Project Examples with Visualizations

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Based on slides from Charles Severance

From Python for Everybody

www.py4e.com

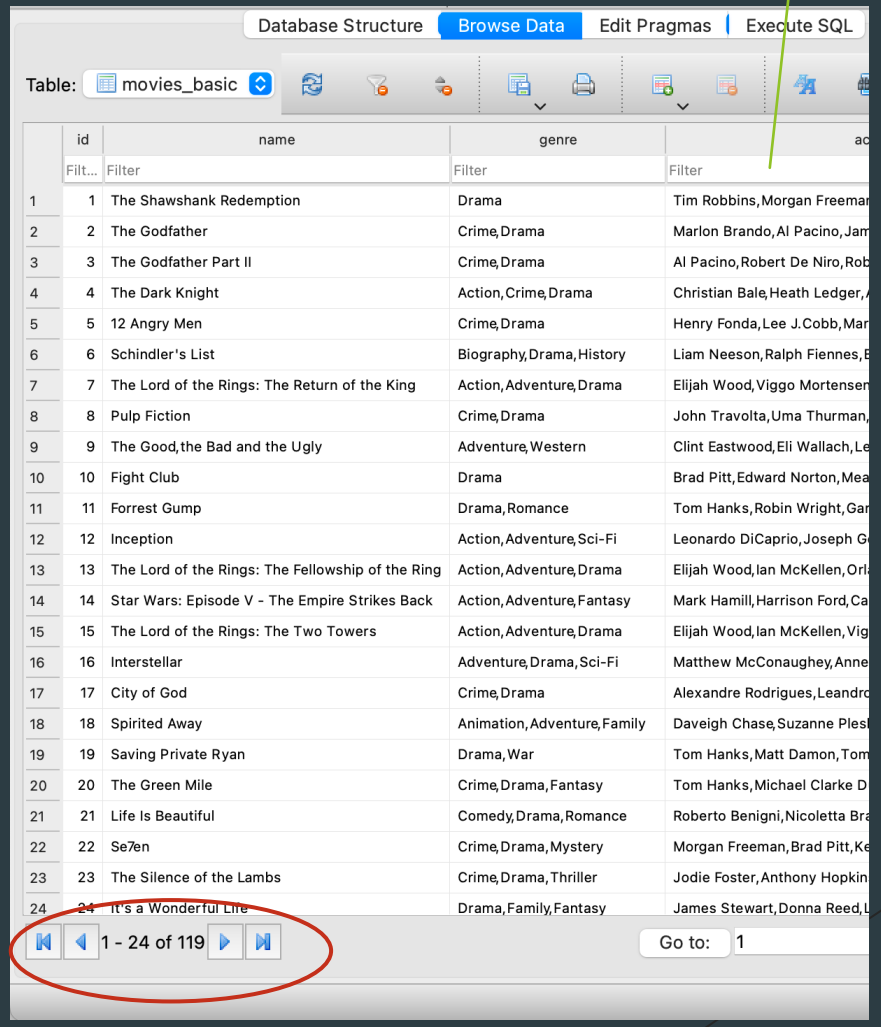
Grading Rubric for Final Project is on Canvas

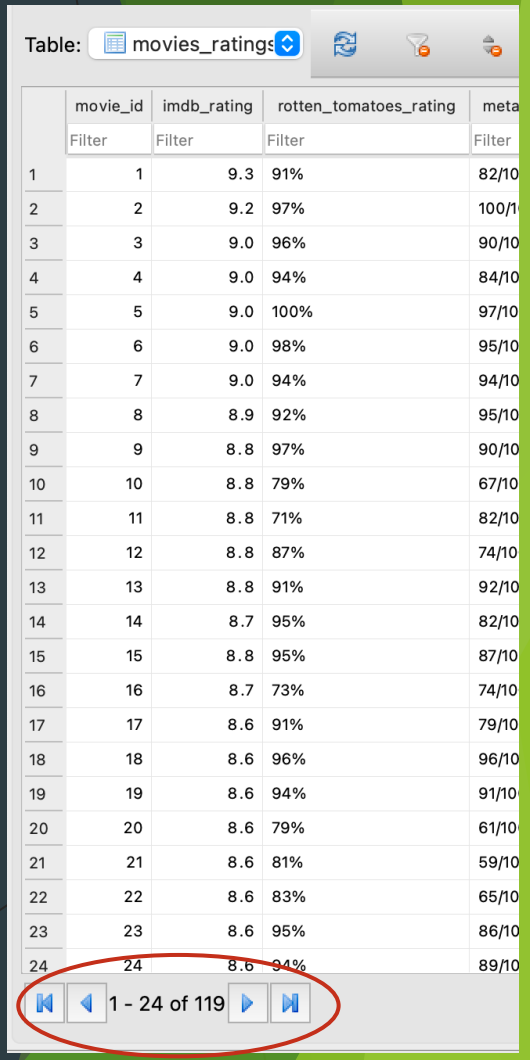
- Two+ files (two+ functions)
  - Function to save data to the database
    - Save a max of 25 rows on each execution in one table per API/website
    - Must have two tables with a shared integer key for one API/website
      - Don't duplicate string data and don’t break one table into two
  - Function to read data from the database, calculate something, write a report, and create visualizations from what you calculated
  - Don't store any data from an API/website in a file - it should be stored in the database!

Breaking One Table Into Two

- If the data belongs to the same entity
- If both tables have the same number of rows
- If putting the data in one table would not result in any duplicate string data

Duplicate string data





Duplicate String Data

- Do not store duplicate string data in a database!
  - In the same table
  - In two different tables
  - Watch out for dates if they are strings

Table: Players

	PLAYER_ID	NAME	TEAM_ID	AGE
	Filter	Filter	Filter	Filter
1	2544	LeBron James	1610612747	38
2	2617	Udonis Haslem	1610612748	43
3	2738	Andre Iguodala	1610612744	39
4	101108	Chris Paul	1610612756	38
5	200752	Rudy Gay	1610612762	36
6	200768	Kyle Lowry	1610612748	37
7	200782	P.J.Tucker	1610612755	38
8	201142	Kevin Durant	1610612756	34
9	201143	Al Horford	1610612738	37
10	201144	Mike Conley	1610612750	35
11	201145	Jeff Green	1610612743	36
12	201152	Thaddeus Young	1610612761	35
13	201565	Derrick Rose	1610612752	34
14	201566	Russell Westbrook	1610612746	34
15	201567	Kevin Love	1610612748	34
16	201569	Eric Gordon	1610612746	34
17	201572	Brook Lopez	1610612749	35
18	201577	Robin Lopez	1610612739	35
19	201580	JaVale McGee	1610612742	35
20	201586	Serge Ibaka	1610612749	33
21	201587	Nicolas Batum	1610612746	34
22	201588	George Hill	1610612754	37
23	201599	DeAndre Jordan	1610612743	34
24	201609	Goran Dragic	1610612749	37

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Table: Salaries

	player _id	name	salary
	Filter	Filter	Filter
1	1	Lonzo Ball	19534884
2	2	Eric Bledsoe	19375000
3	3	Derrick Favors	10183800
4	4	Chet Holmgren	9891240
5	5	Aron Baynes	7350000
6	6	Danilo Gallinari	6479000
7	7	David Nwaba	5022000
8	8	Dante Exum	5000000
9	9	Lou Williams	5000000
10	10	Maurice Harkless	4564980
11	11	Chandler Hutchison	4019459
12	12	Gabriel Deck	3676852
13	13	Sekou Doumbouya	3613680
14	14	Trey Burke	3243750
15	15	Marc Gasol	2692991
16	16	Anthony Tolliver	2692991
17	17	Marquese Chriss	2193920
18	18	Nik Stauskas	2193920
19	19	Jahlil Okafor	2130023
20	20	Abdel Nader	2000000
21	21	Jontay Porter	1950000
22	22	Denzel Valentine	1939350
23	23	Killian Tillie	1901625
24	24	Wes Iwundu	1824003

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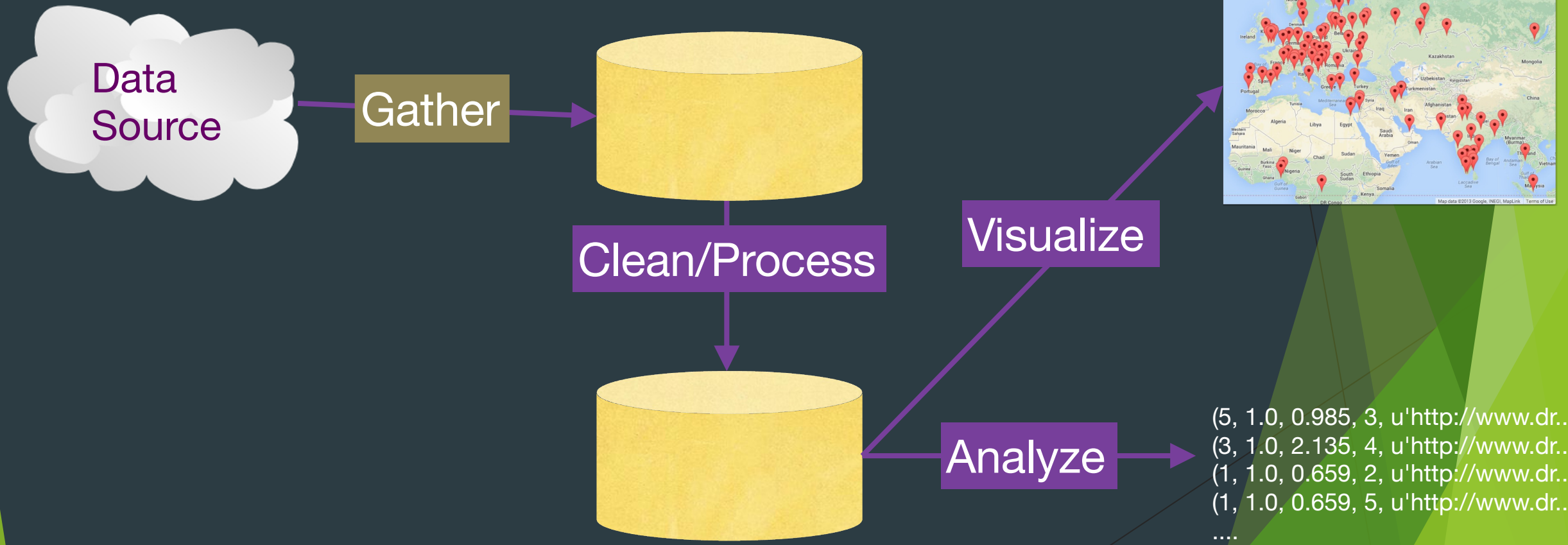
More Useful SQL Commands

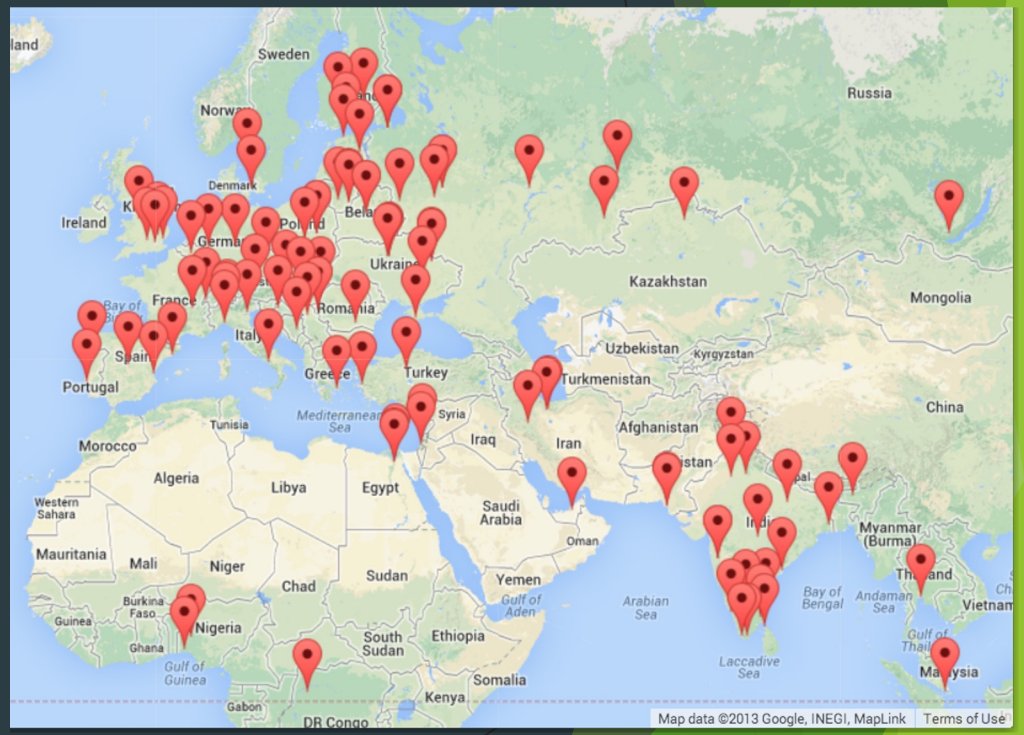
- SELECT MAX(col) FROM table
- SELECT COUNT(col) FROM table
- SELECT AVG(col) FROM table
- SELECT SUM(col) FROM table

Multi-Step Data Analysis

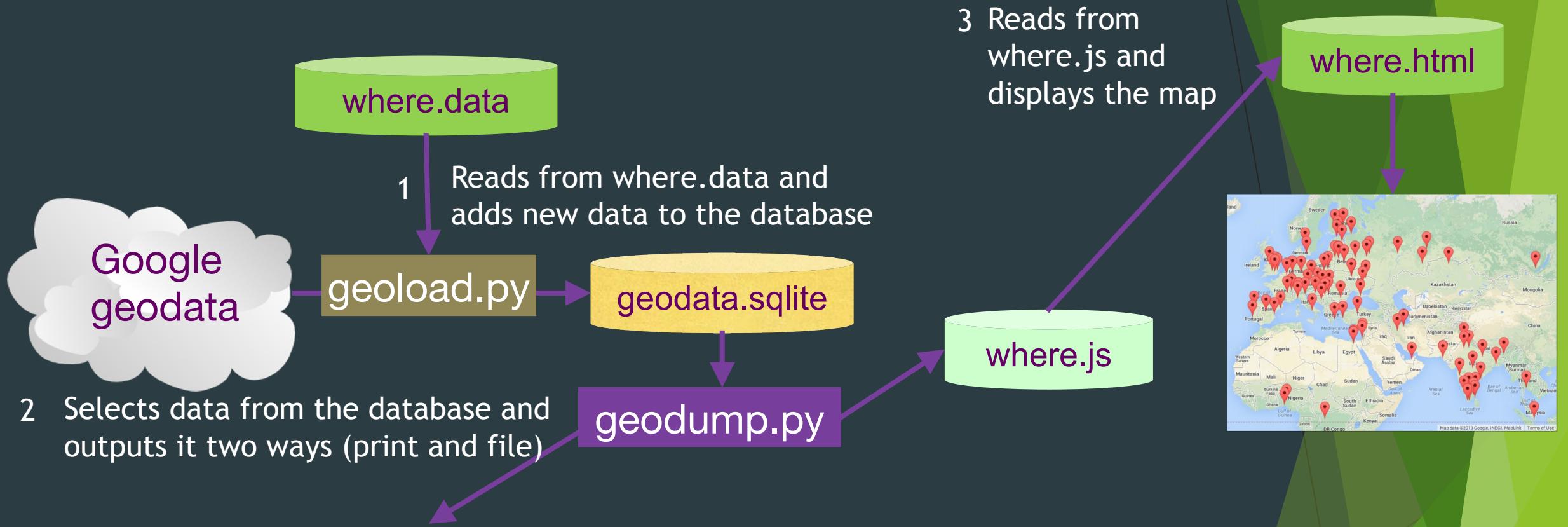


GeoData

- Makes a Google Map from user entered location data from a MOOC
- Uses the Google Geodata API to get latitude and longitude data
- Stores data in a database to avoid rate limiting and allow restarting
- Visualized in a browser using the Google Maps API



http://www.py4e.com/code3/geodata.zip

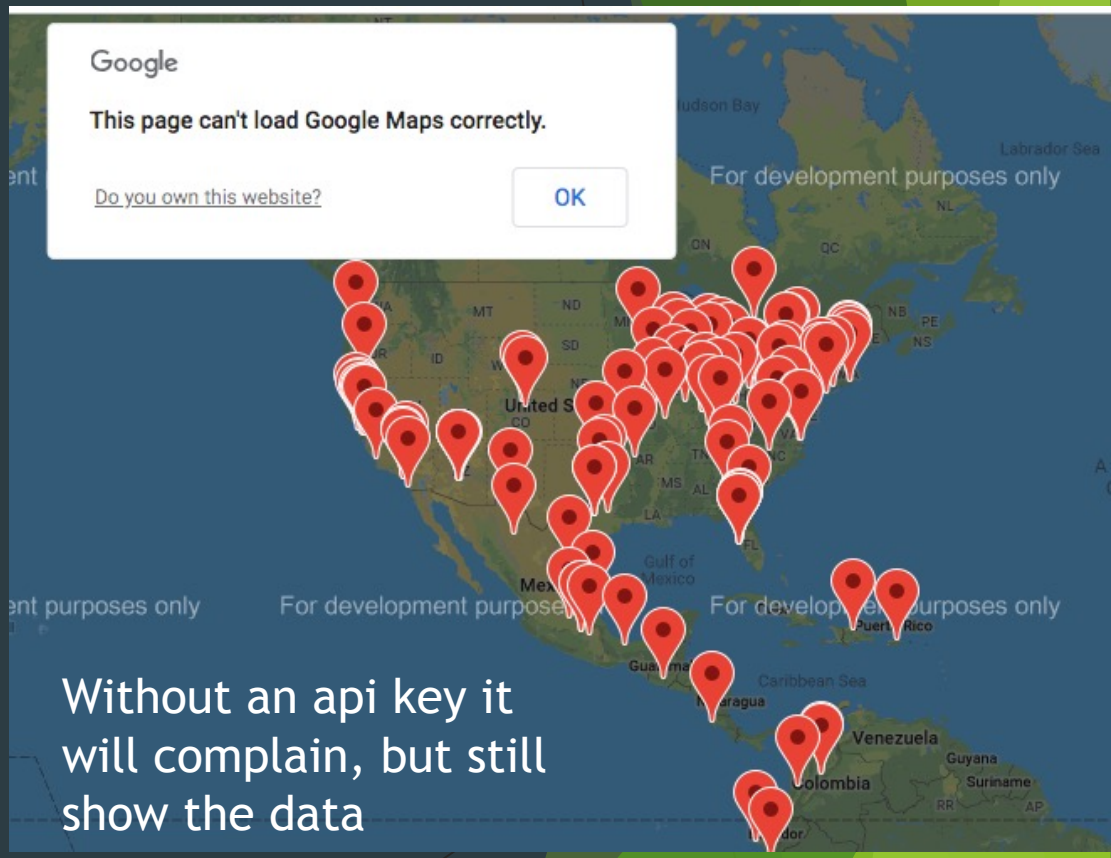


Northeastern University, ... Boston, MA 02115, USA 42.3396998 -71.08975
Bradley University, 1501 ... Peoria, IL 61625, USA 40.6963857 -89.6160811
...
Technion, Viazman 87, Kesalsaba, 32000, Israel 32.7775 35.0216667
Monash University Clayton ... VIC 3800, Australia -37.9152113 145.134682
Kokshetau, Kazakhstan 53.2833333 69.3833333
...
12 records written to where.js
Open where.html to view the data in a browser

http://www.py4e.com/code3/geodata.zip

Try It

- Download the zip file from Canvas
- Open *where.html* in a browser to see the resulting visualization
  - Hover over the markers to see information



Run the Code!

- cd to the current directory
  - The code doesn’t add the path to the current file
- python geoload.py
  - read from where.data and add to the database
- Browse the database - geodata.sqlite
- python geodump.py
  - Reads from database, prints output, and stores in where.js
- Click on where.html
  - Displays the data in where.js

How does the visualization work?

- Reads a javascript list of lists from where.js

where.js

```
myData = [
[42.340075,-71.0895367, 'Northeastern, Boston, MA 02115, USA'],
[32.778949,35.019648, 'Technion/ Sports Building, Haifa'],
[33.1561058,131.826132, 'Japan, 〒875-0002 Ōita-ken, Usuki-shi, Shitanoe, 1232-2 UMD'],
[42.4036847,-71.120482, 'South Hall Tufts University, 30 Lower Campus Rd, Somerville, MA 02144, USA'],
[-37.914517,145.1303881, 'Monash College, Wellington Rd, Clayton VIC 3168, Australia'],
[53.2948229,69.4047872, 'Kokshetau 020000, Kazakhstan'],
```

where.html

```
<html>
  <head>
    <meta name="viewport" content="initial-scale=1.0, user-scalable=no">
    <meta charset="utf-8">
    <title>A Map of Information</title>
    <link href="https://google-developers.appspot.com/maps/documentation/javascript/examples/default.css" rel="stylesheet">

    <!-- If you are in China, you may need to use theis site for the Google Maps code
    <script src="https://maps.google.cn/maps/api/js" type="text/javascript"></script> -->

    <script src="https://maps.googleapis.com/maps/api/js"></script>
    <script src="where.js"></script>
```

Getting the Data

- Reads from *where.data*
  - Gets the location from a file
  - Checks if in the database
    - If yes, continue
    - Else, get the data

```
1  AGH University of Science and Technology
2  Academy of Fine Arts Warsaw Poland
3  American University in Cairo
4  Arizona State University
5  Athens Information Technology
6  BITS Pilani
7  Babcock University
8  Banaras Hindu University
9  Bangalore University
```

where.data

geoload.data

```
33  fh = open("where.data")
34  count = 0
35  for line in fh:
36      if count > 200 :
37          print('Retrieved 200 locations, restart to retrieve more')
38          break
39
40      address = line.strip()
41      print('')
42      cur.execute("SELECT geodata FROM Locations WHERE address= ?",
43          (memoryview(address.encode()), ))
44
45      try:
46          data = cur.fetchone()[0]
47          print("Found in database ",address)
48          continue
49      except:
50          pass
```

Stop the current loop

Get the current address

Is in database?

If yes, continue (skip rest of this)

Otherwise keep going

continue, break, and exit in Python

- continue
  - Returns control to the beginning of the loop
    - Won't execute any statements in the loop after it
- break
  - Terminates the loop
    - Execution continues after the loop
- sys.exit()
  - Ends the program

Get the Data from the web

```
52      parms = dict()
53      parms["address"] = address
54      if api_key is not False: parms['key'] = api_key
55      url = serviceurl + urllib.parse.urlencode(parms)
56
57      print('Retrieving', url)
58      uh = urllib.request.urlopen(url, context=ctx)
59      data = uh.read().decode()
60      print('Retrieved', len(data), 'characters', data[:20].replace('\n', ' '))
61      count = count + 1
```

Code uses urllib rather than requests

Replace new line with space

Increment the count

If got the JSON data, save it in the database

```
63      try:
64          js = json.loads(data)
65      except:
66          print(data)  # We print in case unicode causes an error
67          continue
68
69      if 'status' not in js or (js['status'] != 'OK' and js['status'] != 'ZERO_RESULTS') :
70          print('==== Failure To Retrieve ====')
71          print(data)
72          break
73
74      cur.execute('''INSERT INTO Locations (address, geodata)
75              VALUES ( ?, ? )''', (memoryview(address.encode()), memoryview(data.encode()) ) )
76      conn.commit()
77      if count % 10 == 0 :
78          print('Pausing for a bit...')
79          time.sleep(5)
```

Insert into the database

Commit the changes

Sleep for 5 seconds every 10th time

geodump.py

- Select from the database
  - Loop through the results
  - Convert from JSON to Python
  - Check result was okay

```
5  conn = sqlite3.connect('geodata.sqlite')
6  cur = conn.cursor()
7
8  cur.execute('SELECT * FROM Locations')
9  fhand = codecs.open('where.js', 'w', "utf-8")
10 fhand.write("myData = [\n")
11 count = 0
12 for row in cur :
13     data = str(row[1].decode())
14     try: js = json.loads(str(data))
15     except: continue
16
17     if not('status' in js and js['status'] == 'OK') : continue
18
```

geodump.py (continued)

- Print the data
- Write the data to
  - where.js

```
19        lat = js["results"][0]["geometry"]["location"]["lat"]
20        lng = js["results"][0]["geometry"]["location"]["lng"]
21        if lat == 0 or lng == 0 : continue
22        where = js['results'][0]['formatted_address']
23        where = where.replace("'", "")
24        try :
25            print(where, lat, lng)
26
27            count = count + 1
28            if count > 1 : fhand.write(",\n")
29            output = "["+str(lat)+","+str(lng)+", '"+where+"']"
30            fhand.write(output)
31        except:
32            continue
33
34    fhand.write("\n];\n")
35    cur.close()
36    fhand.close()
37    print(count, "records written to where.js")
38    print("Open where.html to view the data in a browser")
```

Print the data

Write the data

Peer Instruction #1

Q-1: Which of the following is how geoload.py limits the data that it gets from the API?

- A. Only asks the API for 200 items at a time
- B. Quits the program after retrieving 200 new items from the API
- C. Quits the program after reading 200 items from where.data
- D. Only reads 200 items from the database

Check Me Compare me

Restart and Limit Process for geoload.py

- Create the table if it doesn't exist
  - Keep the table around
- Read locations from a file (where.data)
- Keep a count of the number retrieved from the API and stop at 200
- Check if the current location is already in the database
  - and if so move on to the next
  - Otherwise, get the data for the current location and add it to the database
  - Increment the count of items retrieved
- Sleep every 10th retrieved item
  - Some systems limit how many items you can get in a time period

Mailing Lists - Gmane

- Crawl the archive of a mailing list
- Do some analysis / cleanup
- Visualize the data as word cloud and lines

http://www.py4e.com/code3/gmane.zip

Warning: This Dataset is > 1GB

- Do not just point this application at gmane.org and let it run
- There is no rate limit - these are cool folks

Use this for your testing:

http://mbox.dr-chuck.net/sakai.devel/4/5

1. add data to the database

mbox.dr-chuck.net

gmane.py

content.sqlite

gmodel.py

mapping.sqlite

2. clean the data

index.sqlite

gbasic.py

gword.py

gword.js

gword.htm
d3.js

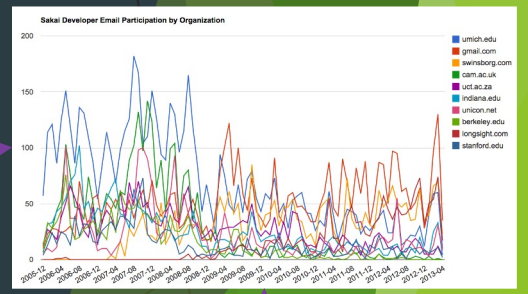
4. create word cloud

gline.py

3. output data

How many to dump? 5
Loaded messages= 51330 subjects= 25033 senders= 1584
Top 5 Email list participants
steve.swinsburg@gmail.com 2657
azeckoski@unicon.net 1742
ieb@tfd.co.uk 1591
csev@umich.edu 1304
david.horwitz@uct.ac.za 1184
...

gline.js



5. output line chart

gline.htm
d3.js

http://www.py4e.com/code3/gmane.zip

D3.js - Data-Driven Documents

- JavaScript library for modifying an HTML document to display data
  - Very popular
  - Used to create data visualizations in web browsers
    - Can be interactive
  - See https://d3js.org/

Examples: https://github.com/d3/d3/wiki/Gallery

Gallery

Jump to bottom

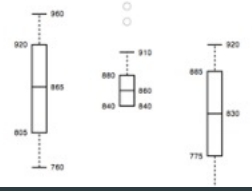
Mike Bostock edited this page on Oct 27 · 1287 revisions

Wiki ▸ Gallery

Welcome to the **D3 gallery**! More examples are available for forking on Observable; see my profile and the visualization collection. Feel free to publish and share your own!

Visual Index

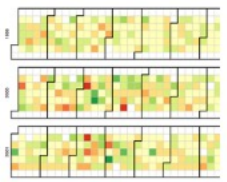
Box Plots



Bubble Chart

Bullet Charts

Calendar View



Try it!

- Download http://www.py4e.com/code3/gmane.zip
- Can also download

  https://online.dr-chuck.com/files/sakai/email/content.sqlite

Run gmane.py

- It asks how many messages to get and then gets that number (adds to the database)

```
How many messages:5
http://mbox.dr-chuck.net/sakai.devel/32/33 2910
    ggolden@umich.edu 2005-12-12T20:02:00-05:00 sakai 2.1 conversion - an update
http://mbox.dr-chuck.net/sakai.devel/33/34 3512
    ys2n@virginia.edu 2005-12-12T21:15:22+00:00 worksite taxonomy
http://mbox.dr-chuck.net/sakai.devel/34/35 5362
    lfernandez@weber.edu 2005-12-13T01:08:01-07:00 re: memory error with 2.1
http://mbox.dr-chuck.net/sakai.devel/35/36 2270
    lfernandez@weber.edu 2005-12-13T01:29:49-07:00 audio recordings of austin presentations
http://mbox.dr-chuck.net/sakai.devel/36/37 6958
    ys2n@virginia.edu 2005-12-13T02:46:51+00:00 re: worksite taxonomy
How many messages:8
http://mbox.dr-chuck.net/sakai.devel/37/38 8425
    jleasia@umich.edu 2005-12-13T08:02:47-05:00 re: worksite taxonomy
http://mbox.dr-chuck.net/sakai.devel/38/39 3014
    csev@umich.edu 2005-12-13T08:12:08-05:00 re: audio recordings of austin presentations
http://mbox.dr-chuck.net/sakai.devel/39/40 9459
```

Peer Instruction #2

Q-1: What technique does gmane.py use to restart?

- A. Read items to be processed from a file and only gather data that isn't already in the database
- B. Keeps a count of the number of items retrieved and exits after a limit is reached
- C. Limits the number of items retrieved from the API on the API call
- D. Uses the primary key to know where to start when restarted

Check Me | Compare me

Problem: 3 -- Activity: 1 Multiple Choice (db-example-gmane)

Run gmodel.py

- Cleans and summarizes the data
  - Reads from content.sqlite and mapping.sqlite
  - Writes to index.sqlite

```
0587395416:gmane-orig barbarer$ python gmodel.py
Loaded allsenders 1771 and mapping 29 dns mapping 1
1 2005-12-08T23:34:30-06:00 ggolden22@mac.com
251 2005-12-22T10:03:20-08:00 tpamsler@ucdavis.edu
501 2006-01-12T11:17:34-05:00 lance@indiana.edu
751 2006-01-24T11:13:28-08:00 vrajgopalan@ucmerced.edu
1001 2006-02-02T08:27:30-07:00 john.ellis@rsmart.com
1251 2006-02-15T19:13:17-05:00 ggolden22@mac.com
1501 2006-02-23T16:49:00-05:00 csev@umich.edu
1751 2006-03-13T13:48:36-05:00 csev@umich.edu
```

Run gbasic.py

- Reports on the data
  - Top email list participants
  - Top email list organizations

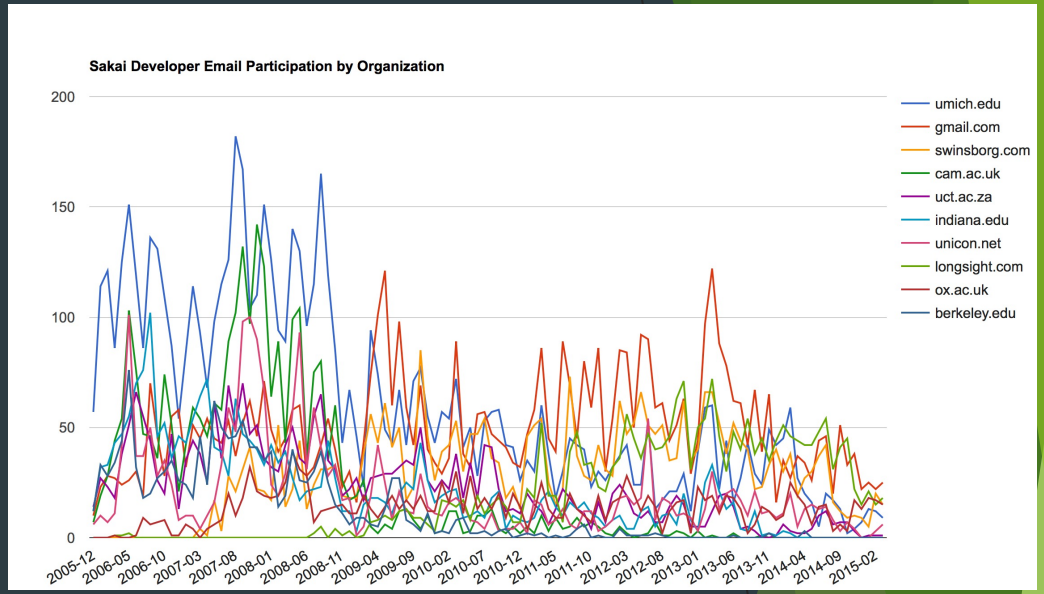
```
0587395416:gmane-orig barbarer$ python gbasic.py
How many to dump? 5
Loaded messages= 58970 subjects= 29065 senders= 1765

Top 5 Email list participants
steve.swinsburg@swinsborg.com 3303
azeckoski@unicon.net 1907
ian@cam.ac.uk 1591
csev@umich.edu 1471
david.horwitz@uct.ac.za 1221

Top 5 Email list organizations
umich.edu 6785
gmail.com 5588
swinsborg.com 3303
cam.ac.uk 2626
uct.ac.za 2577
```

Create the visualizations

- Run gline.py
  - Reads from index.sqlite
  - Writes to gline.js
- Run gword.py
  - Reads from index.sqlite
  - Writes gword.js

View the visualizations

- Open gline.htm in a browser
  - Line chart using d3.js



- Open gword.htm in a browser

How to Limit the Rows Stored to 25

- If your API has way to specify a limit, use it
- Keep a count of the number of new rows added to the database and break when you reach 25
  - Check that the data isn't in the database before you add it
  - Can use SELECT MAX(column) to get the highest number on a primary key
- Have the user input something like a city name and add 25 rows for that item
  - Or read data from a file (like city names)