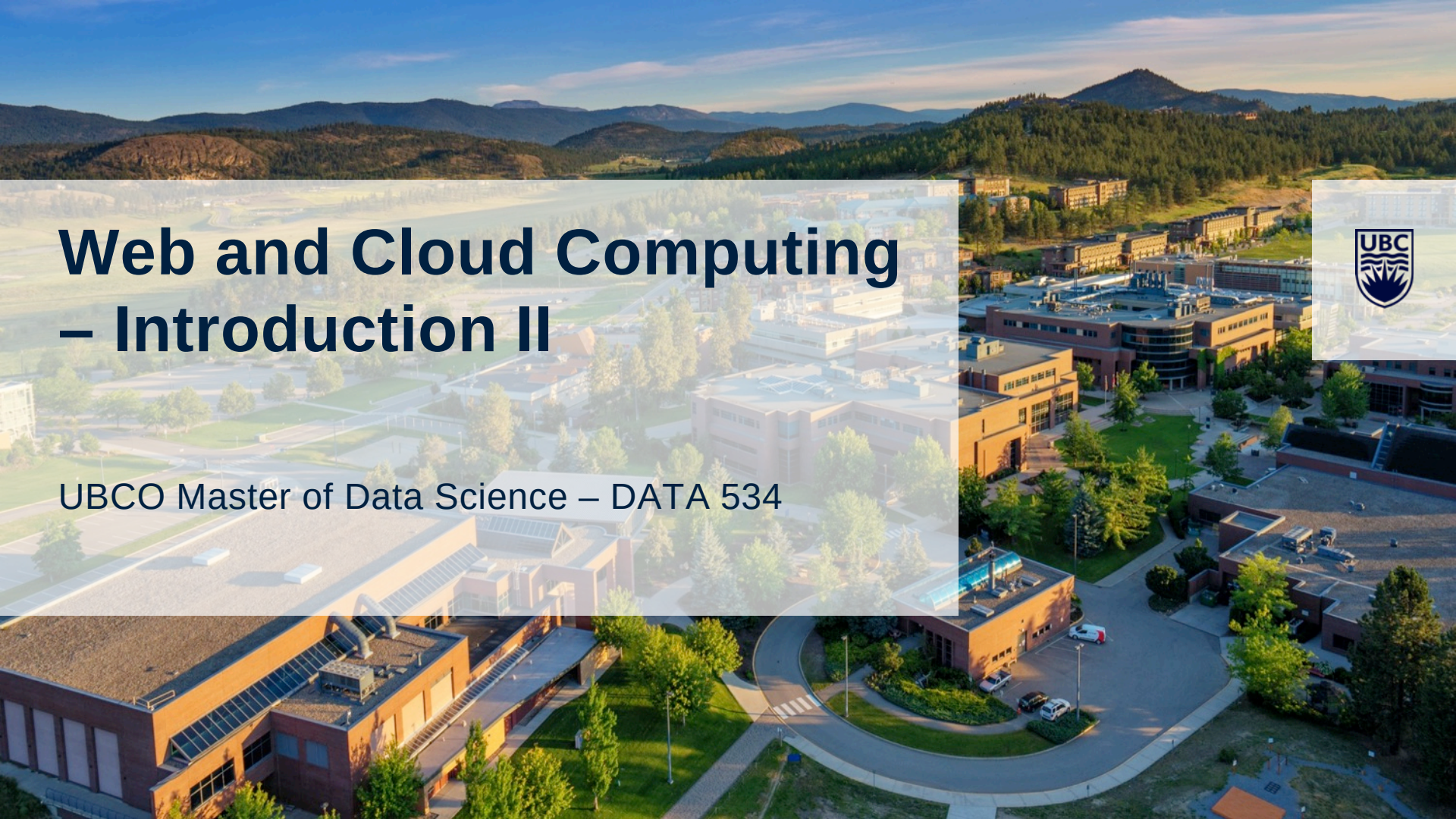


Web and Cloud Computing – Introduction II

UBCO Master of Data Science – DATA 534

Lecture Learning Goals

- Identify the HTML tags that are used to structure data on a web page and describe how they do this.
- Explain the difference between static and dynamic web data and how these concepts relate to the the first three learning goals and how they impact web scraping.
- Explain what a web scraper is, why it is useful and how it works.
- Be able to use a web-scraping tool to collect static and dynamic data from web pages.

Internet and Web Basics

Difference between internet and web

- *the Internet* is infrastructure while *the Web* is served on top of that infrastructure.
- Use different protocols:
  - Internet: TCP, UDP, etc.
  - Web: HTTP

TCP/UDP defines how to establish and maintain a network connection through which data is then exchanged.

HTTP is a request-response protocol that allows users to communicate data on the WWW and transfer hypertext.

Internet and Web Basics

A typical HTTP requests contains:

- HTTP version type
- URL
- HTTP method
  - GET, POST
- HTTP requests headers
- HTTP body (optional)

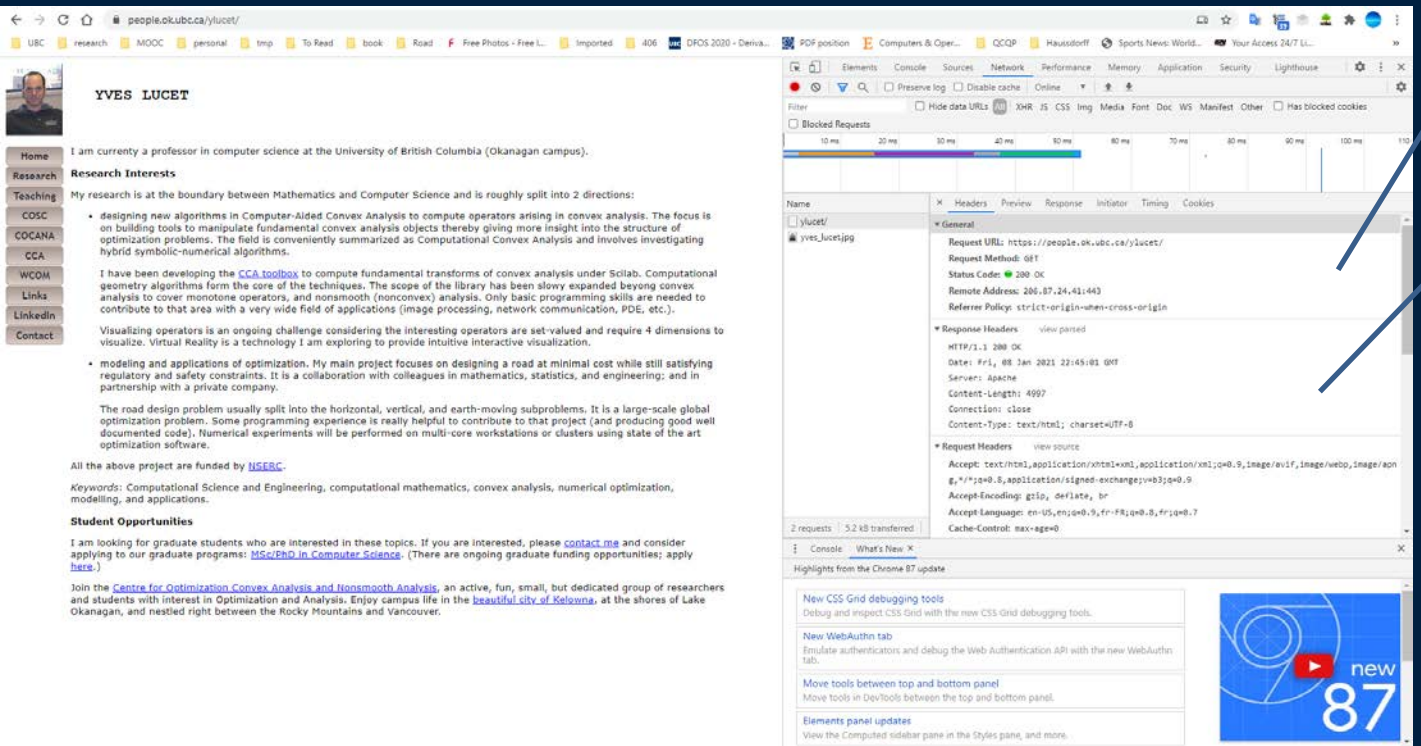
URLs

- Protocol
- Domain name (host)
- Path
- Parameter values

https://courses.students.ubc.ca/cs/courseschedule?pname=subjarea&dept=DATA

Example

Point Chrome to https://people.ok.ubc.ca/ylucet/ then right click and choose Inspect



HTTP request from Chrome
GET content of webpage

Server response
This is an Apache web server

HTTP headers

General

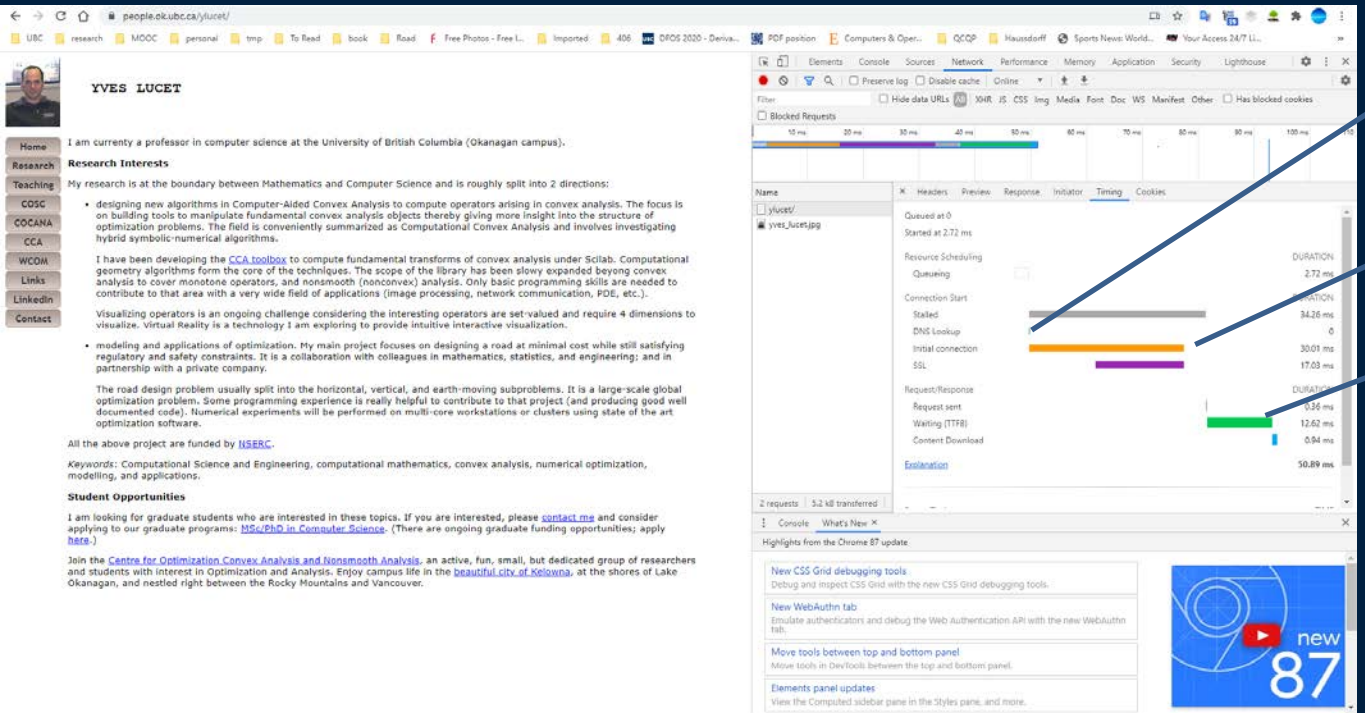
- **Request URL:** https://cmps-people.ok.ubc.ca/ylucet/
- **Request Method:** GET
- **Status Code:** 200 OK
- **Remote Address:** 206.87.25.212:443
- **Referrer Policy:** strict-origin-when-cross-origin

Response Headers View source

- **Connection:** Keep-Alive
- **Content-Type:** text/html; charset=UTF-8
- **Date:** Fri, 07 Jan 2022 18:40:10 GMT
- **Keep-Alive:** timeout=5, max=100
- **Server:** Apache/2.4.37 (Red Hat Enterprise Linux) OpenSSL/1.1.1k
- **Strict-Transport-Security:** max-age=63072000; includeSubDomains; preload
- **Transfer-Encoding:** chunked
- **X-Content-Type-Options:**
- nosniff
- **X-Powered-By:**
- PHP/7.4.19

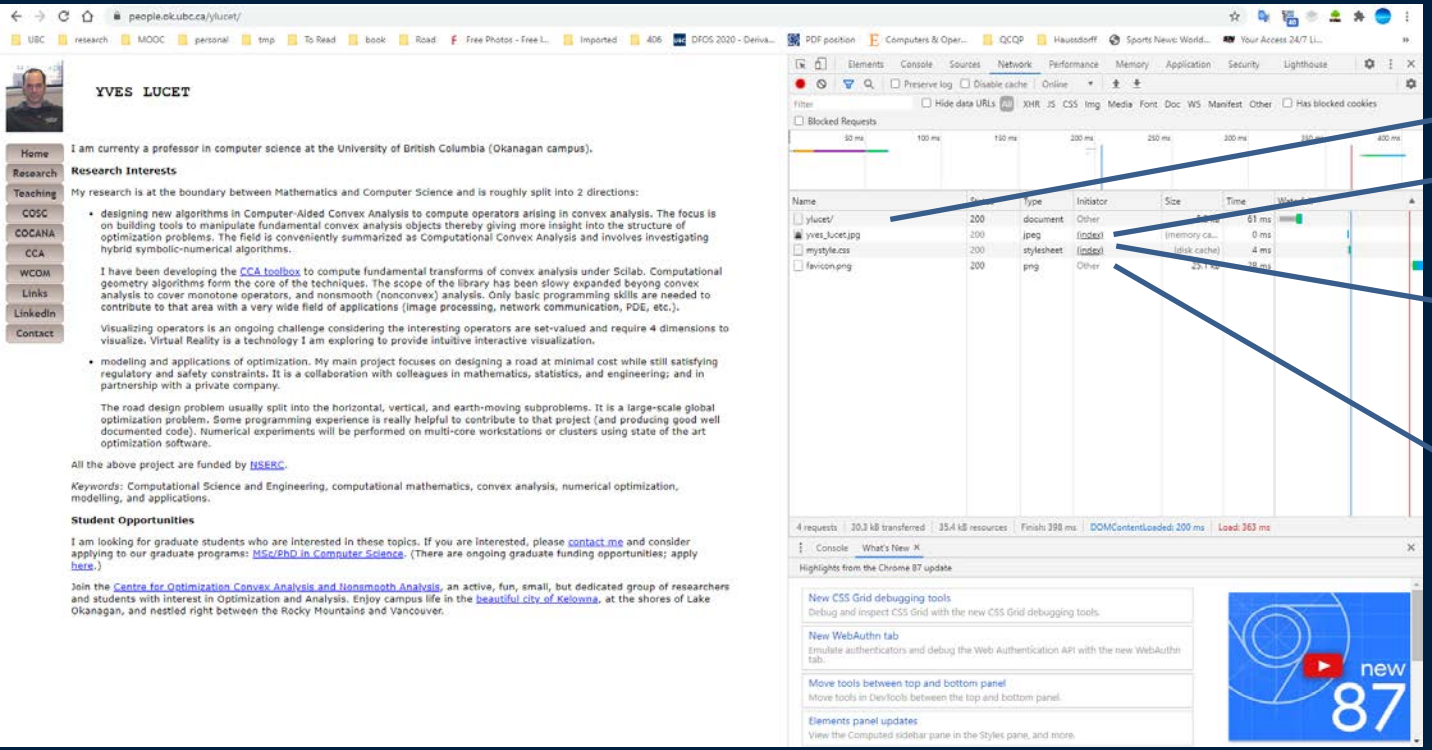
Example

Performance



Example

Performance

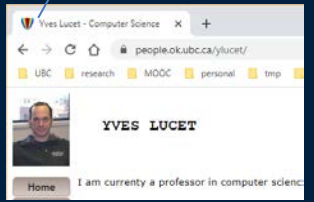


If no file is indicated, default to index.html (or index.php)

Index.php requires image

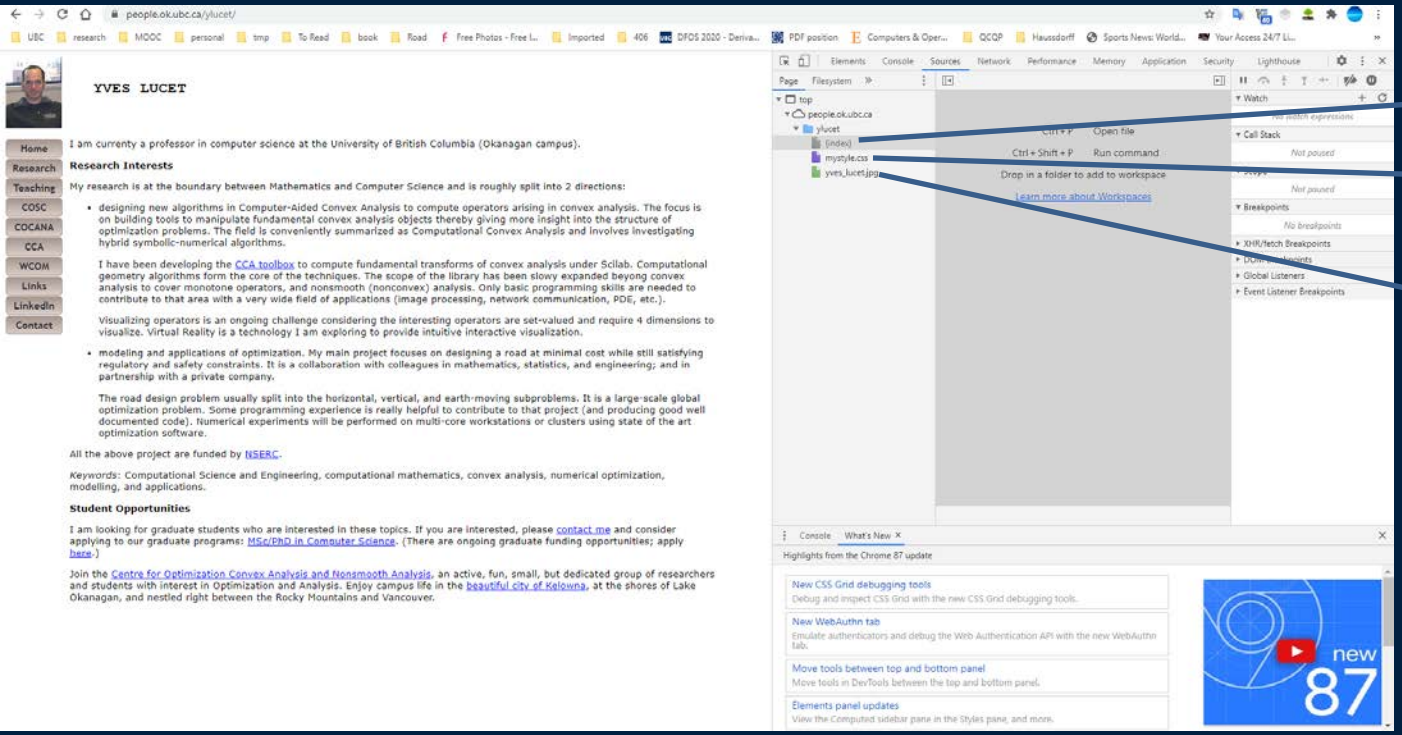
Index.php also requires a css stylesheet

Browser requests the icon from the website to display on the tab



Example

Files included



Default is index.html

CSS file

Image file

HTML the Language of Web Pages

```
<!DOCTYPE html>
<html lang="en-US">
  <head>
  </head>
  <body>
  </body>
</html>
```

XML syntax

- hierarchical collection of elements
- element consists of start tag, content and end tag, and attributes
  - tags have names and are delimited with “<“ and “>”; end tag with “</“
  - attributes added inside of
- HTML defines an XML namespace and schema
  - specific names that can be used as tags, their meaning and their format

HTML document

- consists of a single HTML element with children for head and body
- and a doctype declaration

HTML Head

```
<head>
  <meta http-equiv="Content-Type" content="text/html; charset=UTF-8"/>
  <title>UBC Student Services - Courses</title>
  <!-- Stylesheets -->
  <link href="/static/ubcclf/7.0.2/css/ubc-clf-full.min.css" rel="stylesheet">
  <script src="/static/shared/scripts/jquery-1.8.1.min.js"></script>
</head>
```

The head contains meta information for document

- document title
- names of other files that are part of the document (e.g., css, js, etc)
- other meta information such as author and search engine guidance

HTML Body

```
<body>
  <div class="collapse expand" id="ubc7-global-menu">
    ...
  </div>
  <table class="sortable table table-striped" id="mainTable">
    ...
  </table>
</body>
```

Body contains a list of elements

- This is the webpage
- Each element has children
- Forms a tree

Body elements

- Structure the page, assign classes, contain text, allow interaction

Document Object Model (DOM)

HTML

- a text based description of a tree of *objects*

Object

- a collection of named property values and operations

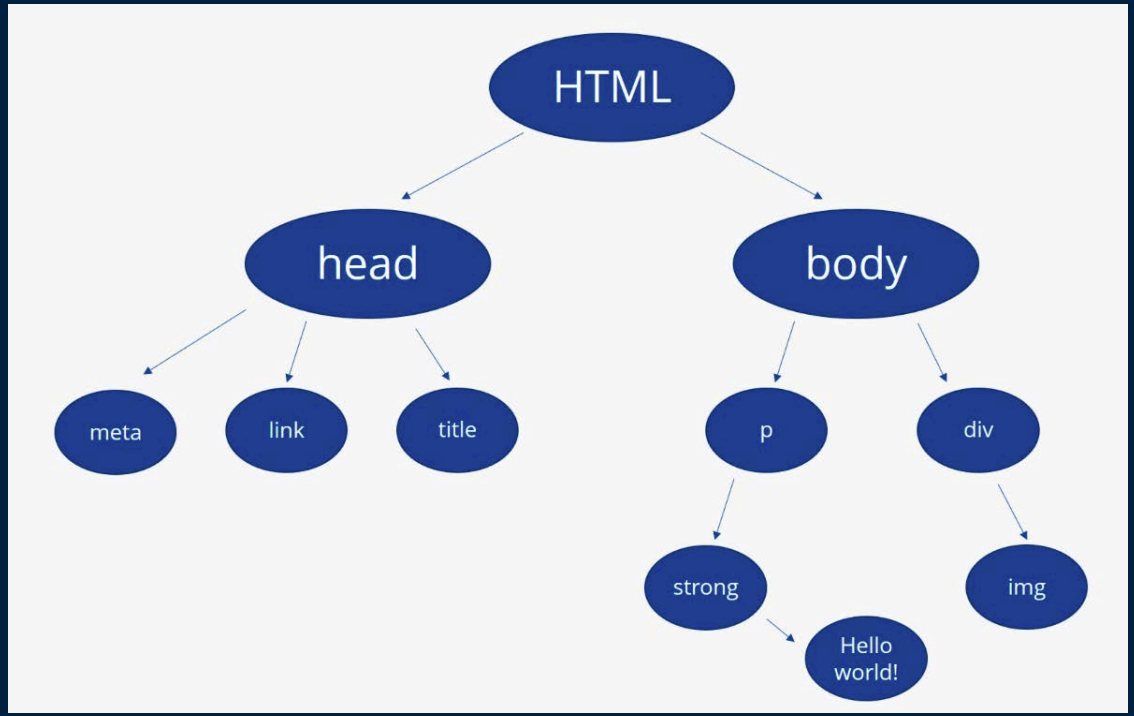
DOM

- specification objects that correspond to HTML elements

DOM tree

- a tree of objects that make up a web document (a.k.a., page)

DOM Tree



Basic Structure

- groups blocks of other elements
- typically to assign them a common class or common style (css)

<p>
- groups blocks of text

- groups in-line runs of elements or text

<table>
- row / column list of data

, <ol>, <dl>
- linear list of data either unordered or ordered … elements are <li> <dt> <dd>

<form>
- group of input-widget elements that allows user to enter data and send it back to the server

Tables

```
<table class="sortable table table-striped" id="mainTable">
  <thead>
    <tr>
      <th>Course</th><th>Title</th>
    </tr>
  </thead>
  <tbody>
    <tr class=&#39;section1&#39;>
      <td>DSCI 511</td><td>Programming for Data Science</td>
    </tr>
  </tbody>
</table>
```

<thead>, <tfoot>, <tbody>

- header, footer and body of the table

<tr>

- table row

<th>, <td>

- a column of either the header or body/foot.

User Interaction with Hyperlinks

```
<a href="/cs/main;jsessionid=MMzbPz-yJYAt7il-6Vh-ntQF?
pname=subjarea&amp;tname=subjareas&amp;req=3&amp;dept=DSCI&amp;course=511">DSCI 511</a>
```

Hyper link text

- displays “Hyper link text”
- if users clicks their mouse on this text, then the browser goes to link

link can be

- different position on current page
- URL for which the browser will issue a new HTML GET request
- javascript code (e.g., procedure call) to execute

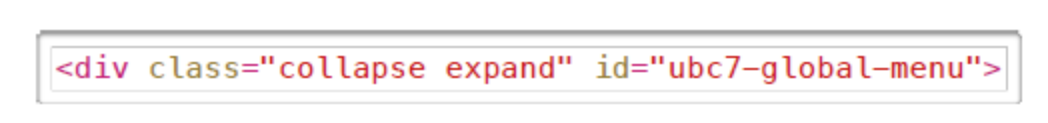
User Interaction with Forms

```
<form class="form-search" method="get" action="http://www.ubc.ca/search/refine/" role="search">
  <input type="search" name="q" placeholder="Search Course Schedule" class="input-xlarge search-query">
  <button type="submit" class="btn">Search</button>
</form>
```

Forms group inputs and related elements

- an input allows user to enter text, click button, etc
- each input has a field name
- types of inputs include: <input>, <select>, <button>

Naming Elements



tag name
- html element's name
- div

id
- unique id assigned with id attribute
- #ubc7-global-menu

class
- list of class names assigned with class attribute
- .collapse or .expand or .collapse.expand

pseudo names
- ::after, ::text, :nth-child(n), :not(selector), …

CSS Element Selectors

selector

- one selector or several concatenated together to be more selective; * selects all
- div or div.collapse

alternative

- separate with commas to select all that match
- div.expand, div.collapse

child

- separate with > to select specified child
- div.expand > span

descendant

- separate with space to select specified descendant (does not have to be child)
- div.expand span

What has all of that to do with Data Science?

Internet was created to share information

Web hosts huge amount of data

Web Pages are for Humans, but …

There's lots of valuable data embedding in web pages

- course listings
- bank records
- blogs

What if we want to collect this data for analysis

- we need a program that acts like a web browser
- but collect web document data rather than displaying it
- collecting data this way is called ***web scraping***

Web Scrapers

A Web Scraper

- acts like a web browser (i.e., sends HTTP GET requests to web server)
- but allows you to process the data that comes back

curl

- utility and library for accessing web servers
- delivers web data as text

Beautiful Soup

- python library that can parse HTML

scrapy

- python utility to organize crawling of web tree
- collect subsets of web data
- process in python

Beautiful Soup

Parse a web page

- s = BeautifulSoup (request.get (url) .text, ‘html5lib’)

Use CSS selectors to find things

- dls = s .select (‘dl.double’)
- dls is array of matching dom objects

Digging into a dom object

- o .children is an iterator over its children

```
from bs4 import BeautifulSoup

import requests

r = requests.get('http://www.calendar.ubc.ca/okanagan/courses.cfm?code=DATA')

s = BeautifulSoup(r.text,'html5lib')


# we are interested in the dl list with class '.double'

dls = s .select ('dl.double')       # array of all dom objects that match 'dl.double'

dl  = dls[0]                        # there is just one in this case, get it

# now select again to get all of the dts that are in the subtree routed by dl

dts = dl .select ('dt')

# take a look at what one of the looks like

print(dts[0])                       # notice that the course name is the second child

# now get the course name from each of them

courses = []

for dt in dts:

    courses .append ([c for c in dt .children][1])   # add the course name to the list

for course in courses:

    print(course)
```

```
<dl class="double">

                <dt><a name="101"></a>DATA 101 (3)  <b>Making Predictions with Data</b></dt>

                <dd>Introduction to the techniques and software for handling real-world data. Topics include data cleaning, visualization, simulation, basic modelling, and prediction making. [3-1-0]<br>

                </dd>

                <dt><a name="301"></a>DATA 301 (3) <b>Introduction to Data Analytics</b></dt>

                <dd>Techniques for computation, analysis, and visualization of data using software. Manipulation of small and large data sets. Automation using scripting. Real-world applications from life sciences, physical sciences, economics, engineering, or psychology. No prior computing background is required. Credit will be granted for only one of COSC 301, DATA 301 or DATA 501. [3-2-0]<br> <i>Prerequisite:</i> Either (a) third-year standing, or (b) one of COSC 111 or COSC 122<br> <i>Equivalency:</i> COSC 301.

                </dd>

.....

</dl>
```

```
<dt><a name="101"></a>DATA 101 (3)  <b>Making Predictions with Data</b></dt>
DATA 101 (3)
DATA 301 (3)
```

Scrapy

Install Anaconda; then launch Anaconda powershell and run

- conda install scrapy
- conda intall protego
- Go to the folder you wish to create your project

Create a project (from Anaconda powershell)

- scrapy startproject *myproject*
  - *cd myproject\; it contains myproject.cfg and myproject*
  - *In myproject\myproject\spiders copy the file C2Scrapy.py (see next slide)*

Run the spider (from Anaconda powershell in myproject\)

- *run scrapy crawl quotes*

Scrapy

Create a spider

- a class that extends scrapy.Spider
- start_request method yields a request for every URL, specifying a callback method

Spider callback method

- parses web page and yields results as *json*
- possibly follow other links to generate additional requests

```python
import scrapy

# a class is a spider if it extends scrapy .Spider
class QuoteSpider (scrapy.Spider):
    # the name used to run spider (e.g., from project root type: scrapy crawl quotes)
    name = 'quotes'

    # you need this procedure ... this is where crawling starts
    def start_requests (self):
        url = 'http://quotes.toscrape.com/page/1/'

    # yield one or more results from scrapy .Request
    # each request fetches a url, parses the resulting page, and calls the specificed callback
function
    # in this case self .parse is called for this URL
        yield scrapy.Request (url = url, callback = self.parse)

    # called by scrapy .Request to parse a single web page
    def parse(self, response):

        # get the text of every quote as a collection
        quotes = response.css('.quote > .text::text').getall()

        # iterate yielding a json object for every quote
        # the resulting collection of objects is placed in specified output file
        # you can change, augment this by changing items.py
        for quote in quotes:
            yield {'quote': quote}
        # locate URL associated with the page's NEXT button
        nextU = response.css('.pager .next a::attr(href)').get()
        # if there is a next button then yield result of calling parse on that page
        if nextU is not None:
            yield response.follow(nextU, callback=self.parse)
```

Spider name

url to scrap

{'quote': '“The world as we have created it is a process of our thinking. It cannot be changed without changing our thinking.”'}
{'quote': '“It is our choices, Harry, that show what we truly are, far more than our abilities.”'}

JavaScript Object Notation (**json**)

Textual format for structured data

- [a,b,c] for arrays
- {‘x’: m, ‘y’: n, ‘z’: o} for objects

More popular alternative to XML

For example:

```
[
{‘title’: ‘1984’, ‘author’: ‘Orwell’},
{‘title: ‘Moby Dick’, ‘author:’Melville’}
]
```

Next Lecture

- APIs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