Web Scrapping

(Lectures on High-performance Computing for Economists X)

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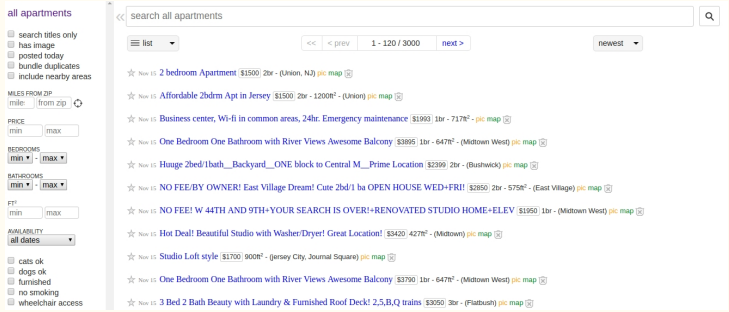
Web scraping I

- Internet includes thousands of data points that can be used for research.
- Examples:
  1. Yelp: David, Dingel, Monras, and Morales: "'How segregated is urban consumption' (**Accepted JPE**).
  2. Craigslist: Halket and Pignatti: "Homeownership and the scarcity of rentals" (**JME 2015**).
  3. Walmart, Target, CVS ...: Cavallo (2017): "Are Online and Offline Prices Similar? Evidence from Large Multi-channel Retailers" (**AER 2017**).
  4. Government document: Hsieh, Miguel, Ortega, and Rodriguez: "The Price of Political Opposition: Evidence from Venezuela's Maisanta" (**AEJ: Applied Economics, 2011**).
  5. Google: Ginsberg, Mohebbi, Patel, Brammer, Smolinski, and Brilliant: "Detecting influenza epidemics using search engine query data" (**Nature, 2009**).

Web scraping II

- However, data may be split across thousands of URLs (requests):

- And include multiple filters: bedrooms, bathrooms, size, price range, pets:



- Automatize data collection: code that gathers data from websites.
- (Almost) any website can be scraped.

Permissions

- Beware of computational, legal, and ethical issues related with web scrapping. Check with your IT team and read the terms of service of a web site.
- Go to *The Robots Exclusion Protocol* of a website, adding "/robots.txt" to the website's URL: `www.google.com/robots.txt`.
- E.g.: Spotify's *robots.txt*'s file:

- Three components:
  1. User-agent: the type of robots to which the section applies.
  2. Disallow: directories/prefixes of the website not allowed to robots.
  3. Allow: sections of the website allowed to robots.
- `robots.txt` is a *de facto* standard (see `http://www.robotstxt.org`).

How do you scrap?

- You can rely on existing packages:
  1. Scraper for Google Chrome.
  2. Scrapy: `https://scrapy.org/`
- Or you use your own code:
  1. Custom made.
  2. `Python`: packages `BeautifulSoup`, `requests`, `httplib`, and `urllib`.
  3. `R`: package `httr`, `RCurl`, and `rvest`.

HMTL

- Nearly all websites are written in standard `HTML (Hyper Text Markup Language)`.
- Due to simple structure of `HTML`, all data can be extracted from the code written in this language.
- Advantages of web scrapping vs., for example, `APIs`:
  1. Websites are constantly updated and maintained.
  2. No rate limits (such as limits to daily queries in `APIs`) – apart from explicit restrictions.
  3. Data is readily available.
- However, there is no bulletproof method:
  1. Data is structured differently on every website (different request methods, `HTML` labels, etc.).
  2. Unlike `APIs`, usually no documentation.
  3. Take your time, be patient!

A motivating example in R I

Let us first clear everything:

```
rm(list=ls())
```

We install and load required packages:

```
install.packages("rvest")
library(rvest)
library(dplyr)
```

We read a webpage into a a parsed HTML document:

```
my_page <- read_html("relevant_page.html")
```

We extract a table:

```
my_page %>%
  html_node("table") %>% html_table()
```

A motivating example II

A more realistic example of getting financial information:

```
page <- read_html("https://finance.yahoo.com/quote/MSFT")
```

We get price:

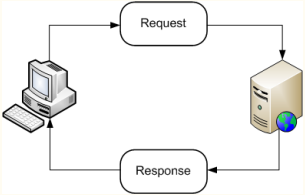
```
page %>%
  html_node("div#quote-header-info > section > span") %>%
  html_text() %>%
  as.numeric()
```

We get key statistics:

```
page %>%
  html_node("#key-statistics table") %>%
  html_table()
```

Requests

- Every time you click on a website and data is updated, a *request* is being made.



- Steps to web scraping:
  1. Figure out request method of website:
     - Usually data split over different URLs.
     - Tables update with filters.
     - ...
  2. Fetch the `HTML`, `JSON`, ... data of a website using a request.
  3. Parse the data in a structured way.
  4. Access/organize the data.
- Avoid 1 if interested only in scraping data from a single URL.

HTTP

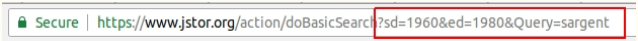
- `HTTP` (Hypertext Transfer Protocol) enables communication between clients and servers.
- Works through a request-response protocol.
- Every time data is updated in browser, a request has been made.
- Most used `HTTP` request methods are `GET` and `POST` (although there are many others, such as `HEAD`, `PATCH`, `PUT`, ...).
- Understanding requests is useful to scrape multiple websites/queries:
  - Prices on Craigslist.
  - Government press releases.
  - Flight data.
- Before scraping, need to figure out:
  1. What type of request is being made?
  2. What are the parameters of the request/query?

GET requests I

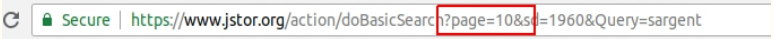
- Most common `HTTP` request method.
- `GET` requests sent through `URL`.
- Look if/how `URL` changes as you change filters/search terms.
- Remove/add parameters in `URL` to see changes in data displayed.
- On every request there's usually a "?" at the beginning of request, and a "&" between each key/value.

GET requests II

- In JSTOR, search for "sargent" with publication dates starting in 1960 and ending in 1980:



- Try to remove unnecessary filters/parameters until left with only necessary ones to load data.
- Usually there's limit on number of results displayed – multiple pages.
- Go to "next" page and see how URL changes:



- OR try to change "Display 10 results per page"

GET requests III

- Anatomy of `GET` request:

- Response (`HTML`):

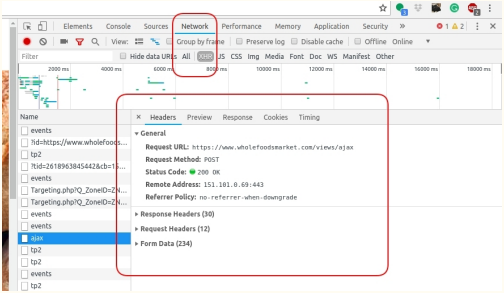
```
HTTP/1.1 404 Not Found
Date: Mon, 15 Nov 2018 12:15:08 GMT
Server: Apache/2.2.14 (Win32)
Content-Length: 204
Connection: close
Content-Type: text/html; charset=iso-8859-1

<!DOCTYPE HTML PUBLIC "...">
<html><head>
<title>404 Not Found</title>
</head><body> ... </body></html>
```

- `HTML` code ready to use

POST requests I

- `POST` requests **not** sent through `URL` $\Rightarrow$ data displayed changes without `URL` changing.
- Sent through an HTML form with headers.
- Response usually in nicely-structured format (e.g. `JSON`).
- To inspect headers and response of request, go to Chrome's: DevTools >> Network >> XHR.
- Look through XHR requests for the ones that are pulling data:



POST requests II

- Anatomy of `POST` request:

```
POST /library.html HTTP/1.0
Content—Type: mime—type
Content—Length: number—of—bytes
(Query string)
```

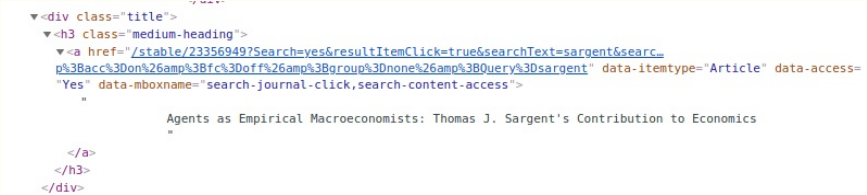
- Response is usually nicely-formatted data.

GET vs. POST requests I

	GET	POST
History	Parameters saved in browser history	Parameters not saved in browser history
Bookmark	Can be bookmarked	Cannot be bookmarked
Parameters	Length restrictions (characters in URL)	No restrictions on data/parameter length
Cache	Can be cached	Cannot be cached
Security	Low – sent through URL	Higher – data not exposed in URL

GET vs. POST requests II

- GET: data has to be gathered directly from HTML:



- POST: data usually comes in structured way. E.g. JSON:

```
{
"name":"John",
"age":30,
"cars":[ "Ford", "BMW", "Fiat" ]
}
```

Fetching the data I: Python

- Libraries: requests, httplib, urllib

```
import requests
URL = "http://maps.googleapis.com/maps/..."
location = "Philadelphia"
PARAMS = {'address':location}

r = requests.get(url = URL, params = PARAMS)
```

```
import requests
API_ENDP = "http://pastebin.com/api/..."
API_KEY = "123456"
data = {'api_key':API_KEY, 'api_opt':'paste'}

r = requests.post(url = API_ENDP, data = data)
```

Fetching the data II: R

- Packages: `httr`, `RCurl`, `rvest`

```
library(httr)
r <- GET("http://maps.googleapis.com/maps/...",
        request = list(address = "Mexico"))
```

```
library(httr)
API_KEY = "123456"
r <- POST("http://httpbin.org/post",
          body = list(api_key = "123456",
                      api_opt = 'paste'))
```

- Or if interested on a single URL:

```
library(rvest)
mypage <- read_html("https://finance.yahoo.com/quote/MSFT"
    )
```

Parsing HTML/XML I

- Recall that HTML/XML code comes in nested structure of tags:

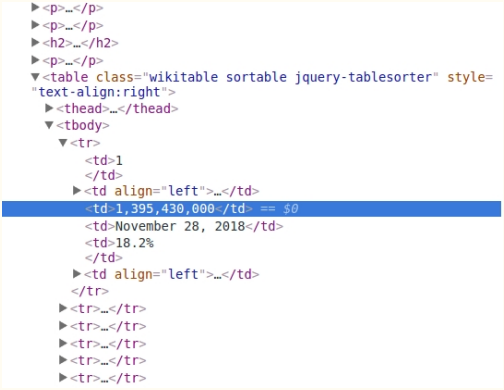
```
<!DOCTYPE html>
<html>
<head>
  <title>Your web page</title>
</head>
<body>
  <h1>Heading 1</h1>
  <p>Paragraph 1.</p>
</body>
</html>
```

- Many of those websites employ CSS (Cascading Style Sheets).
- Useful to find data within the code.

Parsing HTML/XML II

Data on website:

HTML code:



- Idea: extract the "$1,395,430,000$" from HTML

Parsing HTML/XML III

"A parser is a software component that takes input data (frequently text) and builds a data structure – often some kind of parse tree, abstract syntax tree or other hierarchical structure..."

- Use DOM (Document Object Model) to parse HTML.
- Take as input XML/HTML code and generate a tree.
- Functions used to access nodes in tree:
  - Root: returns root node.
  - Name: returns name of node.
  - Atributes: returns node attributes.
  - Parent: parent of a node.
  - Siblings: siblings of a node.
  - Value: value of node.
- Use XPath language (described later) to query nodes, extract data.

Parsing HTML/XML IV

- In Python, library BeautifulSoup:

```
import requests
from bs4 import BeautifulSoup

URL = "https://www.wikipedia.org/"
r = requests.get(url = URL)
soup = BeautifulSoup(r.text)
```

- In R, library XML:

```
library(httr)
library(XML)

html = GET("https://en.wikipedia.org/wiki/XML")
tree = htmlTreeParse(html)
```

- Data stored as an XML object

Accessing the data: XPath I

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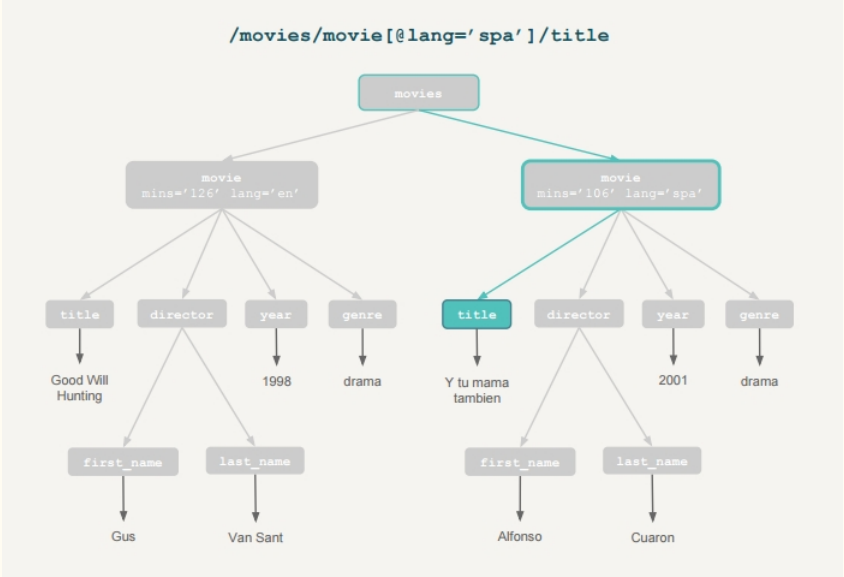
- Once we have parsed HTML into an XML object, we need to locate specific nodes with data.
- XPath (XML Path Language): language to query and access XML elements.
- Path-like syntax to navigate through nodes.
- Expressions that return nodes:

node	Selects nodes with name "node"
/node	Selects root element "node"
//node	Selects all elements of type "node"
node[@attrname]	Selects node with attribute named "attrname"
node[@attrname='name']	Node with "attrname" and value 'name'

Accessing the data: XPath II



XPath in Python

- Many functions, depending on parsing package.
- Using `lxml`:

```
from lxml import html
import requests

page = requests.get('http://econpy.pythonanywhere.com/...'
    )
tree = html.fromstring(page.content)
buyers = tree.xpath('//div[@title="buyer-name"]/text()')
prices = tree.xpath('//span[@class="item-price"]/text()')
```

XPath in R

- Main function to access nodes of XML tree using XPath: `getNodeSet(tree, path)`
  - `tree` is the XML tree stored.
  - `path` is the XPath path of the node of interest.
- In R:

```
getNodeSet(movies_xml, "/movies/movie")
getNodeSet(movies_xml, "//title")
getNodeSet(movies_xml, "//movie[@lang='eng']")
```