Week 12: *Webscraping*

EMSE 4571 / 6571: Intro to Programming for Analytics

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Quiz 10

10:00

Write your name on the quiz!

Rules:

- Work alone; no outside help of any kind is allowed.
- No calculators, no notes, no books, no computers, no phones.

Week 12: *Webscraping*

1. Scraping static pages

2. Scraping multiple pages

BREAK

3. Using APIs

Some disclaimers (here for more details)

You're probably okay if the data is:

- Public
- Non-personal
- Factual

Otherwise, consult a lawyer and / or maybe don't scrape it.

Terms of service

Generally are not upheld, unless you **need an account to access the data**.

Copyright

Data is not copyright protected (in the US). But works are. Be careful.

Another good resource:
https://www.zyte.com/learn/web-scraping-best-practices/

Week 12: *Webscraping*

1. HTML basics

1. Scraping static pages

2. Scraping multiple pages

BREAK

3. Using APIs

Hyper**T**ext **M**arkup **L**anguage

```
<html>
<head>
  <title>Page title</title>
</head>
<body>
  <h1 id='first'>A heading</h1>
  <p>Some text &amp;amp; <b>some bold text.</b></p>
  <img src='myimg.png' width='100' height='100'>
</body>
```

HTML has a hierarchical structure formed by:

- Start and end **"tags"** (e.g. `<tag>` and `</tag>`)
- Optional attributes (e.g. `id='first'`)
- Contents (everything in between the start and end tag).

Common tags

- `<h1>` = Header level 1
- `<a>` = Url link
- `<b>` = **Bold** text
- `<i>` = *Italic* text
- `<p>` = Paragraph
- `<li>` = List item

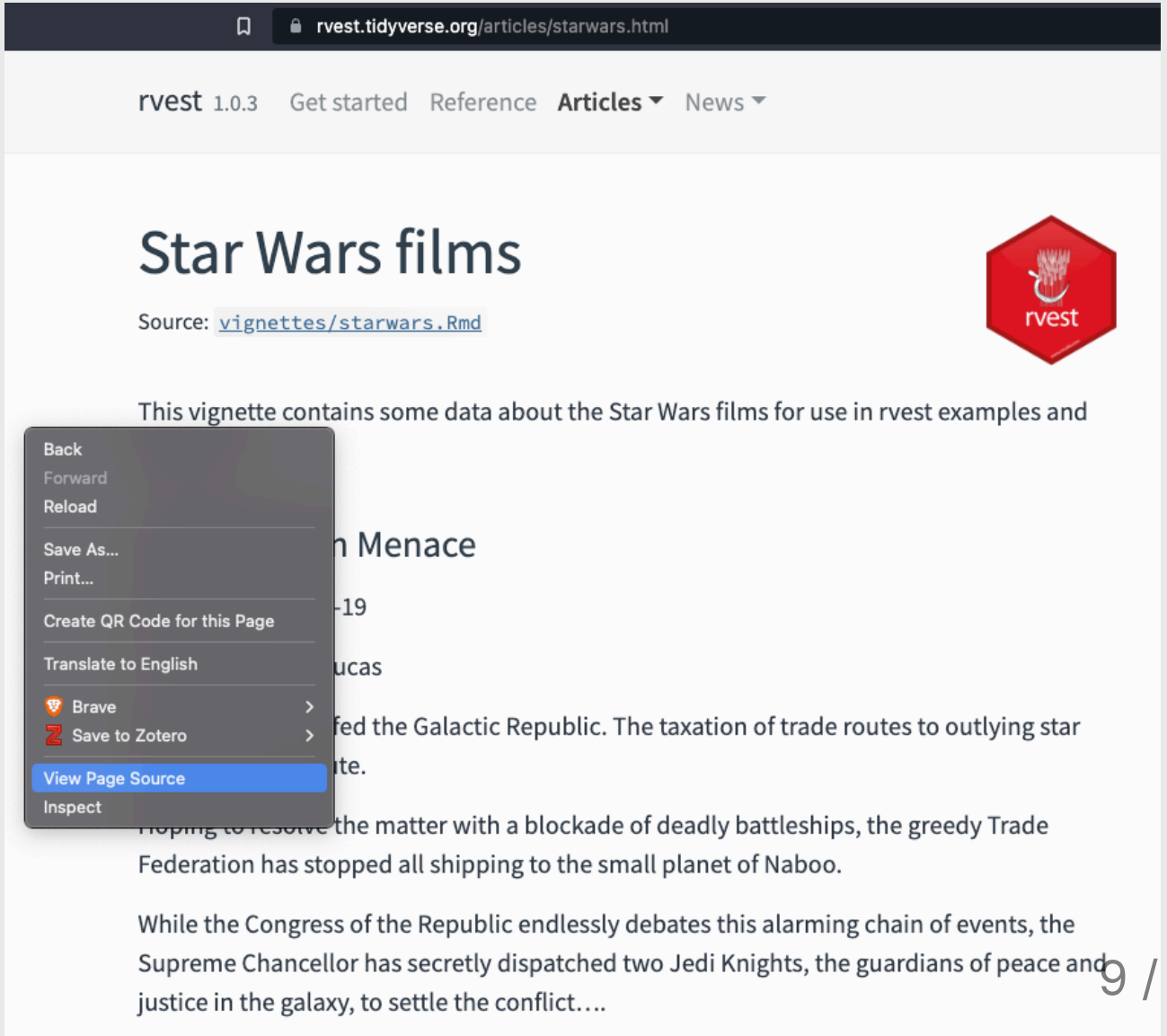
Attributes

- `id`: Element identifier, e.g. `<h1 id='first'>A heading</h1>`
- `class`: Styling class, e.g. `<h1 class='header'>A heading</h1>`

Quick example

- Go here
- Right-click, select "View Page Source"

https://rvest.tidyverse.org/articles/starwars.html



Strategy: Use tags and classes to parse html

`source_code`

```
<html>
<head>
  <title>Page title</title>
</head>
<body>
  <h1 id='first'>A heading</h1>
  <p>Some text &amp;amp; <b>some bold text.</b>
  <img src='myimg.png' width='100' height='
</body>
```

Use `{rvest}` package to parse html

```
library(rvest)

html <- read_html(source_code)

html %>%
  html_elements("h1")
```

```
#> {xml_nodeset (1)}
#> [1] <h1 id="first">A heading</h1>
```

Strategy: Use tags and classes to parse html

`source_code`

```
<html>
<head>
  <title>Page title</title>
</head>
<body>
  <h1 id='first'>A heading</h1>
  <p>Some text &amp;amp; <b>some bold text.</b><
  <img src='myimg.png' width='100' height='1
</body>
```

Use `{rvest}` package to parse html

```
library(rvest)

html <- read_html(source_code)

html %>%
  html_elements("p")
```

```
#> {xml_nodeset (1)}
#> [1] <p>Some text &amp;amp; <b>some bold text.
```

Dealing with multiple nodes (bullet list example)

`source_code`

```
<ul>
  <li><b>C-3PO</b> is a <i>droid</i> that we
  <li><b>R4-P17</b> is a <i>droid</i></li>
  <li><b>R2-D2</b> is a <i>droid</i> that we
  <li><b>Yoda</b> weighs <span class='weigh
</ul>
```

Rendered source code (in a browser)

- **C-3PO** is a *droid* that weighs 167 kg
- **R4-P17** is a *droid*
- **R2-D2** is a *droid* that weighs 96 kg
- **Yoda** weighs 66 kg

Dealing with multiple nodes (bullet list example)

`source_code`

```
<ul>
  <li><b>C-3PO</b> is a <i>droid</i> that we
  <li><b>R4-P17</b> is a <i>droid</i></li>
  <li><b>R2-D2</b> is a <i>droid</i> that we
  <li><b>Yoda</b> weighs <span class='weigh
</ul>
```

Use `{rvest}` package to parse html

```
library(rvest)

html <- read_html(source_code)

html %>%
  html_elements("li")
```

```
#> {xml_nodeset (4)}
#> [1] <li>\n<b>C-3PO</b> is a <i>droid</i>
#> [2] <li>\n<b>R4-P17</b> is a <i>droid</i>
#> [3] <li>\n<b>R2-D2</b> is a <i>droid</i>
#> [4] <li>\n<b>Yoda</b> weighs <span class=
```

Extract the names with "b"

`source_code`

```
<ul>
  <li><b>C-3PO</b> is a <i>droid</i> that we
  <li><b>R4-P17</b> is a <i>droid</i></li>
  <li><b>R2-D2</b> is a <i>droid</i> that we
  <li><b>Yoda</b> weighs <span class='weigh
</ul>
```

Use `{rvest}` package to parse html

```
library(rvest)

html <- read_html(source_code)

html %>%
  html_elements("li") %>%
  html_element("b")
```

```
#> {xml_nodeset (4)}
#> [1] <b>C-3PO</b>
#> [2] <b>R4-P17</b>
#> [3] <b>R2-D2</b>
#> [4] <b>Yoda</b>
```

Extract the *text* with `html_text2()`

`source_code`

```
<ul>
  <li><b>C-3PO</b> is a <i>droid</i> that we
  <li><b>R4-P17</b> is a <i>droid</i></li>
  <li><b>R2-D2</b> is a <i>droid</i> that we
  <li><b>Yoda</b> weighs <span class='weigh
</ul>
```

Use `{rvest}` package to parse html

```
library(rvest)

html <- read_html(source_code)

html %>%
  html_elements("li") %>%
  html_element("b") %>%
  html_text2()
```

```
#> [1] "C-3PO"  "R4-P17" "R2-D2"  "Yoda"
```

Extract the weights using ".weight" class

`source_code`

```
<ul>
  <li><b>C-3PO</b> is a <i>droid</i> that we
  <li><b>R4-P17</b> is a <i>droid</i></li>
  <li><b>R2-D2</b> is a <i>droid</i> that we
  <li><b>Yoda</b> weighs <span class='weigh
</ul>
```

Use `{rvest}` package to parse html

```
library(rvest)

html <- read_html(source_code)

html %>%
  html_elements("li") %>%
  html_element(".weight") %>%
  html_text2()
```

```
#> [1] "167 kg" NA       "96 kg"  "66 kg"
```

Putting it together in a data frame

```
library(rvest)

items <- read_html(source_code) %>%
  html_elements("li")
```

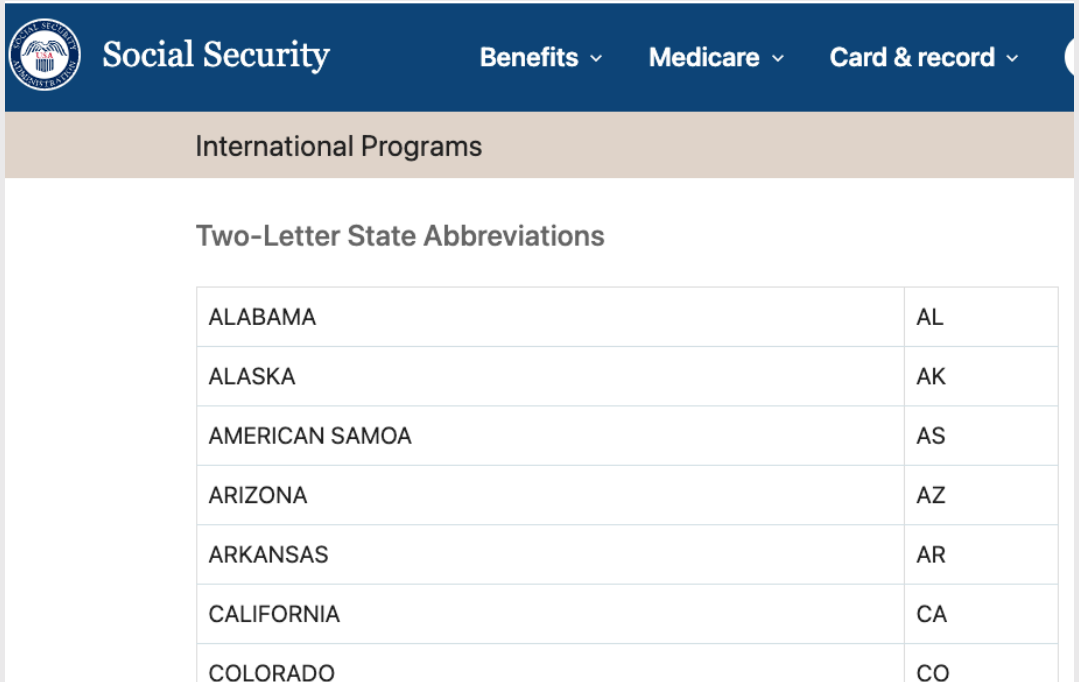
```
data <- tibble(
  name = items %>%
    html_element("b") %>%
    html_text2(),
  weight = items %>%
    html_element(".weight") %>%
    html_text2() %>%
    parse_number()
)

data
```

```
#> # A tibble: 4 × 2
#>   name   weight
#>   <chr>   <dbl>
#> 1 C-3PO     167
#> 2 R4-P17     NA
#> 3 R2-D2      96
#> 4 Yoda       66
```

`html_table()` is awesome (if the site uses an HTML table)

Some pages have HTML tables in the source code, e.g.

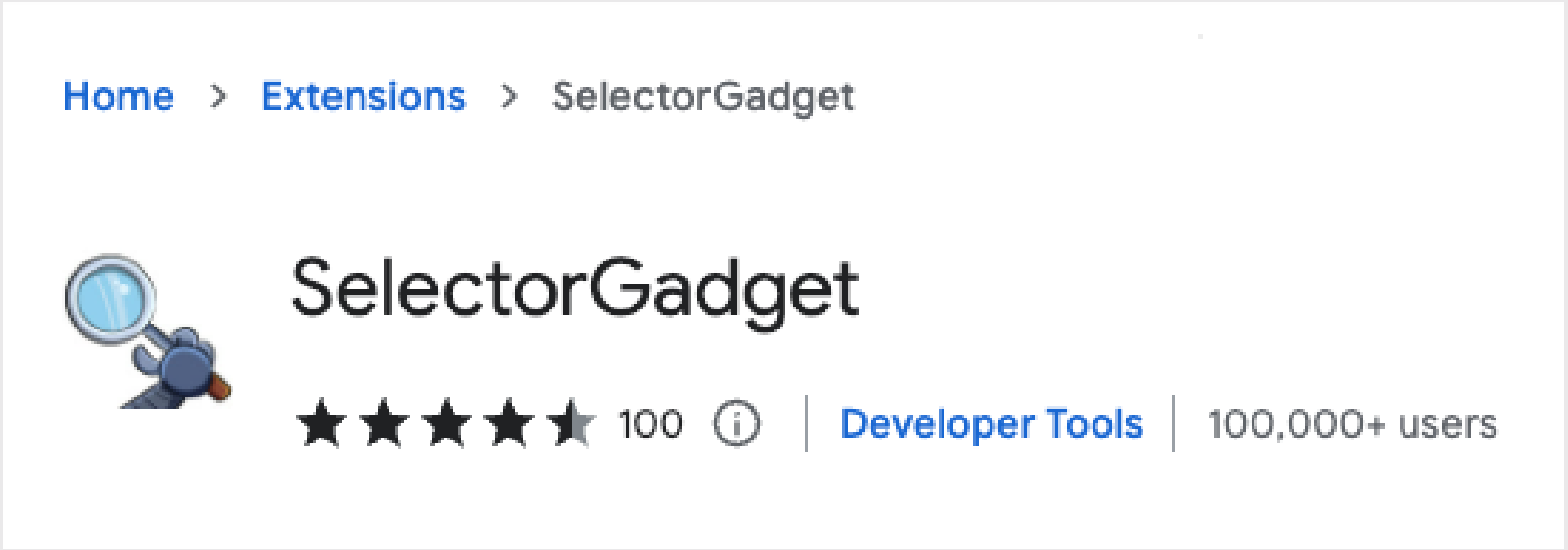
https://www.ssa.gov/international/coc-docs/states.html



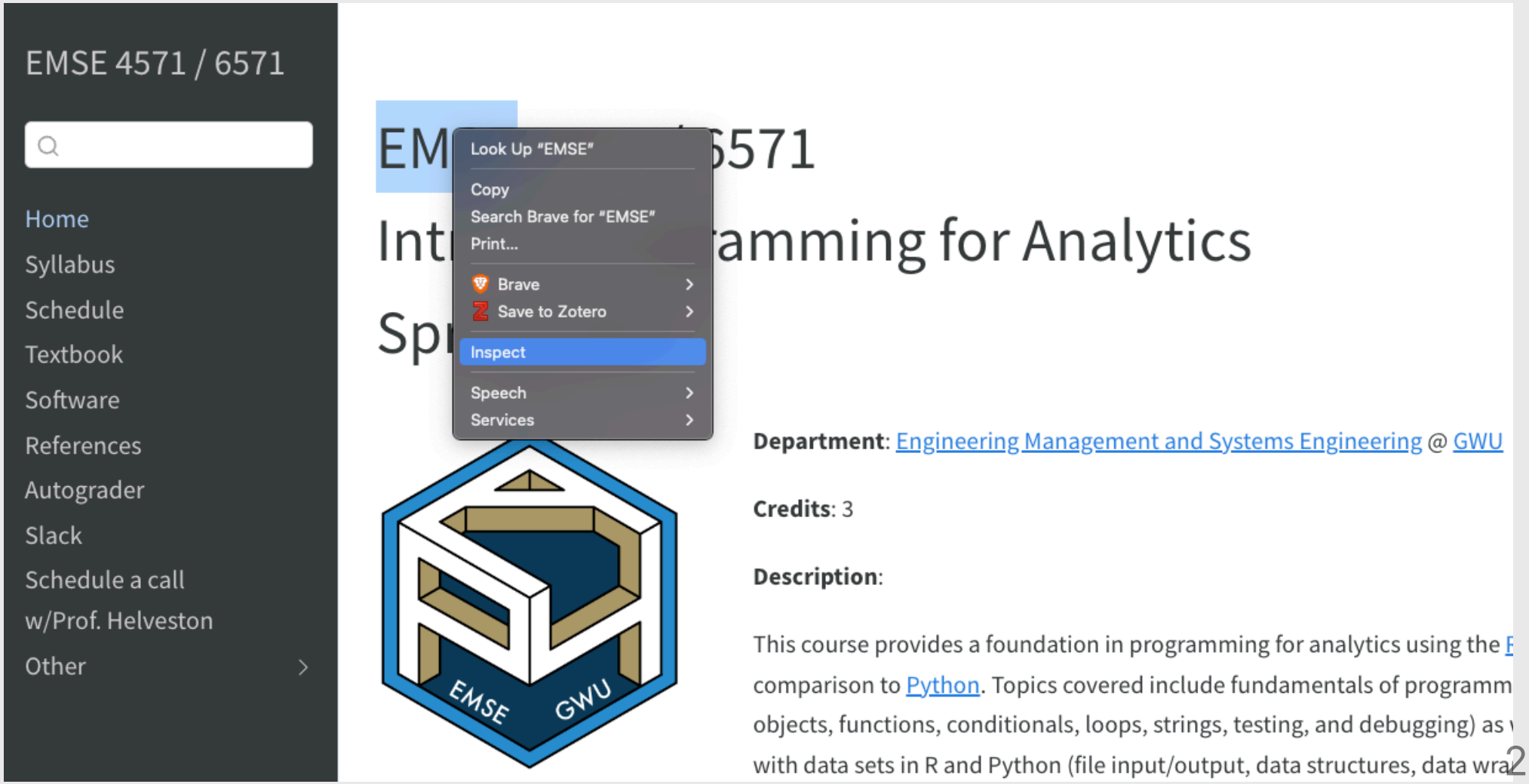

```
url <- "https://www.ssa.gov/international/c
df <- read_html(url) %>%
  html_table()

df
```

```
#> [[1]]
#> # A tibble: 56 × 2
#>    X1                   X2
#>    <chr>                <chr>
#>  1 ALABAMA              AL
#>  2 ALASKA               AK
#>  3 AMERICAN SAMOA       AS
#>  4 ARIZONA              AZ
#>  5 ARKANSAS             AR
#>  6 CALIFORNIA           CA
#>  7 COLORADO             CO
#>  8 CONNECTICUT          CT
#>  9 DELAWARE             DE
#> 10 DISTRICT OF COLUMBIA DC
#> # ℹ 46 more rows
```

Find elements with SelectorGadget



Find elements with "inspect"



Your turn

15:00

Scrape data on famous quotes from http://quotes.toscrape.com/

Your resulting data frame should have these fields:

- `quote`: The quote
- `author`: The author of the quote
- `about_url`: The url to the "about" page

```
#> Rows: 10
#> Columns: 3
#> $ quote     <chr> "“The world as we have created it is a process of our thinking. It ca
#> $ author    <chr> "Albert Einstein", "J.K. Rowling", "Albert Einstein", "Jane Austen",
#> $ about_url <chr> "http://quotes.toscrape.com/author/Albert-Einstein", "http://quotes.t
```

Week 12: *Webscraping*

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3. Using APIs

What if there is more than one page to scrape?

Use a loop!

Iterative scraping!

1. Find the url pattern

2. Scrape one page

3. Iteratively scrape each page with `map_df()`

1. Find the url pattern

Example: http://quotes.toscrape.com/

url to page 2: http://quotes.toscrape.com/page/2

Pattern: `http://quotes.toscrape.com/page/` + `#`

I can *build* the url to any page with `paste()`:

```
root <- "http://quotes.toscrape.com/page/"
page <- 3
url <- paste(root, page, sep = "")
url
```

```
#> [1] "http://quotes.toscrape.com/page/3"
```

2. Scrape one page

Build the url to a single page:

```
root <- "http://quotes.toscrape.com/page/"
page <- 3
url <- paste(root, page, sep = "")
url
```

```
#> [1] "http://quotes.toscrape.com/page/3"
```

Scrape the data on that page:

```
quote_nodes <- read_html(url) %>%
    html_elements(".quote")
df <- tibble(
    quote = quote_nodes %>%
        html_element(".text") %>%
        html_text(),
    author = quote_nodes %>%
        html_element(".author") %>%
        html_text(),
    about_url = quote_nodes %>%
        html_element("a") %>%
        html_attr("href")
) %>%
    mutate(about_url = paste0(url, about_ur
```

3. Iteratively scrape each page with `map_df()`

Make a function to get data from a page:

```
get_page_data <- function(page) {
    root <- "http://quotes.toscrape.com/page/"
    url <- paste(root, page, sep = "")
    quote_nodes <- read_html(url) %>%
        html_elements(".quote")
    df <- tibble(
        quote = quote_nodes %>%
            html_element(".text") %>%
            html_text(),
        author = quote_nodes %>%
            html_element(".author") %>%
            html_text(),
        about_url = quote_nodes %>%
            html_element("a") %>%
            html_attr("href")
    ) %>%
        mutate(about_url = paste0(url, about_url))
    return(df)
}
```

Iterate with `map_df()`:

```
pages <- 1:10

df <- map_df(pages, \(x) get_page_data(x))
```

Your turn

15:00

Template code is provided to scrape data on F1 drivers for the 2024 season from https://www.formula1.com/en/results/2024/drivers

Your job is to extend it to scrape the data from seasons 2010 to 2024.

Your final dataset should look like this:

```
#> # A tibble: 6 × 8
#>    year position first   last          abb   nationality team                    poi
#>   <dbl>    <int> <chr>   <chr>         <chr> <chr>       <chr>                    <i
#> 1  2024        1 Max     VerstappenVER <NA>  NED         Red Bull Racing Honda RBPT
#> 2  2024        2 Lando   NorrisNOR     <NA>  GBR         McLaren Mercedes
#> 3  2024        3 Charles LeclercLEC    <NA>  MON         Ferrari
#> 4  2024        4 Oscar   PiastriPIA    <NA>  AUS         McLaren Mercedes
#> 5  2024        5 Carlos  SainzSAI      <NA>  ESP         Ferrari
#> 6  2024        6 George  RussellRUS    <NA>  GBR         Mercedes
```

Intermission

05:00

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1. HTML basics

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Hopefully you won't need to scrape

Before you start scraping, ask...

1. Is there a formatted dataset I can download?
(e.g. see this page)

2. Is there an API I can use?

Application Programming Interface (API)

A set of defined rules that enable different applications to communicate (and pass data) with each other

Basically, APIs make it easier to get data from the web

APIs use the `url` to "ask" a website for data

Example: Stock market prices from https://www.alphavantage.co/

API Request:
https://www.alphavantage.co/query?function=TIME_SERIES_DAILY&symbol={symbol}&apikey={api_key}&datatype=csv

- `function`: The time series of your choice
- `symbol`: Stock price symbol (e.g. `NFLX` = Netflix)
- `apikey`: Your API key (have to register to get one)
- `datatype`: `csv` or `json`

Set up your `.env` file

1. Make a `.env` file:

```
# Create an empty .env file
file.create(".env")
```

2. Open the file to edit:

```
# Create an empty .env file
file.edit(".env")
```

Store your API key

3. Register for a key here: https://www.alphavantage.co/support/#api-key

4. Store your key in the file:

```
ALPHAVANTAGE_API_KEY=ZF33JCWPWWQDX4LW
```

Get your API key

5. Load your `.env` variables:

```
dotenv::load_dot_env()
```

6. Retrieve your key:

```
api_key <- Sys.getenv("ALPHAVANTAGE_API_KEY")
```

Using your key to get data

```
api_key <- Sys.getenv("ALPHAVANTAGE_API_KEY")
symbol <- "NFLX" # Netflix

# Build the url data request

url <- paste0(
  "https://www.alphavantage.co/query",
  "?function=TIME_SERIES_DAILY",
  "&symbol=", symbol,
  "&apikey=", api_key,
  "&datatype=csv"
)

# Read in the data

df <- readr::read_csv(url)
```

```
glimpse(df)
```

```
#> Rows: 100
#> Columns: 6
#> $ timestamp <date> 2025-04-11, 2025-
#> $ open      <dbl> 920.000, 931.940,
#> $ high      <dbl> 944.8599, 941.2350
#> $ low       <dbl> 906.6800, 894.0000
#> $ close     <dbl> 918.29, 921.17, 94
#> $ volume    <dbl> 4073638, 5129755,
```

Using your key to get data

```
df %>%
    ggplot() +
    geom_line(
      aes(
        x = timestamp,
        y = close
      )
    ) +
    theme_bw() +
    labs(
        x = "Date",
        y = "Closing Price ($USD)",
        title = paste0("Stock Prices: ", symbol)
    )
```

Want something else?

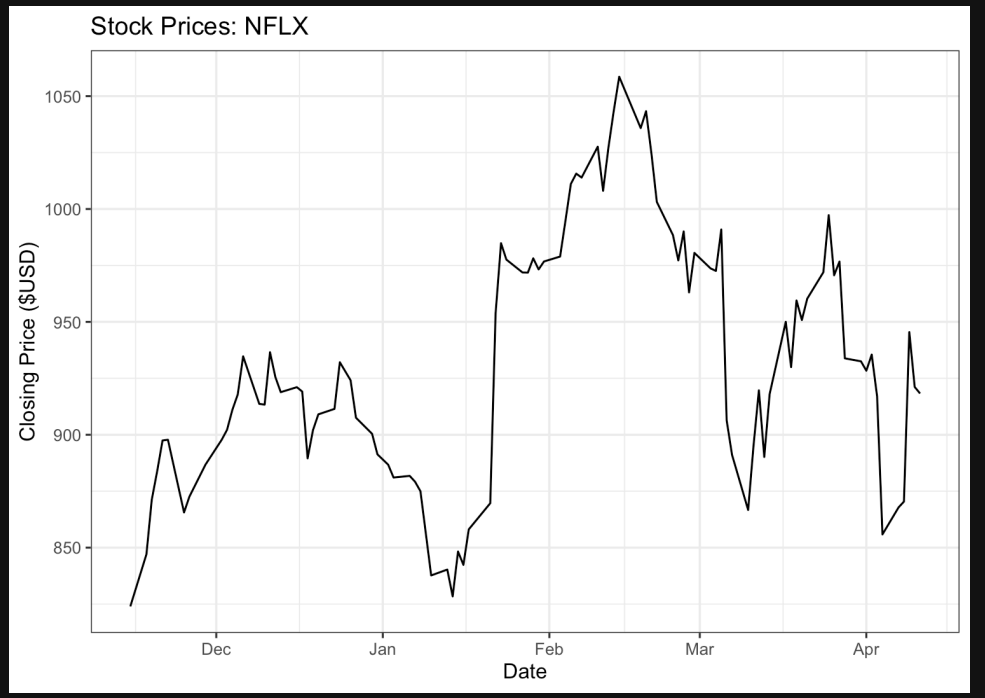
Read the docs!

https://www.alphavantage.co/documentation/

Your turn

20:00

1. Make your .env file:
   `file.create(".env")`
2. Edit your .env file:
   `file.edit(".env")`
3. Register for a key:
   https://www.alphavantage.co/support/#api-key
4. Store your key, e.g.
   `ALPHAVANTAGE_API_KEY=ZF33JCWPWWQDX4LW`
5. Load your .env file: `dotenv::load_dot_env()`
6. Load your API key:
   ```
   api_key <-
   Sys.getenv("ALPHAVANTAGE_API_KEY")
   ```
7. Build the url to request historical stock prices for a stock of your choice
8. Read in the data, then make this a stock plot with ggplot



HW12