STAT606
Computing for Data Science and Statistics

Lecture 18: APIs

Previously: Scraping Data from the Web

We used BeautifulSoup to process HTML that we read directly

- We had to figure out where to find the data in the HTML
- This was okay for simple things like Wikipedia…
- ...but what about large, complicated data sets?
  - E.g., Climate data from NOAA; Twitter/reddit/etc.; Google maps

Many websites support **APIs**, which make these tasks simpler

Instead of scraping for what we want, just ask!

Example: ask Google Maps for a computer repair shop near a given address

APIs: Application Programming Interfaces

Recall the implementation-interface distinction

Interface: “what we can do”
Implementation: “how it is done”

APIs are an example of this!

The API provides a set of tools or functions for interacting with a web service

Example: Google Maps supplies tools for asking about addresses and directions

- Get information about a specific address
- Get directions from one address to another
- Get traffic information

These are supplied as interfaces that we can use…

...but their inner workings are hidden from us as end users

Three common API approaches

Via a Python package

Service (e.g., Google maps, ESRI*) provides library for querying DB

Example: `from arcgis.gis import GIS`

Via a command-line tool

Example: `twurl` https://developer.twitter.com/

Via HTTP requests

We submit an HTTP request to a server

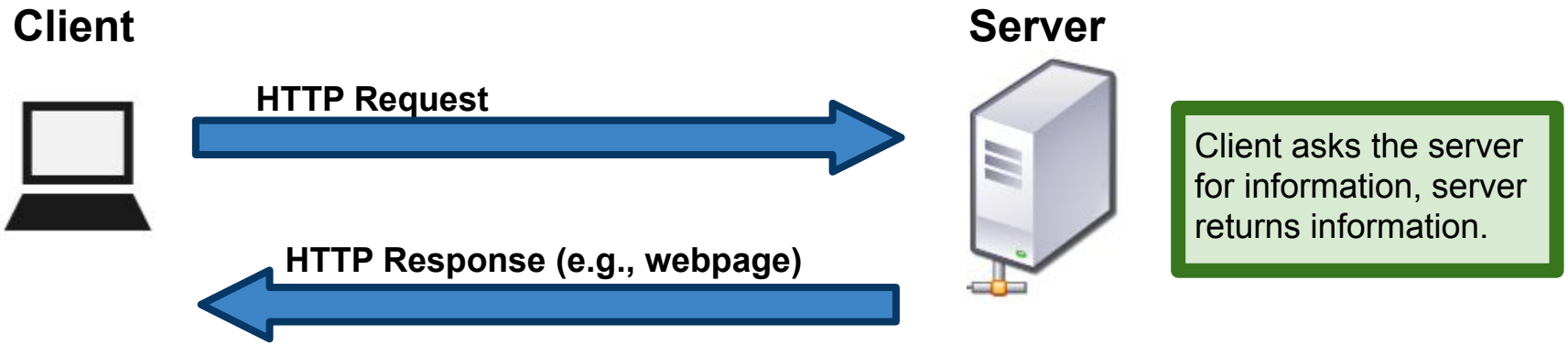
Supply additional parameters in URL to specify our query

Example: https://www.yelp.com/developers/documentation/v3/business_search

Ultimately, all three of these approaches end up submitting an HTTP request to a server, which typically returns information in the form of a JSON or XML file.

* ESRI is a GIS service, to which the university has a subscription: https://developers.arcgis.com/python/

Reminder: Client-server model



Request can be as simple as “give me website X”...

...but we can also make more complicated requests.

Web service APIs

Step 1: Create URL with query parameters

Example (non-working): www.example.com/search?key1=val1&key2=val2

Step 2: Make an HTTP request

Communicates to the server what kind of action we wish to perform

https://en.wikipedia.org/wiki/Hypertext_Transfer_Protocol#Request_methods

Step 3: Server returns a response to your request

May be as simple as a code (e.g., 404 error)...

...but typically a JSON or XML file (e.g., in response to a DB query)

HTTP Requests

Allows a client to ask a server to perform an action on a resource

E.g., perform a search, modify a file, submit a form

Two main parts of an HTTP request:

URI: specifies a resource on the server

Method: specifies the action to be performed on the resource

HTTP request also includes (optional) additional information

E.g., specifying message encoding, length and language

More information:
https://en.wikipedia.org/wiki/Hypertext_Transfer_Protocol#Request_methods
RFC specifying HTTP requests: https://tools.ietf.org/html/rfc7231#section-4

HTTP Request Methods

GET: retrieves information from the server

POST: sends information to the serve (e.g., a file for upload)

PUT: replace the URI with a client-supplied file

DELETE: delete the file indicated by the URI

CONNECT: establishes a tunnel (i.e., connection) with the server

More: https://developer.mozilla.org/en-US/docs/Web/HTTP/Methods

See also **Representational State Transfer**:
https://en.wikipedia.org/wiki/Representational_state_transfer

Submitting HTTP Requests: Parameters

We submit an HTTP request to a URL, e.g., api.example.com
but often we want to further specify our request with parameters

Example: when we ask Google Maps for directions, we need to specify:

- Start location, destination
- Mode of transportation (e.g., walking, bike, bus, plane, train, automobile)

We do this with **URL parameters**, passed as key-value pairs

Example: api.example.com/server?course=STAT606&location=UWMadison
Passes two parameters: `course`, with value `STAT606`
and `location`, with value `UWMadison`.
Roughly comparable to Python keyword arguments.

Refresher: JSON

JavaScript Object Notation

https://en.wikipedia.org/wiki/JSON

Commonly used by website APIs

Basic building blocks:

- attribute–value pairs
- array data

Example (right) from wikipedia:

- Possible JSON representation of a person

```
{
  "firstName": "John",
  "lastName": "Smith",
  "isAlive": true,
  "age": 25,
  "address": {
    "streetAddress": "21 2nd Street",
    "city": "New York",
    "state": "NY",
    "postalCode": "10021-3100"
  },
  "phoneNumbers": [
    {
      "type": "home",
      "number": "212 555-1234"
    },
    {
      "type": "office",
      "number": "646 555-4567"
    },
    {
      "type": "mobile",
      "number": "123 456-7890"
    }
  ],
  "children": [],
  "spouse": null
}
```

Refresher: Python `json` module

```
1 import json
2 json_string = '{"first_name":"John",  "last_name":"Bardeen", "alma_mater":"University of Wisconsin"}'
3 parsed_json = json.loads(json_string)
4 parsed_json
```

```
{'alma_mater': 'University of Wisconsin',
 'first_name': 'John',
 'last_name': 'Bardeen'}
```

```
1 json.dumps(parsed_json)
```

```
'{"first_name": "John", "last_name": "Bardeen", "alma_mater": "University of Wisconsin"}'
```

JSON string encoding information about physicist John Bardeen

`json.loads` parses a string and returns a JSON object.

`json.dumps` turns a JSON object back into a string.

Refresher: Python `json` module

```
1 parsed_json
```

```
{'alma_mater': 'University of Wisconsin',
 'first_name': 'John',
 'last_name': 'Bardeen'}
```

```
1 parsed_json['alma_mater']
```

```
'University of Wisconsin'
```

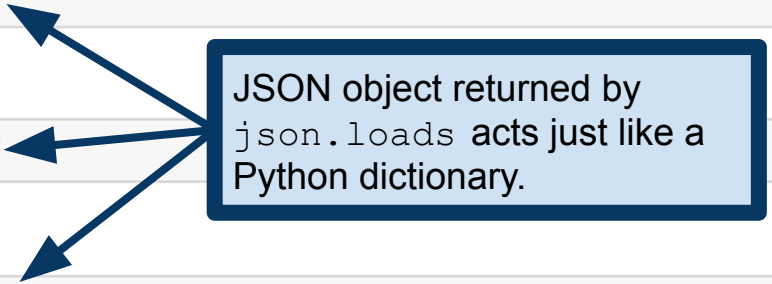
```
1 parsed_json['first_name']
```

```
'John'
```

```
1 parsed_json['middle_name']
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
<ipython-input-9-e0447f76c1d5> in <module>()
----> 1 parsed_json['middle_name']

KeyError: 'middle_name'
```



Example: Querying Yelp's Business Search Service

I am sitting at my desk, woefully under-caffeinated

I could open a new browser tab and search for coffee nearby…

...but why leave the comfort of my Jupyter notebook?

Yelp provides several services under their "Fusion API"

https://www.yelp.com/developers/documentation/v3/get_started

We'll use the business search endpoint

Supports queries that return businesses reviewed on Yelp

https://www.yelp.com/developers/documentation/v3/business_search

Example: Querying Yelp's Business Search Service

```
1  import requests
2  url = 'https://api.yelp.com/v3/businesses/search'
3  headers = {'Authorization': 'Bearer %s' % yelp_api_key}
4  url_params = {'term': 'coffee', # Search for coffee...
5                'radius': 1000, # ...within 1000 meters...
6                # ...near the statistics department
7                'location': '1300 University Ave, Madison WI'}
8  r = requests.get(url, headers=headers, params=url_params)
9  r.json()
```

URL to which to direct our request, specified in Yelp's documentation.

```
{'businesses': [{'alias': 'indie-coffee-madison',
   'categories': [{'alias': 'cafes', 'title': 'Cafes'}],
   'coordinates': {'latitude': 43.067526, 'longitude': -89.406553},
   'display_phone': '(608) 259-9621',
   'distance': 739.1752296826008,
```

Documentation: https://www.yelp.com/developers/documentation/v3/business_search

Example: Querying Yelp's Business Search Service

```
1  import requests
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9  r.json()
```

```
{'businesses': [{'alias': 'indie-coffee-madison',
    'categories': [{'alias': 'cafes', 'title': 'Cafes'}]
    'coordinates': {'latitude': 43.067526, 'longitude':
    'display_phone': '(608) 259-9621',
    'distance': 739.1752296826008,
    'id': 'k76nkEY6PbIW4T_Rig15nQ'
```

Yelp requires that we obtain an API key to use for authentication. You must register with Yelp to obtain such a key.

Documentation: https://www.yelp.com/developers/documentation/v3/business_search

Example: Querying Yelp's Business Search Service

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1  import requests
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8  r = requests.get(url, headers=headers, params=url_params)
9  r.json()
```

We are going to pass a dictionary of parameter values for `requests` to use in constructing a GET request for us.

The resulting URL looks like this (can be access with `r.url`):
https://api.yelp.com/v3/businesses/search?term=coffee&radius=1000&location=1300+University+Ave%2C+Madison+WI
Notice that if you try to follow that link, you'll get an error asking for an authentication token.

```
'distance': 739.1752296826008,
```

Documentation: https://www.yelp.com/developers/documentation/v3/business_search

Example: Querying Yelp's Business Search Service

```
1  import requests
2  url = 'https://api.yelp.com/v3/businesses/search'
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4  url_params = {'term': 'coffee', # Search for coffee...
5                'radius': 1000, # ...within 1000 meters...
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7                'location': '1300 University Ave, Madison WI'}
8  r = requests.get(url, headers=headers, params=url_params)
9  r.json()
```

```
{'businesses': [{'alias': 'indie-coffee-
   'categories': [{'alias': 'cafes', 'ti
   'coordinates': {'latitude': 43.067526
   'display_phone': '(608) 259-9621',
   'distance': 739.1752296826008,
```

This line actually submits the GET request to the URL, and includes the authorization header and our search parameters. `requests` handles all the annoying formatting and construction of the HTTP request for us.

Documentation: https://www.yelp.com/developers/documentation/v3/business_search

Example: Querying Yelp's Business Search Service

```
1  import requests
2  url = 'https://api.yelp.com/v3/businesses/search'
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5                'radius': 1000, # ...within 1000 meters...
6                # ...near the statistics department
7                'location': '1300 University Ave, Madison WI'}
8  r = requests.get(url, headers=headers, params=url_params)
9  r.json()
```

```
{'businesses': [{'alias': 'indie-cof
   'categories': [{'alias': 'cafes',
   'coordinates': {'latitude': 43.06
   'display_phone': '(608) 259-9621'
   'distance': 739.1752296826008,
```

`requests` packages up the JSON object returned by Yelp, if we ask for it. Recall that JSON objects in Python are really just dictionaries, so it makes sense that `r.json()` is a dictionary.

Documentation: https://www.yelp.com/developers/documentation/v3/business_search

```
1 r = requests.get(url, headers=headers, params=url_params)
2 [res['alias'] for res in r.json()['businesses']]
```

```
['indie-coffee-madison',
 'valentia-coffee-madison',
 'aldos-cafe-madison',
 'a-just-brew-madison',
 'java-den-at-1022-madison',
 'peets-coffee-madison-2',
 'greenbush-bakery-madison',
 'the-library-cafe-and-bar-madison',
 'mickies-dairy-bar-madison',
 'mcdonalds-madison-27',
 'prairie-fire-madison',
 'saigon-sandwich-madison-madison',
 'babcock-hall-dairy-store-madison',
 'badger-market-union-south-madison',
 'kwik-trip-madison-3',
 'the-wise-madison',
 'orange-tree-imports-madison',
 'der-rathskeller-madison',
 'capital-cafe-madison',
 'daily-scoop-in-memorial-union-madison']
```

The `businesses` attribute of the JSON object returned by Yelp is a list of dictionaries, one dictionary per result. The name of each business is stored in its `alias` key.

See Yelp's documentation for more information on the structure of the returned JSON object. https://www.yelp.com/developers/documentation/v3/business_search

More interesting API services

National Oceanic and Atmospheric Administration (NOAA)
https://www.ncdc.noaa.gov/cdo-web/webservices/v2

ESRI ArcGIS
https://developers.arcgis.com/python/

MediaWiki (includes API for accessing Wikipedia pages)
https://www.mediawiki.org/wiki/API:Main_page

Open Movie Database (OMDb)
https://omdbapi.com/

Major League Baseball
http://statsapi.mlb.com/docs

Of course, these are just examples. Just about every large tech company provides an API, as do most groups/agencies that collect data.