



Illustration: Amrei Binzer-Panchal

Basic Biostatistics and Bioinformatics

Session 1: Introduction to R

Swedish University of Agricultural Sciences, Alnarp

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Today's Presentation

R & RStudio

Data handling

- Filter
- Select
- Transform

Plotting

Some RStudio features

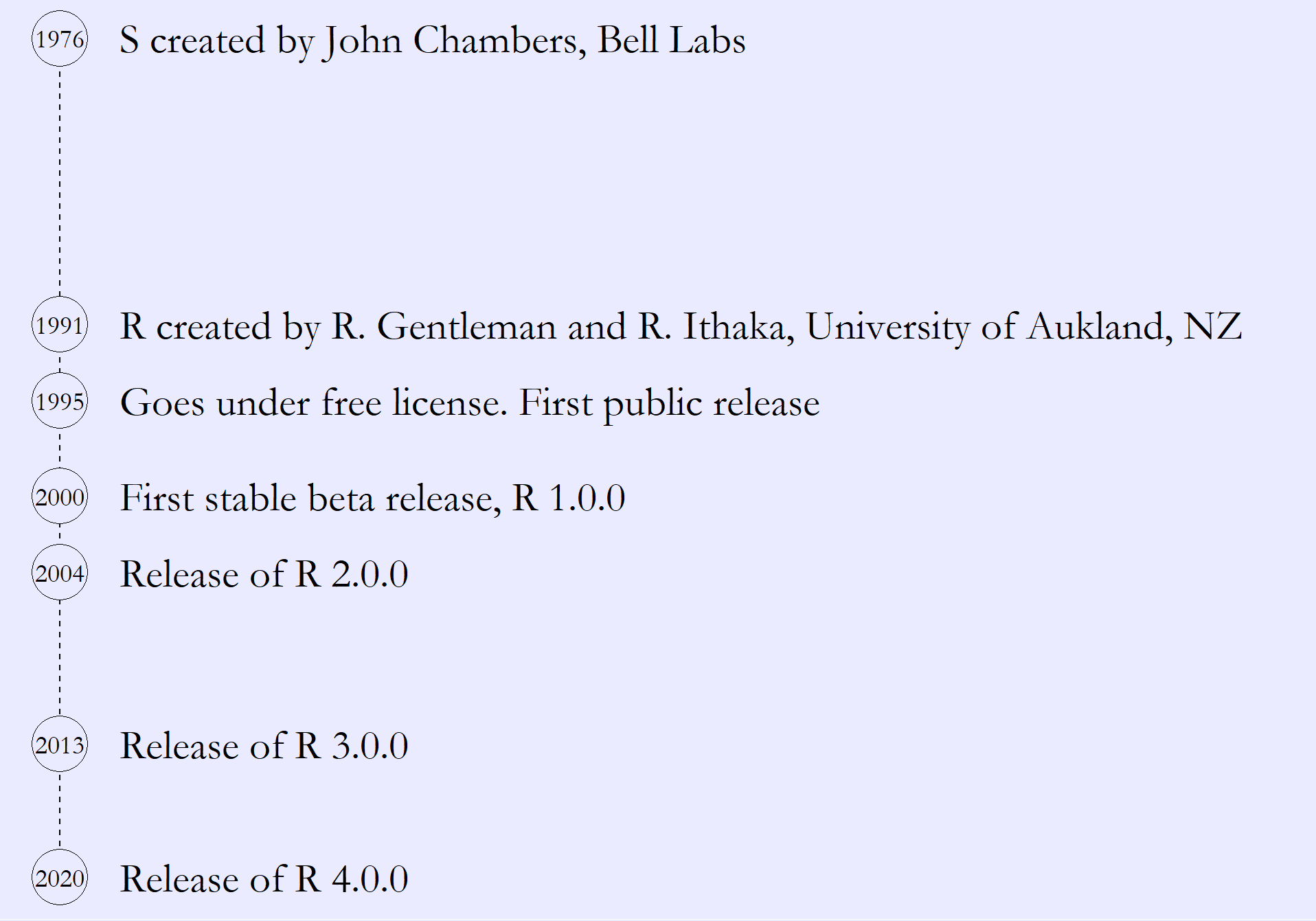
Troubleshooting

Exercise session



Introduction & History

Open software used for statistical analysis
Code-based interface



R & RStudio

R itself is the programming language

The installation of the language comes with a basic interface

Most users work in more advanced interfaces, the most common of which is *RStudio*



Installation of R & RStudio

R. <https://www.r-project.org/>

CRAN in left frame > Select any mirror > Select depending on operating system

RStudio. <https://posit.co/>

Products > Select open version > Select RStudio Desktop > Select free version



Base R & Packages

R is extended by creating new functions

Collections of functions are called *packages*

The basic installation comes with a set of packages

New packages can be installed from CRAN (the *Comprehensive R Archive Network*)

```
1 install.packages("tidyverse")  
2 library(tidyverse)
```



Objects

In R, information is stored as named *objects*

Objects are stored by writing a name followed by the *assign arrow* `<-`

Objects can be very simple, like a single number

```
1 x <- 3
2 x # Simple writing the name of an object will print it
```

```
[1] 3
```

A bit more complex, like a *vector* (an ordered sequence of numbers)

```
1 x <- c(3, 14, 159)
2 x
```

```
[1] 3 14 159
```



And more complex still, like a collection of vectors in a *data frame*

```
1 dat <- data.frame(x = c(1,2,3), y = c("a", "b", "c"))
2 dat
```

```
  x y
1 1 a
2 2 b
3 3 c
```



Functions

Objects are created and changed using *functions*

Function take some input and produce an output

Functions typically have a set of arguments, allowing the user to control its behaviour

Called using the function name followed by the input and arguments in brackets

```
1 x <- c(3, 14, 159)
2 sum(x) # Calculates the sum of the vector
```

```
[1] 176
```

The output of a function can be printed directly or stored as a new object

```
1 s <- sum(x)
2 s
```

```
[1] 176
```



NA is used for missing values

```
1 x <- c(3, 14, 159, NA)
2 sum(x)
```

[1] NA

```
1 sum(x, na.rm = TRUE) # Setting the argument na.rm to TRUE removes the NAs
```

[1] 176

Code Structure and Piping

Many different ways to structure code with several steps

Simple example: (i) given a vector, (ii) transform with the logarithm, (iii) take the sum.

1. Store each step and use in next line

```
1 dat <- c(3, 14, 159)
2 dat <- log(dat)
3 sum(dat)
```

```
[1] 8.806574
```

2. Use functions within functions

```
1 sum(log(c(3, 14, 159)))
```

```
[1] 8.806574
```

3. Use piping (`%>%` or `|>`) to send output into the next function

```
1 c(3, 14, 159) %>% # Take the data, the
2   log() %>% # ... log-transform, then.
3   sum() # ... sum
```

```
[1] 8.806574
```

The pipe takes the output of the left function and sends it as input to the right function

RStudio shortcut: `ctrl + shift + M`

Data Import

Base R and add-on packages include multiple functions to import data

The specific choice of function depends on the data type

The file path can be specified relative a *working directory* - the base folder of the current R session

```
1 dat_tv <- read.table("Data/IMDb_Economist_tv_ratings.csv", header = T, sep = ",", dec = ".")

1 library(readxl)
2 dat_tv <- read_excel("Data/IMDb_Economist_tv_ratings.xlsx")
3 dat_tv
```

A tibble: 2,266 × 7

	titleId	seasonNumber	title	date	av_rating	share	genres
	<chr>	<dbl>	<chr>	<dtm>	<dbl>	<dbl>	<chr>
1	tt2879552	1	11.22.63	2016-03-10 00:00:00	8.49	0.51	Drama...
2	tt3148266	1	12 Monkeys	2015-02-27 00:00:00	8.34	0.46	Adven...
3	tt3148266	2	12 Monkeys	2016-05-30 00:00:00	8.82	0.25	Adven...
4	tt3148266	3	12 Monkeys	2017-05-19 00:00:00	9.04	0.19	Adven...
5	tt3148266	4	12 Monkeys	2018-06-26 00:00:00	9.14	0.38	Adven...
6	tt1837492	1	13 Reasons...	2017-03-31 00:00:00	8.44	2.38	Drama...
7	tt1837492	2	13 Reasons...	2018-05-18 00:00:00	7.51	2.19	Drama...
8	tt0285331	1	24	2002-02-16 00:00:00	8.56	6.67	Actio...
9	tt0285331	2	24	2003-02-09 00:00:00	8.70	7.13	Actio...
10	tt0285331	3	24	2004-02-09 00:00:00	8.72	5.88	Actio...

i 2,256 more rows

Transforming and Adding Columns

Columns can be transformed or added by using functions on existing columns

1. Using `$` and the assign arrow `<-`

```
1 dat_tv$year <- year(dat_tv$date)
```

2. Using piping and `mutate`

```
1 dat_tv <- dat_tv %>%  
2   mutate(year = year(date))
```

Note that we still have to assign in order to store the new data frame



Selecting

Selecting takes a subset of *columns*

The show names are in the third column, called **title**

1. Using **\$** and the name

```
1 dat_tv$title
```

2. Using **[]** and an index

```
1 dat_tv[ , 3] # First index left empty because we want all rows
```

3. Using piping and **select**

```
1 dat_tv %>%  
2   select(title)
```



Filtering

Filtering takes a subset of *rows*

We pick out seasons with an average rating (**av_rating**) above 9

1. Using **[]** and a logical statement

```
1 dat_tv[dat_tv$av_rating > 9,]
```

2. Using piping and **filter**

```
1 dat_tv %>%  
2   filter(av_rating > 9)
```



Sorting

Sorting gives a re-ordering of the data

We order by average rating

1. Using `[]` and `order`

```
1 dat_tv[order(dat_tv$av_rating, decreasing = T), ]
```

Note the use the argument `decreasing` to get the highest ratings first

2. Using piping and `arrange`

```
1 dat_tv %>%  
2   arrange(-av_rating)
```

Note the use of `-` to get the highest rating first



Results

```
1 dat_tv %>% # Take the TV data, then ...
2   filter(title == "Midsomer Murders") %>% # filter for title being Midsomer Murders, then ...
3   arrange(-av_rating) %>% # sort by average rating in decreasing order, then ...
4   select(title, seasonNumber, av_rating, genres) # select a subset of columns
```

A tibble: 19 × 4

	title	seasonNumber	av_rating	genres
	<chr>	<dbl>	<dbl>	<chr>
1	Midsomer Murders	2	7.92	Crime,Drama,Mystery
2	Midsomer Murders	3	7.76	Crime,Drama,Mystery
3	Midsomer Murders	9	7.74	Crime,Drama,Mystery
4	Midsomer Murders	1	7.73	Crime,Drama,Mystery
5	Midsomer Murders	5	7.66	Crime,Drama,Mystery
6	Midsomer Murders	6	7.63	Crime,Drama,Mystery
7	Midsomer Murders	7	7.63	Crime,Drama,Mystery
8	Midsomer Murders	12	7.61	Crime,Drama,Mystery
9	Midsomer Murders	16	7.59	Crime,Drama,Mystery
10	Midsomer Murders	17	7.54	Crime,Drama,Mystery
11	Midsomer Murders	4	7.53	Crime,Drama,Mystery
12	Midsomer Murders	10	7.51	Crime,Drama,Mystery

Aggregating

Aggregating calculates a summary value over a subset of values

We calculate mean rating across seasons

1. Using the `aggregate` function

```
1 aggregate(av_rating ~ title, dat_tv, FUN = mean)
```

2. Using piping, `group_by` and `summarise`

```
1 dat_tv %>%  
2   group_by(title) %>%  
3   summarise(mean_rating = mean(av_rating))
```



The Mode of a Column

Single vectors have a *mode*

```
1 a <- c(1,2,3)
2 b <- c("Alice", "Bob", "Carla")
3
4 mode(a) # "numeric"
5 mode(b) # "character"
```

In a data frame, each column has a mode

```
1 dat <- data.frame(a, b)
2 as_tibble(dat) # Using a tibble to get a display of the mode

# A tibble: 3 × 2
   a b
<dbl> <chr>
1     1 Alice
2     2 Bob
3     3 Carla
```



Changing mode

A column getting the wrong mode is a common import error

There are functions to change the mode

```
1 dat$a <- as.character(dat$a) # Changes the first column to character
2 as_tibble(dat)
```

```
# A tibble: 3 × 2
```

```
  a      b
  <chr> <chr>
1 1    Alice
2 2     Bob
3 3    Carla
```

The mode can also be specified in most import functions



Plots

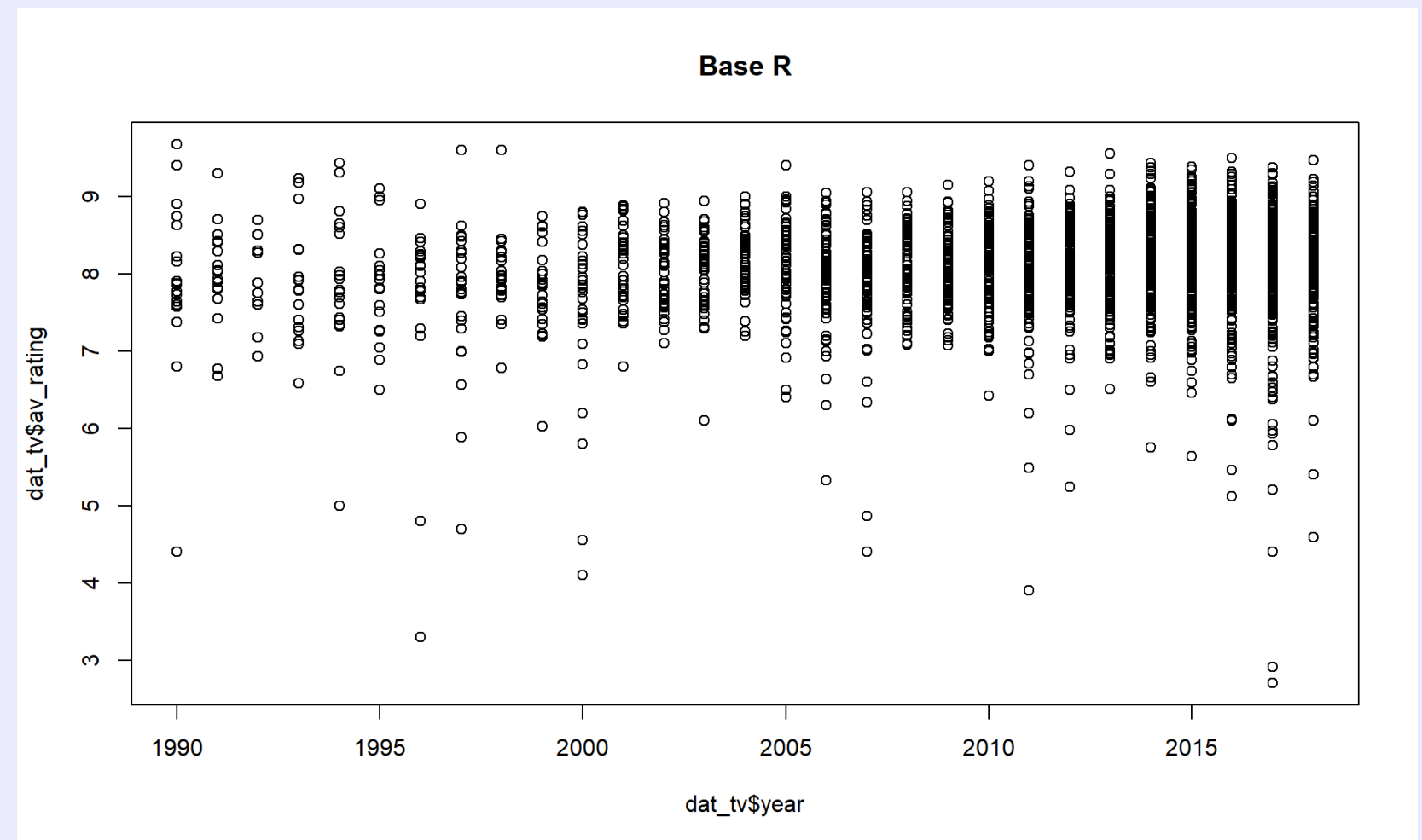
Base R includes functions to make plots

Highly customizable

Can add elements using functions like `points()`, `lines()` and `text()`

Average rating by year

```
1 plot(dat_tv$year, dat_tv$av_rating, main = "Base R")
```



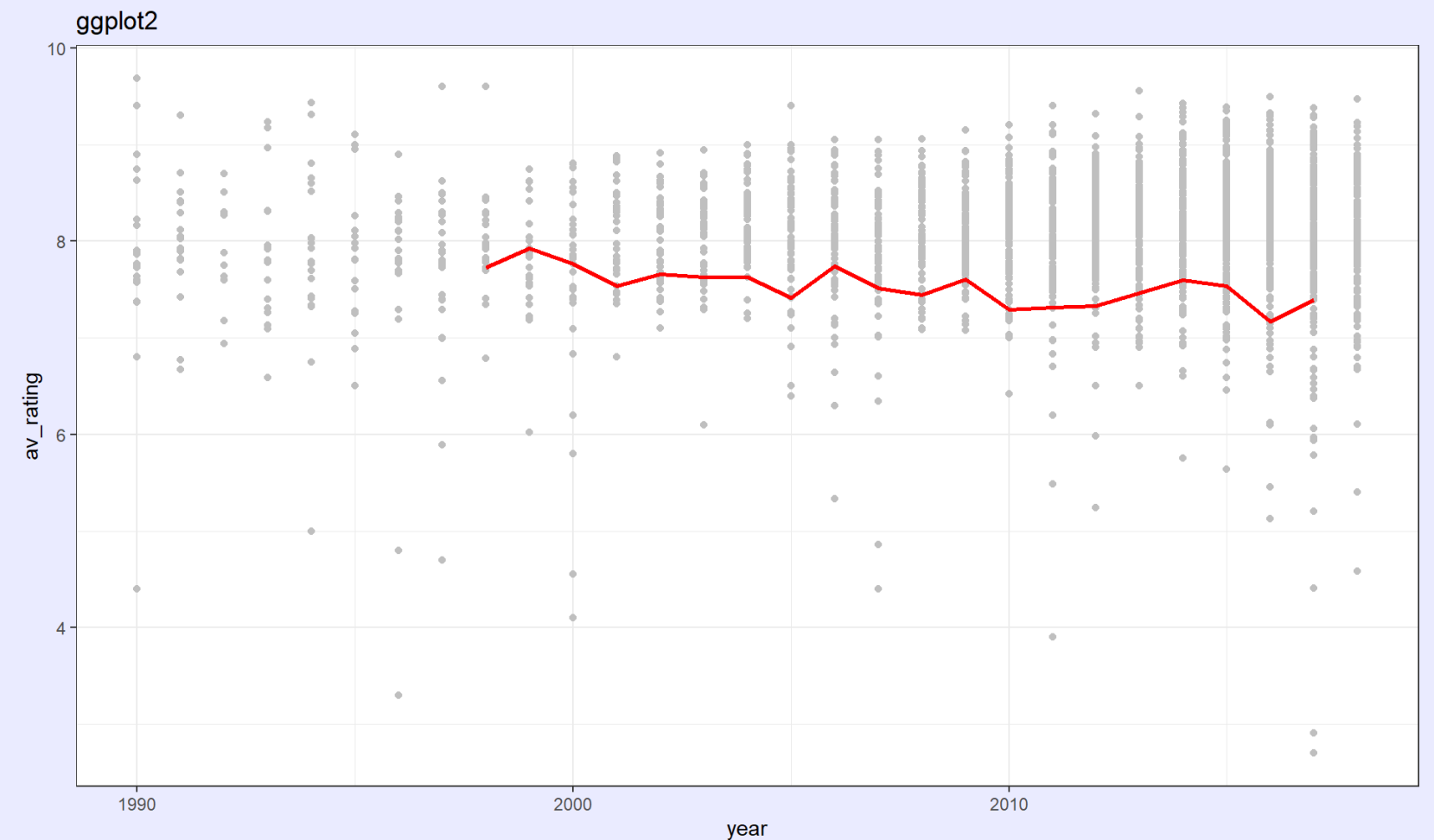
Plots. ggplot2

Many packages extend the plotting functionality, most notably **ggplot2**

Variables are specified in a special **aes()** function (aesthetics)

Plot elements are added as **geoms** (geometries)

```
1 library(ggplot2)
2 ggplot(dat_tv, aes(year, av_rating)) +
3   geom_point(col = "grey75") +
4   geom_line(data = dat_tv %>% filter(title == "Midsomer Murders"),
5             col = "red", size = 1) +
6   ggtitle("ggplot2")
```



RStudio

The RStudio window is divided into several frames

Code is run in the *Console* frame

Scripts

One usually writes code in a script (a separate text file)

File > New file > R Script

Lines from the script are run in the console by clicking the *Run* button or ctrl + enter

Scripts are saved with the file extension .R, but are just basic text files which can be opened in any text editor

Divide into sections and comment specific rows using #



RStudio. Projects

File > New project...

Creates a new folder for storing scripts, data, and output

Keeps the material contained, making it easier to keep track of changes and to share

Opening the project automatically sets the working directory to the project folder

Perfect to keep track of scripts written during a course



Something About Style

R does not read empty space

Divide into several steps and add spaces and line breaks to make readable code

```
1 x <- c(3, 14, 159)
2 y <- c(5, 2, 12)
3
4 plot(x, y, col = "red", pch = 3)
```

is more readable than

```
1 plot(c(3,14,159),c(5,2,12),col="red",pch=3)
```



RMarkdown / Quarto

RMarkdown and Quarto allows one to mix written text and R code

The file can then be rendered into some standard format

File > New file > R Markdown... or *Quarto Document...*, then select file type

Possible output file types include html, pdf, and word



Troubleshooting

Every function has a help page

Either search in the *Help* frame in RStudio or run `?function_name`

```
1 ?plot
```

Always read error messages carefully

Use Google and Stack Overflow



Resources

R website: <http://r-project.org>

RStudio website: <https://posit.co/>

RStudio cheat sheets: <https://posit.co/resources/cheatsheets/>

Grolemund & Wickham, R for Data Science, <https://r4ds.had.co.nz/>

Wickham, Navarro & Pedersen, <https://ggplot2-book.org/>





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The End. Stick around for
practical exercise