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Workshop 'Computational Text Analysis'

Session 1: Web-Scraping

Mirko Wegemann

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About us I

Mirko Wegemann (he/him)

- 4th-year PhD Candidate at European University Institute
- Research Agenda
  - Political Parties
  - Gender & Politics
  - Political Communication

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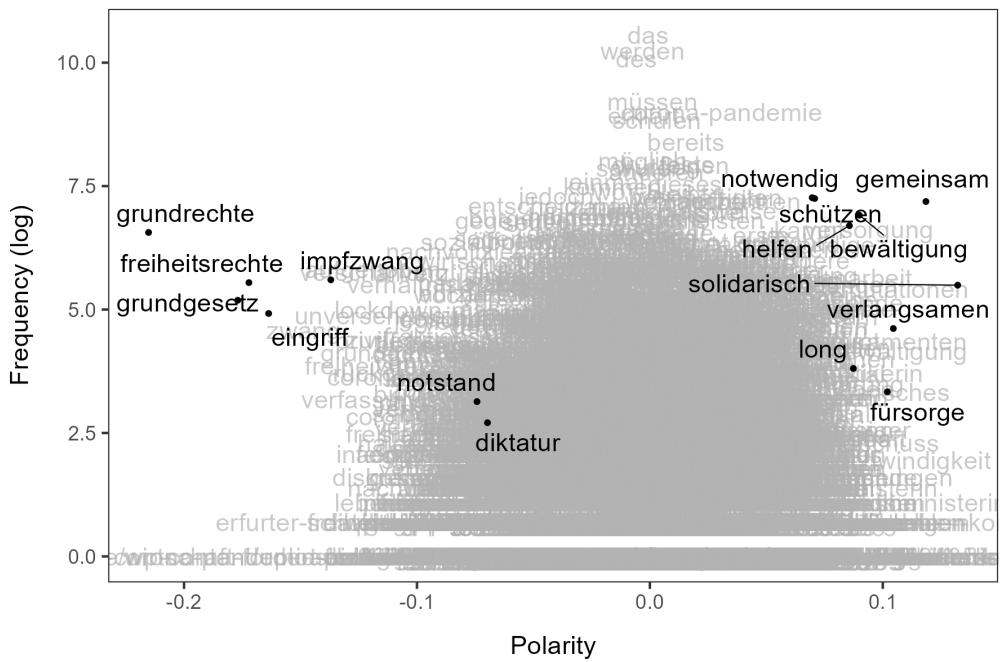
About us II

Application of CTA in my own work

- scaling the Covid-19 discourse using Latent Semantic Scaling (joint work with Rebecca Kittel)



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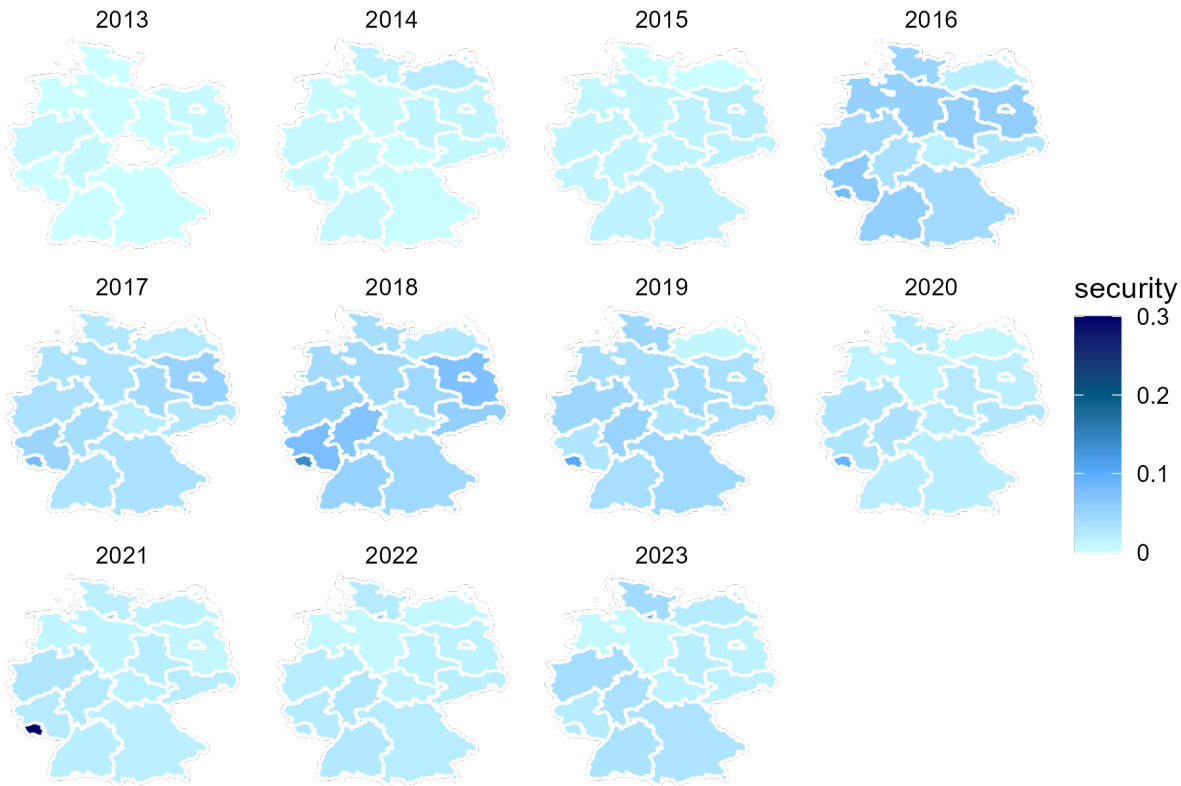
About us III

- classification of gender appeals by the radical right using a multilingual transformer model (joint work with Leon Küstermann)



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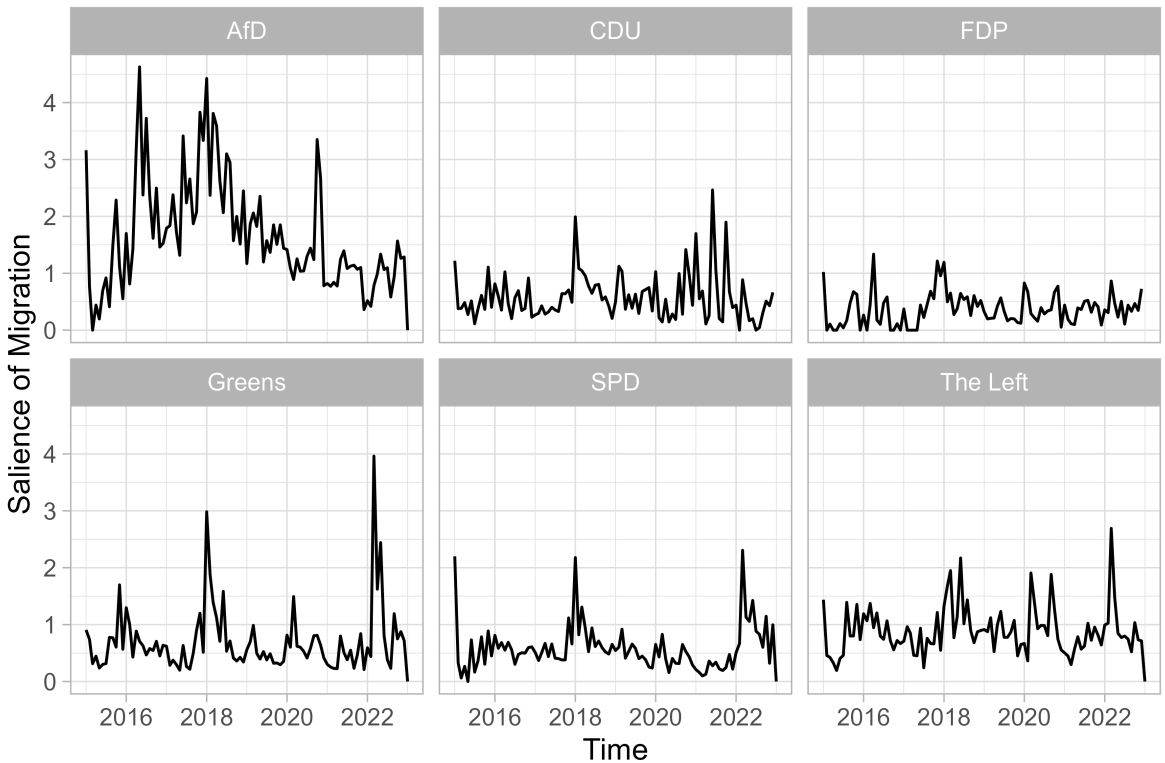
About us IV

- tracing the migration discourse in Germany using large language models



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About us V

Eva Krejcova (she/her)

- Max Weber Fellow
- introduces you to images-as-data

Sara Dybesland (she/her)

- 1st-year SPS PhD Researcher
- regularly uses web-scraping and topic models in R
- analyses parliamentary speeches
- TA for the lab sessions

About you

- your name (if you want pronoun)
- research topic
- what's text analysis doing for your studies?
- do you have any experiences with text analysis?
- do you have any experiences with images-as-data?

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Goals of this workshop

1. Automation of data collection
2. Analysis of textual data
   - unsupervised approaches (e.g., topic models)
   - supervised approaches (e.g. text classification)
3. Analysis of images-as-data

→ understanding and dealing with key challenges, implementing first own analyses, getting a 'glimpse' into what's possible

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Basic structure

- Session 1 & 2 on web-scraping and basic text-analysis techniques

  Seminar session: Introduction into the topic with first parallel application

  Lab session: Application on your own data

- Session 3 & 4 on transformer models and images-as-data are showcase sections

$\rightarrow$ to get the most out of it: bring your own data to the lab sessions!

What is web-scraping?

The process of systematically collecting data from the Internet to store it in a structured data format.

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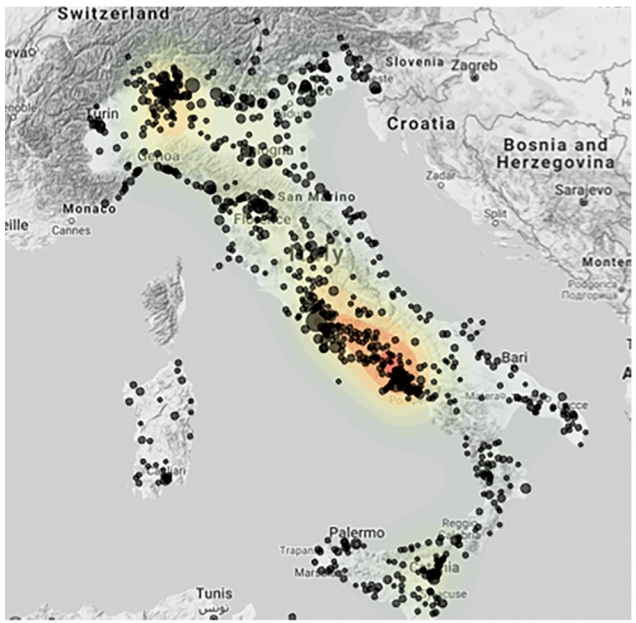
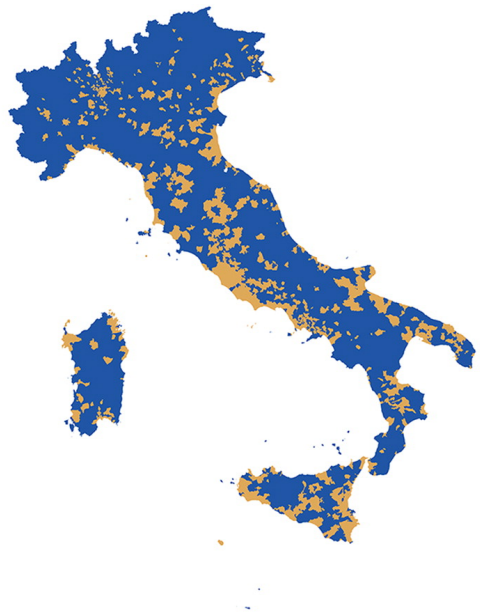
How can we utilize it in research? I

A



B



Bischof and Kurer (2023) show how local campaigning of M5S mobilizes voters

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How can we utilize it in research? II

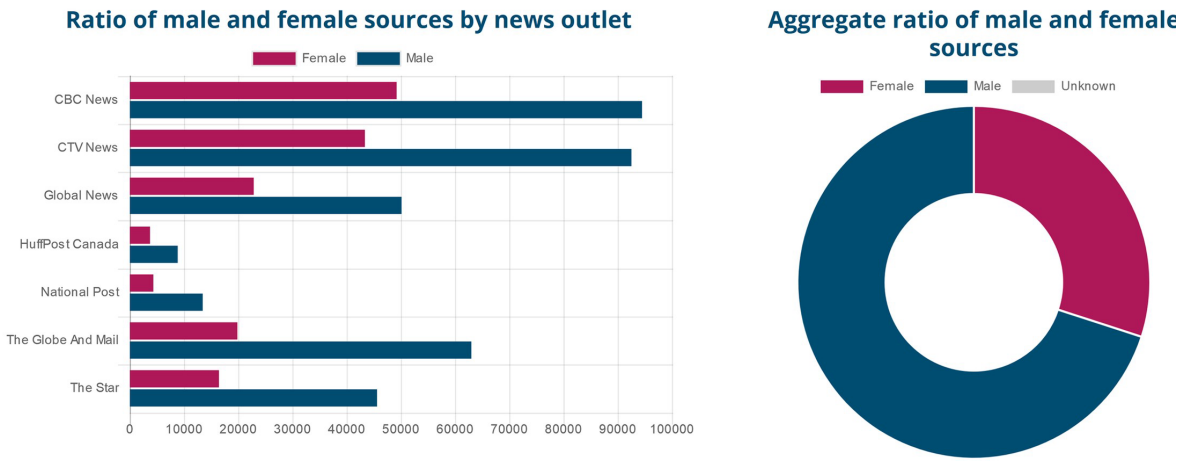

Fig 1. The Gender Gap Tracker online dashboard page. Reprinted from https://gendergaptracker.informedopinions.org/ under a CC BY license, with permission from Informed Opinions, original copyright 2018.

Asr et al. (2021) on how Canadian newspaper quote men more often than women (still online!)

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Types of web-scraping

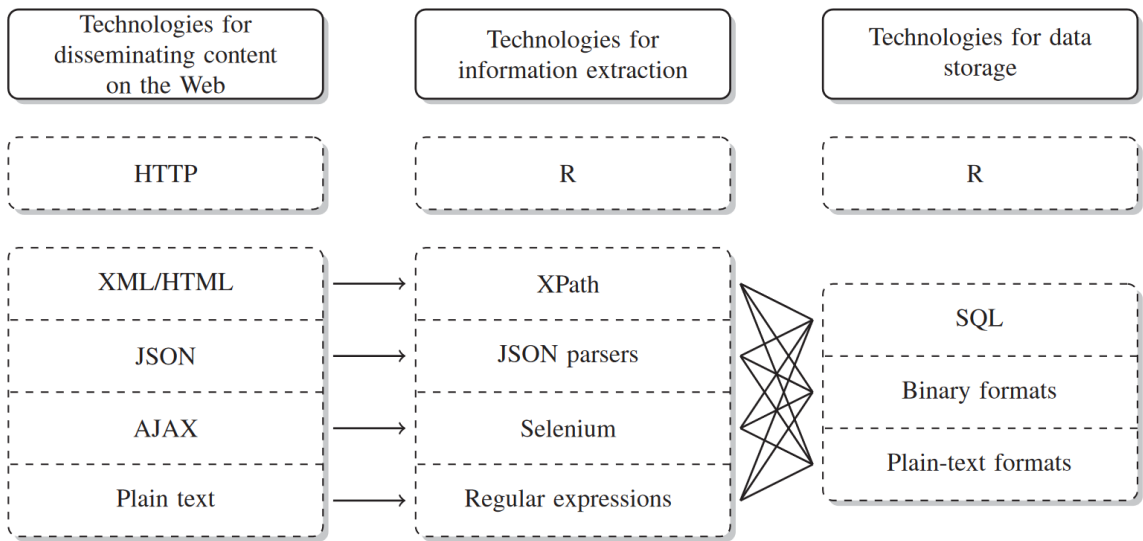

Figure 1.4 Technologies for disseminating, extracting, and storing web data

Munzert (2015, p. 10)

What we'll cover...

1. 'static' HTML structures (`rvest`)
   - all content is available by parsing the HTML
2. 'dynamic' webpages (`RSelenium`)
   - content becomes available after interacting with the webpage

Before you scrape data

1. carefully consider whether this is the data you need for your research question (measurement, quality, effort)
2. check whether the data is directly available (e.g., someone else downloaded it, there is a direct download link, there is API access)
3. consider legal constraints

Disclaimer: Legal considerations I

Is web-scraping even allowed?

It depends...

- violation against terms of service?

Disclaimer: Legal considerations II

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Terms of Service of 'The Guardian'

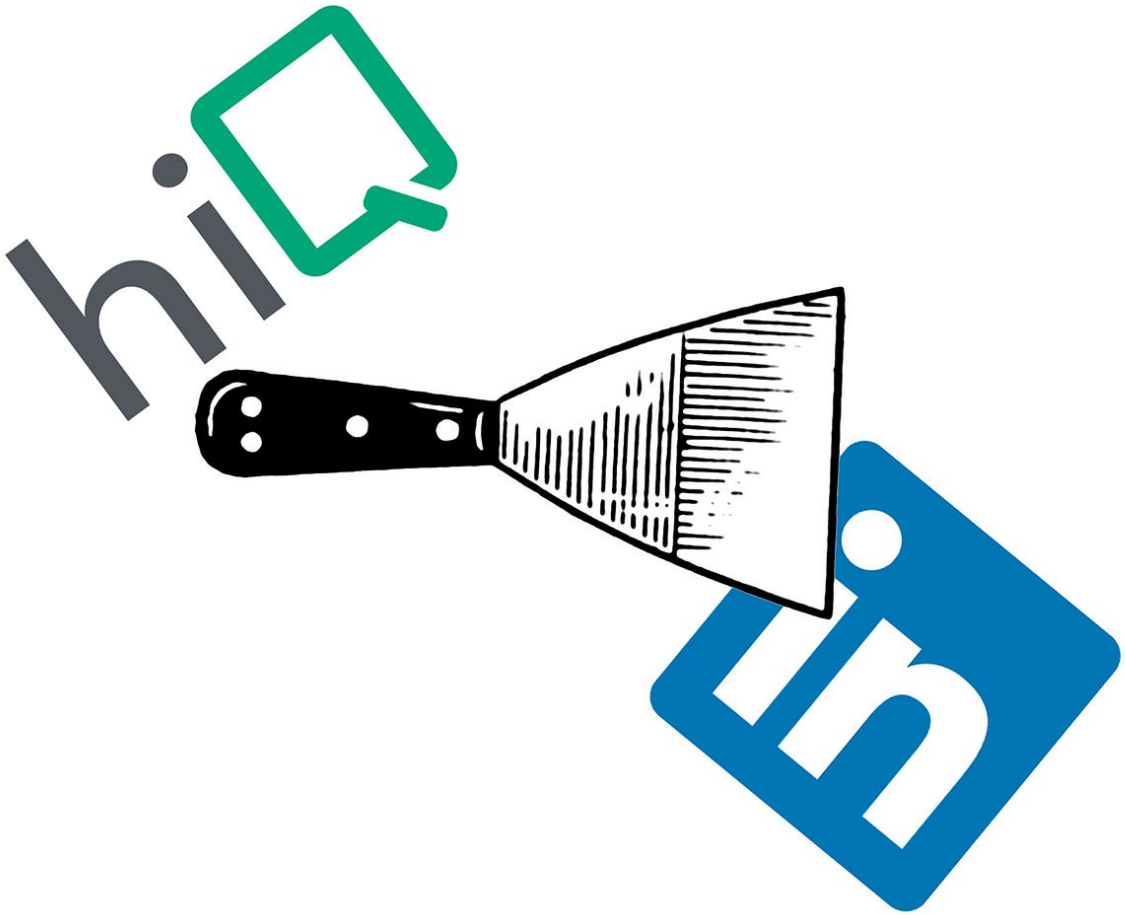
Disclaimer: Legal considerations III

Is web-scraping even allowed?

It depends...

- violation against terms of service?
- gathering of personally-identifiable information may violate EU General Data Protection Regulation (GDPR)
- even if you do not collect personal data, you may infringe copyright regulations
- check robots.txt

Disclaimer: Legal considerations IV



- hiQ scraped data from LinkedIn public profiles

Disclaimer: Legal considerations V

- LinkedIn tried to prevent that
- initial ruling: scraping allowed; later rulings: hiQ breached User Agreement $\rightarrow$ settlement

In the end, "[l]egalities depend a lot on where you live. However, as a general principle, if the data is public, non-personal, and factual, you're likely to be ok" (Wickham et al. 2023)

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HTML Basics

Websites are based on **H**yper**T**ext **M**arkup **L**anguage

- HTML contains information about the structure of a web-page
- it's responsible for how content is graphically displayed

An example

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HTML Elements and Attributes

- HTML consists of elements, tags and attributes
  - elements are the different components of a webpage (e.g. headlines, text, images)
  - elements are mostly embedded into tags (`<element>content</element>`) but some come without start and end tags
  - attributes are additional information of an element (e.g., the size of an image, the font type etc.)

We will only cover HTML in a superficial way, but try this **tutorial**

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HTML head vs body

```
1 <!DOCTYPE html>
2 <html>
3 <head>
4   <title>"EUI Website"</title>
5 </head>
6 <body>
7   <h1>"New Academic Year"</h1>
8 </body>
9 </html>
```

HTML documents consist of a head (with meta information on the webpage) and a body (with content) → mainly interested in the body!

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Important elements

- *h1*, *h2*, *h3*, etc.: headline elements
- *p*: paragraph elements
- *a*: hyperlink elements
- *img*: image elements

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Important attributes

- *href*: weblink, always comes with *a* element
- *src*: source of an image

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How to use HTML for scraping?

We need to identify the CSS selector of an element of interest.
There are **two** options:

- manual approach: cursor on element of interest > right-click > Inspect
- semi-automatic approach: download **SelectorGadget** or save as bookmark

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Basic pipeline

Setup

- install SelectorGadget
- R library: `rvest`

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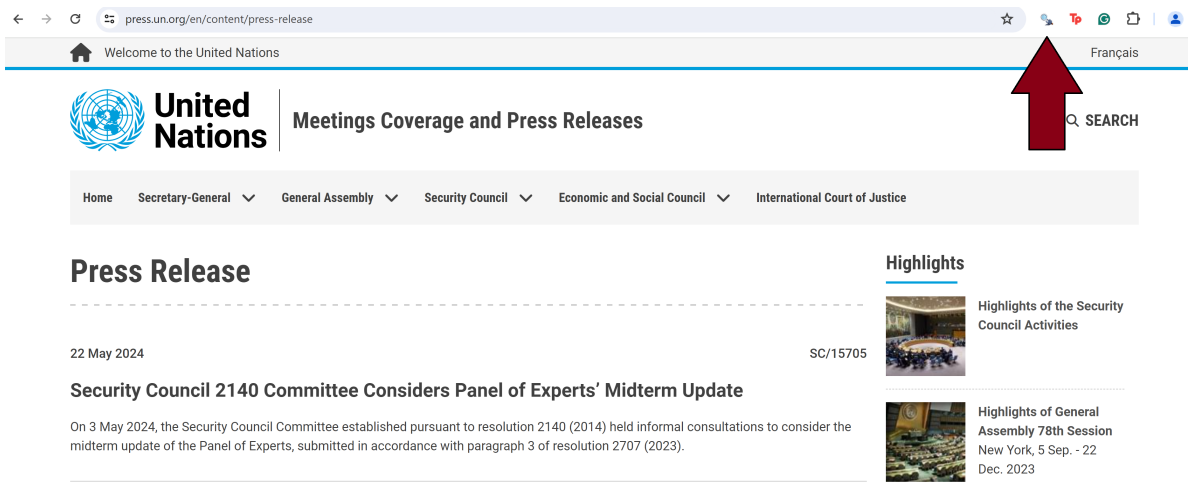
Step 1

Download HTML source with `rvest`

```
1  > library(rvest)
2  > url <- "https://press.un.org/en/content/press-release"
3  > html <- read_html(url)
4  > html
5  {html_document}
6  <html lang="en" dir="ltr">
7  [1] <head>\n<meta http-equiv="Content-Type"
       content="text/html; charset=UTF-8">\n<meta
       charset="utf-8">\n<link rel="canonical" href="https:
       ...
8  [2] <body class="layout-one-sidebar
       layout-sidebar-first page-view-home-press
       path-content">\n    <div
       class="visually-hidden-focusable bg- ..
```

Step 2

Example: **UN press releases**



Step 3


United Nations
Meetings Coverage and Press Releases
SEARCH
Home
Secretary-General
General Assembly
Security Council
Economic and Social Council
International Court of Justice
Press Release
22 May 2024
SC/15705
Security Council 2140
ittee Considers Panel of Experts' Midterm Update
On 3 May 2024, the Security Council Committee established pursuant to resolution 2140 (2014) held informal c
midterm update of the Panel of Experts, submitted in accordance with paragraph 3 of resolution 2707 (2023).
21 May
Activities of the Secretary-General in Bahrain, 15-17 May
United Nations Secretary-General António Guterres flew from Muscat, Oman, to Manama, Bah
Highlights
Highlights of the Security Council Activities
lights of General
embly 78th Session
New York, 5 Sep. - 22 Dec. 2023
68th Session of the Commission on the Status of Women
copy CSS selector
click on element of interest
h1
Clear (1)
Toggle Position
XPath
?
X

Try it out yourself!

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Headline

Here, we retrieve every level-1 headline of the webpage.

```
> library(rvest)
> (top_level_headline <- read_html(url)
+     %>% html_elements("h1")
+     %>% html_text())
[1] "Press Release"
```


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Text

Here, we retrieve every paragraph on the webpage.

```
1 > library(rvest)
2 > (paragraphs <- read_html(url) %>%
3 +     html_elements("p") %>%
4 +     html_text())
5 [1] "On 3 May 2024, the Security Council Committee
    established pursuant to resolution 2140 (2014) held
    informal consultations to consider the midterm
    update of the Panel of Experts, submitted in
    accordance with paragraph 3 of resolution 2707
    (2023)."
6 [2] "United Nations Secretary-General Antonio Guterres
    flew from Muscat, Oman, to Manama, Bahrain, in the
    early evening of Wednesday, 15 May."
```

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Links

If we want to access links, we need to retrieve the `a` element first, and then call its attribute `href`

```
> (pr_urls <- read_html(url) %>%
+     html_elements(".field__item a") %>%
+     html_attr("href"))
[1] "/en/2024/sc15705.doc.htm"
    "/en/2024/sgt3388.doc.htm"
    "/en/2024/sgt3387.doc.htm"   "/en/2024/3386.doc.htm"
```


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Tables

`rvest` has a pre-defined function `read_table()` to extract information from HTML tables

```
> html <- read_html(url2)
> table <- html %>%
+     html_element(".wikitable:nth-child(4)") %>%
+     html_table()
```

Images

For images, it is a bit more complicated.

1. open a session
2. retrieve image source link
3. download the image to your directory

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Images II

```
1  > session <- session(url)
2  >
3  > # access links for image sources
4  > imgsrc <- session %>%
5  +     read_html() %>%
6  +     html_nodes("img") %>%
7  +     html_attr("src")
8  >
9  > # access page of source image (only retrieve the
       first image here)
10 > img <- session_jump_to(session, paste0(root_url,
       imgsrc[[1]]))
11 >
12 > # write to our project's directory
13 > writeBin(img$response$content, basename(imgsrc[1]))
```


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Let's do it in `R`

Loops I

Often, we want to automatize these steps for multiple pages.
Two options:

1. creating empty objects and filling them in a `for-loop`
2. defining a function, apply it and retrieve objects of interest from list

$\rightarrow$ usually, functions are more versatile and can be easier run in parallel

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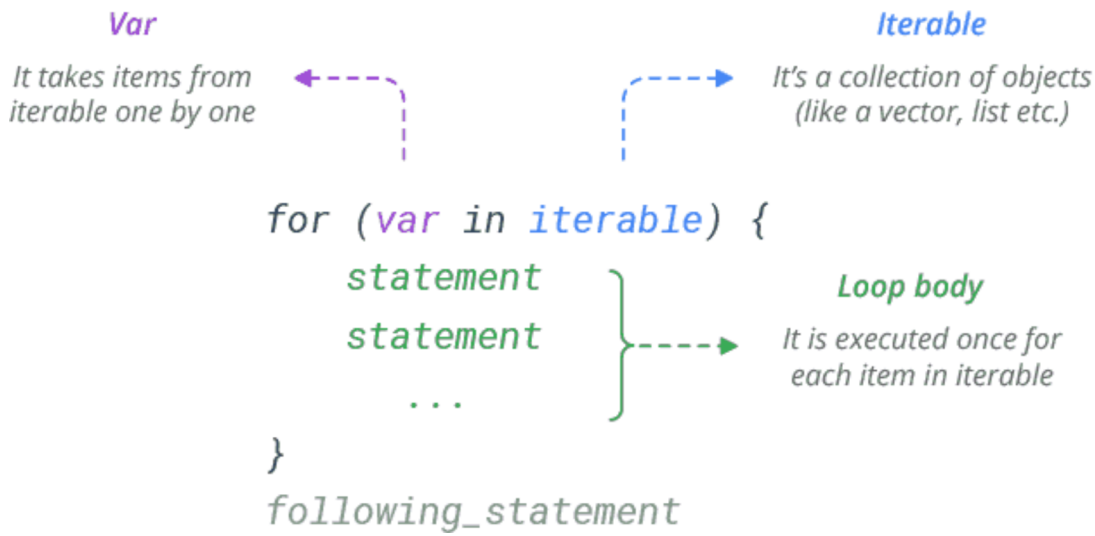
Loops II

Before creating a loop/function

1. check the pagination structure of a website (e.g. United Nations use '?page=#' to list results)
2. make sure which elements you need to retrieve (often, you just want links but some information, such as date, may not be available on sub-pages, so you want to gather these as well)
3. test the pipeline on a single element before using it in a loop

For-loops



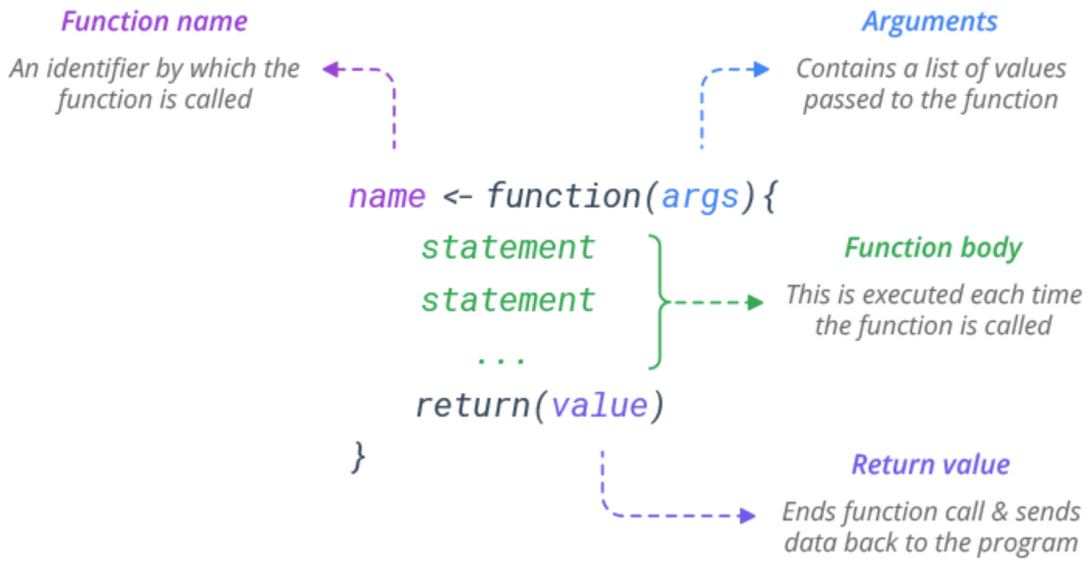
Tutorial on for-loops
Graph and guide to for-loops

For-loops for automation

```
1
2  > urls <- c("https://www.eui.eu/en/home",
       "https://www.ceu.edu/")
3  > links <- c()
4  > for(url in 1:length(urls)){
5    +     html <- read_html(urls[[url]])
6    +     links[url] <- html %>%
7    +         html_node("h1") %>%
8    +         html_text()
9    + }
10 > links
11 [1] "\nOpening doors to the future\n" "Apply Now for
       2024-2025!"
```

Let's do it in `R`

Functions in R



Tutorial on Functions

Graph and guide to functions

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Functions for automation

```
> h1_scrape <- function(url){
  +     html <- read_html(urls[[url]])
  +     links[url] <- html %>%
  +         html_node("h1") %>%
  +         html_text()
  + }
>
> (links <- sapply(1:length(urls), h1_scrape))
[1] "\nOpening doors to the future\n" "Apply Now for
    2024-2025!"
```


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Let's do it in `R`

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Post processing

Regular expressions

Often, the data you retrieve are not in the targeted format. Regular expressions are handy for data processing, they can match/extract/remove a pattern in text

```
> library(stringr)
> date_time <- "2009/03/12 20:12:31"
> str_extract(date_time, "\\d{4}/\\d{2}/\\d{2}")
[1] "2009/03/12"
```


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Regular expressions in R

- base R includes regular expressions in functions like `gsub` (replacement), `regmatches` (extraction) or `regexpr` (detection)
- `stringr` is the `tidyverse` approach to regex and provides equivalent functions such as `str_replace`, `str_extract` or `str_detect`

More information on regular expressions

- You can try out regular expressions in online tools like **these**
- **StringR cheat sheet**
- A **guide to regular expressions**

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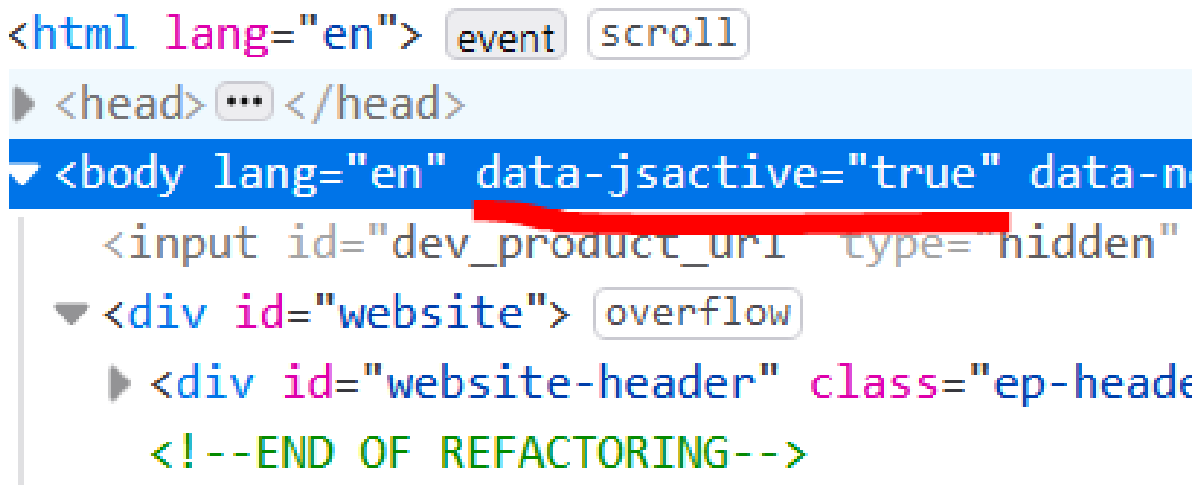
Dynamic Webpages

Sometimes, webpages change only when we interact with them in a browser session (e.g. by clicking on specific objects). For these **webpages**, `rvest` is not applicable.
Usually, you can identify these pages by their usage of active classes



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Functionality of RSelenium

Solution?

RSelenium

RSelenium was initially built to test webpages, we use it to send commands to a virtual browser window (e.g. clicking a button)

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Before using RSelenium

Whenever possible, try to use the static approach, it's easier and less prone to error

- check other webpages which may contain the same information
- look for other sub-directories that may store the same content
- check the Wayback Machine
- use the 'Search' bar of a webpage to list results

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Pipeline of RSelenium and wdman

A typical pipeline looks as follows:

- configuration of a session (now more complex, we need `wdman` for this)
- opening browser
- navigate to URL
- accept/decline cookies
- identify css selector for button, click on it (repeat if necessary)
- retrieve object of interest (usually links)

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Setup

- configure driver
- extract client
- navigate to webpage

```
> url <- "https://www.europarl.europa.eu/news/en"
> rd <- rsDriver(browser = "firefox",
+                chromever = NULL,
+                port = sample(1:65535, 1),
+                verbose = FALSE)
> browser <- rd[["client"]]
> browser$navigate(url)
```


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Identifying and clicking on a button

1. Find an element by its css selector
2. store it as an object
3. use the clickElement() function

```
1 > cookies <- browser$findElement(using = 'css
    selector', value='.epjs_agree:nth-child(1) span')
2 > cookies$clickElement()
```

How to extract the text of a dynamic webpage

- identify element**s** by css selector
- elements contain lots of other information
- to extract plain text, loop through the elements and extract only the text

```
1  > paragraphs <- browser$findElements(using = 'css
       selector', value='p')
2  > text <- c()
3  > for(i in 1:length(paragraphs)){
4    +     text[i] <- paragraphs[[i]]$getElementText()[[1]]
5    + }
6  > text[1]
7  [1] "On Thursday afternoon, the Eurovision debate
       between the lead candidates for the presidency of
       the European Commission took place in the European
       Parliament."
```

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How to extract the link of a dynamic webpage

```
1 > urls_euparl <- browser$findElements(using = 'css
    selector', value='.ep_title > a')
2 > urls_euparl2 <- c()
3 > for(i in 1:length(urls_euparl)){
4   +     urls_euparl2[i] <-
      urls_euparl[[i]]$getElementAttribute('href')[[1]]
5 }
```


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Let's do it in `R`

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Processing data

Once we have downloaded individual links to pages, we can often proceed in `rvest` (which is easier to handle).

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Thank you for your attention!

References I

Asr, F. T., Mazraeh, M., Lopes, A., Gautam, V., Gonzales, J., Rao, P., & Taboada, M. (2021). The Gender Gap Tracker: Using Natural Language Processing to measure gender bias in media. *PLOS ONE*, *16*(1), e0245533. https://doi.org/10.1371/journal.pone.0245533

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