CSE 503
Introduction to Computer Science for Non-Majors

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Day 22
Web Servers (Part 1)
Announcements

- Lab #3 due Monday @ Midnight
A Fun Little Trick

Any guess as to what the following does?

```javascript
for (let elem of document.all) {
    elem.style.fontFamily = "courier";
}
```
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```

Let's test it on a real website...Since most websites we look at use HTML and JavaScript, we can also run our own JavaScript on those websites by using our browsers Developer Console (just like the console in repl.it).

https://www.w3schools.com/cssref/css_websafe_fonts.asp
What is a Web Server?

How do you get food at a nice restaurant?
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*Do you go back into the kitchen and get it?*
What is a Web Server?

How do you get food at a nice restaurant?

Do you go back into the kitchen and get it? **NO**
What is a Web Server?

How do you get food at a nice restaurant?

Do you go back into the kitchen and get it? **NO**

You interact with the menu and waiter/waitress (front-end)
What is a Web Server?

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Do you go back into the kitchen and get it? **NO**

You interact with the menu and waiter/waitress (front-end)

Does the waiter/waitress then go back and make your food?
What is a Web Server?

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Do you go back into the kitchen and get it? **NO**

You interact with the menu and waiter/waitress (front-end)

Does the waiter/waitress then go back and make your food? **NO**

They put in a request for the kitchen (the back-end) to make your food
Web Server

Software runs continuously, waiting for requests from clients.
Responds to requests.

Client
Sends requests to the server

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How Does This Relate to Us?

- **Python** is great for reading, processing, and manipulating data
- **JavaScript** is great for building a front-end, and displaying results
- Our project consists of two main parts:
  1. A **Python Web Server** back-end which reads, processes and manipulates our data efficiently
  2. A **JavaScript** front-end which communicates with the web server, displays our results, and allows for users to interact with our data
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The next few lectures will be about how to setup a web server in Python, and how to facilitate communication between the Python and JavaScript parts of our project.
HTTP

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- The server sends back an **HTTP response**
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The server sends back an **HTTP response**
Requests follow the following format:

```plaintext
<protocol>://<server>/<path>?<query string>
```

**Protocol:** HTTP or HTTPS
HTTP

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- The server sends back an **HTTP response**
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  `<protocol>://<server>/<path>?<query string>`

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**Server:** The domain name for the server, ie [www.buffalo.edu](http://www.buffalo.edu)
Communication with the web server happens via **HTTP requests**

The server sends back an **HTTP response**

Requests follow the following format:

```
<protocol>://<server>/<path>?<query string>
```

**Protocol:** HTTP or HTTPS

**Server:** The domain name for the server, ie **www.buffalo.edu**

**Path:** Name for the resource being requested
HTTP

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- The server sends back an HTTP response
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  \(<\text{protocol}>://\<\text{server}>/\<\text{path}>?\<\text{query string}>\)

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**Server:** The domain name for the server, i.e., www.buffalo.edu

**Path:** Name for the resource being requested

**Query String:** Provide additional info with key-value pairs (not always used)
Communication with the web server happens via **HTTP requests**.

- The server sends back an **HTTP response**.
- Requests follow the following format:

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**Server:** The domain name for the server, i.e., [www.buffalo.edu](http://www.buffalo.edu)

**Path:** Name for the resource being requested

**Query String:** Provide additional info with key-value pairs (not always used)

**Example:** [https://engineering.buffalo.edu/computer-science-engineering.html](https://engineering.buffalo.edu/computer-science-engineering.html)
import urllib.request

protocol = "https"
server = "engineering.buffalo.edu"
path = "computer-science-engineering.html"
url = protocol + "://" + server + "/" + path

response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
Making an HTTP request in Python

```python
import urllib.request

protocol = "https"
server = "engineering.buffalo.edu"
path = "computer-science-engineering.html"
url = protocol + "://" + server + "/" + path

response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
```

Import a library for making HTTP requests
import urllib.request

protocol = "https"
server = "engineering.buffalo.edu"
path = "computer-science-engineering.html"
url = protocol + "://" + server + "/" + path

response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
import urllib.request

protocol = "https"
server = "engineering.buffalo.edu"
path = "computer-science-engineering.html"
url = protocol + "://" + server + "/" + path

response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
Making an HTTP request in Python

```python
import urllib.request

protocol = "https"
server = "engineering.buffalo.edu"
path = "computer-science-engineering.html"
url = protocol + "://" + server + "/" + path

response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
```

Read and decode the response (initially it's just 0s and 1s)
import urllib.request

protocol = "https"
server = "engineering.buffalo.edu"
path = "computer-science-engineering.html"
url = protocol + "://" + server + "/" + path

response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)

Do whatever we want with the response! (It's just a string)
Query Strings

Query strings are a set of key-value pairs to pass extra information in your request.

Keys and values are separated by "="; multiple key-value pairs are separated by "&".
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Query strings are a set of key-value pairs to pass extra information in your request. Keys and values are separated by "=" and multiple key-value pairs are separated by "&".

**Examples**

- [https://www.youtube.com/watch?v=wL9E2QKP2us](https://www.youtube.com/watch?v=wL9E2QKP2us)
  - Query String: "v=wL9E2QKP2us"
  - key "v" with value "wL9E2QKP2us"

- [https://duckduckgo.com/?q=internships&t=h_&ia=web](https://duckduckgo.com/?q=internships&t=h_&ia=web)
  - key "q" with value "internships"
  - key "t" with value "h_"
  - key "ia" with value "web"
The Internet, as most people know it, is designed for human consumption. What if we want to write software that reads data from the Internet?
Brief Aside on Web Scraping

The Internet, as most people know it, is designed for human consumption

What if we want to write software that reads data from the Internet?

- A web scraper is software that reads data from HTML
- Many libraries exist to make this easier
- We won't explore this in CSE503, though it can be a fun area to explore on your own
Web APIs - An Alternative to Scraping

The Internet, as most people know it, is designed for human consumption

What if we want to write software that reads data from the Internet?
Web APIs - An Alternative to Scraping

The Internet, as most people know it, is designed for human consumption

What if we want to write software that reads data from the Internet?

- Web APIs are hosted by web servers at urls, but instead of sending HTML they send raw data
- Designed for programmatic consumption
- Typically send data as JSON
import urllib.request

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
Web APIs - ISS Example

```python
import urllib.request

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)
```

Make a request to the open-notify API

Documentation: http://open-notify.org/Open-Notify-API/ISS-Location-Now/
import urllib.request
url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content = response.read().decode()
print(content)

Returns a JSON string…

{  
  "message": "success",
  "iss_position": {  
    "longitude": "135.1326",
    "latitude": "19.9913"  
  },
  "timestamp": 1666207804
}
So...What's a JSON string? How can we use it? Does it look familiar?
What's a JSON String?

**JSON (JavaScript Object Notation)** is a data format that can be represented as strings

- We can send these strings to communicate data across the Internet
- All programming languages can read strings
- Doesn't matter what language was used for client or server program
- They can all "speak" JSON since it's just strings
- More flexible than CSV
6 different data types:
1. String: Any value in "double quotes"
2. Number: Any value not in quotes "true", "false", and "null" will be interpreted as a number.
3. Boolean: Either "true" or "false" without the quotes
4. Null: The word "null" without the quotes
5. Array: A comma-separated list of values surrounded by [brackets]
6. Object: A comma-separated list of key-value pairs surrounded by {braces}

Closely resembles JavaScript and Python syntax that we've seen, except it is a string.

JSON Example

[{
"title": "God Am (Live 1996)", "artist": "Alice in Chains", "ratings": [5, 4], "youtubeID": "74P4W_okEqA"}, {
"title": "Fade to Black", "artist": "Metallica", "ratings": [5, 2], "youtubeID": "WEQnzs8w16E"}]

import urllib.request
import json

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()
content = json.loads(content_string)
import urllib.request
import json

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()
content = json.loads(content_string)
import urllib.request
import json

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()

content = json.loads(content_string)

Make a request just like before
import urllib.request
import json

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()
content = json.loads(content_string)

Use the json.loads() function to convert the string into python type (in this case a dictionary)
import urllib.request
import json

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()

content = json.loads(content_string)

???? Do whatever we want with the data!!!
import urllib.request
import json

text = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()

content = json.loads(content_string)

print(content) We can print it
import urllib.request
import json

url = "http://api.open-notify.org/iss-now.json"
response = urllib.request.urlopen(url)
content_string = response.read().decode()

content = json.loads(content_string)

print(content['iss_position']['longitude'])
print(content['iss_position']['latitude'])

Or do anything else we may want to do