Intro to Programming for Public Policy Week 7
Web Scraping and APIs

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Web Resources

Variety

- There's a variety of information on the web:
  - *Unstructured* text
  - Tables
  - "Hidden" APIs
  - Documented APIs

Examples of Web Resources

1. Google has many straightforward APIs for mapping.
2. Twitter provides a well-known API that is used heavily by researchers.
3. U.S. Census provides a data website and APIs.
4. Bureau of Labor Statistics has an API.
5. Lots of Wikipedia articles have nice tables
6. Some websites go to great lengths to keep you out, e.g. Google Trends

Tools

1. `requests`: Python module for retrieving web resources
   - Basic methods for authentication, `POST`ing, etc.
   - Basically `curl`/`wget` for Python
2. `beautifulsoup`: Python module for traversing and extracting elements from a web page.
3. `pandas.read_html()`: reads a well-formatted html table into a pandas DataFrame.
4. `selenium` is similar but actually launches a web browser like Firefox
   - Works with JavaScript heavy pages
5. Command line tools (`curl`, `wget`)

Scraping

What is scraping?

- Look at HTML and individual requests (e.g. using developers tools in your browser)
- Identify patterns in HTML and URLs that allow you to download the right resources
- Extract data from those resources
- Relatively ad-hoc, need to write new scraping tools for each (part of each) site

Requests

```
import requests

base = 'https://www.nytimes.com'
path = '/interactive/projects/guantanamo/detainees/current

response = requests.get(base + path)
```

Responses

```
>>> type(response)
requests.models.Response
>>> response.status_code
200
>>> print(response.text)
<!DOCTYPE html>
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en" la
  <head>
    <meta http-equiv="Content-Type" content="text/html; cha
    <meta name="viewport" content="width=device-width, user
    <title>The Detainees - The Guant&aacute;namo Docket</ti
    <meta name="hdl" content="The Detainees - The Guant&aac
...
```

Identify

The first step in scraping is figuring out a way to identify the information you want.

```
 97  <table class="s-full s-datatable">
 98    <tr class="bar"><th>Name</th><th>Citizenship</th></tr>
 99    <tr class="divide nytint-first">
100      <td><a href="/interactive/projects/guantanamo/detainees/694-sufyian-barhoumi">Barhoumi, Sufyian</a></td>
101      <td><a href="/interactive/projects/guantanamo/country/algeria">Algeria</a></td>
102    </tr>
103    <tr class="divide ">
104      <td><a href="/interactive/projects/guantanamo/detainees/244-abdul-latif-nasir">Nasir, Abdul Latif</a></td>
105      <td><a href="/interactive/projects/guantanamo/country/morocco">Morocco</a></td>
106    </tr>
107    <tr class="divide ">
108      <td><a href="/interactive/projects/guantanamo/detainees/38-ridah-bin-saleh-al-yazidi">al Yazidi, Ridah Bin Saleh</
109      <td><a href="/interactive/projects/guantanamo/country/tunisia">Tunisia</a></td>
110    </tr>
111    <tr class="divide ">
112      <td><a href="/interactive/projects/guantanamo/detainees/893-tolfiq-nassar-ahmed-al-bihani">al Bihani, Tolfiq Nassa
113      <td><a href="/interactive/projects/guantanamo/country/yemen">Yemen</a></td>
114    </tr>
115    <tr class="">
116      <td><a href="/interactive/projects/guantanamo/detainees/309-muieen-a-deen-jamal-a-deen-abd-al-fusal-abd-al-sattar"
117      <td><a href="/interactive/projects/guantanamo/country/unknown-national-origin">Unknown National Origin</a></td>
118    </tr>
119  </table>
```

Parsing HTML

- You could manually search for `response.text` for

`<a href="/interactive/projects/gauntanamo/detainees/...`

- Then, to get the detainee's name you'd need to find the next > and the closing tag and extract the text in between.
- This would be cumbersome

Beautiful Soup

- The Beautiful Soup library makes this much easier by converting the text into a data structure that is easy to "traverse"

```
>>> from bs4 import BeautifulSoup
>>> page = BeautifulSoup(response.text, 'html.parser')
>>> type(page)
bs4.BeautifulSoup
```

find all()

Use the `find_all()` function to find all tags of a paticular type:

```
>>> page.find_all('a')
[<a href="http://www.nytimes.com" target="_blank"><img alt=
 <a class="nytint-sharetoolsShareLink nytint-sharetoolsShar
 <a class="nytint-sharetoolsShareLink nytint-sharetoolsShar
 <a href="https://www.nytimes.com/interactive/projects/guan
 <img alt="The Guantanamo Docket" src="https://static01.nyt
 </a>,
 <a href="http://www.nytimes.com/guantanamo-files">Related
 <a href="https://www.nytimes.com/interactive/projects/guan
...
```

Tag

- Each element in the list returned by `find_all()` is a special `Element` data type:

```
>>> a = page.find_all('a')[0]
>>> type(a)
bs4.element.Tag
```

- You can see its HTML by simply printing it:

```
>>> a
<a href="http://www.nytimes.com" target="_blank"><img a
```

Tag details

- You can see a dictionary of its attributes:

```
>>> a.attrs
{'href': 'http://www.nytimes.com',
 'target': '_blank'}
```

- You can see its contents:

```
>>> a.contents
[<img alt="The New York Times" src="https://int.nyt.com
>>> a.text
''
```

Detainee links

- But we only want the detainee links
- These can be identified as having an `href` that starts with `'/interactive/projects/guantanamo/detainees'`
- So one way to get them would be:

```
detainee_links = []
prefix = '/interactive/projects/guantanamo/detainees'
for a in page.find_all('a'):
    if a.attrs['href'].startswith(prefix):
        detainee_links.append(a)
```

Issues

```
>>> detainee_links
[<a href="/interactive/projects/guantanamo/detainees/curren
 <a href="/interactive/projects/guantanamo/detainees/694-su
 <a href="/interactive/projects/guantanamo/detainees/244-ab
 <a href="/interactive/projects/guantanamo/detainees/38-ric
 <a href="/interactive/projects/guantanamo/detainees/893-to
...
```

- This includes the links to `detainees/current` and `detainees/country`
- We could manually remove them but there's a better way

Regex

- Regular expressions are a language for expressing patterns that can be matched to text
- For example the regular expression `\d` matches any numeric digit
- The regular expression `detainees/\d` matches `detainees/\d` followed by a digit

Python `re`

The `re` module provide regular expression matching in Python:

```
>>> import re
>>> pattern = re.compile('\d')
>>> type(pattern)
_sre.SRE_Pattern
>>> pattern.findall('1')
['1']
>>> pattern.findall('abc')
[]
>>> pattern.findall('Chicago, IL 60637')
['6', '0', '6', '3', '7']
```

More regex

- Match either “gray” or “grey”:

  `gray|grey`

- Same:

  `gr(a|e)y`

Regex quantifiers

- `?`: match zero or one occurence
  - `colou?r` matches both “color” and “colour”
- `*`: match any number of occurences
  - `1\d*` matches any number whose first digit is 1
- `+`: match one or more occurences
  - `\d+` matches any number

Regex `find_all()`

The `BeatifulSoup.find_all()` function can filter an attribute to match a regular expression:

```
page.find_all('a', href=re.compile('detainees/\d'))
```

Print prisoner names

```
import requests
from bs4 import BeautifulSoup
import re

base = 'https://www.nytimes.com'
path = '/interactive/projects/guantanamo/detainees/current

response = requests.get(base + path)
page = BeautifulSoup(response.text, 'html.parser')

detainee_links = page.find_all('a', href=re.compile('detai

for a in detainee_links:
    print(a.text)
```

Country

- After each prisoner link in the HTML there is a link to their country.
- We can scrape this, too like so:

```
>>> a
<a href="/interactive/projects/guantanamo/detainees/694-sui
>>> a.find_next('a')
<a href="/interactive/projects/guantanamo/country/algeria">
>>> a.find_next('a').text
'Algeria'
```

More information

- What if we want to get more information about each detainee?
  - For example, how long they've been detained
- We'll need to requst each detainee's page and scrape that:

```
>>> detainee_path = detainee_links[0].attrs['href']
>>> detainee_path
'/interactive/projects/guantanamo/detainees/694-sufyian-ba
>>> detainee_response = requests.get(base + detainee_path)
>>> det_page = BeautifulSoup(detainee_response.text,
                             'html.parser')
```

Detainee HTML

```
77              <div class="nytint-detainee-fullcol">
78                <h1 class="nytint-detainee-header nytint-mainheader">
79                  Sufyian Barhoumi
80                </h1>
81
82                <p>
83                      Sufyian Barhoumi
84        is a 44-year-old
85      citizen of
86      <a href="https://www.nytimes.com/interactive/projects/guantanamo/country/algeria">Algeria</a>.
87
88
89
90
91              As of January 2010, the <a href="http://www.justice.gov/ag/guantanamo-review-final-
    report.pdf">Guantánamo Review Task Force</a> had recommended him for prosecution.
92            A parole-like <a href="http://www.prs.mil/Home.aspx">Periodic Review Board</a> later
    recommended him for transfer.
93          As of May 9, 2018, he has been <a href="https://www.nytimes.com/interactive/projects/guantanamo
    /detainees/held">held at Guantánamo</a> for 15 years 11 months.
94
95
96
97            War crimes charges against Mr. Barhoumi have been dismissed but may be refiled.
98
99                </p>
100
```

Detainee `div`

To get the div with *class* 'full

```
>>> div = det_page.find('div',
                        class_='nytint-detainee-fullcol')
```

Extract time detained

```
>>> time_pattern = re.compile('\d+ year')
>>> time_pattern.findall(div.text)
['15 year']
```

How can we get the number 15?

Extract time detained

```
>>> time_pattern = re.compile('\d+ year')
>>> time_pattern.findall(div.text)
['15 year']
```

How can we get the number 15?

```
>>> matches = time_pattern.findall(div.text)
>>> int(matches[0].rstrip(' year'))
15
```

Put it in a function

```
time_pattern = re.compile('\d+ year')

def get_years(det_page):
    div = det_page.find('div',
                        class_='nytint-detainee-fullcol')
    matches = time_pattern.findall(div.text)
    return int(matches[0].rstrip(' year'))
```

Another function

```
def get_detainee_page(detainee_link):
    detainee_response = requests.get(
            base + detainee_link.attrs['href'])

    return BeautifulSoup(detainee_response.text,
                         'html.parser')
```

Putting it together

```
import time
names, countries, years = [], [], []

for a in detainee_links:
    print(a.text)
    names.append(a.text)
    countries.append(a.find_next('a').text)

    detainee_page = get_detainee_page(a)
    years.append(get_years(detainee_page))

    time.sleep(2)

detainees = pd.DataFrame({'name': names,
                          'country': countries,
                          'years': years})
```

Full code here

Pandas `read_html()`

HTML Table

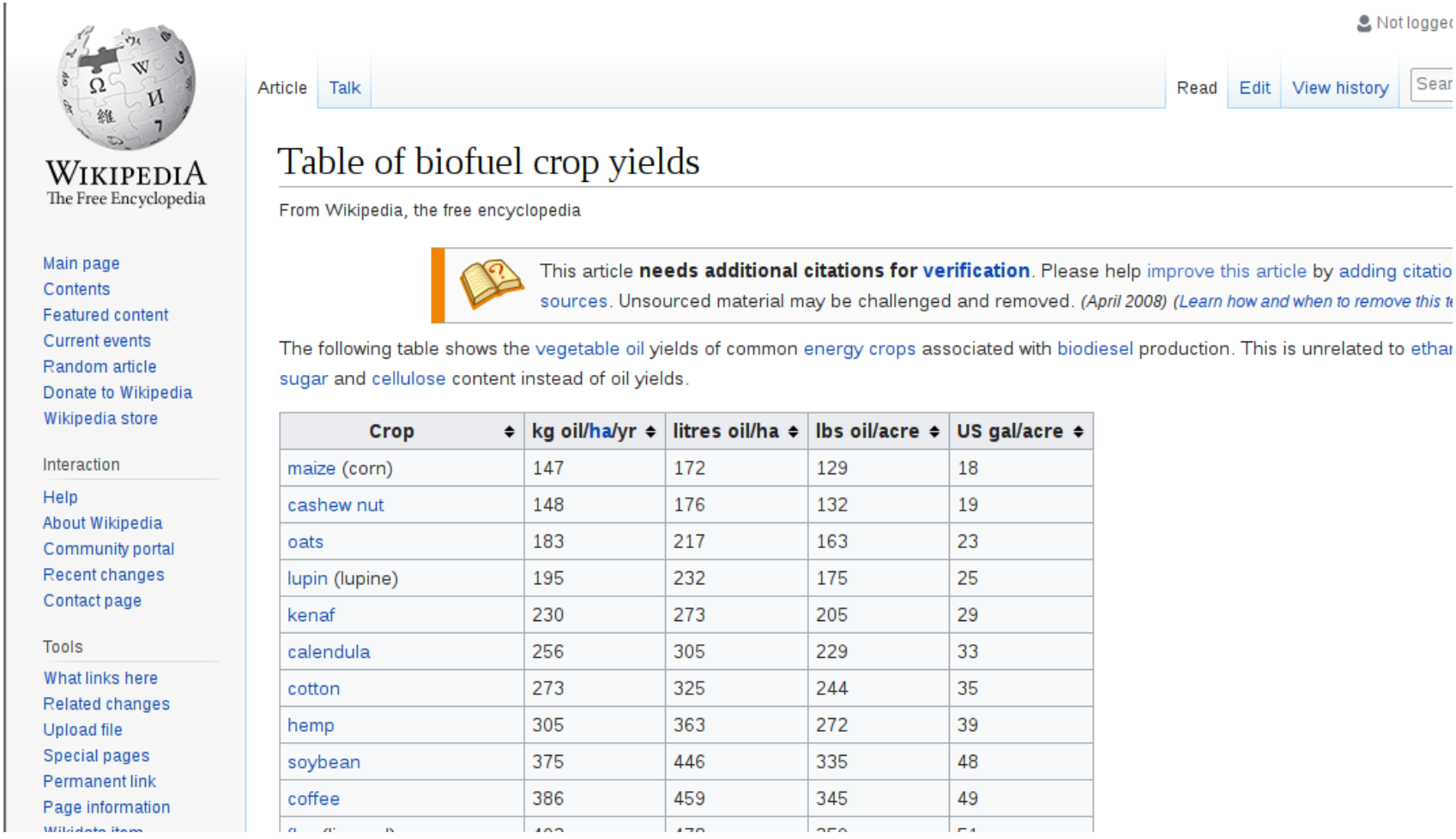

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Table of biofuel crop yields

From Wikipedia, the free encyclopedia

This article **needs additional citations for verification**. Please help improve this article by adding citatio sources. Unsourced material may be challenged and removed. *(April 2008) (Learn how and when to remove this te*

The following table shows the vegetable oil yields of common energy crops associated with biodiesel production. This is unrelated to ethan sugar and cellulose content instead of oil yields.

Crop	kg oil/ha/yr	litres oil/ha	lbs oil/acre	US gal/acre
maize (corn)	147	172	129	18
cashew nut	148	176	132	19
oats	183	217	163	23
lupin (lupine)	195	232	175	25
kenaf	230	273	205	29
calendula	256	305	229	33
cotton	273	325	244	35
hemp	305	363	272	39
soybean	375	446	335	48
coffee	386	459	345	49

Figure 1: https://en.wikipedia.org/wiki/Table_of_biofuel_crop_yields

read_html()

In [21]:
```
import pandas as pd
pd.read_html('https://en.wikipedia.org/wiki/Table_of_biofuel_crop_yields')[0]
```

Out[21]:

	0	1
0	NaN	This article needs additional citations for ve...

In [22]:
```
pd.read_html('https://en.wikipedia.org/wiki/Table_of_biofuel_crop_yields')[1]
```

Out[22]:

	0	1	2	3	4
0	Crop	kg oil/ha/yr	litres oil/ha	lbs oil/acre	US gal/acre
1	maize (corn)	147	172	129	18
2	cashew nut	148	176	132	19
3	oats	183	217	163	23
4	lupin (lupine)	195	232	175	25
5	kenaf	230	273	205	29
6	calendula	256	305	229	33
7	cotton	273	325	244	35

read_html() arguments

In [23]:
```
import pandas as pd
pd.read_html('https://en.wikipedia.org/wiki/Table_of_biofuel_crop_yields',
             match='Crop',
             header=0)[0]
```

Out[23]:

	Crop	kg oil/ha/yr	litres oil/ha	lbs oil/acre	US gal/acre
0	maize (corn)	147.0	172.0	129.0	18.0
1	cashew nut	148.0	176.0	132.0	19.0
2	oats	183.0	217.0	163.0	23.0
3	lupin (lupine)	195.0	232.0	175.0	25.0
4	kenaf	230.0	273.0	205.0	29.0
5	calendula	256.0	305.0	229.0	33.0
6	cotton	273.0	325.0	244.0	35.0
7	hemp	305.0	363.0	272.0	39.0
8	soybean	375.0	446.0	335.0	48.0
9	coffee	386.0	459.0	345.0	49.0
10	flax (linseed)	402.0	478.0	359.0	51.0

APIs

API Overview

- Application Programming Interfaces (APIs) are web-based resources that serve data directly
- Typically in `json`, `csv`, or `xml` format
- You can access them with `requests` in python or `curl`
- The parameters are typically provided in the URL with a query string (`?param1=value1&param2=value2`)

REST

REST is a standard style for organizing API resources. The philosophy is that:

- Client and server are "stateless", i.e. each request is independent and the server does not save state between requests
- Service is scalable and cacheable
- Typically use HTTP methods (`GET`, `DELETE`, `PUT`, etc.) meaningfully

Census API

- U.S. Census data available through API
- For example the 5-year ACS estimates
  - List of variables

  https://api.census.gov/data/2014/acs5/profile?get=DP02_0037PE,NAME&for=state:*
- Can simply `curl`

curl

```
$ curl "https://api.census.gov/data/2014/acs5/profile?get=N
    -o fertility.json
$ head fertility.json
[["DP02_0037PE","NAME","state"],
["41.7","Alabama","01"],
["34.2","Alaska","02"],
["39.7","Arizona","04"],
["37.7","Arkansas","05"],
["33.2","California","06"],
["28.3","Colorado","08"],
["33.7","Connecticut","09"],
["39.3","Delaware","10"],
["47.7","District of Columbia","11"],
...
```

python

```
>>> path = "https://api.census.gov/data/2014/acs5/profi
>>> j = requests.get(path).json()
>>> j
[[u'DP02_0037PE', u'NAME', u'state'],
 [u'41.7', u'Alabama', u'01'],
 [u'34.2', u'Alaska', u'02'],
 [u'39.7', u'Arizona', u'04'],
 [u'37.7', u'Arkansas', u'05'],
 [u'33.2', u'California', u'06'],
...
```

How can we put this data in a pandas DataFrame?

python

```
>>> path = "https://api.census.gov/data/2014/acs5/profi
>>> j = requests.get(path).json()
>>> j
[[u'DP02_0037PE', u'NAME', u'state'],
 [u'41.7', u'Alabama', u'01'],
 [u'34.2', u'Alaska', u'02'],
 [u'39.7', u'Arizona', u'04'],
 [u'37.7', u'Arkansas', u'05'],
 [u'33.2', u'California', u'06'],
...
```

How can we put this data in a pandas DataFrame?

```
>>> pd.DataFrame(j[1:], columns=j[0])
```