Web scraping

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Scraping the web: what? why?

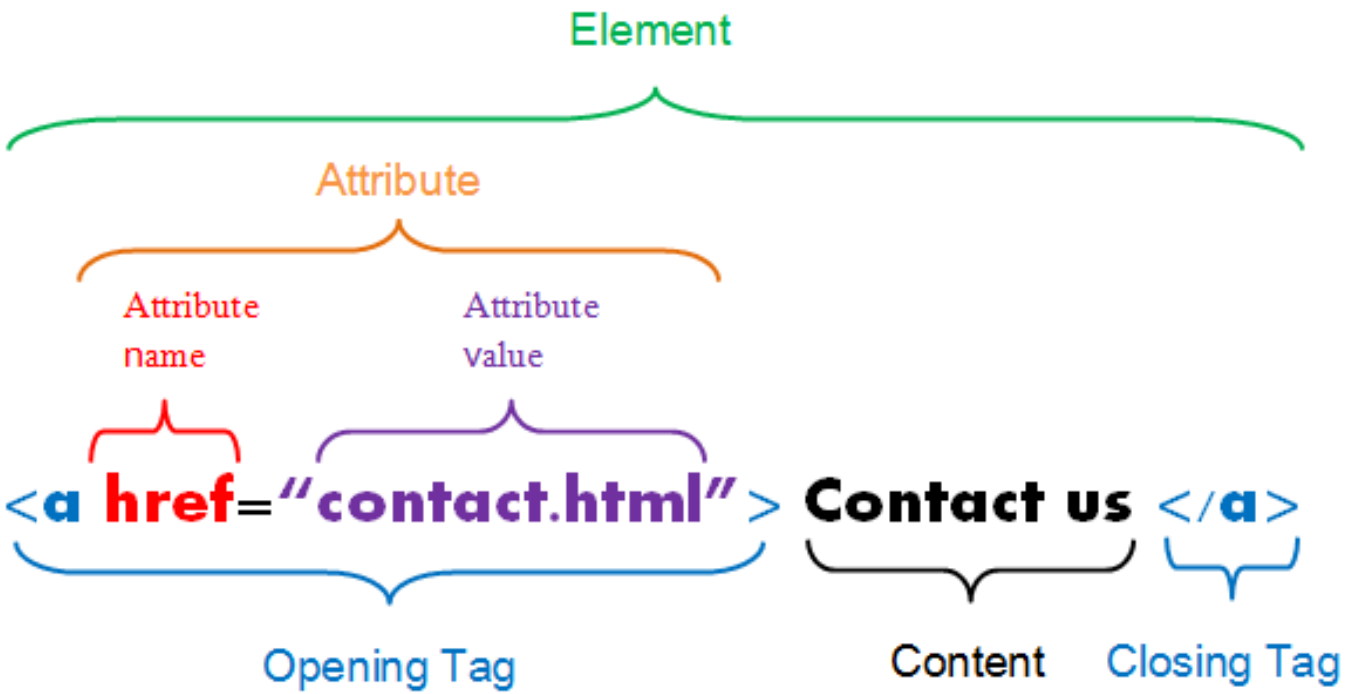
- Increasing amount of data is available on the web
- These data are provided in an unstructured format: you can always copy&paste, but it's time-consuming and prone to errors
- Web scraping is the process of extracting this information automatically and transform it into a structured dataset
- Two different scenarios:
  - Screen scraping: extract data from source code of website, with html parser (easy) or regular expression matching (less easy).
  - Web APIs (application programming interface): website offers a set of structured http requests that return JSON or XML files.

Web Scraping with rvest

Hypertext Markup Language (HTML)

- HTML describes the structure of a web page; your browser interprets the structure and contents and displays the results.
- The basic building blocks include elements, tags, and attributes.
  - an element is a component of an HTML document
  - elements contain tags (start and end tag)
  - attributes provide additional information about HTML elements

Hypertext Markup Language (HTML)



Simple HTML document

```
<html>
<head>
<title>Web Scraping</title>
</head>
<body>

<h1>Using rvest</h1>
<p>To get started...</p>

</body>
</html>
```

Simple HTML document

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<html>
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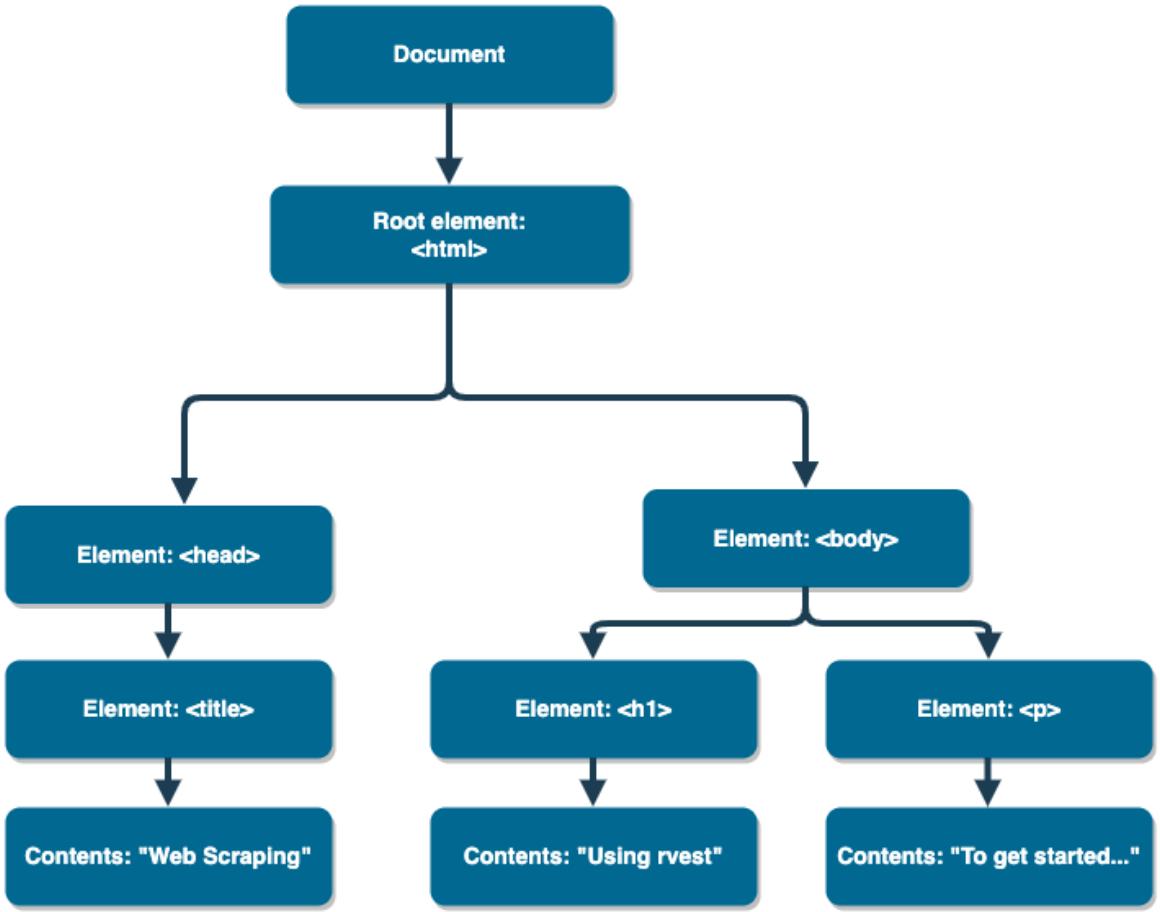
</body>
</html>
```

We can visualize this in a tree-like structure.

HTML tree-like structure



If we have access to an HTML document, then how can we easily extract information and get it in a format that's useful for analysis?

rvest

- The **rvest** package makes basic processing and manipulation of HTML data straight forward
- It's designed to work with pipelines built with **%>%**

Core rvest functions

- **`read_html`** - Read HTML data from a url or character string
- **`html_node`** - Select a specified node from HTML document
- **`html_nodes`** - Select specified nodes from HTML document
- **`html_table`** - Parse an HTML table into a data frame
- **`html_text`** - Extract tag pairs' content
- **`html_name`** - Extract tags' names
- **`html_attrs`** - Extract all of each tag's attributes
- **`html_attr`** - Extract tags' attribute value by name

Example: simple_html

Let's suppose we have the following HTML document from the example website with the URL **`simple_html`**

```
<html>
<head>
<title>Web Scraping</title>
</head>
<body>
<h1>Using rvest</h1>
<p>To get started...</p>
</body>
</html>
```

HTML in R

Read in the document with **`read_html()`**.

```
page <- read_html(simple_html) #replace with URL in practice
```

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What does this look like?

HTML in R

Read in the document with **`read_html()`**.

```
page <- read_html(simple_html) #replace with URL in practice
```

What does this look like?

```
page
```

```
## {html_document}
## <html>
## [1] <head>\n<meta http-equiv="Content-Type" content="text/html; charset=UTF
## [2] <body>\n<h1>Using rvest</h1>\n<p>To get started...</p>\n</body>
```

Subset with `html_nodes()`

Let's extract the highlighted component below.

```
<html>
<head>
<title>Web Scraping</title>
</head>
<body>

<h1>Using rvest</h1>
<p>To get started...</p>

</body>
</html>
```

Subset with `html_nodes()`

Let's extract the highlighted component below.

```
<html>
<head>
<title>Web Scraping</title>
</head>
<body>

<h1>Using rvest</h1>
<p>To get started...</p>

</body>
</html>
```

```
h1_nodes <-page %>%
  html_nodes(css = "h1")
h1_nodes
```

```
## {xml_nodeset (1)}
## [1] <h1>Using rvest</h1>
```

Extract contents and tag name

Let's extract "Using rvest" and **`h1`**.

```
<html>
<head>
<title>Web Scraping</title>
</head>
<body>

<h1>Using rvest</h1>
<p>To get started...</p>

</body>
</html>
```

Extract contents and tag name

Let's extract "Using rvest" and **h1**.

```
<html>
<head>
<title>Web Scraping</title>
</head>
<body>

<h1>Using rvest</h1>
<p>To get started...</p>

</body>
</html>
```

```
h1_nodes %>%
  html_text()
```

```
## [1] "Using rvest"
```

```
h1_nodes %>%
  html_name()
```

```
## [1] "h1"
```

Scaling up

Most HTML documents are not as simple as what we just examined. There may be tables, hundreds of links, paragraphs of text, and more. Naturally, we may wonder:

1. How do we handle larger HTML documents?

2. How do we know what to provide to **`css`** in function **`html_nodes()`** when we attempt to subset the HTML document?

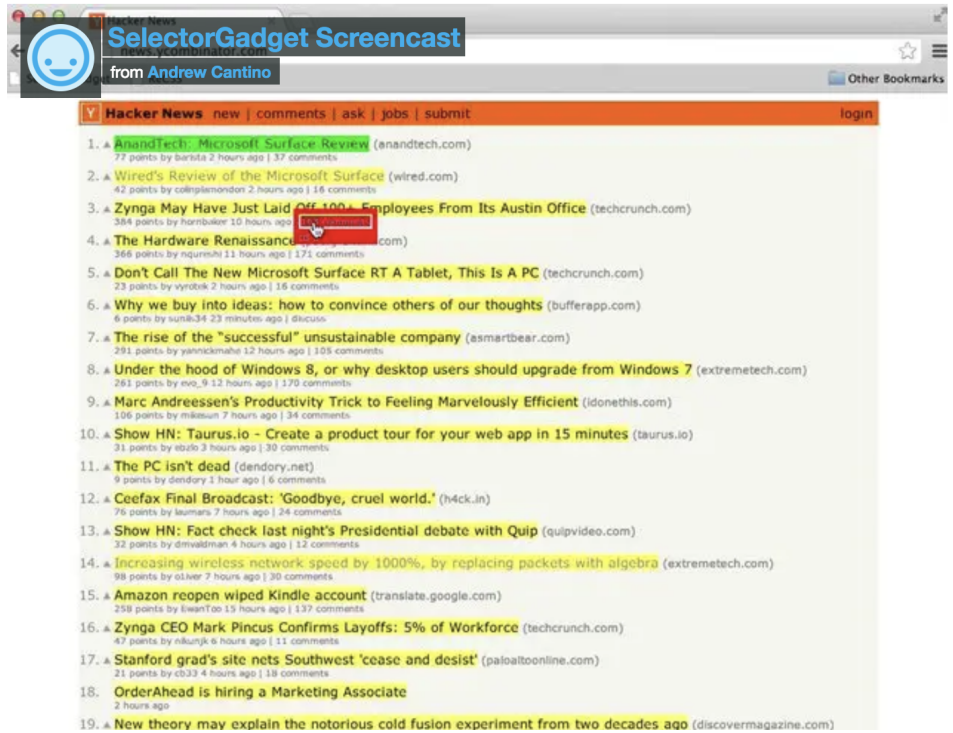
3. Are these functions in **`rvest`** vectorized? For instance, are we able to get all the content in the **`td`** tags on the slide that follows?

In Chrome, you can view the HTML document associated with a web page by going to **`View > Developer > View Source`**.

SelectorGadget

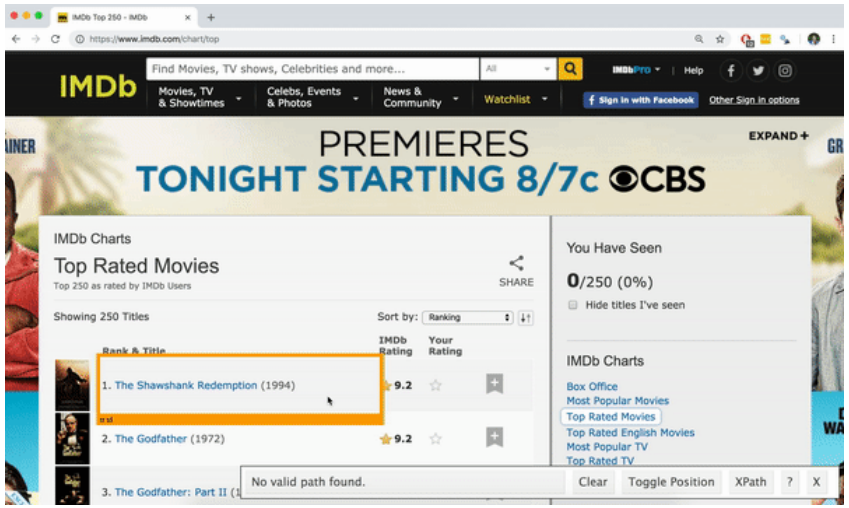
- Open source tool that eases CSS selector generation and discovery
- Can use through the Chrome Extension or the bookmark available on selectorgadget.com
- Find out more on the SelectorGadget vignette

SelectorGadget:
point and click CSS selectors



Using the SelectorGadget

- Click on the app logo next to the search bar. A box will open in the bottom right of the website.
- Click on a page element (it will turn green), SelectorGadget will generate a minimal CSS selector for that element, and will highlight (yellow) everything that is matched by the selector.



- 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

Top 250 movies on IMDB

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

First check if you're allowed!

```
library(robotstxt)
paths_allowed("http://www.imdb.com")
```

```
## [1] TRUE
```

vs. e.g.

```
paths_allowed("http://www.facebook.com")
```

```
## [1] FALSE
```

Select and format pieces

```
page <- read_html("http://www.imdb.com/chart/top")
```

Select and format pieces

```
page <- read_html("http://www.imdb.com/chart/top")
```

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

Select and format pieces

```
page <- read_html("http://www.imdb.com/chart/top")
```

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

```
years <- page %>%
  html_nodes(".secondaryInfo") %>%
  html_text() %>%
  str_replace("\\(", "") %>% # remove (
  str_replace("\\)", "") %>% # remove )
  as.numeric()
```

Select and format pieces

```
page <- read_html("http://www.imdb.com/chart/top")
```

```
titles <- page %>%
  html_nodes(".titleColumn a") %>%
  html_text()
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years <- page %>%
  html_nodes(".secondaryInfo") %>%
  html_text() %>%
  str_replace("\\(", "") %>% # remove (
  str_replace("\\)", "") %>% # remove )
  as.numeric()
```

```
scores <- page %>%
  html_nodes("#main strong") %>%
  html_text() %>%
  as.numeric()
```

Select and format pieces

```
page <- read_html("http://www.imdb.com/chart/top")
```

```
titles <- page %>%
  html_nodes(".titleColumn a") %>%
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years <- page %>%
  html_nodes(".secondaryInfo") %>%
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  str_replace("\\(", "") %>% # remove (
  str_replace("\\)", "") %>% # remove )
  as.numeric()
```

```
scores <- page %>%
  html_nodes("#main strong") %>%
  html_text() %>%
  as.numeric()
```

```
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
```

```
imdb_top_250 %>%
  DT::datatable(options(list(dom = "p")))
```

Show 10 entries Search:

	title	year	score
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

Showing 1 to 10 of 250 entries Previous 1 2 3 4 5 ... 25 Next

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

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…
```

Add a variable for rank

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

```
imdb_top_250 %>%
  DT::datatable(options(list(dom = "p")), height = 350)
```

Previous 1 2 3 4 5 ... 25 Next

	title	year	score	rank
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

Analyze

How would you go about answering this question: Which 1995 movies made the list?

Analyze

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```
imdb_top_250 %>%
  filter(year == 1995)
```

```
## # A tibble: 8 x 4
##   title                year score  rank
##   <chr>               <dbl> <dbl> <int>
## 1 Se7en                1995   8.6    20
## 2 The Usual Suspects   1995   8.5    32
## 3 Braveheart           1995   8.3    78
## 4 Toy Story            1995   8.3    81
## 5 Heat                 1995   8.2   123
## 6 Casino               1995   8.2   139
## 7 Before Sunrise       1995   8.1   191
```

Analyze

How would you go about answering this question: Which years have the most movies on the list?

Analyze

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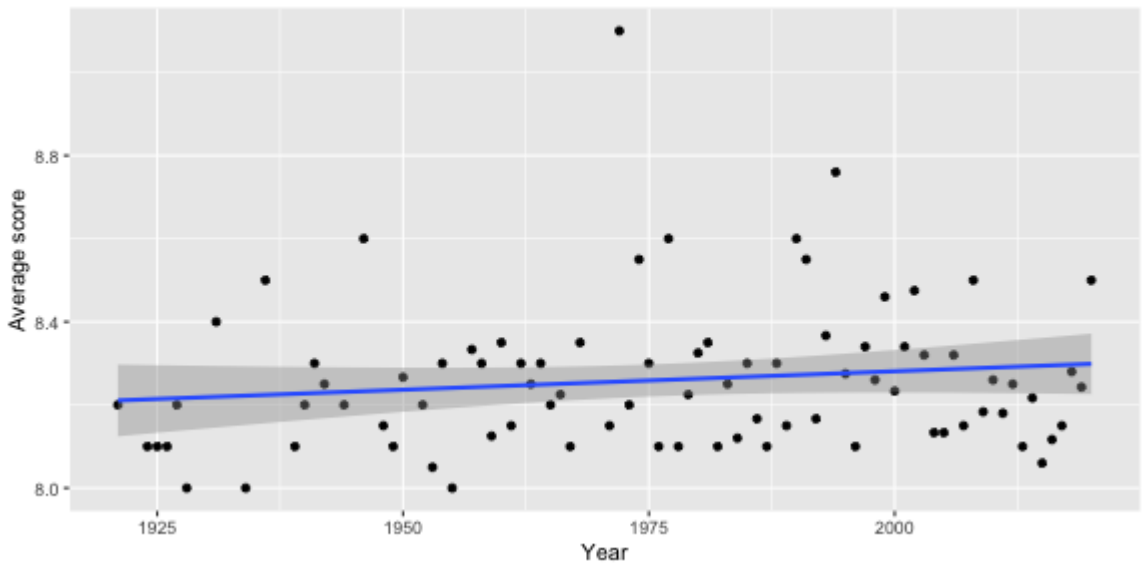
```
imdb_top_250 %>%
  group_by(year) %>%
  summarise(total = n()) %>%
  arrange(desc(total)) %>%
  head(5)
```

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

How would you go about creating this visualization: Visualize the average yearly score for movies that made it on the top 250 list over time.

Plot Code



Potential challenges

- Unreliable formatting at the source
- Data broken into many pages
- ...

Compare the display of information at **raleigh.craigslist.org/search/apa** to the list on the IMDB top 250 list. What challenges can you foresee in scraping a list of the available apartments?