Webscraping I

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Introduction to HTML and Web Scraping

Roadmap:

- Intro to webscraping
- Intro to HTML
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- Do-pair-share

Webscraping

- **Webscraping** uses code to systematically extract content and data from websites
- Though websites vary a lot in how they're structured and where data is located, most are constructed using a common language: HTML
- Each website can be converted into its underlying HTML code and then parsed with Python

Webscraping

The steps of building a webscraper are:

0. *Manual*: inspect website's HTML to see how the info we want to extract is structured
1. *Code*: download and save HTML code associated with a URL
2. *Code*: parse through HTML code to extract information based on what we learned in Step 0 + refine
3. *Code*: organize and save extracted information

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3. *Code*: organize and save extracted information

So before we learn how to code a web scraper, we need to **understand how to read HTML code**

Intro to HTML

- **HTML**: Hypertext Markup Language
- Tells your web browser how to display the content of a web page

Intro to HTML

- **HTML**: Hypertext Markup Language
- Tells your web browser how to display the content of a web page
- Structure:

```
<name_of_tag attribute1 = 'value'> content <\name_of_tag>
```

1. **Tags**: keyword that defines what element is, such as text, paragraph, heading, link, etc.
2. **Attributes**: additional information about element
3. **Content**: text, images, or other media associated with that element

- HTML is structured hierarchically, so tags can be nested within tags

simple.txt example

File: simple.txt

```
<!DOCTYPE html>
<html>
<head>
<title>Welcome to my webpage</title>
</head>

<body>
<h1 id='first'>Today we start <em>coding!</em></h1>
<h2 class='myclass'>Hello world</h2>
<p style="color: green;">Hello world, but in green.</p>

<p><a href='https://en.wikipedia.org/wiki/Dog'>click for
dogs</a></p>
<p id = ‘second'> Goodbye!</p>


</body>
</html>
```

simple.txt example

File: simple.txt

opening tag

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<!DOCTYPE html>
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<p><a href='https://en.wikipedia.org/wiki/Dog'>click for
dogs</a></p>
<p id = ‘second'> Goodbye!</p>


</body>
</html>
```

closing tag

simple.txt example

File: simple.txt

opening tag

For the <html> tag, this is all content

closing tag

```
<!DOCTYPE html>
<html>
<head>
<title>Welcome to my webpage</title>
</head>

<body>
<h1 id='first'>Today we start <em>coding!</em></h1>
<h2 class='myclass'>Hello world</h2>
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dogs</a></p>
<p id = ‘second'> Goodbye!</p>


</body>
</html>
```

simple.txt example

File: simple.txt

Head: metadata

Body: browser content

```
<!DOCTYPE html>
<html>
<head>
<title>Welcome to my webpage</title>
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<body>
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<h2 class='myclass'>Hello world</h2>
<p style="color: green;">Hello world, but in green.</p>

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dogs</a></p>
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</body>
</html>
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simple.txt example

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dogs</a></p>
<p id = ‘second'> Goodbye!</p>


</body>
</html>
```

Head: metadata

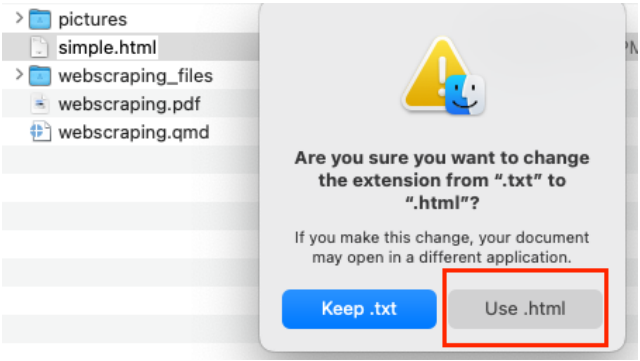
Relative to <head>, this is the content

Body: browser content

Relative to <body>, this is the content

simple.txt example

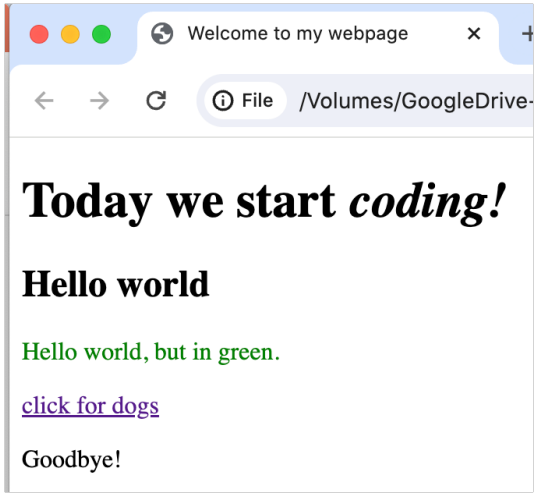
To see the HTML in action, rename the file extension from `.txt` to `.html`



Click "Use .html" when prompted

`simple.txt` example

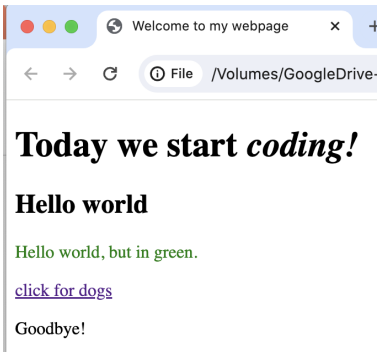
This should open as a web page in your default web browser



simple.txt example

File: simple.txt

<name_of_tag attribute='value'>Content<\name_of_tag>




```
<!DOCTYPE html>
<html>
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<body>
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simple.txt example

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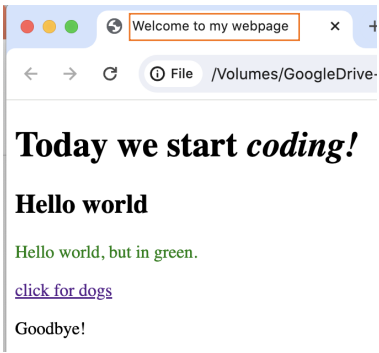


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simple.txt example

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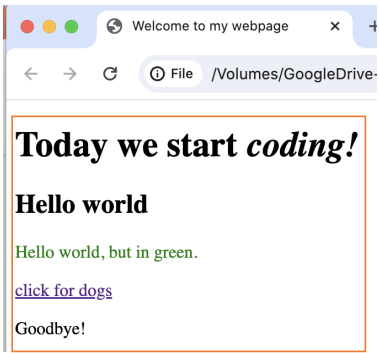


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<!DOCTYPE html>
<html>
<head>
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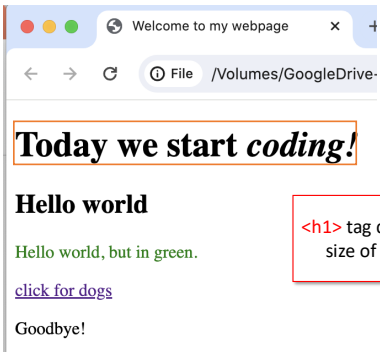

<h1> tag determines size of the text

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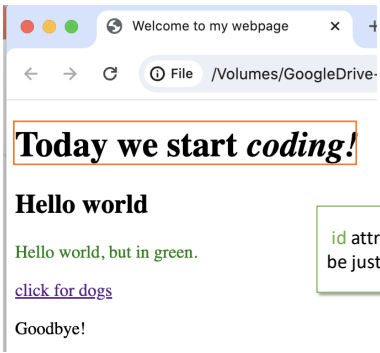


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<p><a href='https://en.wikipedia.org/wiki/Dog'>click for
dogs</a></p>
<p id = 'second'> Goodbye!</p>

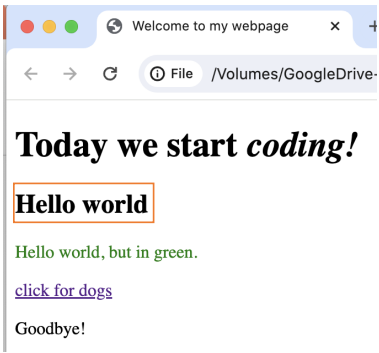

</body>
</html>
```

id attribute: should be just *one* per page

simple.txt example

File: simple.txt

<name_of_tag attribute='value'>Content<\name_of_tag>




```
<!DOCTYPE html>
<html>
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<title>Welcome to my webpage</title>
</head>

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simple.txt example

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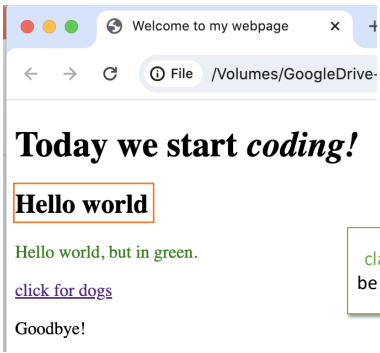


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<html>
<head>
<title>Welcome to my webpage</title>
</head>

<body>
<h1 id='first'>Today we start <em>coding!</em></h1>
<h2 class='myclass'>Hello world</h2>
<p style="color: green;">Hello world, but in green.</p>

                          f='https://en.wikipedia.org/wiki/Dog'>click for
                          /p>
                          second'> Goodbye!</p>

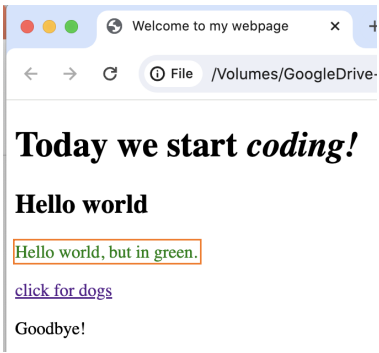

</body>
</html>
```

class attribute: can be *multiple* per page

simple.txt example

File: simple.txt

<name_of_tag attribute='value'>Content<\name_of_tag>

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```

simple.txt example

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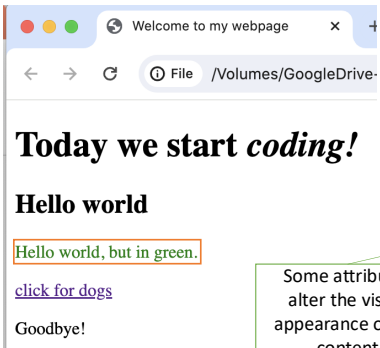


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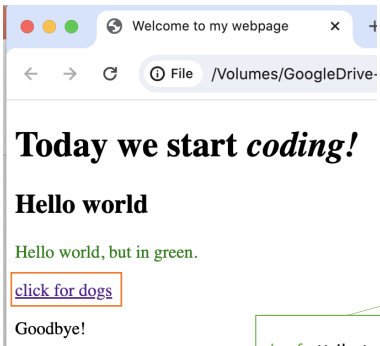
</body>
</html>
```

Some attributes alter the visual appearance of the content

simple.txt example

File: simple.txt

<name_of_tag attribute='value'>Content<\name_of_tag>

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<!DOCTYPE html>
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<p><a href='https://en.wikipedia.org/wiki/Dog'>click for
dogs</a></p>
<p id = 'second'> Goodbye!</p>

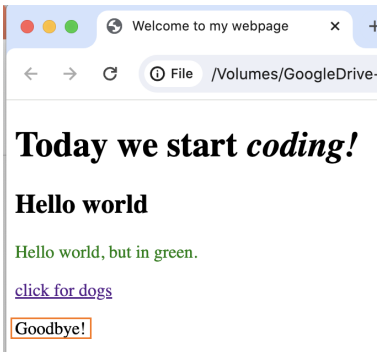

</body>
</html>
```

href attribute turns it into a hyperlink

simple.txt example

File: simple.txt

<name_of_tag attribute='value'>Content<\name_of_tag>

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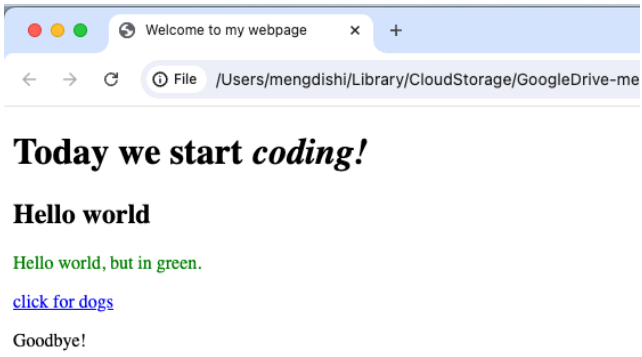
```

`simple.txt` example

If we open the `simple.html` file and right-click + "Inspect"...



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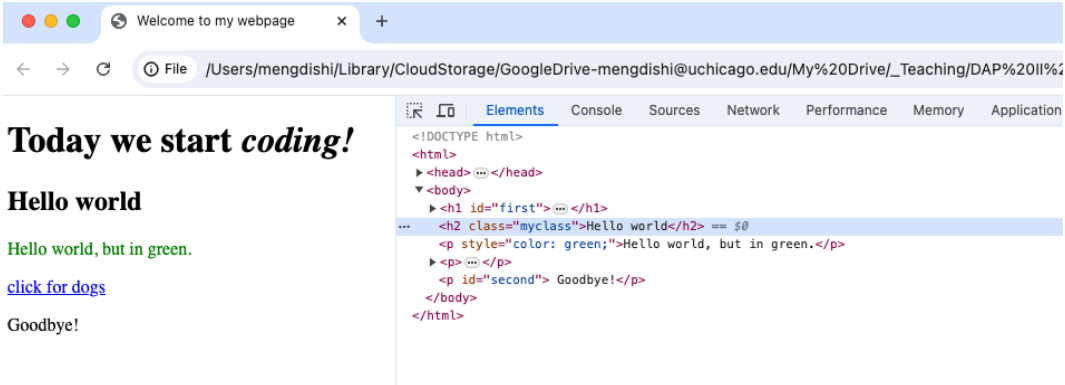
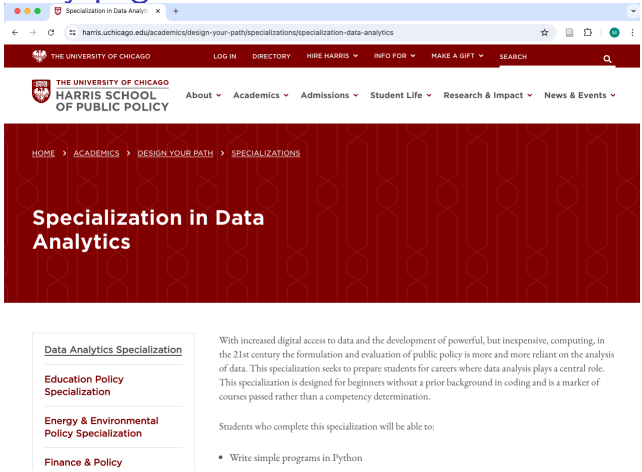
If we open the simple.html file and right-click + "Inspect"...



simple.txt example

Once we expand this, we get back simple.txt!

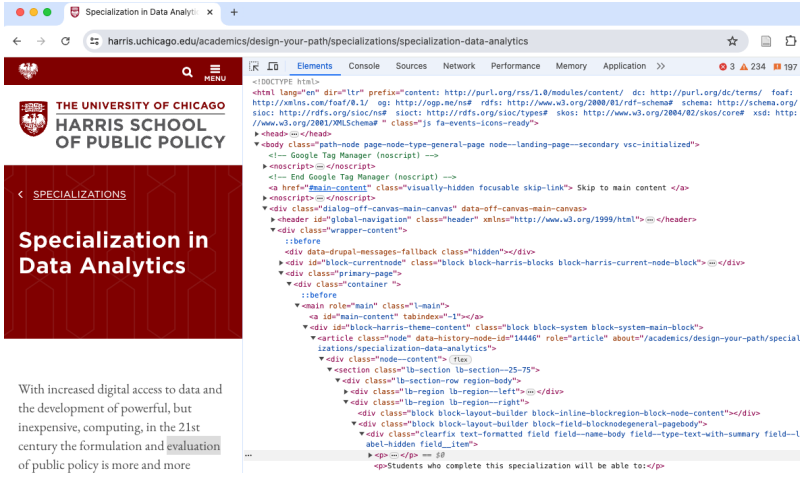
We can "inspect" any page on the web for its HTML



Link: Harris Specialization in Data Analytics (also available as `harris_specialization.html`)

Note: the Inspect console will automatically focus on wherever you right click

We can “inspect” any page on the web for its HTML



Link: Harris Specialization in Data Analytics (also available as `harris_specialization.html`)

Some Common HTML Tags

HTML **tags** always have the structure:

```
<open> ... </close>
```

Some Common HTML Tags

HTML **tags** always have the structure:

```
<open> ... </close>
```

- Headings: `<h1> ... </h1>`, `<h6> ... </h6>`
- Bold, italic: `<b> ... </b>`, `<i> ... </i>`
- Paragraph: `<p> ... </p>`
- Hyperlinks `<a> ... </a>`
- Images: `<img> ... </img>`

Some Common HTML Attributes

HTML **attributes** always have the following structure:

```
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```

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HTML **attributes** always have the following structure:

```
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```

- ID: `<TAG id = 'idvalue'> ... </TAG>`
- Class: `<TAG class = 'classname'> ... </TAG>`
  - Website elements often have unique IDs and classes, which are used to categorize types of content
  - We don't have to know when to use an id vs. class attribute – we just have to khow how to scrape them

Some Common HTML Attributes

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- ID: `<TAG id = 'idvalue'> ... </TAG>`
- Class: `<TAG class = 'classname'> ... </TAG>`
  - Website elements often have unique IDs and classes, which are used to categorize types of content
  - We don't have to know when to use an id vs. class attribute – we just have to khow how to scrape them
- Style: `<TAG style = 'color:red;'> ... </TAG>`

Some Common HTML Tags and Attributes

- Some tags and attributes are **commonly used together**
- Image + source:

```
<img src = 'image.png'>... </img>
```

`img` is the tag while `src` is the attribute (source path for the image file)

Some Common HTML Tags and Attributes

- Some tags and attributes are **commonly used together**
- Image + source:

```
<img src = 'image.png'>... </img>
```

`img` is the tag while `src` is the attribute (source path for the image file)

- Links:

```
<a href = 'www.google.com'> ... </a>
```

Some Common HTML Tags and Attributes

- Some tags and attributes are **commonly used together**
- Image + source:

```
<img src = 'image.png'>... </img>
```

`img` is the tag while `src` is the attribute (source path for the image file)

- Links:

```
<a href = 'www.google.com'> ... </a>
```

- Attributes can also be combined:

```
<img src = 'image.png' width = 500 height = 600> ... </img>
```

- This combines 1 tag (`img`) with 3 attributes (`src`, `width`, and `height`)

Do-pair-share

1. Inspect the HTML code on the Harris Specialization in Data Analytics (link) page
2. What is the tag associated with the text that starts with: "Students in the Master of Science in Computational Analysis and Public Policy..."?
3. What are examples of other content associated with the same tag?
4. Look at attributes for tags with links. Some of them do not appear to be "full" links. Can you explain why?

HTML to web scraping

- Webscraping steps:
  0. ~~*Manual*: inspect website's HTML to see how the info we want to extract is structured~~
  1. *Code*: download and save HTML code associated with a URL
  2. *Code*: parse through HTML code to extract information based on what we learned in Step 0 + refine
  3. *Code*: organize and save extracted information
- Now we can use code to do Steps 1-3!

Summary

- All websites are built in HTML – to web scrape, we need to know how to read it in order
- HTML has 3 elements: tags, attributes, and content
- "Inspect" a website to view its HTML

Using `BeautifulSoup` to Parse HTML

Roadmap

- Introduce `BeautifulSoup` library
- Example using `simple.txt`
- Demo how to extract URLs (used in webscraping later)

BeautifulSoup

- `BeautifulSoup` library: takes in HTML code and parses it in a structured way
- *Aside: the name Beautiful Soup is a reference to poorly-structured HTML code, which is called "tag soup"*
- In Terminal: `pip install bs4`, `pip install requests`, and `pip install lxml`

```
import pandas as pd
import requests
from bs4 import BeautifulSoup
```

BeautifulSoup

- `requests` allows you to open webpages. Usually use with URLs but in this case, we'll use it with a file on disk

```
with open(r'files/simple.html', 'r') as page:
    text = page.read()
```

- The `soup` object is the website content, parsed into an easy-to-use reference
- `lxml` is an external resource used by browsers to parse HTML

```
soup = BeautifulSoup(text, 'lxml')
```

BeautifulSoup

```
print(text)
```

```
<!DOCTYPE html>
<html>
<head>
<title>Welcome to my webpage</title>
</head>

<body>
<h1 id='first'>Today we start <em>coding!</em></h1>
<h2 class='myclass'>Hello world</h2>
<p style="color: green;">Hello world, but in green.</p>

<p><a href='https://en.wikipedia.org/wiki/Dog'>click for dogs</a></p>
<p id = 'second'> Goodbye!</p>
```

BeautifulSoup

```
print(soup)
```

```
<!DOCTYPE html>
<html>
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</head>
<body>
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<p id="second"> Goodbye!</p>
</body>
</html>
```

Searching a `soup` object

- At first glance, `soup` object is very similar to the HTML code itself
- But it has "parsed" the code, making it **searchable** by tag and attribute

Searching a soup object

- `.find_all()`: searches for and returns list of *all* elements with a given tag

```
soup.find_all('p')
```

```
[<p style="color: green;">Hello world, but in green.</p>,
 <p><a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a></p>,
 <p id="second"> Goodbye!</p>]
```

Searching a soup object

- `.find_all()`: searches for and returns list of *all* elements with a given tag

```
soup.find_all('p')
```

```
[<p style="color: green;">Hello world, but in green.</p>,
 <p><a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a></p>,
 <p id="second"> Goodbye!</p>]
```

- Individual elements of the `.find_all()` output can be accessed via subscript

```
soup.find_all('p')[2]
```

```
<p id="second"> Goodbye!</p>
```

Searching a soup object

- `.find_all()`: searches for and returns list of *all* elements with a given tag

```
soup.find_all('p')
```

```
[<p style="color: green;">Hello world, but in green.</p>,
 <p><a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a></p>,
 <p id="second"> Goodbye!</p>]
```

- Individual elements of the `.find_all()` output can be accessed via subscript

```
soup.find_all('p')[2]
```

```
<p id="second"> Goodbye!</p>
```

- A similar method: `.find()` searches for the *first* instance of an open/close tag

```
soup.find('p')
```

```
<p style="color: green;">Hello world, but in green.</p>
```

Searching a soup object

- We can use **`lambda` functions** with `.find_all()` to search for more specific things (refresher in mini-lesson this week)

```
soup.find_all('p', id = lambda h: h!=None and 'second' in h)
```

- Within all elements with tag `p`
- This `lambda` functions searches for elements:
  1. Where the `id` attribute is non-missing: `h != None`
  2. And the `id` tag includes the term `'second'`

Searching a soup object

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- Within all elements with tag `p`
- This `lambda` functions searches for elements:
  1. Where the `id` attribute is non-missing: `h != None`
  2. And the `id` tag includes the term `'second'`

Results:

```
[<p id="second"> Goodbye!</p>]
```

Searching a soup object

- The output of `.find_all()` is always a *list* of objects, even if there's only one element in the list

```
soup.find_all('a')
```

```
[<a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a>]
```

- The brackets that indicate that it's a list

Searching a soup object

- The output of `.find_all()` is always a *list* of objects, even if there's only one element in the list

```
soup.find_all('a')
```

```
[<a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a>]
```

- The brackets that indicate that it's a list
- In contrast: `.find()` outputs just the object

```
soup.find('a')
```

```
<a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a>
```

tag object and methods

- The output of `.find_all()` is a **tag** object

```
tag = soup.find_all('h1')[0]
print(type(tag))
```

```
<class 'bs4.element.Tag'>
```

tag object and methods

- The output of `.find_all()` is a **tag** object

```
tag = soup.find_all('h1')[0]
print(type(tag))
```

```
<class 'bs4.element.Tag'>
```

- The tag object is aware of its tag and attributes

```
tag.name
```

```
'h1'
```

```
tag.attrs
```

```
{'id': 'first'}
```

tag object and methods

- Most usefully for web scraping: it is aware of its contents.
- `tag.contents` returns a list of content (including nested tags)

```
tag.contents
```

```
['Today we start ', <em>coding!</em>]
```

```
print(type(tag.contents[0]))
print(type(tag.contents[1]))
```

```
<class 'bs4.element.NavigableString'>
<class 'bs4.element.Tag'>
```

tag object and methods

- Most usefully for web scraping: it is aware of its contents.
- `tag.contents` returns a list of content (including nested tags)

```
tag.contents
```

```
['Today we start ', <em>coding!</em>]
```

```
print(type(tag.contents[0]))
print(type(tag.contents[1]))
```

```
<class 'bs4.element.NavigableString'>
<class 'bs4.element.Tag'>
```

- While `tag.text` returns just the string inside

```
tag.text
```

```
'Today we start coding!'
```

tag objects can be nested

- We can apply `BeautifulSoup` methods to `tag` objects as well
- Example: this "p" tag object has an "a" tag nested within it

```
p_tag = soup.find_all('p')[1]
p_tag
```

```
<p><a href="https://en.wikipedia.org/wiki/Dog">click for dogs</a></p>
```

- If we wanted to get to the text inside the a tag, we have to apply `.find()` *again* to `p_tag`

```
a_tag = p_tag.find('a')
a_tag.text
```

```
'click for dogs'
```

tag objects methods can be used iteratively

- A more direct way of getting to the same text:

```
soup.find_all('p')[1].find('a').text
```

```
'click for dogs'
```

Extracting attribute value of `tag` object

- Say instead of the text, we were interested in the associated *URL*, which is contained in the attribute, `href`

```
print(a_tag.attrs)
```

```
{'href': 'https://en.wikipedia.org/wiki/Dog'}
```

- Output of `.attrs` is a *dictionary* with key `href`

Extracting attribute value of `tag` object

- Say instead of the text, we were interested in the associated *URL*, which is contained in the attribute, `href`

```
print(a_tag.attrs)
```

```
{'href': 'https://en.wikipedia.org/wiki/Dog'}
```

- Output of `.attrs` is a *dictionary* with key `href`
- So to access the URL, we use the `.get()` method

```
print(a_tag.get('href'))
```

```
https://en.wikipedia.org/wiki/Dog
```

- This forms the basis of *web crawling*, which we will next class

Summary

- Read in HTML code with `open()` from `requests`
- Then use `BeautifulSoup` parses HTML code into nested "tag" objcts
- Key methods from `BeautifulSoup`:
  - `.find_all()`: return list of all tags
  - `.attrs`, `.contents`, `text` retrieve contents or attributes
- Key for web crawling: use `.get('href')` to get URLs associated with "`a`" tags

Example: Applying `BeautifulSoup` to a Website

Roadmap

- Applying BeautifulSoup methods to a real website
- The tricky part is specifying the combination of tags and attributes we want

Example with Harris Website

- Now let's try pulling an actual website's HTML code and navigating it with `BeautifulSoup`
- First, make a get request from Harris Specialization in Data Analytics page

```
url =
 ↪  'https://harris.uchicago.edu/academics/design-your-path/specializations
response = requests.get(url)
```

Example with Harris Website

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- First, make a get request from Harris Specialization in Data Analytics page

```
url =
 ↪  'https://harris.uchicago.edu/academics/design-your-path/specializations
response = requests.get(url)
```

- Convert into a soup object

```
soup = BeautifulSoup(response.text, 'lxml')
soup.text[0:50]
```

```
'\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\n\nSpecialization in Data Analyti'
```

- soup object is the text of the HTML code for this page

Example with Harris Website

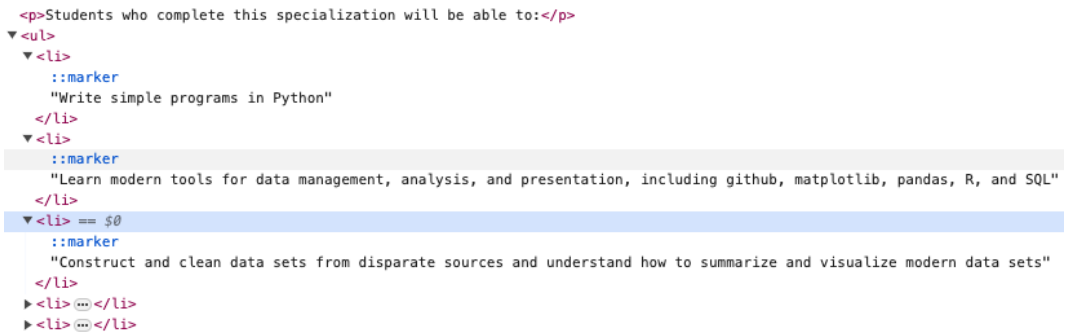
Let's say we're interested in scraping all the bulleted items like the following:

- Write simple programs in Python
- Learn modern tools for data management, analysis, and presentation, including github, matplotlib, pandas, R, and SQL
- Construct and clean data sets from disparate sources and understand how to summarize and visualize modern data sets
- Use modern, computationally intensive methods to analyze data for the evaluation of policy
- The specialization's menu of electives is designed to allow students to increase their exposure to analytical methods used in the evaluation of public policy.

- *Right click + Inspect...*

Example with Harris Website

- Upon manual inspection of the HTML code, they appear to be under the `<li>` tag



Example with Harris Website

- Use `.find_all()` and then sanity-check the output

```
tag = soup.find_all('li')
len(tag)
```

```
262
```

Example with Harris Website

- Use `.find_all()` and then sanity-check the output

```
tag = soup.find_all('li')
len(tag)
```

262

- `.find_all()` has found 266 `li` tags in the HTML code
- That is much more than the total number of bullet points we're looking for!

Example with Harris Website

- To see what's going on, we can inspect the first few elements in the `tag` object

Example with Harris Website

- To see what's going on, we can inspect the first few elements in the `tag` object

```
tag[0:2]
```

```
[<li class="utility-navigation__item">
 <a class="utility-navigation__item-link" data-drupal-link-system-path="us
 </li>,
 <li class="utility-navigation__item">
 <a class="utility-navigation__item-link" data-drupal-link-system-path="di
 </li>]
```

Example with Harris Website

- To see what's going on, we can inspect the first few elements in the `tag` object

```
tag[0:2]
```

```
[<li class="utility-navigation__item">
 <a class="utility-navigation__item-link" data-drupal-link-system-path="us
 </li>,
 <li class="utility-navigation__item">
 <a class="utility-navigation__item-link" data-drupal-link-system-path="di
 </li>]
```

- To decide where to go next, have to think about what differentiates the elements we want vs. the elements we're getting
- The `tag` object is picking up elements that have another tag nested in them
- But from earlier, we know the bullet points we're interested in don't have anything nested in them

Example with Harris Website

- Recall that if a tag has something nested in it, we can apply `.find_all()` to it again
- So we can refine our search to exclude any elements that have another tag nested in them

```
li_nochildren = soup.find_all(lambda t: t.name == 'li' and not
↪  t.find_all())
```

- `lambda` function looks for `li` tags that have **nothing nested in them**
- *Aside: since `t.contents` returns a list, we can't use `t.contents == None`

Example with Harris Website

- Recall that if a tag has something nested in it, we can apply `.find_all()` to it again
- So we can refine our search to exclude any elements that have another tag nested in them

```
li_nochildren = soup.find_all(lambda t: t.name == 'li' and not
↪  t.find_all())
```

- `lambda` function looks for `li` tags that have **nothing nested in them**
- *Aside: since `t.contents` returns a list, we can't use `t.contents == None`
- Sanity-check the length: this seems to have eliminated many of the `li` tags that we didn't want

```
len(li_nochildren)
```

15

Example with Harris Website

- We can then extract the content from this tag object into a list using `.contents`

```
li_nochildren_content = [li.contents for li in li_nochildren]
```

Example with Harris Website

- Inspecting the beginning of the list ...

```
for item in li_nochildren_content[0:4]:
    print(item)
```

```
['\n                    Specialization in Data Analytics\n              ']
['Write simple programs in Python']
['Learn modern tools for data management, analysis, and presentation, inclu
['Construct and clean data sets from disparate sources and understand how
```

Example with Harris Website

- Inspecting the beginning of the list ...

```
for item in li_nochildren_content[0:4]:
    print(item)
```

```
['\n                    Specialization in Data Analytics\n                ']
['Write simple programs in Python']
['Learn modern tools for data management, analysis, and presentation, inclu
['Construct and clean data sets from disparate sources and understand how
```

- and the end...

```
for item in li_nochildren_content[-4:-1]:
    print(item)
```

```
['PPHA 42000 Applied Econometrics I\xa0']
['PPHA 42100 Applied Econometrics II\xa0']
['PPHA 60000 Policy Labs\xa0(with permission of the Specialization Directo
```

Example with Harris Website

- Do some final cleanup to remove the first element, which is not a bullet point

```
li_nochildren_content = li_nochildren_content[1:]
for item in li_nochildren_content[0:5]:
    print(item)
```

```
['Write simple programs in Python']
['Learn modern tools for data management, analysis, and presentation, inclu
['Construct and clean data sets from disparate sources and understand how
['Use modern, computationally intensive methods to analyze data for the eva
["The specialization's menu of electives is designed to allow students to
```

Example with Harris Website

Final webscraping code:

```
# 1. Extracts and saves HTML code as a parseable object
url =
 ↪  'https://harris.uchicago.edu/academics/design-your-path/specializations/specia
response = requests.get(url)
soup = BeautifulSoup(response.text, 'lxml')

# 2. Specifies tags and attributes we want to collect
li_nochildren = soup.find_all(lambda t: t.name == 'li' and not
 ↪  t.find_all())

# 3. "Scrapes" elements from HTML code based on step 2
li_nochildren_content = [li.contents for li in li_nochildren][1:]

# 4. Final cleanup
li_nochildren_content = li_nochildren_content[1:]
```

Summary: generalizing from this example

- Step 1 of a scraper (requesting and extracting HTML) will almost always be the same
- The "hard" part of writing a web scraper is step 2: identifying the tags and attributes we want to collect
  - Steps 2 and 3 have to be uniquely tailored to each specific task and website
  - Ironing out 2 and 3 may require several iterations of going back and forth between your code and manually parsing