

Web Scraping with `{rvest}`

Data Acquisition and Distribution

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Aquiring Data by Web Scraping

The data you need will not always be delivered to you, sometimes you have to go out and get it for yourself.

- **Web scraping** is one common way to obtain this data
- **APIs** are another common way to both obtain and distribute data

This video we will focus of the former: extracting data from a HTML webpage.

1. What is a webpage?

What is a webpage?

Like with LaTeX, content and presentation are handled separately. With webpages, this separation is even more extreme.

- **HyperText Markup Language** (HTML) files store content of a webpage.
- **Cascading Style Sheet** (CSS) files describe how that content should be displayed.

A Basic HTML page - Code

```
1 <html>
2 <head>
3   <title>Page title</title>
4 </head>
5 <body>
6   <h1 id='first'>A level 1 heading</h1>
7   <p>Hello World!</p>
8   <p>Here is some plain text &amp; <b>some bold text.</b></p>
9   <img src='myimg.png' width='100' height='100'>
10 </body>
```

A Basic HMTL Page - In Browser

A level 1 heading

Hello World!

Here is some plain text & **some bold text.**



[CSS Zen Garden](#) - multiple CSS files formatting the same HTML.

A Basic HTML Page - Structure

```
1 <html>
2 <head>
3   <title>Page title</title>
4 </head>
5 <body>
6   <h1 id='first'>A level 1 heading</h1>
7   <p>Hello World!</p>
8   <p>Here is some plain text &amp; <b>some bold text.</b></p>
9   <img src='myimg.png' width='100' height='100'>
10 </body>
```

- Escape characters: > is **>**, < is **<**, & is **&**, ...

Important HTML Elements

- The `<html>` element must enclose every HTML page:
 - `<head>` element contains metadata,
 - `<body>` element contains content displayed in browser.
- Block elements: headers `<h1>`, ..., `<h6>`, paragraphs `<p>`, lists `` & ``.
- Inline elements: bold ``, italic `<i>`, emphasis ``, hyperlinks `<a>`.

Resources: [MDN Web Docs](#) & [W3schools website](#).

HTML Attributes

HTML attributes are contained within the opening tag.

```
1 <tag attribute1='value1' attribute2='value2'>element contents</tag>
```

- **id** and **class** attributes are usually the most important in relation to web scraping.

CSS Selectors

- CSS has its own system for selecting elements of a webpage: **selectors**.

CSS Selectors can work on the level of an element type, a class, or a tag and these can be used in a nested (or **cascading**) way.

- The **p** selector will select all paragraph **<p>** elements.
- The **.title** selector will select all elements with class **"title"**.
- The **p.special** selector will select all **<p>** elements with class **"special"**.
- The **#title** selector will select the element with the id attribute **"title"**.

Which Attributes and Selectors Do You Need?

Before you can scrape data, you first need to be able to describe what you want to scrape!

- right click + “inspect page source” (F12)
- right click + “inspect”
- Rvest [Selector Gadget](#) (very useful but fallible)

Start simple and build your confidence. Dynamic webpages can be more difficult.

2. Reading HTML with `{rvest}`



Reading HTML with `{rvest}`

`{rvest}` gives us functionality just like `{readr}`.

```
1 html <- rvest::read_html("https://www.zakvarty.com/professional/teaching.html")
2 class(html)

[1] "xml_document" "xml_node"
```

Rather than a `tibble` we get an `xml_document`, an object from `{xml2}`.

```
1 html

{html_document}
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
[1] <head>\n<meta http-equiv="Content-Type" content="text/html; charset=UTF-8 ...
[2] <body class="nav-fixed">\n\n<div id="quarto-search-results"></div>\n <he ...
```

Extracting HTML elements

```

1 library(rvest)
2 html %>% html_element("h1")
3 ## {html_node}
4 ## <h1>
5 html %>% html_elements("h2")
6 ## {xml_nodeset (2)}
7 ## [1] <h2 id="toc-title">On this page</h2>
8 ## [2] <h2 class="anchored" data-anchor-id="course-history">Course History</h2>
9 html %>% html_elements("p")
10 ## {xml_nodeset (7)}
11 ## [1] <p>I am fortunate to have had the opportunity to teach in a variety of ro ...
12 ## [2] <p>Developing and teaching a number of modules in statistics, data scienc ...
13 ## [3] <p>Supervising undergraduate, postgraduate and doctoral research projects ...
14 ## [4] <p>Adapting and leading short courses on scientific writing and communica ...

```

```

1 html %>% html_elements("p a,h2")

```

```

{xml_nodeset (3)}
[1] <h2 id="toc-title">On this page</h2>
[2] <a href="https://www.advance-he.ac.uk/fellowship/associate-fellowship">he ...
[3] <h2 class="anchored" data-anchor-id="course-history">Course History</h2>

```

Extracting data from HTML elements

- We have the HTML elements we care about... now what?
- Depends if you are interested in the contents or the attributes of those elements.
- Ideally, someone else will have put everything into a table for you already!

Extracting text

Extract text using `rvest::html_text()` or `rvest::html_text2()`.

```
1 html %>%  
2   html_elements("#teaching li") %>%  
3   html_text2()
```

```
[1] "Developing and teaching a number of modules in statistics, data science and data  
ethics. These were predominantly at the postgraduate-level and include courses designed  
for in-person and remote learning."
```

```
[2] "Supervising undergraduate, postgraduate and doctoral research projects."
```

```
[3] "Adapting and leading short courses on scientific writing and communication."
```

```
[4] "Running workshops and computer labs for undergraduate and postgraduate modules."
```

```
[5] "Speaking at univerisity open days and providing one-to-one tuition to high school  
students."
```

Do you want to extract like the HTML file or like the browser display?

Extracting Attributes

- Attributes can also contain useful data that you want to extract (links, image sizes, image paths,...).
- Get twitter link from the icon in the footer of the webpage using **Selector Gadget**.

```
1 html %>% html_element(".compact:nth-child(1) .nav-link")  
{html_node}  
<a class="nav-link" href="https://www.twitter.com/zakvarty">  
[1] <i class="bi bi-twitter" role="img">\n</i>
```

Extracting Attributes (2)

- Extract the **href** attribute.

```
1 html %>%  
2   html_elements(".compact:nth-child(1) .nav-link") %>%  
3   html_attr("href")  
  
[1] "https://www.twitter.com/zakvarty"
```

Note: Attributes are always extracted as strings, so may need reformatting before analysis.

HTML Tables

There are four main elements to know about that make up an HTML table:

- `<table>`,
- `<tr>` (table row),
- `<th>` (table heading),
- `<td>` (table data).

Example HTML Table

```
1 <table>
2   <tr>
3     <th>Name</th>
4     <th>Number</th>
5   </tr>
6   <tr>
7     <td>A</td>
8     <td>1</td>
9   </tr>
10  <tr>
11    <td>B</td>
12    <td>2</td>
13  </tr>
14  <tr>
15    <td>C</td>
16    <td>3</td>
17  </tr>
18 </table>
```

Extracting HTML Tables

`{rvest}` has a useful function `html_table()` to help us.

```
1 html_2 %>%  
2   html_element("table") %>%  
3   html_table()  
  
# A tibble: 3 × 2  
  Name    Number  
  <chr>   <int>  
1 A         1  
2 B         2  
3 C         3
```

Extracting HTML Tables (2)

```

1  html %>%
2    html_element("table") %>%
3    html_table()

# A tibble: 31 × 3
  Year      Course      Role
  <chr>    <chr>      <chr>
1 "2022-23" Data Science    Lecturer
2 ""      Ethics in Data Science I, II and III Lecturer
3 ""      Data Ethics for Digital Chemistry    Lecturer
4 ""      Y1 research projects: point process models Lecturer
5 "2021-22" Supervised Learning    Lecturer
6 ""      Ethics in Data Science I    Lecturer
7 ""      Ethics in Data Science II    Lecturer
8 ""      Data Ethics for Digital Chemistry    Lecturer
9 ""      Y1 research projects: point process models Lecturer
10 "-"    — —
# i 21 more rows

```

Tip when building tibbles

- Aim: build a tibble with 1 row per observation unit in the HTML (table row, list item, etc).
1. Use `html_elements()` to select the elements that contain each observation unit;
 2. Use `html_element()` to extract the variables from each of those observations.

This avoids issues with missing values.

Tip Example: Star Wars

Example from the [star wars dataset](#).

```
1 starwars_html <- minimal_html("
2   <ul>
3     <li><b>C-3PO</b> is a <i>droid</i> that weighs <span class='weight'>167 kg</span></li>
4     <li><b>R2-D2</b> is a <i>droid</i> that weighs <span class='weight'>96 kg</span></li>
5     <li><b>Yoda</b> weighs <span class='weight'>66 kg</span></li>
6     <li><b>R4-P17</b> is a <i>droid</i></li>
7   </ul>
8   ")
```


Tip Example: what not to do

Do not try to extract each element directly: vectors of differing lengths.

```
1 starwars_html %>% html_elements("b") %>% html_text2()
```

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

```
1 starwars_html %>% html_elements("i") %>% html_text2()
```

```
[1] "droid" "droid" "droid"
```

```
1 starwars_html %>% html_elements(".weight") %>% html_text2()
```

```
[1] "167 kg" "96 kg" "66 kg"
```

Tip Example: correct approach

First select the elements that contain each observation unit.

```
1 starwars_characters <- starwars_html %>% html_elements("li")
```

Then extract the variables from each of those observations.

```
1 tibble::tibble(  
2   name = starwars_characters %>% html_element("b") %>% html_text2(),  
3   species = starwars_characters %>% html_element("i") %>% html_text2(),  
4   weight = starwars_characters %>% html_element(".weight") %>% html_text2()  
5 )
```

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

Wrapping Up

1. Structure of webpages.
2. Using `{rvest}` package to extract the elements of interest.
3. Formatting those extracted into useful formats.

