

Sceen-Scraping

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What is screen-scraping?

Retrieving and processing human-readable information



Is screen-scraping legal?

There's a number of things you can do to check whether site-owners permit scraping:

- communicate with responsible persons
- check `robots.txt` file
- check terms of service

Whether scraping is legal might depend on other factors, such as your country of residence. If unsure, you should consult professional legal advice.

robots.txt

- policy that specifies rules about automated data collection on the site
- example: <https://www.ted.com/robots.txt>

```
User-agent: *
Disallow: /latest
Disallow: /latest-talk
Disallow: /latest-playlist
Disallow: /people
Disallow: /profiles
Disallow: /conversations
Disallow: /themes/rss
```

Terms of Service

Example : <https://www.researchgate.net/terms-of-service>

"In connection with using or accessing the Service, you shall not:

- Impose an unreasonable or disproportionately large administrative burden on ResearchGate{}
- Use any robot, spider, scraper, data mining tools, data gathering and extraction tools, or other automated means to access our Service for any purpose, except with the prior express permission of ResearchGate in writing{}
- Employ any mechanisms, software, or scripts when using the Service"

Warning: screen-scraping can be frustrating

- modern web technologies (e.g. Javascript) make scraping difficult
- what you care about are often elements deeply nested in html structure
- websites change all the time
- my advice: use screen-scraping as a last resort method for data collection

Screen-scraping with R

Install and load R packages

We need the package `tidyverse`, which includes a range of packages for data manipulation (e.g. `dplyr`) as well as `rvest` for reading websites into R:

```
install.packages('tidyverse')
```

Afterwards, you can load all `tidyverse` core packages and `rvest`:

```
library(tidyverse)  
library(rvest)
```

Simple example - scraping a wikipedia page

We are going to begin by scraping this very simple web page from Wikipedia:

The screenshot shows a Wikipedia article page. At the top right are links for 'Create account' and 'Log in'. Below that is a navigation bar with tabs 'Article' (which is selected), 'Talk', 'Read', 'Edit', 'View history', and a search bar. The main title of the article is 'World Health Organization ranking of health systems in 2000'. A sub-header below it says 'From Wikipedia, the free encyclopedia'. The main content discusses the World Health Organization's ranking of health systems in 2000, mentioning its framework and indicators. On the left side, there is a sidebar with links to 'Main page', 'Contents', 'Featured content', 'Current events', 'Random article', 'Donate to Wikipedia', and 'Wikipedia store'. Below that is an 'Interaction' section with links to 'Help', 'About Wikipedia', 'Community portal', 'Recent changes', and 'Contact page'. At the bottom of the sidebar is a 'Tools' section with a link to 'What links here'. A contents table of contents is also present on the right side of the page.

https://en.wikipedia.org/w/index.php?title=World_Health_Organization_ranking_of_health_systems_in_2000

Human-readable vs machine-readable

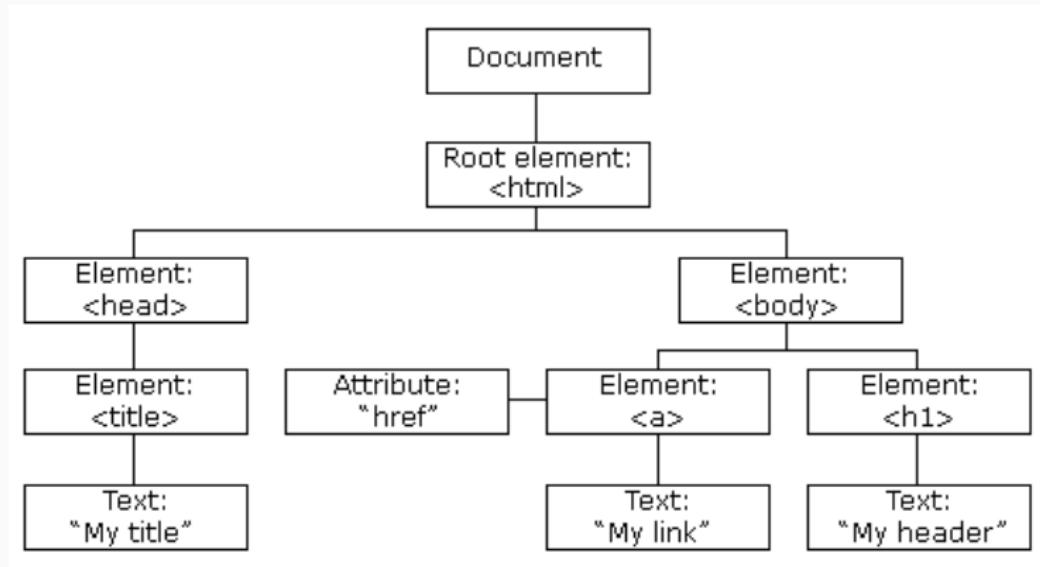
Extracting HTML

Passing the url as character (string) to the rvest function `read_html()`:

```
wikipedia_page <-  
  read_html("https://en.wikipedia.org/w/index.php?title=World_Health_Organization_ranking_of_health_systems_in_200  
  
wikipedia_page # inspect object  
  
## {xml_document}  
## <html class="client-nojs" lang="en" dir="ltr">  
## [1] <head>\n<meta http-equiv="Content-Type" content="text/html; charset= ...  
## [2] <body class="mediawiki ltr sitedir-ltr mw-hide-empty-elt ns-0 ns-sub ...
```

Parsing HTML

Think of HTML as a tree



Parsing HTML

Inspect tool:

Ranking [edit]

Country	Attainment of goals / Health / Level	Attainment of goals / Health / Distribution	Attainment of goals / Health / Overall goal attainment	Health expenditure per capita in international dollars
Afghan	Back	Alt+Left Arrow		
	Forward	Alt+Right Arrow		
	Reload	Ctrl+R		
	Save as...	Ctrl+S	183	184
Alb	Print...	Ctrl+P	86	149
Alg	Cast...		99	114
An	Translate to English		17	23
An	Block element...		181	164
An	View page source	Ctrl+U		
and Ba	Inspect	Ctrl+Shift+I	71	43

```
<th class="headerSort" tabindex="0" role="columnheader button" title="Sort ascending">C</th>
<th class="headerSort" tabindex="0" role="columnheader button" title="Sort ascending">A</th>
...
<th class="headerSort" tabindex="0" role="columnheader button" title="Sort ascending">Attainment of goals / Health / Level (DALE)</th>
...
<th class="headerSort" tabindex="0" role="columnheader button" title="Sort ascending">Attainment of goals / Health / Distribution</th> => $0
<th class="headerSort" tabindex="0" role="columnheader button" title="Sort ascending">Attainment of goals / Health / Overall goal attainment</th>
...
#bodyContent #mw-content-text div table thead tr th.headerS
... #bodyContent #mw-content-text div table thead tr th.headerS
Styles Event Listeners DOM Breakpoints Properties Accessibility
Filter :hover .cls + ▾
element styles
: Console What's New X
```

XPath

Use XPath to select table:

The screenshot shows the Firefox Developer Tools DOM Inspector. A context menu is open over an element with the path 'td'. The 'Copy' option is highlighted in blue. Other options visible in the menu include 'Add attribute', 'Edit as HTML', 'Delete element', 'Cut element', 'Copy element', 'Paste element', 'Copy outerHTML', 'Copy selector', and 'Copy XPath'. The 'Copy XPath' option is also highlighted in blue. The DOM tree on the left shows a table structure with various rows and cells. The bottom navigation bar shows tabs for 'Styles', 'Event Listeners', 'DOM Breakpoints', 'Properties', and 'Accessibility'. The 'td' tab is currently active.

```
<td>168</td>
<td>182</td>
<td>183</td>
<td>184</td>
<td>150</td>
<td>173</td>
```

Copy

Copy XPath

html body #content #bodyContent #mw-content-text div table tbody tr td

Styles Event Listeners DOM Breakpoints Properties Accessibility

XPath in R

Pass xpath string to function `html_node()`:

```
wiki_section <- html_node(wikipedia_page,
                           xpath = '//*[@id="mw-content-text"]/div/table[2]')
head(wiki_section)
```

```
## $node
## <pointer: 0x00000001a7ffb50>
##
## $doc
## <pointer: 0x00000001337e5f0>
```

Convert to DataFrame

Use `html_table()` to convert html table to a Data Frame:

```
health_df <- html_table(wiki_section)
head(health_df[, (1:2)])
```

	Country Attainment of goals / Health / Level (DALE)	
## 1	Afghanistan	168
## 2	Albania	102
## 3	Algeria	84
## 4	Andorra	10
## 5	Angola	165
## 6	Antigua and Barbuda	48

CSS selectors as alternative to XPath

- One alternative for XPath is the use of CSS selectors
- Selector Gadget is a useful interactive tool for finding CSS selectors:
<http://selectorgadget.com>
- Selector Gadget can either be installed as a Chrome plugin or as a bookmark

Selector Gadget

- The idea of selector gadget is to select elements that you want to scrape (shown in green and yellow color) and the gadget returns the corresponding css selector
- You can also click on other elements to exclude those (they will show up in red)
- See the rvest vignette for more details: <https://cran.r-project.org/web/packages/rvest/vignettes/selectorgadget.html>

Example - Humboldt University Berlin news

The screenshot shows a news section from the Humboldt University Berlin website. The top navigation bar includes links for Prospective Students, School, Researchers, Business, Press, Alumni, and Staff. On the right side, there are language selection (DE EN), search (Search Site), and direct access buttons. The main content area displays a list of news items with dates, titles, and brief descriptions. A yellow vertical bar highlights the first news item in the list.

Date	Title	Description
24.07.19	The Discovery of the Homo luzonensis	A New Hominid Species Found in the Philippines – Lecture by Prof. Armand Mijares, University of the Philippines more...
24.07.19	Fostering Diversity: People with a Refugee Background Shape Their Academic and Professional Future at HU	Refugees can register for offers to prepare for studies and career entry more...
19.07.19	Berlin University Alliance Wins Excellence Status	Second huge success for three major Berlin universities and Charité in the German Excellence Strategy competition more...
17.07.19	Illuminating the brain	Warren Alpert Foundation Prize honors Peter Hegemann more...
15.07.19	"Most scientists lack the business know-how"	Dr. Michael J. Bojdys from HU took part in the annual meeting of the new champions (AMNC) in China. The theme was "Leadership 4.0: Succeeding in a new era of globalization". more...
03.06.19	14th International Symposium on Functional n-Electron Systems	Symposium takes place in the Berlin-Adlershof Science and Technology park more...
31.05.19	New Report Finds Widespread Rollbacks to Protected Areas, Threatening Biodiversity Globally	Efforts to Shrink Protections Could Derail Global Efforts to Save Nature more...
28.05.19	A pivotal year for Bolivian conservation policy	Bolivia approaches presidential elections in October 2019 more...
15.05.19		

.pm_titel a Clear (10) Toggle Position XPath Help X

<https://www.hu-berlin.de/en/press-portal/nachrichten-en>

Using the CSS selector in R

Steps:

- parse web page
- choose nodes by css selector
- extract links via attribute (*href*)

```
hu <- "https://www.hu-berlin.de/en/press-portal/nachrichten-en"  
hu_html <- read_html(hu)  
css_nodes <- html_nodes(hu_html, css = '.pm_titel a')  
urls <- html_attr(css_nodes, 'href')  
urls[1:3]
```

```
## [1]  
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19724-1"  
## [2]  
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19724"  
## [3]  
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19719"
```

Same result using the pipe operator

You can think of the pipe operator as a 'and then' statement.

RStudio hotkey: CTRL/CMD + Shift + M

```
urls <- hu %>%
  read_html() %>%
  html_nodes('.pm_titel a') %>%
  html_attr('href')
urls[1:3]

## [1]
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19724-1"
## [2]
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19724"
## [3]
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19719"
```

Looping over news articles

We could further automate the process of visiting each url and extracting the texts of news articles. Possible intermediate steps:

- use SelectorGadget to find the css selector for the text of news articles
- write function to read and parse url
- apply function to urls

Looping over news articles

The following function takes an url for a hu berlin news articles as an input and returns the corresponding text:

```
get_content <- function(url) {  
  print(url) # show url  
  text <- read_html(url) %>% # parse url  
  html_nodes('#content') %>% # find news content  
  html_text() # extract text  
  Sys.sleep(1) # sleep for 1 second  
  return(text) # return text  
}
```

Looping over news articles

Applying the function to the first three URL's:

```
texts <- urls[1:3] %>%  
  map_chr(get_content) # apply function to each url  
  
## [1]  
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19724-1"  
## [1]  
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19724"  
## [1]  
"https://www.hu-berlin.de/en/press-portal/nachrichten-en/july-2019/nr-19719"  
  
str_sub(texts[1], 1, 250) # 250 characters of first article  
  
## [1] "\n\t\t\n\t\t The Discovery of the Homo luzonensis\n A New  
Hominid Species Found in the Philippines - Lecture by Prof. Armand Mijares,  
University of the Philippines\n\n\n\n \n\n \n Invitation to lecture \"The  
Discovery of the H"
```

If everything else fails: browser automation

- if everything else fails, one final solution for screen-scraping might be browser automation
- in many cases where browser automation would be required, websites would not permit automated data collection
- setting up browser automation is more complicated than using `rvest`.
- if you are interested in browser automation, check out RSelenium:
`https://cran.r-project.org/web/packages/RSelenium/`

When should you use screen-scraping?

- consider legal concerns
- consider ethical concerns
- examine other data sources (e.g. API's)
- use Screen-Scraping as last resort

Questions?