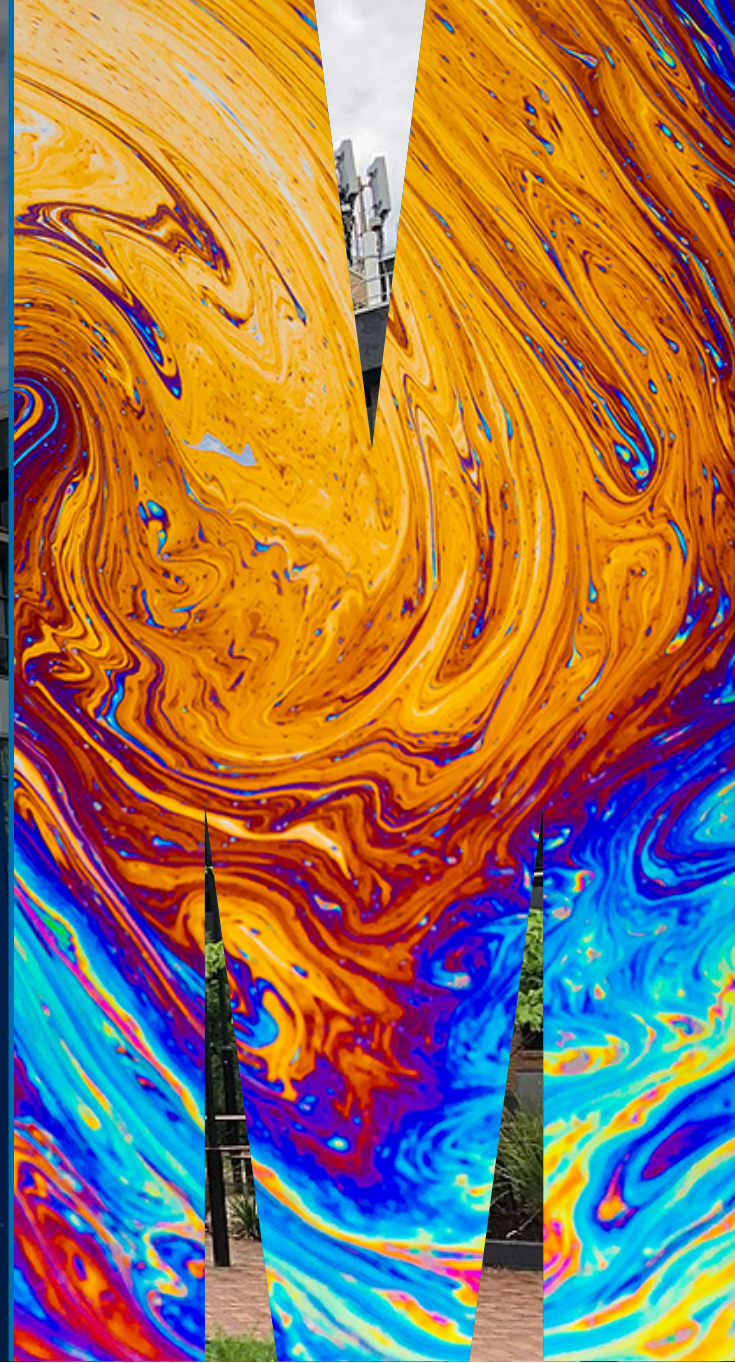
ETC5510: Introduction to Data Analysis

Week 5, part B

Web scraping



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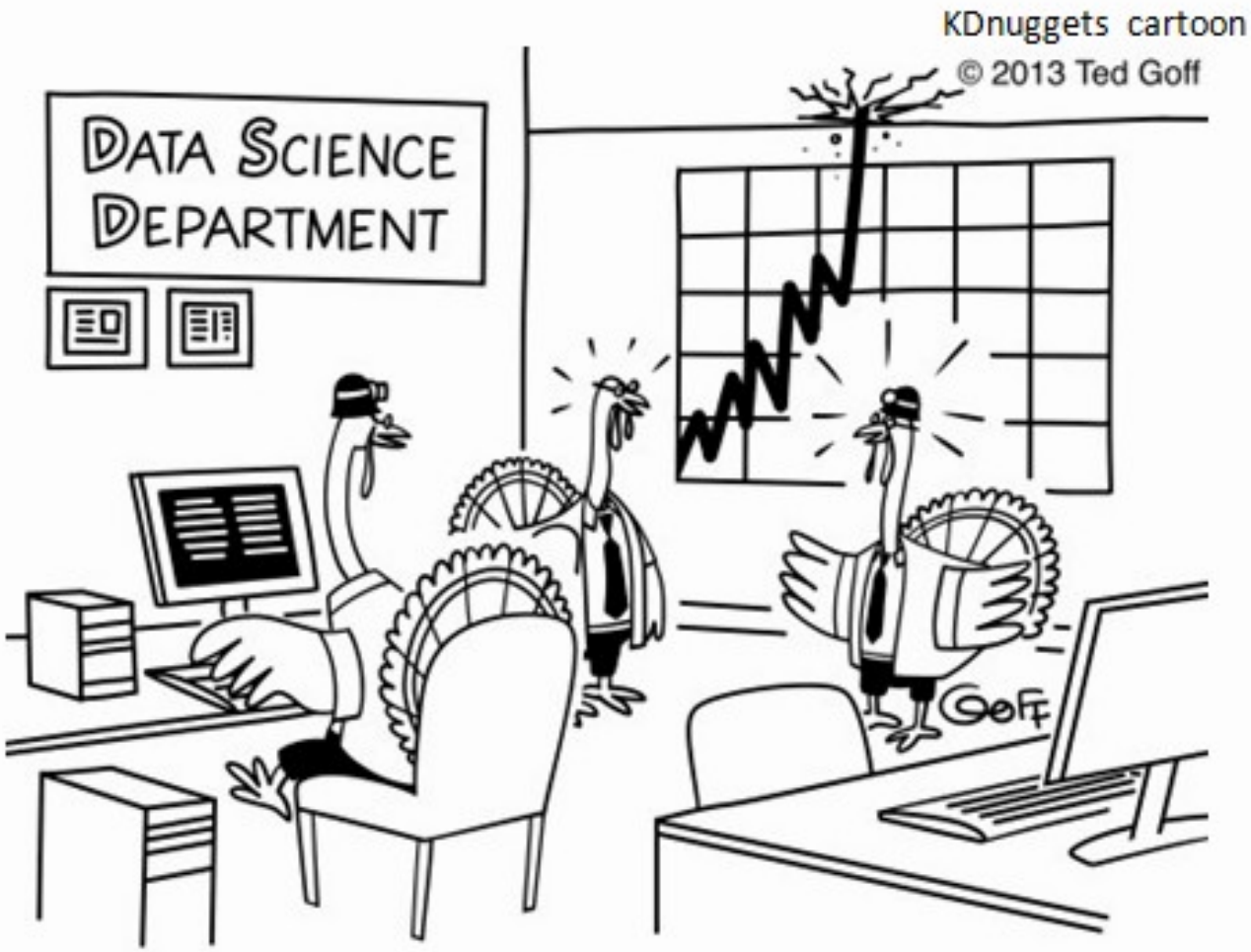


"I don't like the look of this.
Searches for gravy and turkey stuffing
are going through the roof !"

Overview

- Different file formats
  - Audio / binary
- Web data
  - ethics of web scraping
  - how to get data off the web
  - JSON

Recap on some tricky topics

- assignment ("gets" - <-)
- pipes (from the textbook)

The pipe operator: %>%

- Code to tell a story about a little bunny foo foo (borrowed from https://r4ds.had.co.nz/pipes.html):
- Using functions for each verb: `hop()`, `scoop()`, `bop()`.

> *Little bunny Foo Foo Went hopping through the forest Scooping up the field mice And bopping them on the head*

Approach: Intermediate steps

```
foo_foo_1 <- hop(foo_foo, through = forest)
foo_foo_2 <- scoop(foo_foo_1, up = field_mice)
foo_foo_3 <- bop(foo_foo_2, on = head)
```

- Main downside: forces you to name each intermediate element.
- Sometimes these steps form natural names. If this is the case - go ahead.
- **But many times there are not natural names**
- Adding number suffixes to make the names unique leads to problems.

Approach: Intermediate steps

```
foo_foo_1 <- hop(foo_foo, through = forest)
foo_foo_2 <- scoop(foo_foo_1, up = field_mice)
foo_foo_3 <- bop(foo_foo_2, on = head)
```

- Code is cluttered with unimportant names
- Suffix has to be carefully incremented on each line.
- I've done this!
- 99% of the time I miss a number somewhere, and there goes my evening ... debugging my code.

Another Approach: Overwrite the original

```
foo_foo <- hop(foo_foo, through = forest)
foo_foo <- scoop(foo_foo, up = field_mice)
foo_foo <- bop(foo_foo, on = head)
```

- Overwrite originals instead of creating intermediate objects
- Less typing (and less thinking). Less likely to make mistakes?
- **Painful debugging**: need to re-run the code from the top.
- Repitition of object - (`foo_foo` written 6 times!) Obscures what changes.

(Yet) Another approach: function composition

```
bop(
  scoop(
    hop(foo_foo, through = forest),
    up = field_mice
  ),
  on = head
)
```

- You need to read inside-out, and right-to-left.
- Arguments are spread far apart
- Harder to read

Pipe %>% can help!

```
f(x)
```

```
g(f(x))
```

```
h(g(f(x)))
```

```
x %>% f()
```

```
x %>% f() %>% g()
```

```
x %>% f() %>% g() %>%
h()
```

Solution: Use the pipe - %>%

```
foo_foo %>%
  hop(through = forest) %>%
  scoop(up = field_mice) %>%
  bop(on = head)
```

- focusses on verbs, not nouns.
- Can be read as a series of function compositions like actions.

> *Foo Foo hops, then scoops, then bops.*

- read more at: https://r4ds.had.co.nz/pipes.html

Assignment <-

"gets"

Assignment

We can perform calculations in R:

```
1 + 1
read_csv("data.csv")
```

Assignment

But what if we want to use that information later?

```
1 + 1
read_csv("data.csv")
```

Assignment

We can assign these things to an object using <-

This reads as "gets".

```
x <- 1 + 1
my_data <- read_csv("data.csv")
```

- x 'gets' 1+1
- my_data 'gets' the output of read_csv...

Assignment

Then we can use those things in other calculations

```
x <- 1 + 1
my_data <- read_csv("data.csv")

x * x

my_data %>%
  select(age, height, weight) %>%
  mutate(bmi = weight / height^2)
```

Take 3 minutes to think about these two concepts

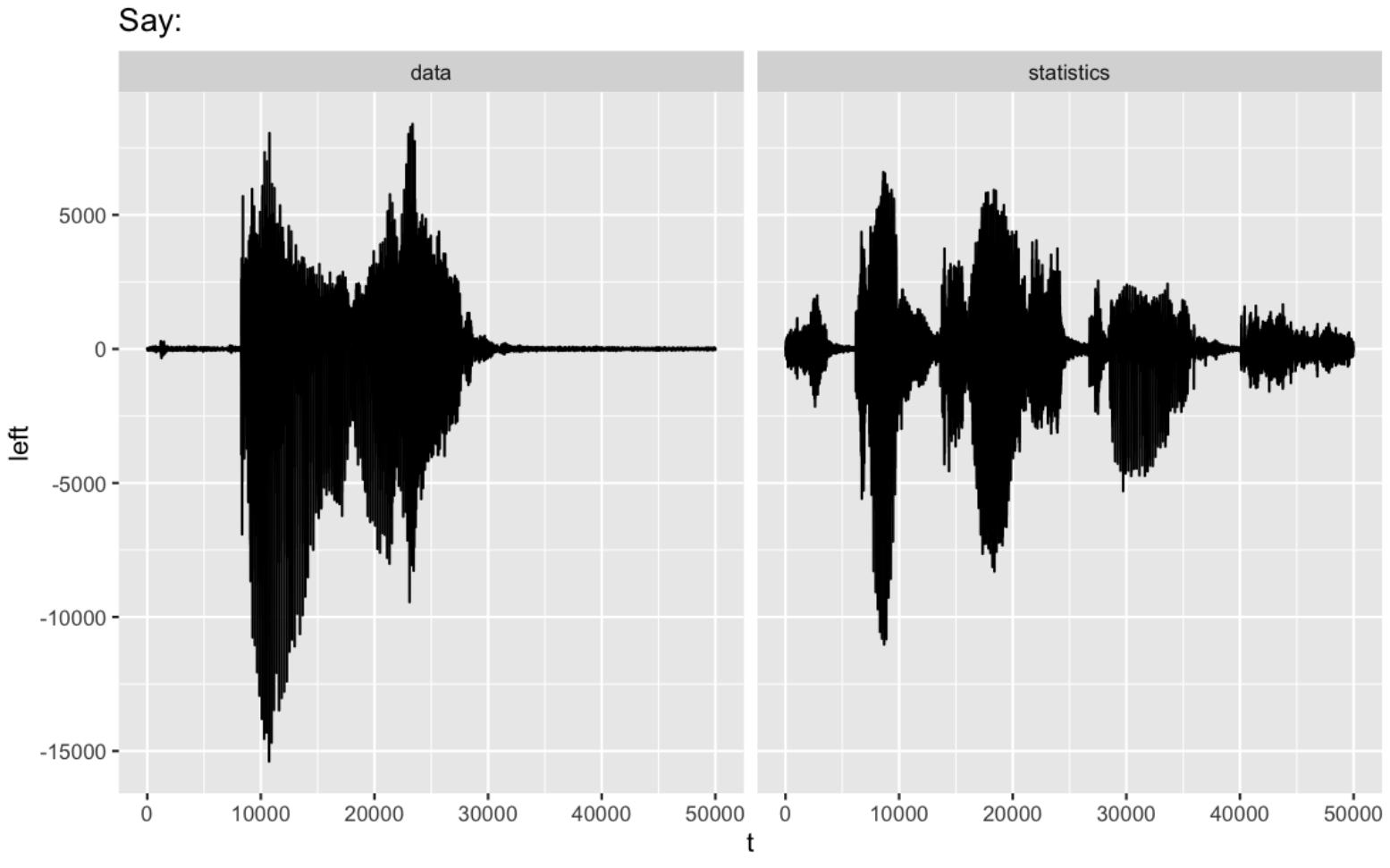
- What are pipes %>%
- What is assignment? <-

The many shapes and sizes of data

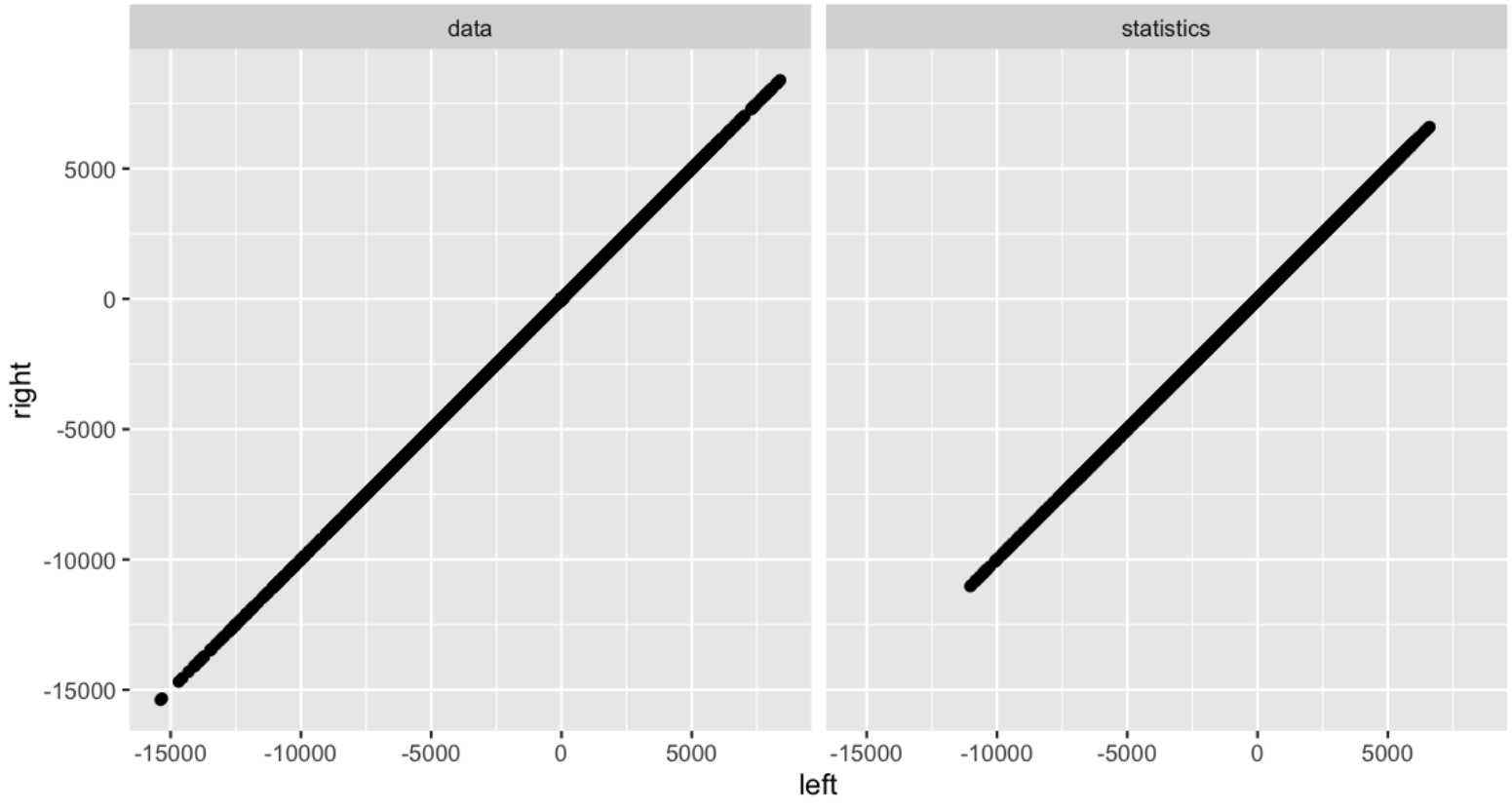
Data as an audio file

```
## Rows: 100,002
## Columns: 4
## $ t     <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, …
## $ left  <int> 28, 27, 26, 24, 22, 15, 15, 12, 15, 18, 20, 27, 20, 18, 18, 12,…
## $ right <int> 29, 28, 24, 27, 18, 19, 13, 13, 16, 16, 21, 26, 18, 22, 13, 17,…
## $ word  <chr> "data", "data", "data", "data", "data", "data", "data", "data",…
```

Plotting audio data?



Compare left and right channels



Compute statistics

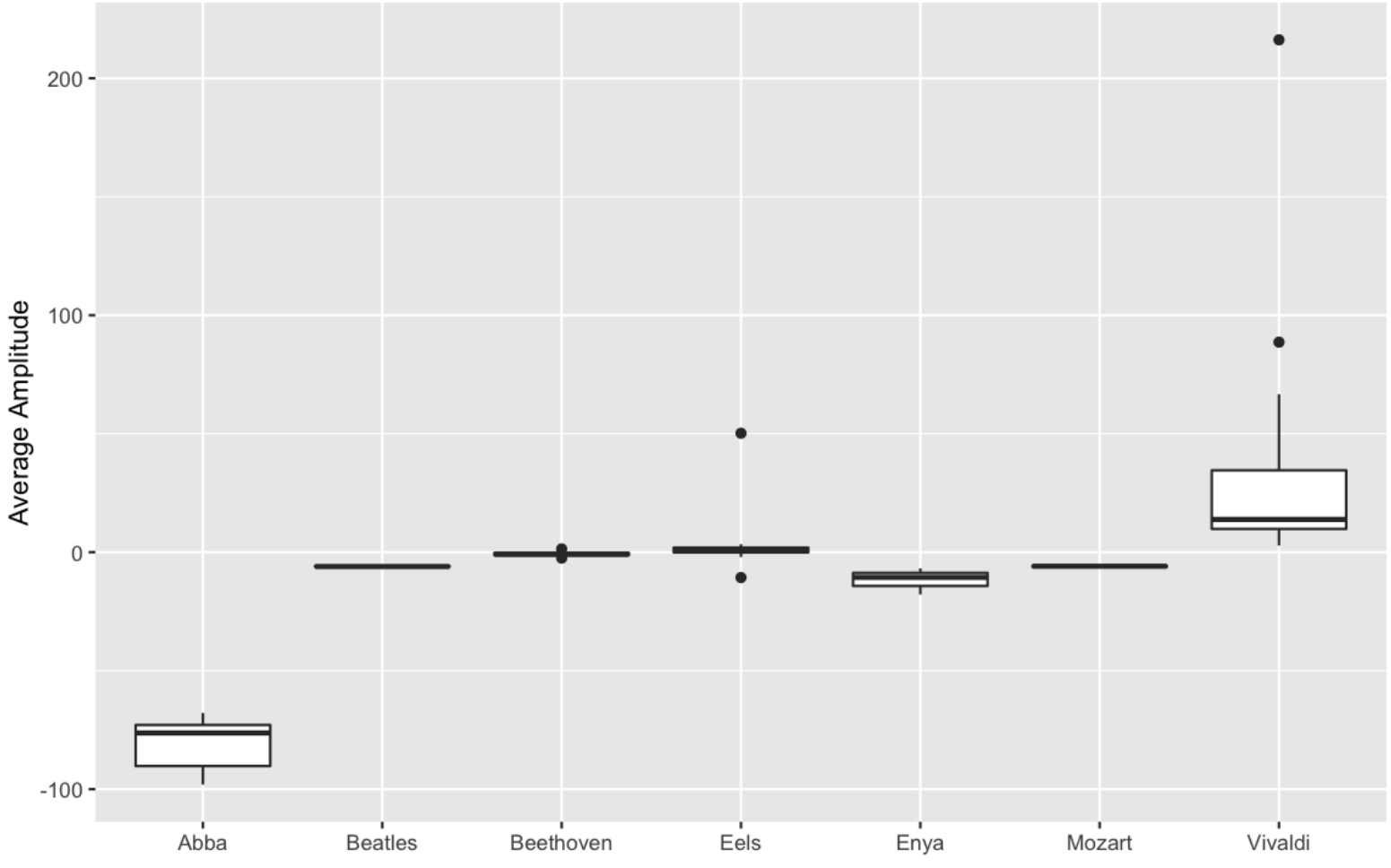
```
## # A tibble: 200,004 x 4
##        t word  channel value
##    <int> <chr> <chr>   <int>
##  1     1 data  left       28
##  2     1 data  right      29
##  3     2 data  left       27
##  4     2 data  right      28
##  5     3 data  left       26
##  6     3 data  right      24
##  7     4 data  left       24
##  8     4 data  right      27
##  9     5 data  left       22
## 10     5 data  right      18
## # … with 199,994 more rows
```

word	m	s	mx	mn
data	0.004	1602.577	8393	-15386

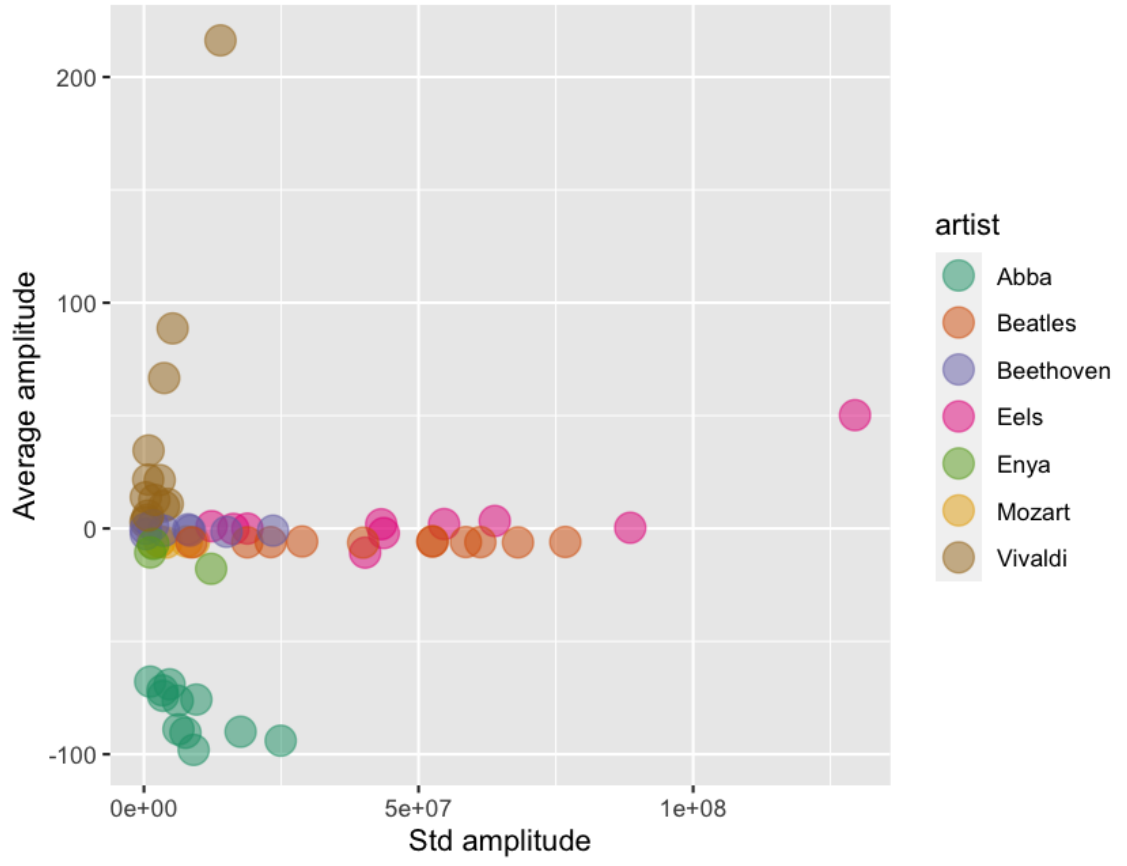
Di's music

```
## # A tibble: 62 x 8
##    X1             artist type       lvar  lave  lmax lfener lfreq
##    <chr>          <chr>  <chr>     <dbl> <dbl> <dbl>  <dbl> <dbl>
##  1 Dancing Queen  Abba   Rock  17600756. -90.0 29921   106.  59.6
##  2 Knowing Me     Abba   Rock   9543021. -75.8 27626   103.  58.5
##  3 Take a Chance  Abba   Rock   9049482. -98.1 26372   102. 125.
##  4 Mamma Mia      Abba   Rock   7557437. -90.5 28898   102.  48.8
##  5 Lay All You    Abba   Rock   6282286. -89.0 27940   100.  74.0
##  6 Super Trouper  Abba   Rock   4665867. -69.0 25531   100.  81.4
##  7 I Have A Dream Abba   Rock   3369670. -71.7 14699   105. 305.
##  8 The Winner     Abba   Rock   1135862  -67.8  8928   104. 278.
##  9 Money          Abba   Rock   6146943. -76.3 22962   102. 165.
## 10 SOS            Abba   Rock   3482882. -74.1 15517   104. 147.
## # … with 52 more rows
```

Plot Di's music



Plot Di's Music



Abba is just different from everyone else!

Question time:

- "How does `data` appear different than `statistics` in the time series?"
- "What format is the data in an audio file?"
- "How is Abba different from the other music clips?",

Why look at audio data?

- Data comes in many shapes and sizes
- Audio data can be transformed ("rectangled") into a data.frame
- Try on your own music with the spotifyr package!

Scraping the web: what? why?

- Increasing amount of data is available on the web.
- These data are provided in an unstructured format: you can always copy&paste, but it's time-consuming and prone to errors.
- Web scraping is the process of extracting this information automatically and transform it into a structured dataset.

Scraping the web: what? why?

1. Screen scraping: extract data from source code of website, with html parser (easy) or regular expression matching (less easy).
2. Web APIs (application programming interface): website offers a set of structured http requests that return JSON or XML files.

- Why R? It includes all tools necessary to do web scraping, familiarity, direct analysis of data... But python, perl, java are also efficient tools.

Web Scraping with `rvest` and `polite`

Hypertext Markup Language

Most of the data on the web is still largely available as HTML - while it is structured (hierarchical / tree based) it often is not available in a form useful for analysis (flat / tidy).

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
  </body>
</html>
```

What if we want to extract parts of this text out?

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
  </body>
</html>
```

- `read_html()`: read HTML in (like `read_csv` and co!)
- `html_nodes()`: select specified nodes from the HTML document using CSS selectors.

Let's read it in with `read_html`

```
example <- read_html(here::here("slides/data/example.html"))
example
## {html_document}
## <html>
## [1] <head>\n<meta http-equiv="Content-Type" content="text/html; charset=UTF-8 ...
## [2] <body>\n    <p align="center">Hello world!</p>\n  </body>
```

- We have two parts - head and body - which makes sense:

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
  </body>
</html>
```

Now let's get the title

```
example %>%
  html_nodes("title")
## {xml_nodeset (1)}
## [1] <title>This is a title</title>
```

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
  </body>
</html>
```

Now let's get the paragraph text

```
example %>%
  html_nodes("p")
## {xml_nodeset (1)}
## [1] <p align="center">Hello world!</p>
```

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
  </body>
</html>
```

Rough summary

- `read_html` - read in a html file
- `html_nodes` - select the parts of the html file we want to look at
  - This requires knowing about the website structure
  - But it turns out website are much...much more complicated than out little example file

rvest + polite:

Simplify processing and manipulating HTML data

- `bow()` - check if the data can be scraped appropriately
- `scrape()` - scrape website data (with nice defaults)
- `html_nodes()` - select specified nodes from the HTML document using CSS selectors.
- `html_table` - parse an HTML table into a data frame.
- `html_text` - extract tag pairs' content.

SelectorGadget: css selectors

- Using a tool called selector gadget to **help** identify the html elements of interest
- Does this by constructing a css selector which can be used to subset the html document.

SelectorGadget: css selectors

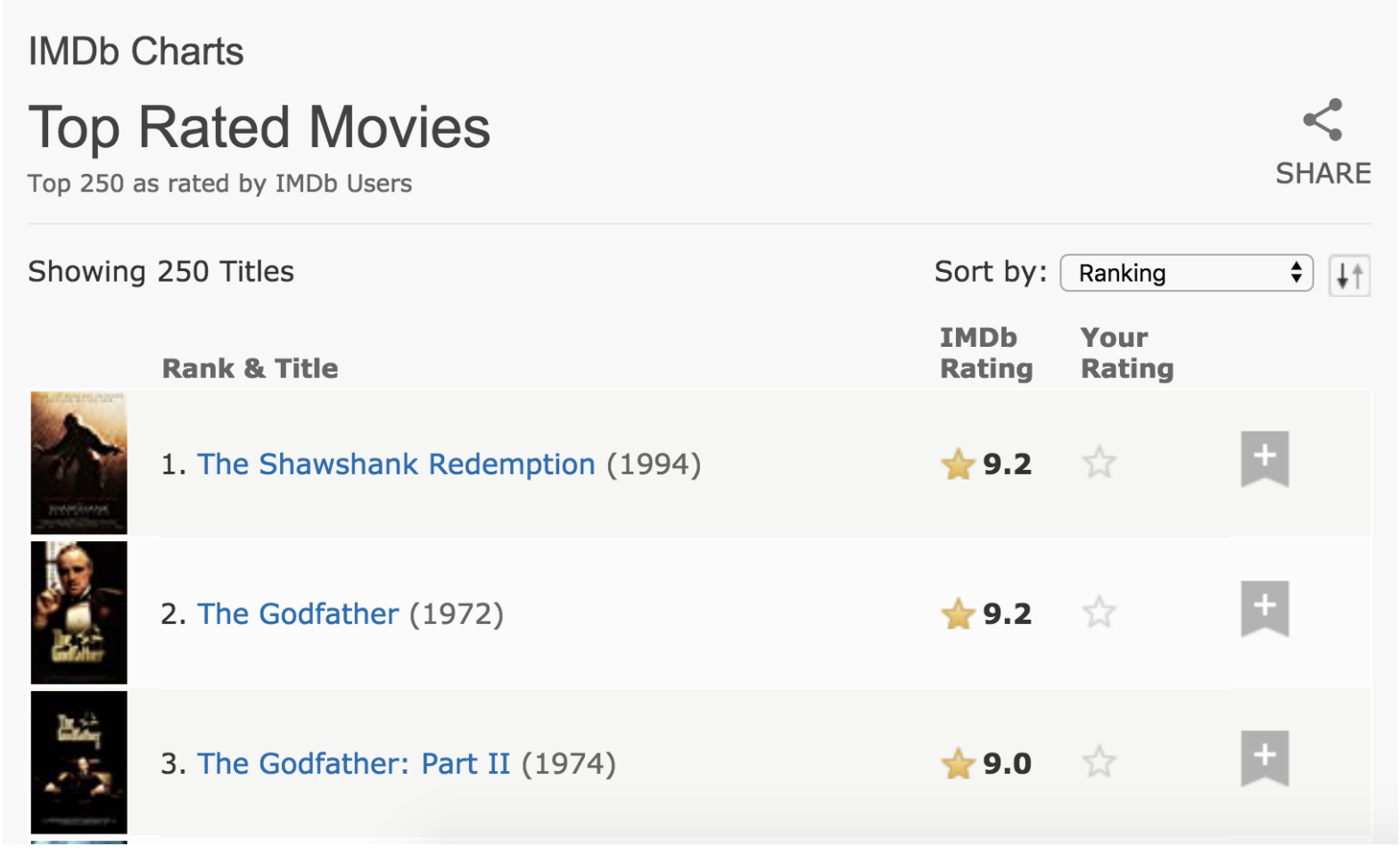
Selector	Example	Description
element	`p`	Select all <p> elements
element element	`div p`	Select all <p> elements inside a element
element>element	`div > p`	Select all <p> elements with as a parent
.class	`.title`	Select all elements with class="title"
#id	`.name`	Select all elements with id="name"
[attribute]	`[class]`	Select all elements with a class attribute
[attribute=value]	`[class=title]`	Select all elements with class="title"

SelectorGadget

- SelectorGadget: Open source tool that eases CSS selector generation and discovery
- Install the Chrome Extension
- A box will open in the bottom right of the website. Click on a page element that you would like your selector to match (it will turn green). SelectorGadget will then generate a minimal CSS selector for that element, and will highlight (yellow) everything that is matched by the selector.
- Now click on a highlighted element to remove it from the selector (red), or click on an unhighlighted element to add it to the selector. Through this process of selection and rejection, SelectorGadget helps you come up with the appropriate CSS selector for your needs.

Top 250 movies on IMDB

Take a look at the source code, look for the tag `table` tag:
http://www.imdb.com/chart/top



First check to make sure you're allowed!

```
# install.packages("remotes")
# remotes::install_github("dmi3kno/polite")
library(polite)
bow("http://www.imdb.com")
## <polite session> http://www.imdb.com
##     User-agent: polite R package - https://github.com/dmi3kno/polite
##     robots.txt: 26 rules are defined for 1 bots
##    Crawl delay: 5 sec
##   The path is scrapable for this user-agent

bow("http://www.google.com")
## <polite session> http://www.google.com
##     User-agent: polite R package - https://github.com/dmi3kno/polite
##     robots.txt: 275 rules are defined for 4 bots
##    Crawl delay: 5 sec
##   The path is scrapable for this user-agent
```

Join in

- Open rstudio and download today's exercises

```
# install.packages("usethis")
library(usethis)
use_course("https://ida.numbat.space/exercises/5b/ida-exercise-5b.zip")
```

Demo

Let's go to http://www.imdb.com/chart/top

Bow and scrape

```
imdb_session <- bow("http://www.imdb.com/chart/top")

imdb_session
## <polite session> http://www.imdb.com/chart/top
##     User-agent: polite R package - https://github.com/dmi3kno/polite
##     robots.txt: 26 rules are defined for 1 bots
##    Crawl delay: 5 sec
##   The path is scrapable for this user-agent

imdb_data <- scrape(imdb_session)

imdb_data
## {html_document}
## <html xmlns:og="http://ogp.me/ns#" xmlns:fb="http://www.facebook.com/2008/fbml">
## [1] <head>\n<meta http-equiv="Content-Type" content="text/html; charset=UTF-8 ...
## [2] <body id="styleguide-v2" class="fixed">\n            <img height="1" widt ...
```

Select and format pieces: titles - `html_nodes()`

```
library(rvest)
imdb_data %>%
  html_nodes(".titleColumn a")
## {xml_nodeset (250)}
##  [1] <a href="/title/tt0111161/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [2] <a href="/title/tt0068646/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [3] <a href="/title/tt0071562/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [4] <a href="/title/tt0468569/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [5] <a href="/title/tt0050083/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [6] <a href="/title/tt0108052/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [7] <a href="/title/tt0167260/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [8] <a href="/title/tt0110912/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
##  [9] <a href="/title/tt0060196/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
## [10] <a href="/title/tt0120737/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
## [11] <a href="/title/tt0137523/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
## [12] <a href="/title/tt0109830/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
## [13] <a href="/title/tt1375666/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
## [14] <a href="/title/tt0080684/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
## [15] <a href="/title/tt0167261/?pf_rd_m=A2FGELUUNOQJNL&amp;pf_rd_p=e31d89dd-3 ...
```

Select and format pieces: titles - `html_text()`

```
imdb_data %>%
  html_nodes(".titleColumn a") %>%
  html_text()
##   [1] "The Shawshank Redemption"
##   [2] "The Godfather"
##   [3] "The Godfather: Part II"
##   [4] "The Dark Knight"
##   [5] "12 Angry Men"
##   [6] "Schindler's List"
##   [7] "The Lord of the Rings: The Return of the King"
##   [8] "Pulp Fiction"
##   [9] "The Good, the Bad and the Ugly"
##  [10] "The Lord of the Rings: The Fellowship of the Ring"
##  [11] "Fight Club"
##  [12] "Forrest Gump"
##  [13] "Inception"
##  [14] "Star Wars: Episode V - The Empire Strikes Back"
##  [15] "The Lord of the Rings: The Two Towers"
##  [16] "The Matrix"
```

Select and format pieces: save it

```
titles <- imdb_data %>%
  html_nodes(".titleColumn a") %>%
  html_text()
```

Select and format pieces: years - nodes

```
imdb_data %>%
  html_nodes(".secondaryInfo")
## {xml_nodeset (250)}
##  [1] <span class="secondaryInfo">(1994)</span>
##  [2] <span class="secondaryInfo">(1972)</span>
##  [3] <span class="secondaryInfo">(1974)</span>
##  [4] <span class="secondaryInfo">(2008)</span>
##  [5] <span class="secondaryInfo">(1957)</span>
##  [6] <span class="secondaryInfo">(1993)</span>
##  [7] <span class="secondaryInfo">(2003)</span>
##  [8] <span class="secondaryInfo">(1994)</span>
##  [9] <span class="secondaryInfo">(1966)</span>
## [10] <span class="secondaryInfo">(2001)</span>
## [11] <span class="secondaryInfo">(1999)</span>
## [12] <span class="secondaryInfo">(1994)</span>
## [13] <span class="secondaryInfo">(2010)</span>
## [14] <span class="secondaryInfo">(1980)</span>
## [15] <span class="secondaryInfo">(2002)</span>
## [16] <span class="secondaryInfo">(1999)</span>
## [17] <span class="secondaryInfo">(1990)</span>
```

Select and format pieces: years - text

```
imdb_data %>%
  html_nodes(".secondaryInfo") %>%
  html_text()
##   [1] "(1994)" "(1972)" "(1974)" "(2008)" "(1957)" "(1993)" "(2003)" "(1994)"
##   [9] "(1966)" "(2001)" "(1999)" "(1994)" "(2010)" "(1980)" "(2002)" "(1999)"
##  [17] "(1990)" "(1975)" "(1954)" "(1995)" "(2002)" "(1997)" "(1991)" "(1946)"
##  [25] "(1977)" "(2019)" "(1998)" "(2001)" "(1999)" "(2014)" "(1994)" "(1995)"
##  [33] "(1962)" "(1994)" "(1998)" "(2002)" "(1991)" "(1985)" "(1936)" "(1960)"
##  [41] "(2000)" "(1931)" "(2011)" "(2006)" "(2014)" "(2006)" "(1968)" "(1988)"
##  [49] "(1942)" "(2019)" "(1988)" "(1954)" "(1979)" "(1979)" "(2000)" "(1981)"
##  [57] "(1940)" "(2006)" "(2012)" "(1957)" "(1980)" "(2018)" "(2008)" "(1950)"
##  [65] "(2018)" "(1997)" "(1964)" "(2003)" "(1957)" "(2019)" "(2012)" "(1984)"
##  [73] "(1986)" "(2016)" "(2017)" "(1999)" "(1995)" "(2019)" "(1981)" "(2009)"
##  [81] "(1995)" "(1963)" "(2007)" "(1983)" "(1984)" "(1992)" "(2009)" "(1997)"
##  [89] "(1968)" "(2000)" "(1958)" "(1931)" "(2016)" "(2004)" "(1941)" "(2012)"
##  [97] "(2018)" "(1987)" "(1959)" "(1971)" "(2000)" "(1921)" "(1948)" "(1952)"
## [105] "(1983)" "(1976)" "(2001)" "(1962)" "(1973)" "(2010)" "(1927)" "(1965)"
## [113] "(1952)" "(2011)" "(1944)" "(1960)" "(1962)" "(2010)" "(1989)" "(2009)"
## [121] "(1997)" "(1975)" "(1995)" "(1950)" "(1988)" "(1961)" "(2005)" "(2018)"
## [129] "(2004)" "(1992)" "(1985)" "(1997)" "(1959)" "(2004)" "(1985)" "(1963)"
```

Select and format pieces: years - remove-brackets

```
imdb_data %>%
  html_nodes(".secondaryInfo") %>%
  html_text() %>%
  str_remove("\\(") %>% # remove (
  str_remove("\\)") %>% # remove )
  as.numeric()
##   [1] 1994 1972 1974 2008 1957 1993 2003 1994 1966 2001 1999 1994 2010 1980 2002
##  [16] 1999 1990 1975 1954 1995 2002 1997 1991 1946 1977 2019 1998 2001 1999 2014
##  [31] 1994 1995 1962 1994 1998 2002 1991 1985 1936 1960 2000 1931 2011 2006 2014
##  [46] 2006 1968 1988 1942 2019 1988 1954 1979 1979 2000 1981 1940 2006 2012 1957
##  [61] 1980 2018 2008 1950 2018 1997 1964 2003 1957 2019 2012 1984 1986 2016 2017
##  [76] 1999 1995 2019 1981 2009 1995 1963 2007 1983 1984 1992 2009 1997 1968 2000
##  [91] 1958 1931 2016 2004 1941 2012 2018 1987 1959 1971 2000 1921 1948 1952 1983
## [106] 1976 2001 1962 1973 2010 1927 1965 1952 2011 1944 1960 1962 2010 1989 2009
## [121] 1997 1975 1995 1950 1988 1961 2005 2018 2004 1992 1985 1997 1959 2004 1985
## [136] 1963 1950 2001 1995 2006 1988 2009 1980 1998 2013 1948 1961 2007 2005 2017
## [151] 1925 1974 1954 2005 1957 2015 2007 2011 2010 1996 1980 1999 1982 2015 1939
## [166] 1993 1982 1957 1957 2003 1949 1954 1979 1996 2003 1998 2008 1953 1978 2003
## [181] 2014 1996 2018 2019 1998 2009 1993 2014 2016 2014 2019 1966 1939 2010 1995
## [196] 2002 1926 1924 2013 2013 1967 2015 1976 1986 1953 1975 2007 2004 1979 1986
```

Select and format pieces: years - `parse_number()`

```
imdb_data %>%
  html_nodes(".secondaryInfo") %>%
  html_text() %>%
  parse_number()
##   [1] 1994 1972 1974 2008 1957 1993 2003 1994 1966 2001 1999 1994 2010 1980 2002
##  [16] 1999 1990 1975 1954 1995 2002 1997 1991 1946 1977 2019 1998 2001 1999 2014
##  [31] 1994 1995 1962 1994 1998 2002 1991 1985 1936 1960 2000 1931 2011 2006 2014
##  [46] 2006 1968 1988 1942 2019 1988 1954 1979 1979 2000 1981 1940 2006 2012 1957
##  [61] 1980 2018 2008 1950 2018 1997 1964 2003 1957 2019 2012 1984 1986 2016 2017
##  [76] 1999 1995 2019 1981 2009 1995 1963 2007 1983 1984 1992 2009 1997 1968 2000
##  [91] 1958 1931 2016 2004 1941 2012 2018 1987 1959 1971 2000 1921 1948 1952 1983
## [106] 1976 2001 1962 1973 2010 1927 1965 1952 2011 1944 1960 1962 2010 1989 2009
## [121] 1997 1975 1995 1950 1988 1961 2005 2018 2004 1992 1985 1997 1959 2004 1985
## [136] 1963 1950 2001 1995 2006 1988 2009 1980 1998 2013 1948 1961 2007 2005 2017
## [151] 1925 1974 1954 2005 1957 2015 2007 2011 2010 1996 1980 1999 1982 2015 1939
## [166] 1993 1982 1957 1957 2003 1949 1954 1979 1996 2003 1998 2008 1953 1978 2003
## [181] 2014 1996 2018 2019 1998 2009 1993 2014 2016 2014 2019 1966 1939 2010 1995
## [196] 2002 1926 1924 2013 2013 1967 2015 1976 1986 1953 1975 2007 2004 1979 1986
## [211] 2009 1959 2013 2017 1928 1966 2011 1989 1959 2006 2004 2000 1984 2015 2016
```

Select and format pieces: years - remove-brackets

```
years <- imdb_data %>%
  html_nodes(".secondaryInfo") %>%
  html_text() %>%
  str_remove("\\(") %>% # remove (
  str_remove("\\)") %>% # remove )
  as.numeric()
```

Select and format pieces: scores - nodes

```
imdb_data %>%
  html_nodes(".imdbRating strong")
## {xml_nodeset (250)}
##  [1] <strong title="9.2 based on 2,223,821 user ratings">9.2</strong>
##  [2] <strong title="9.1 based on 1,532,457 user ratings">9.1</strong>
##  [3] <strong title="9.0 based on 1,072,718 user ratings">9.0</strong>
##  [4] <strong title="9.0 based on 2,198,206 user ratings">9.0</strong>
##  [5] <strong title="8.9 based on 649,936 user ratings">8.9</strong>
##  [6] <strong title="8.9 based on 1,158,141 user ratings">8.9</strong>
##  [7] <strong title="8.9 based on 1,575,650 user ratings">8.9</strong>
##  [8] <strong title="8.8 based on 1,744,462 user ratings">8.8</strong>
##  [9] <strong title="8.8 based on 657,898 user ratings">8.8</strong>
## [10] <strong title="8.8 based on 1,588,379 user ratings">8.8</strong>
## [11] <strong title="8.8 based on 1,772,374 user ratings">8.8</strong>
## [12] <strong title="8.8 based on 1,715,479 user ratings">8.8</strong>
## [13] <strong title="8.7 based on 1,950,012 user ratings">8.7</strong>
## [14] <strong title="8.7 based on 1,111,785 user ratings">8.7</strong>
## [15] <strong title="8.7 based on 1,423,084 user ratings">8.7</strong>
## [16] <strong title="8.6 based on 1,597,852 user ratings">8.6</strong>
## [17] <strong title="8.6 based on 967,824 user ratings">8.6</strong>
```

Select and format pieces: scores - text

```
imdb_data %>%
  html_nodes(".imdbRating strong") %>%
  html_text()
##   [1] "9.2" "9.1" "9.0" "9.0" "8.9" "8.9" "8.9" "8.8" "8.8" "8.8" "8.8" "8.8"
##  [13] "8.7" "8.7" "8.7" "8.6" "8.6" "8.6" "8.6" "8.6" "8.6" "8.6" "8.6" "8.6"
##  [25] "8.6" "8.6" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5"
##  [37] "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.5" "8.4" "8.4"
##  [49] "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4"
##  [61] "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.4" "8.3" "8.3" "8.3"
##  [73] "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3"
##  [85] "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3" "8.3"
##  [97] "8.3" "8.3" "8.3" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2"
## [109] "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2"
## [121] "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2"
## [133] "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2" "8.2"
## [145] "8.2" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1"
## [157] "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1"
## [169] "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1"
## [181] "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1"
## [193] "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1" "8.1"
```

Select and format pieces: scores - as-numeric

```
imdb_data %>%
  html_nodes(".imdbRating strong") %>%
  html_text() %>%
  as.numeric()
##   [1] 9.2 9.1 9.0 9.0 8.9 8.9 8.9 8.8 8.8 8.8 8.8 8.8 8.7 8.7 8.7 8.6 8.6 8.6
##  [19] 8.6 8.6 8.6 8.6 8.6 8.6 8.6 8.6 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5
##  [37] 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.5 8.4 8.4 8.4 8.4 8.4 8.4 8.4
##  [55] 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.4 8.3 8.3 8.3
##  [73] 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3
##  [91] 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.3 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2
## [109] 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2
## [127] 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2 8.2
## [145] 8.2 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1
## [163] 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1
## [181] 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1
## [199] 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.1 8.0 8.0 8.0
## [217] 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0
## [235] 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0
```

Select and format pieces: scores - save

```
scores <- imdb_data %>%
  html_nodes(".imdbRating strong") %>%
  html_text() %>%
  as.numeric()
```

Select and format pieces: put it all together

```
imdb_top_250 <- tibble(title = titles,
                       year = years,
                       score = scores)

imdb_top_250
## # A tibble: 250 x 3
##    title                                                year score
##    <chr>                                               <dbl> <dbl>
##  1 The Shawshank Redemption                             1994   9.2
##  2 The Godfather                                        1972   9.1
##  3 The Godfather: Part II                               1974   9
##  4 The Dark Knight                                      2008   9
##  5 12 Angry Men                                         1957   8.9
##  6 Schindler's List                                     1993   8.9
##  7 The Lord of the Rings: The Return of the King        2003   8.9
##  8 Pulp Fiction                                         1994   8.8
##  9 The Good, the Bad and the Ugly                       1966   8.8
## 10 The Lord of the Rings: The Fellowship of the Ring    2001   8.8
## # … with 240 more rows
```

title	year	score
The Shawshank Redemption	1994	9.2
The Godfather	1972	9.1
The Godfather: Part II	1974	9
The Dark Knight	2008	9
12 Angry Men	1957	8.9
Schindler's List	1993	8.9
The Lord of the Rings: The Return of the King	2003	8.9
Pulp Fiction	1994	8.8
The Good, the Bad and the Ugly	1966	8.8
...	...	...

Aside: Yet another approach - pull the table with `html_table()`

- requires notation we haven't used yet (e.g., what is `[ [ ] ]`)
- requires substantial text cleaning
- If there is time we can cover this at the end of class

```
imdb_table <- html_table(imdb_data)

glimpse(imdb_table[[1]])
## Rows: 250
## Columns: 5
## $ ``              <lgl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA…
## $ `Rank & Title` <chr> "1.\n      The Shawshank Redemption\n        (1994)", …
## $ `IMDb Rating`  <dbl> 9.2, 9.1, 9.0, 9.0, 8.9, 8.9, 8.9, 8.8, 8.8, 8.8, 8.8,…
## $ `Your Rating`  <chr> "12345678910\n        \n        \n            \n      …
## $ ``              <lgl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA…
```

Clean up / enhance

May or may not be a lot of work depending on how messy the data are

- See if you like what you got:

```
glimpse(imdb_top_250)
## Rows: 250
## Columns: 3
## $ title <chr> "The Shawshank Redemption", "The Godfather", "The Godfather: Pa…
## $ year  <dbl> 1994, 1972, 1974, 2008, 1957, 1993, 2003, 1994, 1966, 2001, 199…
## $ score <dbl> 9.2, 9.1, 9.0, 9.0, 8.9, 8.9, 8.9, 8.8, 8.8, 8.8, 8.8, 8.8, 8.7…
```

Clean up / enhance

- Add a variable for rank

```
imdb_top_250 %>%
  mutate(
    rank = 1:nrow(imdb_top_250)
  )
```

```
## # A tibble: 250 x 4
##    title                                          year score  rank
##    <chr>                                         <dbl> <dbl> <int>
##  1 The Shawshank Redemption                       1994   9.2     1
##  2 The Godfather                                  1972   9.1     2
##  3 The Godfather: Part II                         1974   9       3
##  4 The Dark Knight                                2008   9       4
##  5 12 Angry Men                                   1957   8.9     5
##  6 Schindler's List                               1993   8.9     6
##  7 The Lord of the Rings: The Return of the King  2003   8.9     7
##  8 Pulp Fiction                                   1994   8.8     8
##  9 The Good, the Bad and the Ugly                 1966   8.8     9
## 10 The Lord of the Rings: The Fellowship of the Ring 2001   8.8    10
## # … with 240 more rows
```

title	year	score	rank
The Shawshank Redemption	1994	9.2	1
The Godfather	1972	9.1	2
The Godfather: Part II	1974	9	3
The Dark Knight	2008	9	4
12 Angry Men	1957	8.9	5
Schindler's List	1993	8.9	6
The Lord of the Rings: The Return of the King	2003	8.9	7
Pulp Fiction	1994	8.8	8
The Good, the Bad and the Ugly	1966	8.8	9
...	...	...	...

Your Turn: Which 1995 movies made the list?

```
imdb_top_250 %>%
  filter(year == 1995)
## # A tibble: 8 x 3
##   title                year score
##   <chr>               <dbl> <dbl>
## 1 Se7en                1995   8.6
## 2 The Usual Suspects   1995   8.5
## 3 Braveheart           1995   8.3
## 4 Toy Story            1995   8.3
## 5 Heat                 1995   8.2
## 6 Casino               1995   8.2
## 7 Before Sunrise       1995   8.1
## 8 La haine             1995   8
```

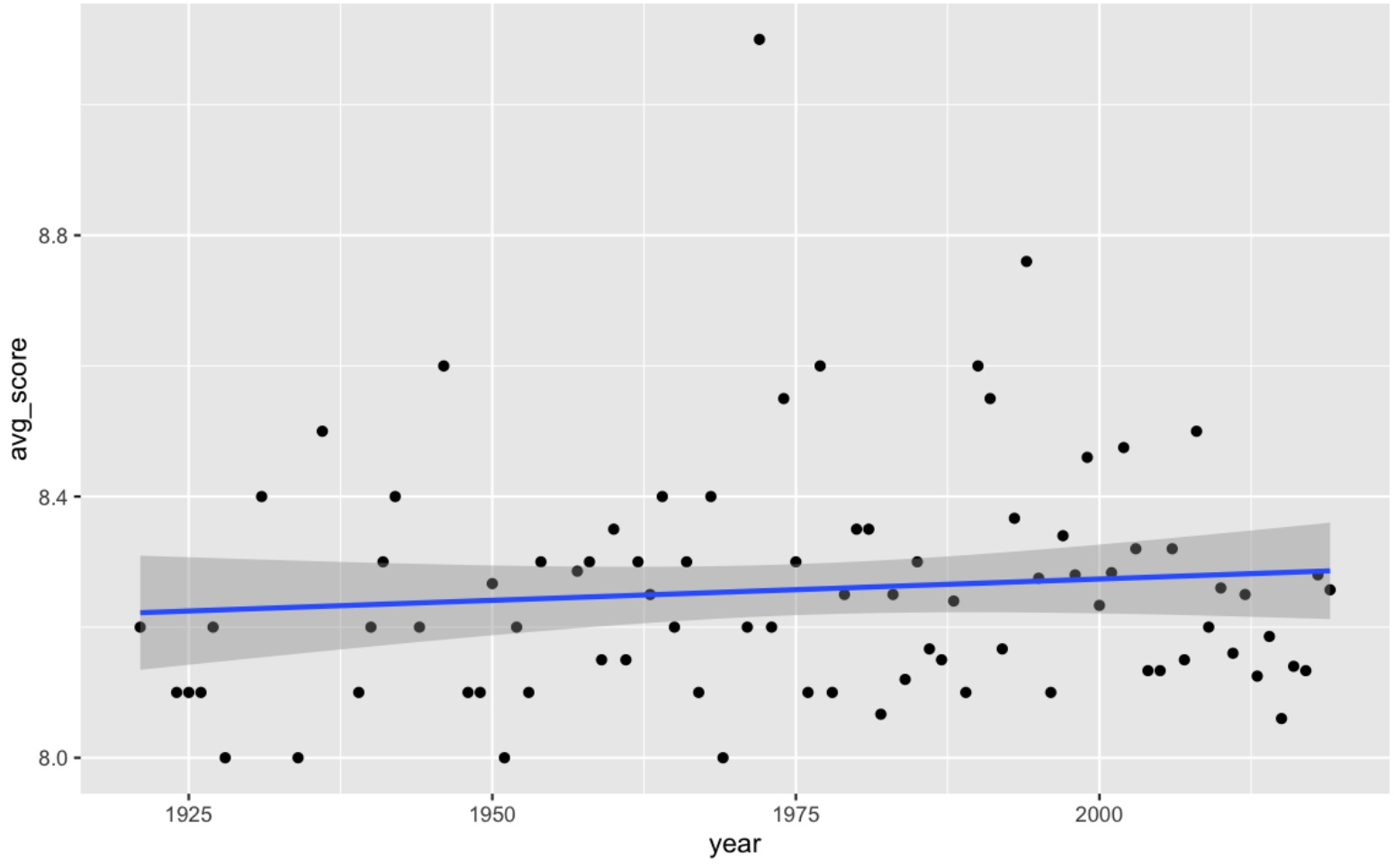
Your turn: Which years have the most movies on the list?

```
imdb_top_250 %>%
  group_by(year) %>%
  summarise(total = n()) %>%
  arrange(desc(total)) %>%
  head(5)
```

```
## # A tibble: 5 x 2
##    year total
##   <dbl> <int>
## 1  1995     8
## 2  1957     7
## 3  2014     7
## 4  2019     7
## 5  2000     6
```

Your Turn: Visualize top 250 yearly mean score over time

```
imdb_top_250 %>%
  group_by(year) %>%
  summarise(avg_score = mean(score)) %>%
  ggplot(aes(y = avg_score, x = year)) +
    geom_point() +
    geom_smooth(method = "lm") +
    xlab("year")
```


avg_score
8.8
8.4
8.0
1925
1950
1975
2000
year

Other common formats: JSON

- JavaScript Object Notation (JSON).
- A language-independent data format, and supplants extensible markup language (XML).
- Data are sometimes stored as JSON, which requires special unpacking

Unpacking JSON: Example JSON from jsonlite

```
library(jsonlite)
json_mario <- '[
  {
    "Name": "Mario",
    "Age": 32,
    "Occupation": "Plumber"
  },
  {
    "Name": "Peach",
    "Age": 21,
    "Occupation": "Princess"
  },
  {},
  {
    "Name": "Bowser",
    "Occupation": "Koopa"
  }
]'
```

```
mydf <- fromJSON(json_mario)
mydf
##     Name Age Occupation
## 1  Mario  32    Plumber
## 2  Peach  21   Princess
## 3   <NA>  NA       <NA>
## 4 Bowser  NA      Koopa
```

Potential challenges with web scraping

- Unreliable formatting at the source
- Data broken into many pages
- Data arriving in multiple excel file formats
- ... We will come back to this when we learn about functions next week.

> *Compare the display of information at gumtree melbourne to the list on the IMDB top 250 list. What challenges can you foresee in scraping a list of the available apartments?]*

Further exploring

People write R packages to access online data! Check out:

- cricinfo by Sayani Gupta and Rob Hyndman
- rwalkr by Earo Wang
- fitzRoy for AFL data
- Top 40 lists of R packages by Joe Rickert - they usually include a "data" section.

A note on midsemester test

- Will be made available next Wednesday after class
- This will be a multiple choice and short answer exam
- The test will be conducted on Moodle
- More details to come soon!