: Defining how objects are being drawn. In Rstudio console window, try typing in “geom_”

Part 3: Defining the rest, such as labels, themes, panel arrangements, colour schemes…

ggplot: structure



ggplot: structure



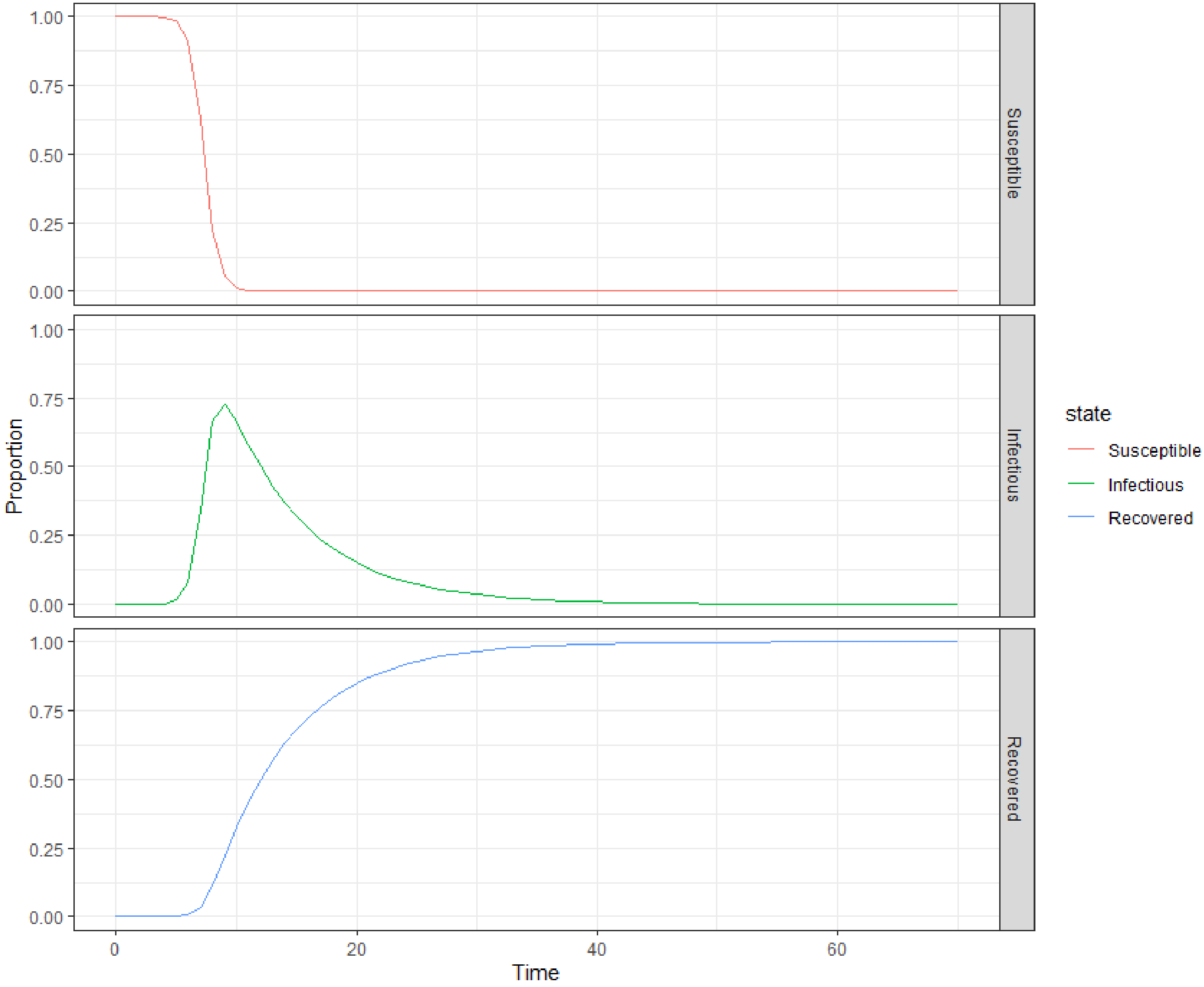
```
ggplot(tmp, aes(x = time,
                y = proportion,
                group = state,
                color = state)) +
  geom_line()+
  labs(x = "Time", y = "Proportion") +
  theme(legend.position = "bottom") +
  theme_bw() +
  facet_grid(rows = vars(state))
```

Part 1: Defining the Environment

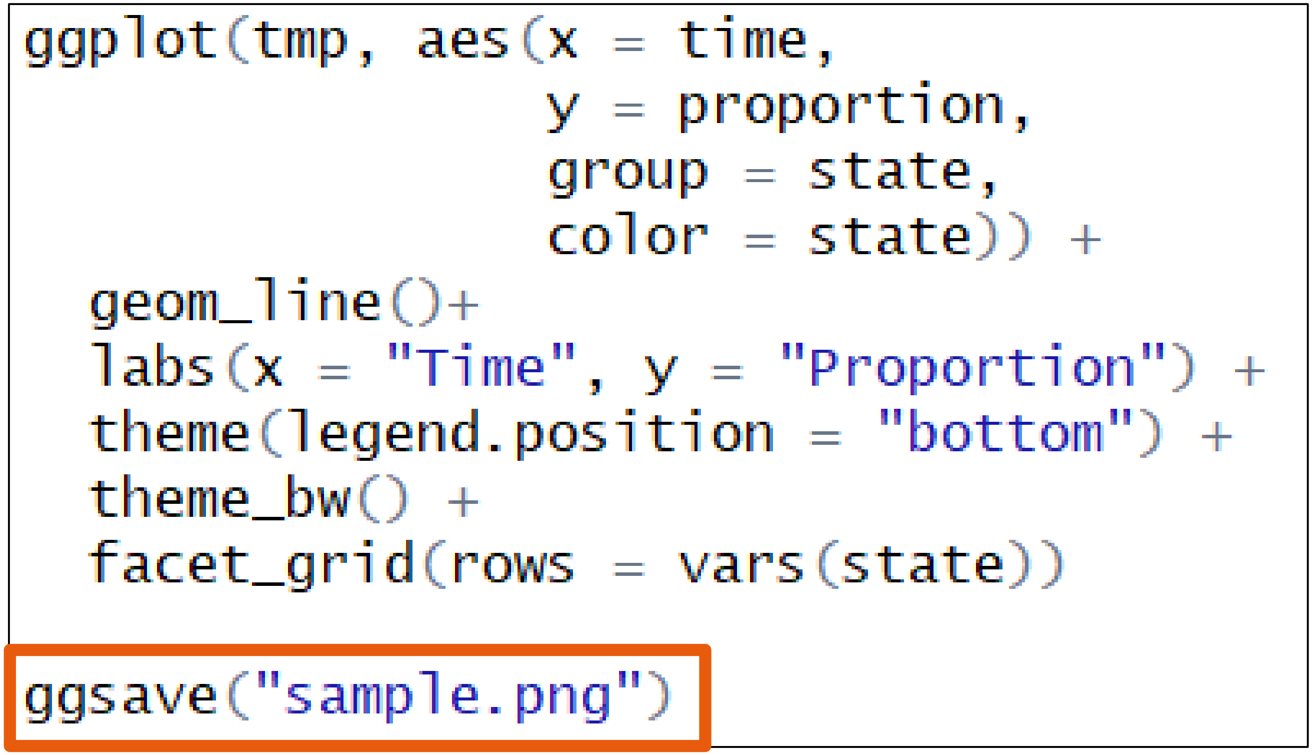
Part 2: Defining how objects are being drawn. In Rstudio console window, try typing in "geom_"

Part 3: Defining the rest, such as labels, themes, panel arrangements, colour schemes…

ggplot: example



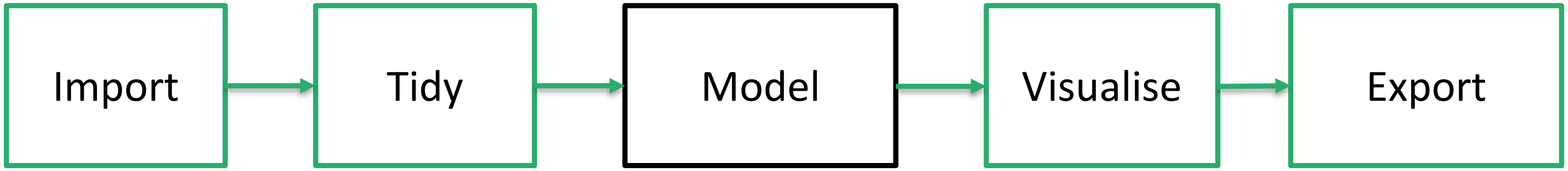
ggplot: save



```
ggplot(tmp, aes(x = time,
                y = proportion,
                group = state,
                color = state)) +
  geom_line()+
  labs(x = "Time", y = "Proportion") +
  theme(legend.position = "bottom") +
  theme_bw() +
  facet_grid(rows = vars(state))

ggsave("sample.png")
```

RECAP



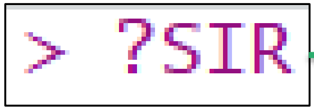
Questions?

Finding Answers/ Self-learning

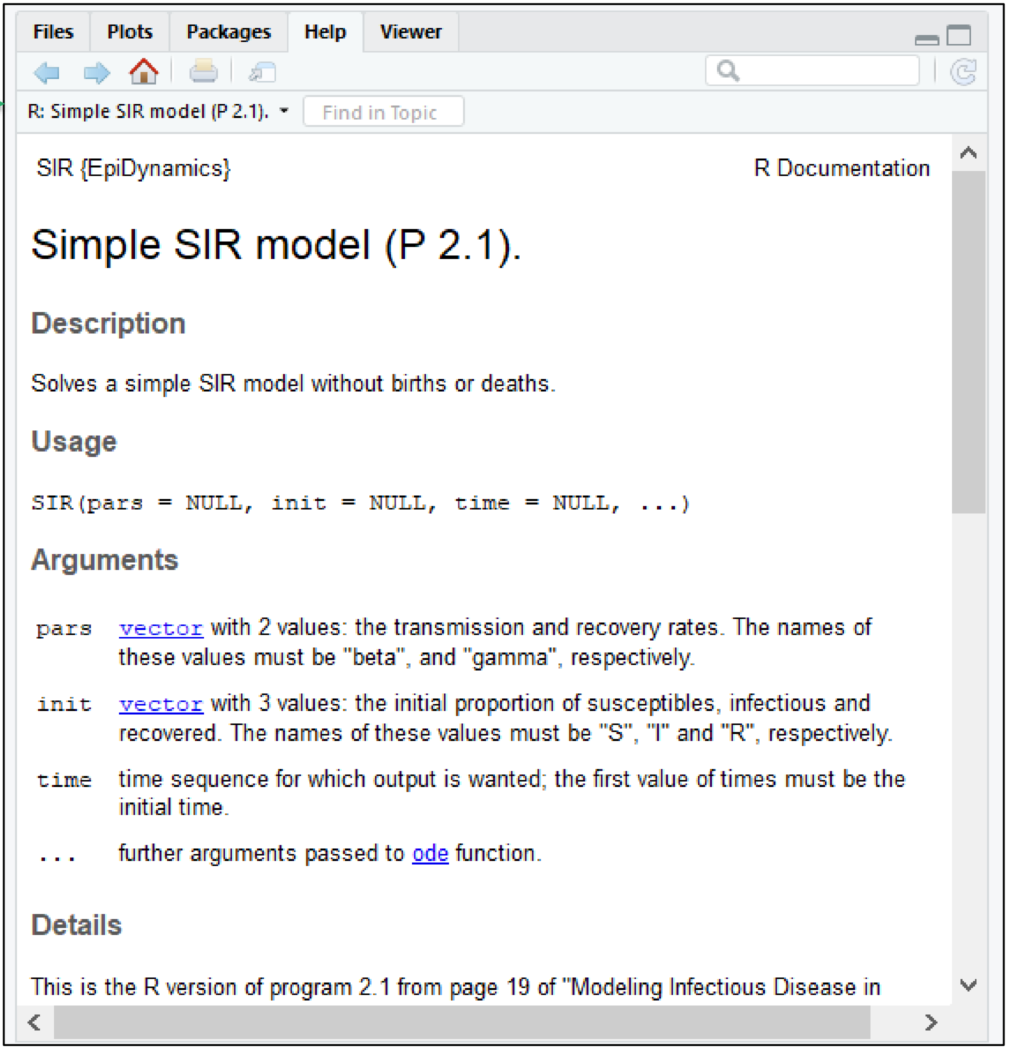
Finding solutions/ self-learning

- Warning message: The code runs but something looks off.
- Error message: The code breaks somewhere. Nothing has been done.

Within R: Option 1



```
> ?SIR
```



SIR {EpiDynamics} R Documentation

Simple SIR model (P 2.1).

Description

Solves a simple SIR model without births or deaths.

Usage

```
SIR(pars = NULL, init = NULL, time = NULL, ...)
```

Arguments

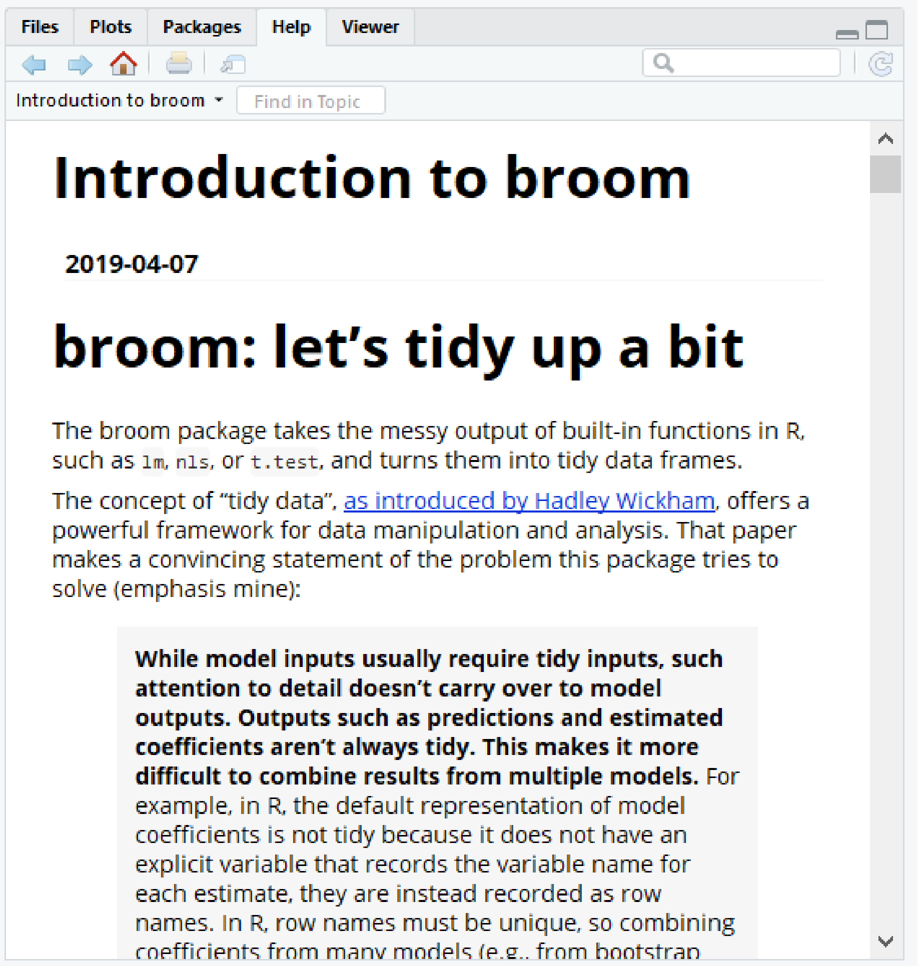
`pars`	vector with 2 values: the transmission and recovery rates. The names of these values must be "beta", and "gamma", respectively.
`init`	vector with 3 values: the initial proportion of susceptibles, infectious and recovered. The names of these values must be "S", "I" and "R", respectively.
`time`	time sequence for which output is wanted; the first value of times must be the initial time.
`...`	further arguments passed to ode function.

Details

This is the R version of program 2.1 from page 19 of "Modeling Infectious Disease in

Within R: Option 2

```
> vignette("broom")
```



Introduction to broom

2019-04-07

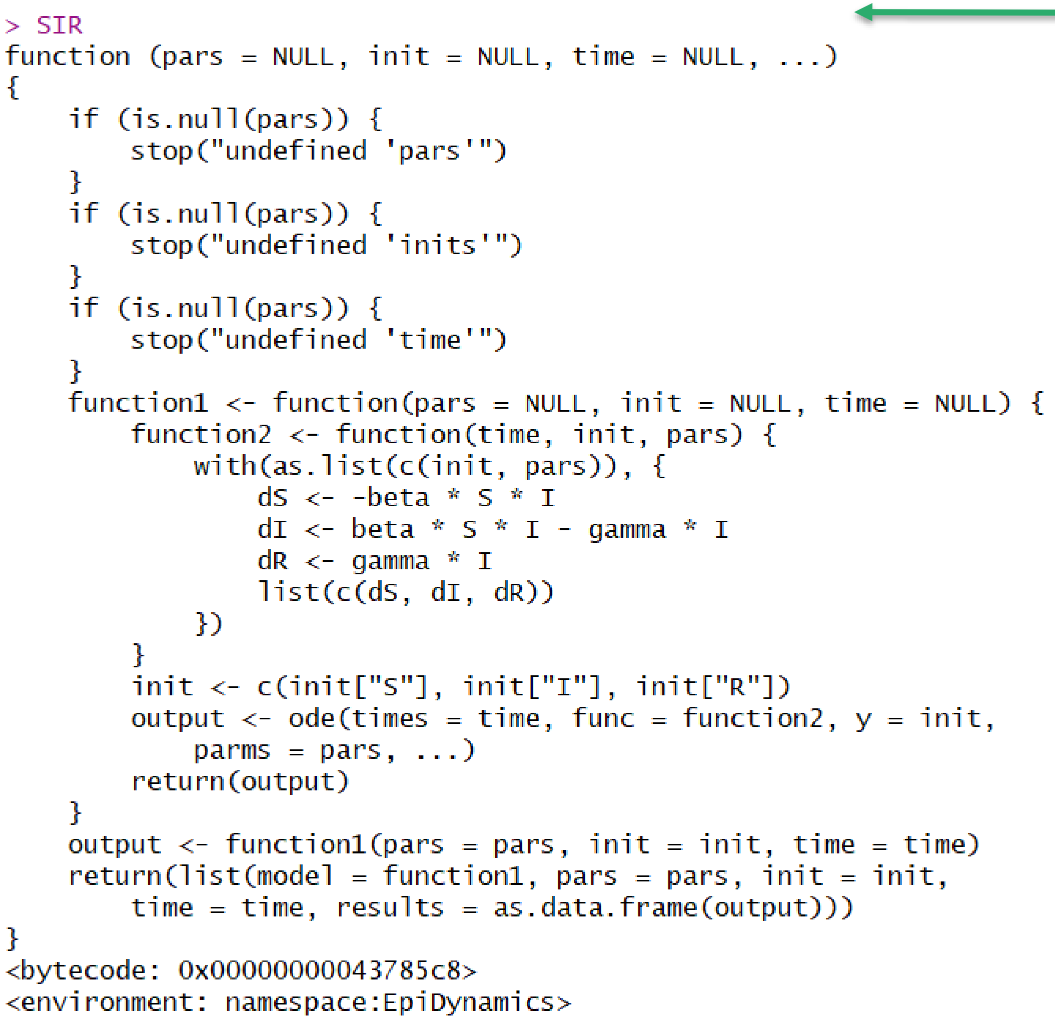
broom: let's tidy up a bit

The broom package takes the messy output of built-in functions in R, such as `lm`, `nls`, or `t.test`, and turns them into tidy data frames.

The concept of "tidy data", as introduced by Hadley Wickham, offers a powerful framework for data manipulation and analysis. That paper makes a convincing statement of the problem this package tries to solve (emphasis mine):

> **While model inputs usually require tidy inputs, such attention to detail doesn't carry over to model outputs. Outputs such as predictions and estimated coefficients aren't always tidy. This makes it more difficult to combine results from multiple models.** For example, in R, the default representation of model coefficients is not tidy because it does not have an explicit variable that records the variable name for each estimate, they are instead recorded as row names. In R, row names must be unique, so combining coefficients from many models (e.g., from bootstrap

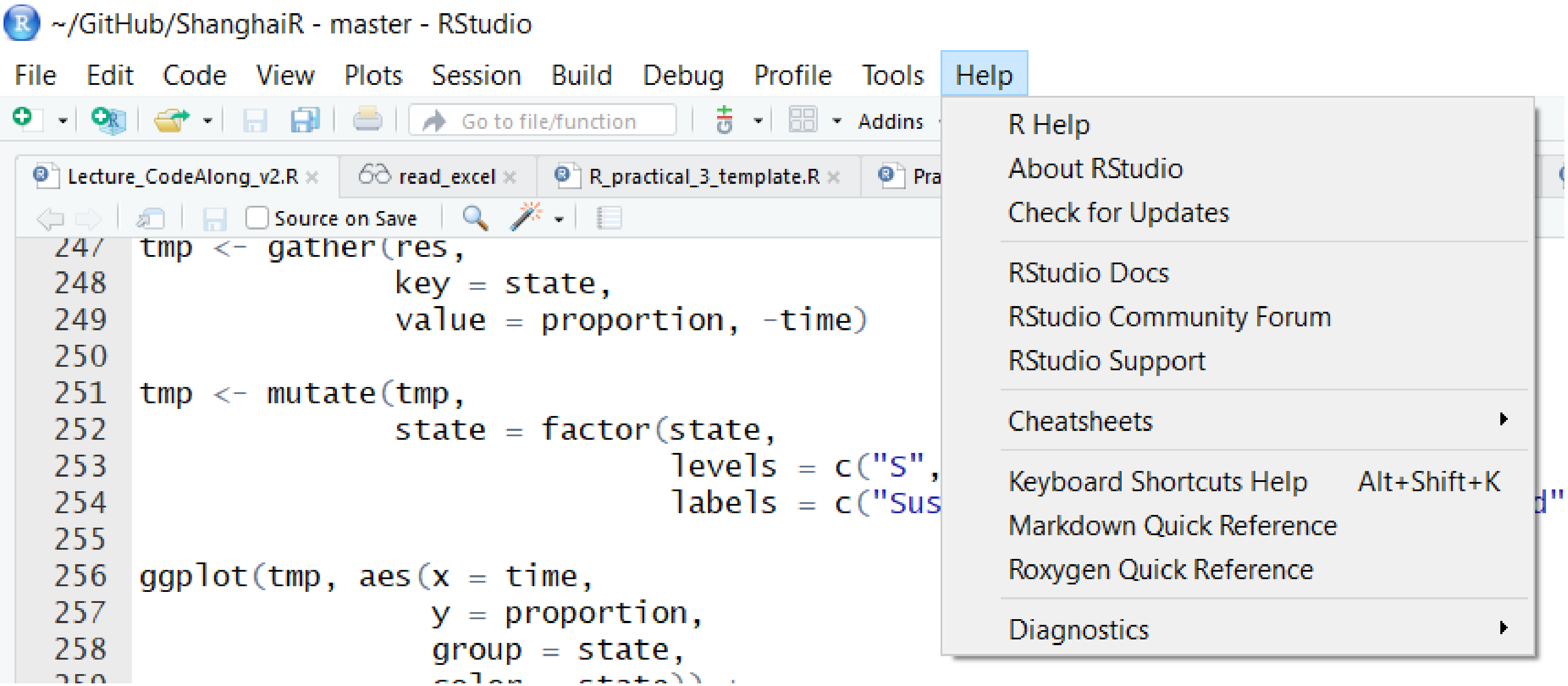
Within R help: Option 3



```
> SIR
function (pars = NULL, init = NULL, time = NULL, ...)
{
    if (is.null(pars)) {
        stop("undefined 'pars'")
    }
    if (is.null(pars)) {
        stop("undefined 'inits'")
    }
    if (is.null(pars)) {
        stop("undefined 'time'")
    }
    function1 <- function(pars = NULL, init = NULL, time = NULL) {
        function2 <- function(time, init, pars) {
            with(as.list(c(init, pars)), {
                dS <- -beta * S * I
                dI <- beta * S * I - gamma * I
                dR <- gamma * I
                list(c(dS, dI, dR))
            })
        }
        init <- c(init["S"], init["I"], init["R"])
        output <- ode(times = time, func = function2, y = init,
            parms = pars, ...)
        return(output)
    }
    output <- function1(pars = pars, init = init, time = time)
    return(list(model = function1, pars = pars, init = init,
        time = time, results = as.data.frame(output)))
}
<bytecode: 0x00000000043785c8>
<environment: namespace:EpiDynamics>
```

Running function without parenthesis.

Within R help: Option 4



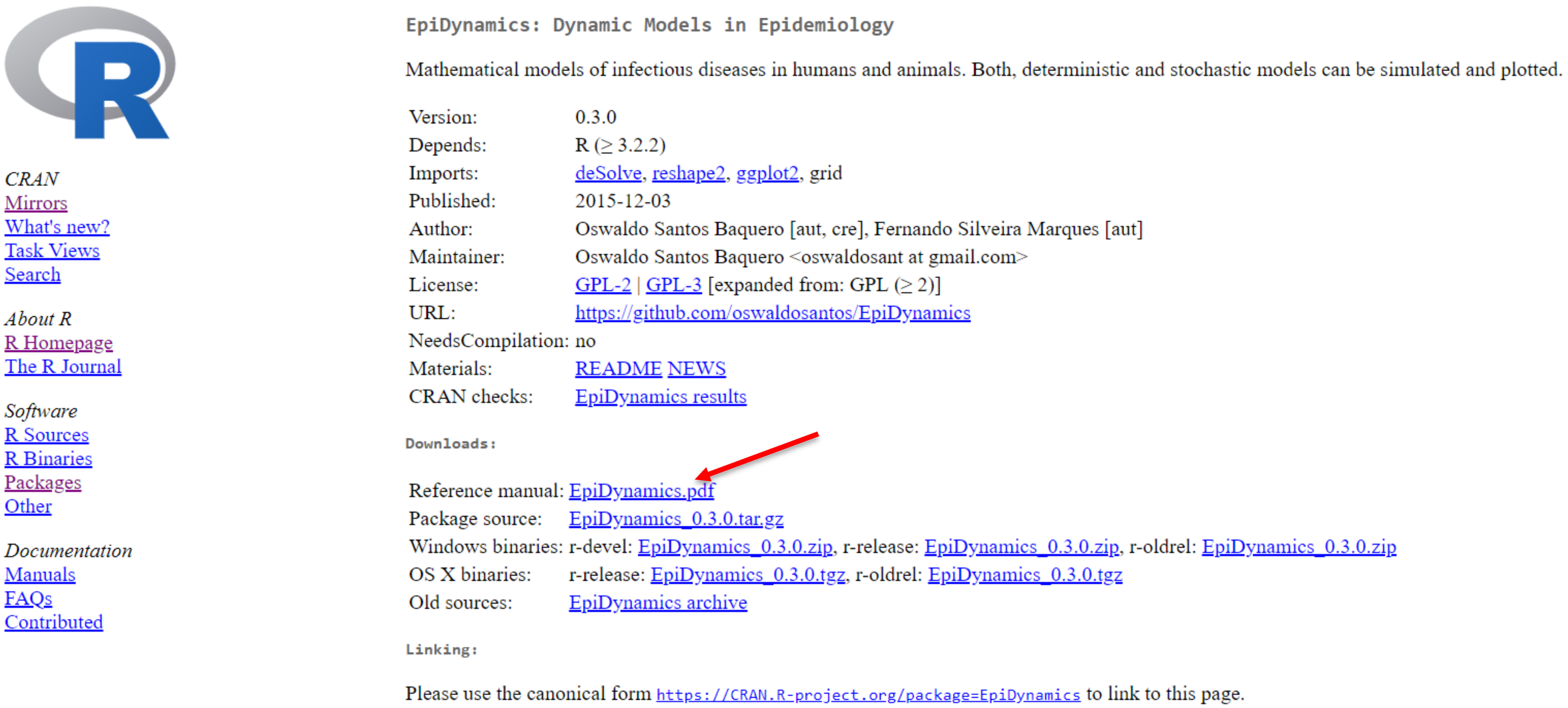
```
tmp <- gather(res,
              key = state,
              value = proportion, -time)

tmp <- mutate(tmp,
              state = factor(state,
                             levels = c("S",
                             labels = c("Sus                          d"

ggplot(tmp, aes(x = time,
                y = proportion,
                group = state,
```

Outside Help: Option 1

https://cran.r-project.org/



EpiDynamics: Dynamic Models in Epidemiology

Mathematical models of infectious diseases in humans and animals. Both, deterministic and stochastic models can be simulated and plotted.

Version:	0.3.0
Depends:	R (≥ 3.2.2)
Imports:	deSolve, reshape2, ggplot2, grid
Published:	2015-12-03
Author:	Oswaldo Santos Baquero [aut, cre], Fernando Silveira Marques [aut]
Maintainer:	Oswaldo Santos Baquero <oswaldosant at gmail.com>
License:	GPL-2 | GPL-3 [expanded from: GPL (≥ 2)]
URL:	https://github.com/oswaldosantos/EpiDynamics
NeedsCompilation:	no
Materials:	README NEWS
CRAN checks:	EpiDynamics results

Downloads:

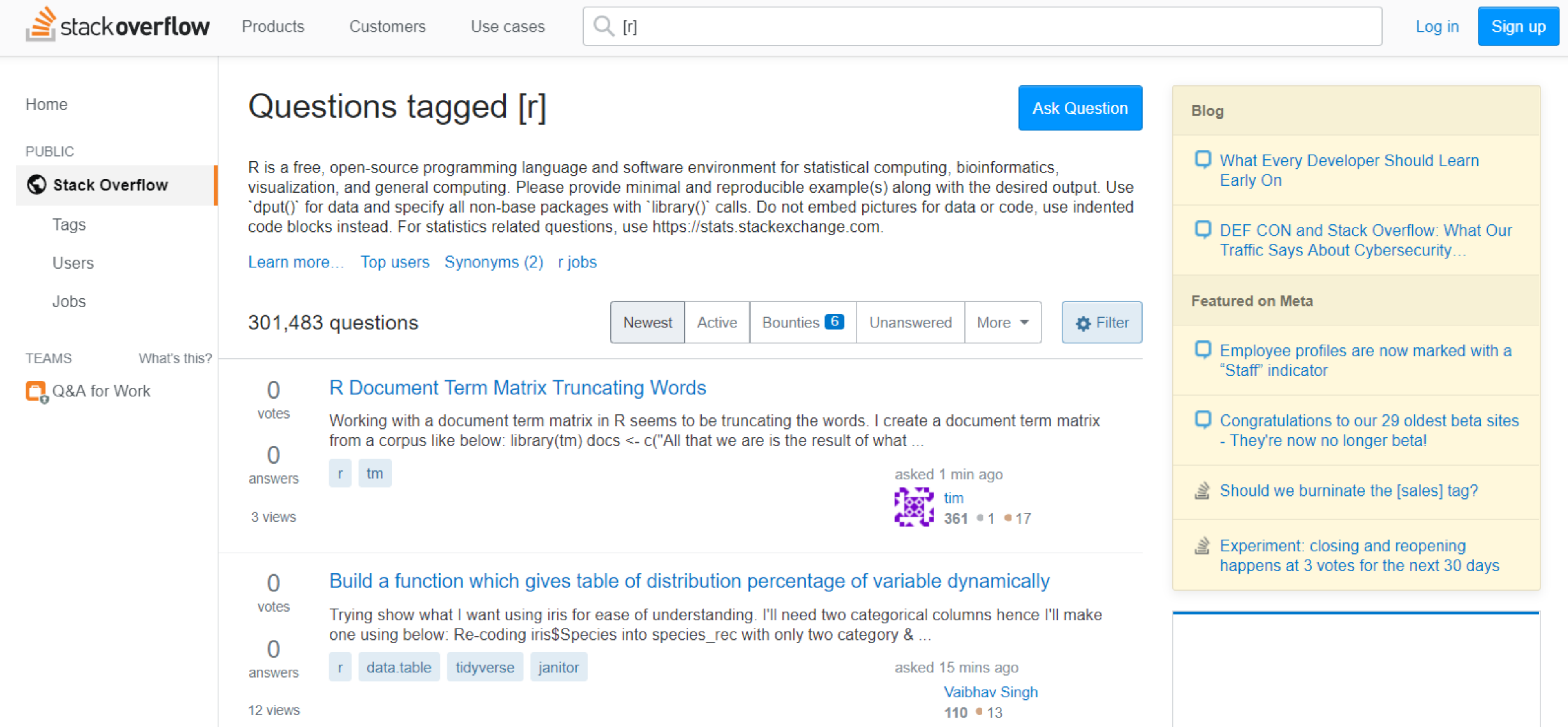
Reference manual:	EpiDynamics.pdf
Package source:	EpiDynamics_0.3.0.tar.gz
Windows binaries:	r-devel: EpiDynamics_0.3.0.zip, r-release: EpiDynamics_0.3.0.zip, r-oldrel: EpiDynamics_0.3.0.zip
OS X binaries:	r-release: EpiDynamics_0.3.0.tgz, r-oldrel: EpiDynamics_0.3.0.tgz
Old sources:	EpiDynamics archive

Linking:

Please use the canonical form `https://CRAN.R-project.org/package=EpiDynamics` to link to this page.

Outside Help: Option 2

https://stackoverflow.com/questions/tagged/r



Questions tagged [r]

R is a free, open-source programming language and software environment for statistical computing, bioinformatics, visualization, and general computing. Please provide minimal and reproducible example(s) along with the desired output. Use `dput()` for data and specify all non-base packages with `library()` calls. Do not embed pictures for data or code, use indented code blocks instead. For statistics related questions, use https://stats.stackexchange.com.

Learn more… Top users Synonyms (2) r jobs

301,483 questions

0 votes 0 answers 3 views

R Document Term Matrix Truncating Words

Working with a document term matrix in R seems to be truncating the words. I create a document term matrix from a corpus like below: library(tm) docs <- c("All that we are is the result of what …

r tm

asked 1 min ago tim 361 ●1 ●17

0 votes 0 answers 12 views

Build a function which gives table of distribution percentage of variable dynamically

Trying show what I want using iris for ease of understanding. I'll need two categorical columns hence I'll make one using below: Re-coding iris$Species into species_rec with only two category & …

r data.table tidyverse janitor

asked 15 mins ago Vaibhav Singh 110 ●13

Blog

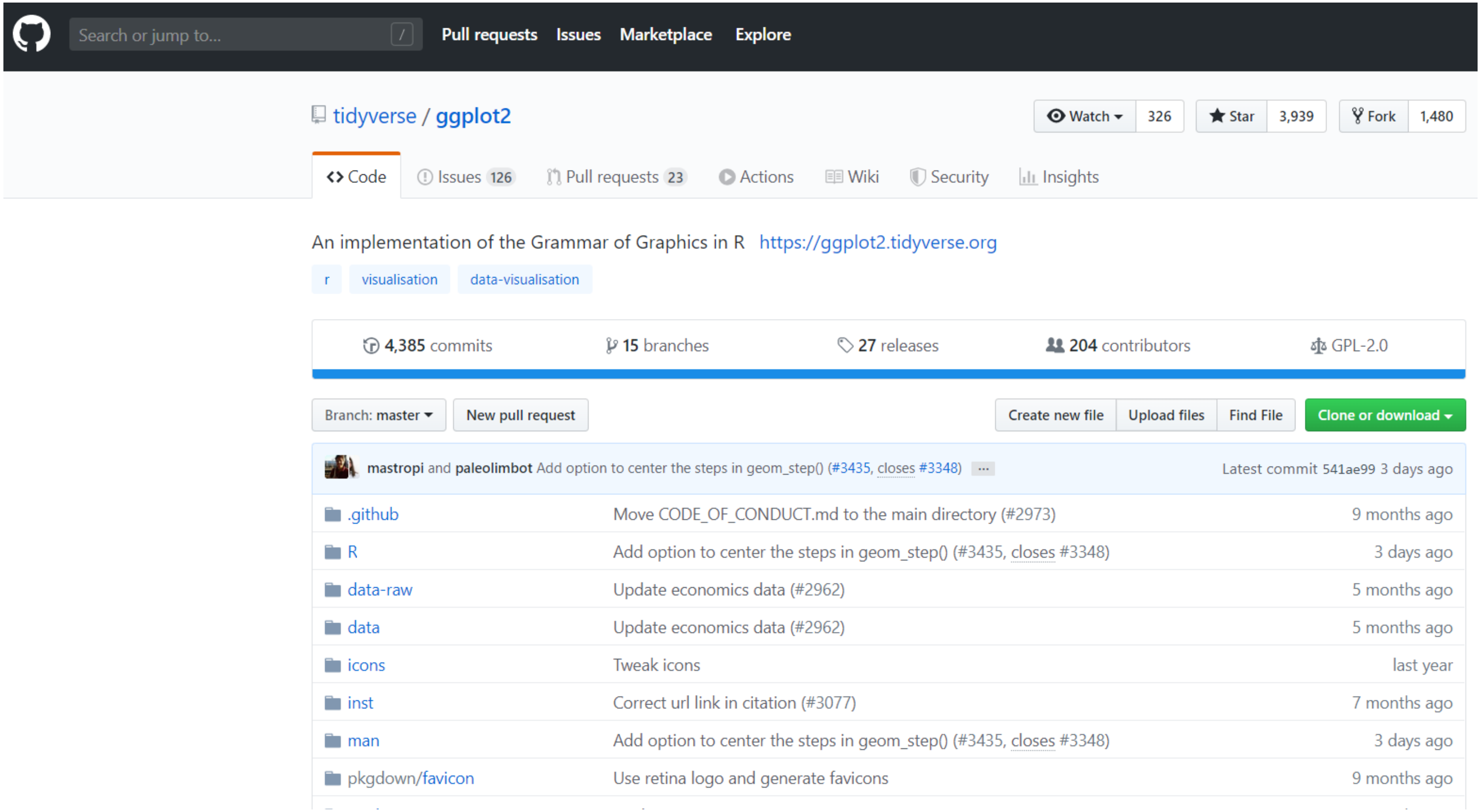
- What Every Developer Should Learn Early On
- DEF CON and Stack Overflow: What Our Traffic Says About Cybersecurity…

Featured on Meta

- Employee profiles are now marked with a “Staff” indicator
- Congratulations to our 29 oldest beta sites - They're now no longer beta!
- Should we burninate the [sales] tag?
- Experiment: closing and reopening happens at 3 votes for the next 30 days

Outside of R: Option 3

https://github.com/



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An implementation of the Grammar of Graphics in R https://ggplot2.tidyverse.org

r visualisation data-visualisation

4,385 commits 15 branches 27 releases 204 contributors GPL-2.0

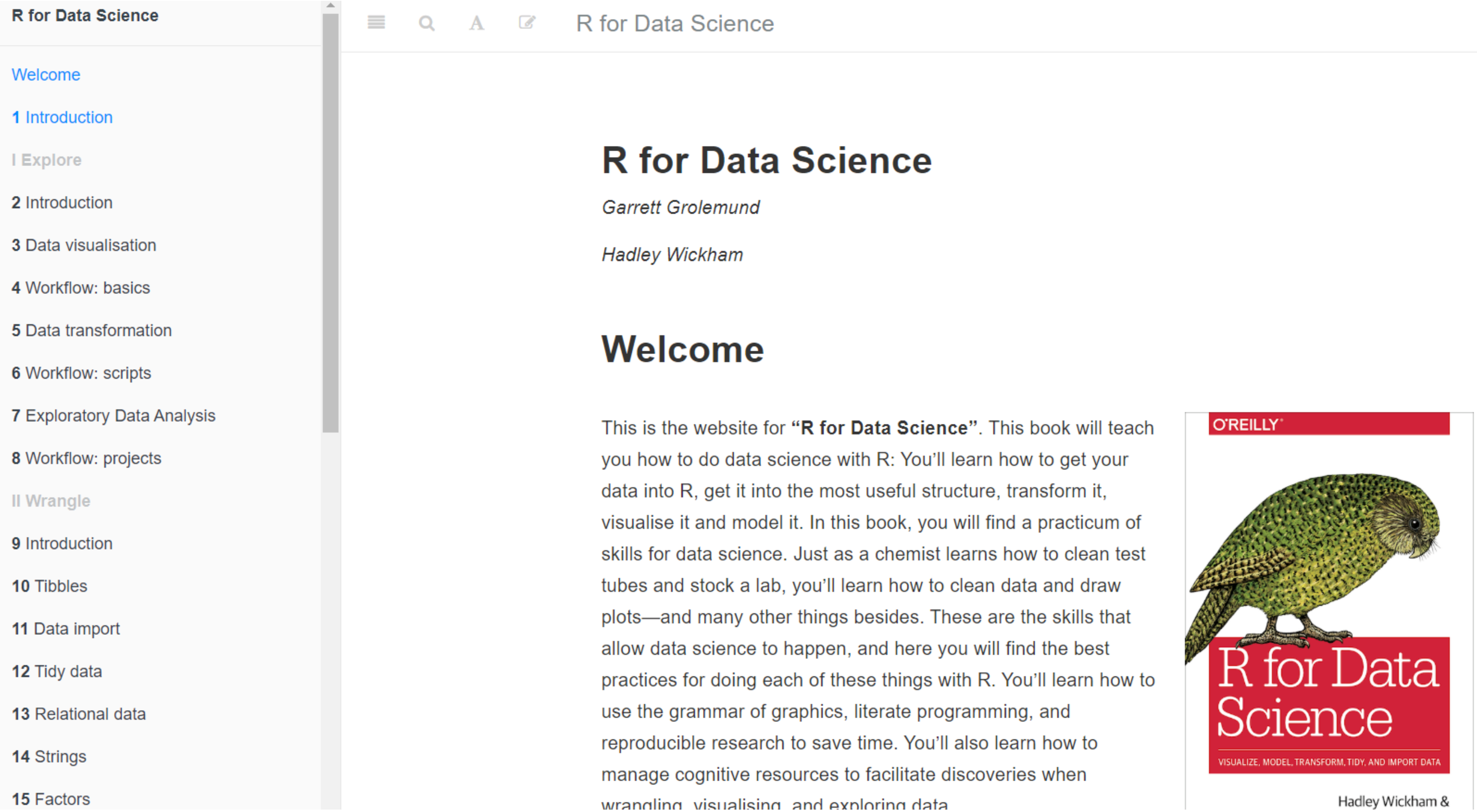
Branch: master New pull request Create new file Upload files Find File Clone or download

mastropi and paleolimbot Add option to center the steps in geom_step() (#3435, closes #3348) ... Latest commit 541ae99 3 days ago

.github	Move CODE_OF_CONDUCT.md to the main directory (#2973)	9 months ago
R	Add option to center the steps in geom_step() (#3435, closes #3348)	3 days ago
data-raw	Update economics data (#2962)	5 months ago
data	Update economics data (#2962)	5 months ago
icons	Tweak icons	last year
inst	Correct url link in citation (#3077)	7 months ago
man	Add option to center the steps in geom_step() (#3435, closes #3348)	3 days ago
pkgdown/favicon	Use retina logo and generate favicons	9 months ago

Outside of R: Option 4

https://r4ds.had.co.nz/



R for Data Science

R for Data Science

Garrett Grolemund

Hadley Wickham

Welcome

This is the website for **"R for Data Science"**. This book will teach you how to do data science with R: You'll learn how to get your data into R, get it into the most useful structure, transform it, visualise it and model it. In this book, you will find a practicum of skills for data science. Just as a chemist learns how to clean test tubes and stock a lab, you'll learn how to clean data and draw plots—and many other things besides. These are the skills that allow data science to happen, and here you will find the best practices for doing each of these things with R. You'll learn how to use the grammar of graphics, literate programming, and reproducible research to save time. You'll also learn how to manage cognitive resources to facilitate discoveries when wrangling, visualising, and exploring data.

Questions?

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&TROPICAL
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