

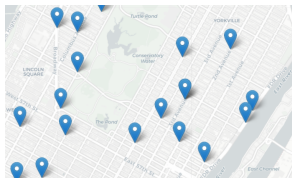
MfA: Python in the City



Katherine St. John
City University of New York
American Museum of Natural History

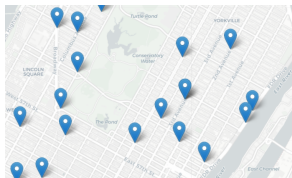
Goal: Sit at a table with someone who you did not sit with the first two sessions.

Outline



- Recap
- HTML-Scalable Maps: Folium
- Extracting Data
- geoJSON Format & Choropleth Maps
- Break
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- Wrap Up

Outline

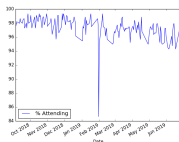
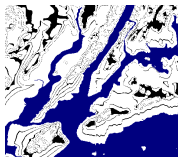


- **Recap**
- HTML-Scalable Maps: Folium
- Extracting Data
- geoJSON Format & Choropleth Maps
- Break
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- Wrap Up

Recap: Workshop Overview

Three sessions:

- ① Flood Maps (arrays & images)
- ② School Attendance (structured data, file I/O)
- ③ Mapping Collisions (using objects, mapping coordinates)



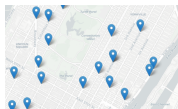
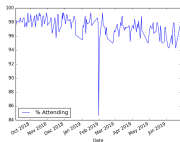
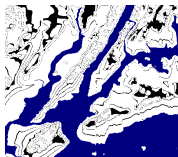
Recap: Workshop Overview

Three sessions:

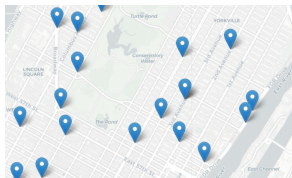
- 1 Flood Maps (arrays & images)
- 2 School Attendance (structured data, file I/O)
- 3 Mapping Collisions (using objects, mapping coordinates)

Each session:

- Design Challenge
 - ▶ Analyze a publicly available dataset
 - ▶ Introduce computing concepts & packages
 - ▶ Write a program to solve the problem
- Variations on the theme
- Design a Challenge

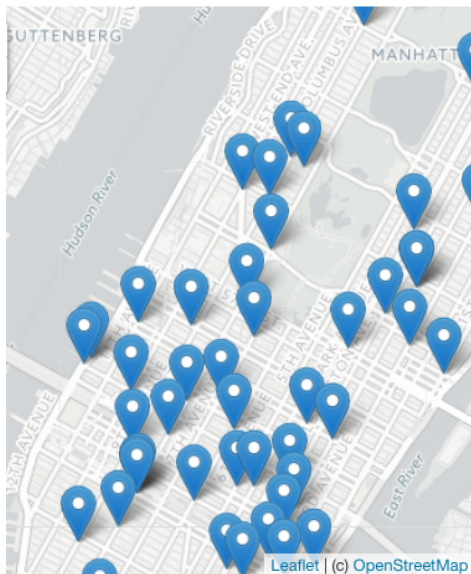


Outline



- Recap
- **HTML-Scalable Maps: Folium**
- Extracting Data
- geoJSON Format & Choropleth Maps
- Break
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- Wrap Up

HTML-Scalable Maps: Folium



Folium

- A module for making HTML maps.

Folium



Folium

Folium



- A module for making HTML maps.
- It's a Python interface to the popular `leaflet.js`.

Folium

Folium



- A module for making HTML maps.
- It's a Python interface to the popular `leaflet.js`.
- Outputs `.html` files which you can open in a browser.

Folium

Folium



- A module for making HTML maps.
- It's a Python interface to the popular `leaflet.js`.
- Outputs `.html` files which you can open in a browser.
- An extra step:

Folium

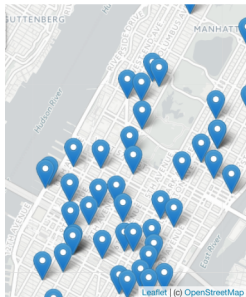
Folium



- A module for making HTML maps.
- It's a Python interface to the popular `leaflet.js`.
- Outputs `.html` files which you can open in a browser.
- An extra step:

Write code. → *Run program.* → *Open .html in browser.*

Demo



(Map created by Folium.)

Your turn: Make a map using folium

- To use:

```
import folium
```

Folium



Your turn: Make a map using folium

- To use:
`import folium`
- Create a map:
`myMap = folium.Map()`

Folium



Your turn: Make a map using folium

- To use:
`import folium`
- Create a map:
`myMap = folium.Map()`
- Make markers:
`newMark = folium.Marker([lat,lon],popup=name)`

Folium



Your turn: Make a map using folium

Folium



- To use:
`import folium`
- Create a map:
`myMap = folium.Map()`
- Make markers:
`newMark = folium.Marker([lat,lon],popup=name)`
- Add to the map:
`newMark.add_to(myMap)`

Your turn: Make a map using folium

Folium



- To use:
`import folium`
- Create a map:
`myMap = folium.Map()`
- Make markers:
`newMark = folium.Marker([lat,lon],popup=name)`
- Add to the map:
`newMark.add_to(myMap)`
- Can customize map with starting location, zoom level and background map ("tiles"):
`myMap = folium.Map(location=[40.75, -74.125],
zoom_start=10, tiles='Stamen Watercolor')`
Many options to customize background map ("tiles"):

Your turn: Make a map using folium

Folium



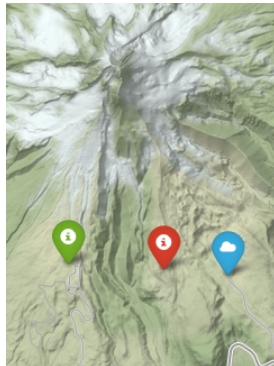
- To use:
`import folium`
- Create a map:
`myMap = folium.Map()`
- Make markers:
`newMark = folium.Marker([lat,lon],popup=name)`
- Add to the map:
`newMark.add_to(myMap)`
- Can customize map with starting location, zoom level and background map ("tiles"):
`myMap = folium.Map(location=[40.75, -74.125],
zoom_start=10, tiles='Stamen Watercolor')`
Many options to customize background map ("tiles"):
(Some background map options: 'Stamen Terrain',
'Stamen Watercolor', 'Mapbox Bright',
'Stamen Toner', 'Cartodb Positron')

In Pairs of Triples

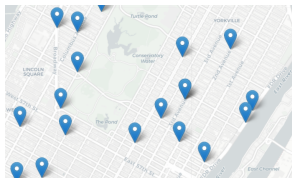
- Predict which each line of code does:

```
m = folium.Map(  
    location=[45.372, -121.6972],  
    zoom_start=12,  
    tiles='Stamen Terrain'  
)  
  
folium.Marker(  
    location=[45.3288, -121.6625],  
    popup='Mt. Hood Meadows',  
    icon=folium.Icon(icon='cloud')  
) .add_to(m)  
  
folium.Marker(  
    location=[45.3311, -121.7113],  
    popup='Timberline Lodge',  
    icon=folium.Icon(color='green')  
) .add_to(m)  
  
folium.Marker(  
    location=[45.3300, -121.6823],  
    popup='Some Other Location',  
    icon=folium.Icon(color='red', icon='info-sign')  
) .add_to(m)
```

(example from Folium documentation)



Outline



- Recap
- HTML-Scalable Maps: Folium
- **Extracting Data**
- geoJSON Format & Choropleth Maps
- Break
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- Wrap Up

Recall: Film Permits Example

NYC OpenData

Home Data About Learn Alerts Contact Us Blog Search Sign In

Film Permits

Permits are generally required when asserting the exclusive use of city property, like a sidewalk, a street, or a park. See <http://www1.nyc.gov/site/nycopen/parks/when-permit-required.page>

Find in this Dataset

More Views Filter Visualize Export Discuss Embed About

EventID	EventType	StartDate	EndDate	EnterDate	EventAg	ParkingHeld	Bor	Cent	Police	Catg	SubC	Count	ZipCo
45503	Shooting Permit	12/06/2018 07:00	12/06/2018 09:00	12/05/2018 12:35	Mayor's Office	STARKE AVENUE b...	Queens	2	108	Television	Episodic S...	United Sta...	11101
45467	Shooting Permit	12/06/2018 07:00	12/06/2018 09:00	12/04/2018 09:11	Mayor's Office	EAGLE STREET bet...	Brooklyn	1	84	Television	Episodic S...	United Sta...	11222
45481	Shooting Permit	12/06/2018 07:00	12/06/2018 07:00	12/04/2018 09:44	Mayor's Office	SOUTH OXFORD ...	Brooklyn	2, 6	76, 88	S&B Photo...	Not Applica...	United Sta...	11215, 11...
45400	Shooting Permit	12/06/2018 13:00	12/06/2018 11:00	12/04/2018 03:28	Mayor's Office	13 AVENUE betwe...	Queens	1, 3, 7	108, 7, 98	Film	Feature	United Sta...	10002, 11...
45414	Shooting Permit	12/06/2018 08:00	12/06/2018 11:00	12/04/2018 03:05	Mayor's Office	ELBERT STREET b...	Brooklyn	4, 6	104, 76, 83	Television	Episodic S...	United Sta...	11200, 11...
45409	Shooting Permit	12/05/2018 08:00	12/05/2018 09:00	12/04/2018 02:45	Mayor's Office	ELBERT STREET b...	Brooklyn	4	83	Television	Episodic S...	United Sta...	11227
45485	Shooting Permit	12/06/2018 07:00	12/06/2018 10:00	12/04/2018 02:17	Mayor's Office	35 STREET betwe...	Queens	1	114	Television	Cable-epic...	United Sta...	11101, 11...

- Download the data as a CSV file and store on your computer.
- Python program:

```
#CSci 127 Teaching Staff
#March 2019
#OpenData Film Permits
```

```
#Import pandas for reading and analyzing CSV data:
```

```
import pandas as pd
csvFile = "filmPermits.csv" #Name of the CSV file
tickets = pd.read_csv(csvFile)#Read in the file to a dataframe
print(tickets) #Print out the dataframe
print(tickets["ParkingHeld"]) #Print out streets (multiple times)
print(tickets["ParkingHeld"].value_counts()) #Print out streets & number of times used
print(tickets["ParkingHeld"].value_counts()[:10]) #Print 10 most popular
```

Extracting Data for a Map



Extracting Data for a Map

A	B	C	D	E	F	G	H	I	J	K
DATE	TIME	BOROUGH	ZIP CODE	LATITUDE	LONGITUDE	LOCATION	ON STREET	CROSS STREET	OFF STREET	NUMBER OF
10/18/16	8:10	STATEN ISLA	10312	40.5405508	-74.1931197	(40.5405508, -74.1931197)	RATHBUN AVE	NIPPON AVENUE		1
10/18/16	8:10	BROOKLYN	11228	40.6864547	-73.9681074	(40.6864547, -73.9681074)		107 GREE		1
10/18/16	8:10	BROOKLYN	11234	40.6261739	-73.9222334	(40.6261739, -73.9222334)		5515 AVE		1
10/18/16	8:10	BROOKLYN	11218	40.6312756	-73.976049	(40.6312756, -73.976049)	18 AVENUE	EAST 2 STREET		1
10/18/16	8:10	BROOKLYN	11217	40.6827366	-73.9722334	(40.6827366, -73.9722334)		718 ATLA		1
10/18/16	8:10			40.7741706	-73.82933	(40.7741706, -73.82933)				0
10/18/16	8:10			40.7713758	-73.877131	(40.7713758, -73.877131)				0
10/18/16	8:10			40.7415268	-73.78455	(40.7415268, -73.78455)				0
10/18/16	8:10			40.7365373	-73.856099	(40.7365373, -73.856099)				0
10/18/16	8:10			40.7361484	-73.926504	(40.7361484, -73.926504)				0
10/18/16	8:10	QUEENS	11426	40.7351801	-73.718346	(40.7351801, -73.718346)	HILLSIDE AVE	249 STREET		0
10/18/16	8:10	QUEENS	11417	40.6719314	-73.851635	(40.6719314, -73.851635)	NORTH CONE	84 STREET		0
10/18/16	8:10	QUEENS	11355	40.7606728	-73.8210074	(40.7606728, -73.8210074)			144-20 41	0
10/18/16	8:10	QUEENS	11103	40.7623893	-73.911797	(40.7623893, -73.911797)	44 STREET	30 AVENUE		0
10/18/16	8:10	QUEENS	11101	40.7462958	-73.930409	(40.7462958, -73.930409)	34 STREET	43 AVENUE		0
10/18/16	8:10	MANHATTAN	10035	40.8050573	-73.939034	(40.8050573, -73.939034)	EAST 125 ST	PARK AVENUE		0
10/18/16	8:10	MANHATTAN	10018	40.7556432	-73.990962	(40.7556432, -73.990962)			607 8 AVI	0
10/18/16	8:10	MANHATTAN	10016	40.7437832	-73.973508	(40.7437832, -73.973508)	EAST 34 ST	1 AVENUE		0
10/18/16	8:10	MANHATTAN	10011	40.7458255	-74.001812	(40.7458255, -74.001812)	WEST 22 STR	9 AVENUE		0
10/18/16	8:10	MANHATTAN	10003	40.7317985	-73.982114	(40.7317985, -73.982114)			251 1 AVI	0
10/18/16	8:10	BROOKLYN	11234	40.6166112	-73.926628	(40.6166112, -73.926628)	UTICA AVENUE	AVENUE O		0
10/18/16	8:10	BROOKLYN	11222	40.7317513	-73.945513	(40.7317513, -73.945513)	RUSSELL STR	GREENPOINT AVENUE		0
10/18/16	8:10	BROOKLYN	11206	40.707655	-73.939838	(40.707655, -73.939838)	BUSHWICK A	MONTROSE AVENUE		0
10/18/16	8:10	BRONX	10468	40.8716697	-73.897797	(40.8716697, -73.897797)	WEST 197 ST	RESERVOIR AVENUE		0

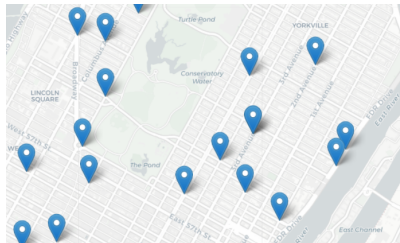
Extracting Data for a Map

A	B	C	D	E	F	G	H	I	J	K
DATE	TIME	BOROUGH	ZIP CODE	LATITUDE	LONGITUDE	LOCATION	ON STREET N	CROSS STREET	OFF STREET I	NUMBER OF
10/18/16	8:10	STATEN ISLA	10312	40.5405508	-74.1931197	(40.5405508, -74.1931197)	RATHBUN AVE	NIPPON AVENUE		1
10/18/16	8:10	BROOKLYN	11228	40.6864547	-73.9681074	(40.6864547, -73.9681074)		107 GREE		1
10/18/16	8:10	BROOKLYN	11234	40.6261739	-73.9222334	(40.6261739, -73.9222334)		5515 AVE		1
10/18/16	8:10	BROOKLYN	11218	40.6312756	-73.976049	(40.6312756, -73.976049)	18 AVENUE	EAST 2 STREET		1
10/18/16	8:10	BROOKLYN	11217	40.6827366	-73.9722334	(40.6827366, -73.9722334)		718 ATLA		1
10/18/16	8:10			40.7741706	-73.82933	(40.7741706, -73.8293296)				0
10/18/16	8:10			40.7713758	-73.877131	(40.7713758, -73.8771311)				0
10/18/16	8:10			40.7415268	-73.78455	(40.7415268, -73.7845496)				0
10/18/16	8:10			40.7365373	-73.856099	(40.7365373, -73.8560987)				0
10/18/16	8:10			40.7361484	-73.926504	(40.7361484, -73.9265043)				0
10/18/16	8:10	QUEENS	11426	40.7351801	-73.718346	(40.7351801, -73.718346)	HILLSIDE AVE	249 STREET		0
10/18/16	8:10	QUEENS	11417	40.6719314	-73.851635	(40.6719314, -73.851635)	NORTH CONE	84 STREET		0
10/18/16	8:10	QUEENS	11355	40.7606728	-73.821007	(40.7606728, -73.8210074)			144-20 41	0
10/18/16	8:10	QUEENS	11103	40.7623893	-73.911797	(40.7623893, -73.911797)	44 STREET	30 AVENUE		0
10/18/16	8:10	QUEENS	11101	40.7462958	-73.930409	(40.7462958, -73.930409)	34 STREET	43 AVENUE		0
10/18/16	8:10	MANHATTAN	10035	40.8050573	-73.939034	(40.8050573, -73.939034)	EAST 125 ST	PARK AVENUE		0
10/18/16	8:10	MANHATTAN	10018	40.7556432	-73.990962	(40.7556432, -73.9909619)			607 8 AVI	0
10/18/16	8:10	MANHATTAN	10016	40.7437832	-73.973508	(40.7437832, -73.973508)	EAST 34 ST	1 AVENUE		0
10/18/16	8:10	MANHATTAN	10011	40.7458255	-74.001812	(40.7458255, -74.001812)	WEST 22 ST	9 AVENUE		0
10/18/16	8:10	MANHATTAN	10003	40.7317985	-73.982114	(40.7317985, -73.9821143)			251 1 AVI	0
10/18/16	8:10	BROOKLYN	11234	40.6166112	-73.926628	(40.6166112, -73.926628)	UTICA AVENUE	AVENUE O		0
10/18/16	8:10	BROOKLYN	11222	40.7317513	-73.945513	(40.7317513, -73.945513)	RUSSELL STR	GREENPOINT AVENUE		0
10/18/16	8:10	BROOKLYN	11206	40.707655	-73.939838	(40.707655, -73.939838)	BUSHWICK AVE	MONTROSE AVENUE		0
10/18/16	8:10	BRONX	10468	40.8716697	-73.897797	(40.8716697, -73.897797)	WEST 197 ST	RESERVOIR AVENUE		0



Extracting Data for a Map

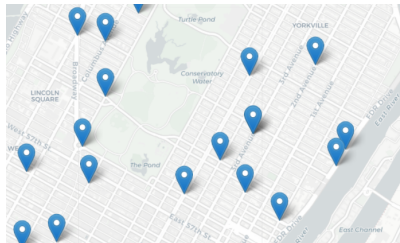
A	B	C	D	E	F	G	H	I	J	K
DATE	TIME	BOROUGH	ZIP CODE	LATITUDE	LONGITUDE	LOCATION	ON STREET	CROSS STREET	OFF STREET	NUMBER OF
10/18/16	8:10	STATEN ISLA	10312	40.5405508	-74.1931197	(40.5405508, -74.1931197)	RATHBUN AVE	NIPPON AVENUE		1
10/18/16	8:10	BROOKLYN	11228	40.6864547	-73.9681074	(40.6864547, -73.9681074)		107 GREE		1
10/18/16	8:10	BROOKLYN	11234	40.6261739	-73.9222334	(40.6261739, -73.9222334)		5515 AVE		1
10/18/16	8:10	BROOKLYN	11218	40.6312756	-73.976049	(40.6312756, -73.976049)	18 AVENUE	EAST 2 STREET		1
10/18/16	8:10	BROOKLYN	11217	40.6827366	-73.9722334	(40.6827366, -73.9722334)		718 ATLA		1
10/18/16	8:10			40.7741706	-73.82933	(40.7741706, -73.8293296)				0
10/18/16	8:10			40.7713758	-73.877131	(40.7713758, -73.8771311)				0
10/18/16	8:10			40.7415268	-73.78455	(40.7415268, -73.7845496)				0
10/18/16	8:10			40.7365373	-73.856099	(40.7365373, -73.8560987)				0
10/18/16	8:10			40.7361484	-73.926504	(40.7361484, -73.9265043)				0
10/18/16	8:10	QUEENS	11426	40.7351801	-73.718346	(40.7351801, -73.718346)	HILLSIDE AVE	249 STREET		0
10/18/16	8:10	QUEENS	11417	40.6719314	-73.851635	(40.6719314, -73.851635)	NORTH CONE	84 STREET		0
10/18/16	8:10	QUEENS	11355	40.7606728	-73.8210074	(40.7606728, -73.8210074)			144-20 41	0
10/18/16	8:10	QUEENS	11103	40.7623893	-73.911797	(40.7623893, -73.911797)	44 STREET	30 AVENUE		0
10/18/16	8:10	QUEENS	11101	40.7462958	-73.930409	(40.7462958, -73.930409)	34 STREET	43 AVENUE		0
10/18/16	8:10	MANHATTAN	10035	40.8050573	-73.939034	(40.8050573, -73.939034)	EAST 125 ST	PARK AVENUE		0
10/18/16	8:10	MANHATTAN	10018	40.7556432	-73.990962	(40.7556432, -73.9909619)		607 8 AVI		0
10/18/16	8:10	MANHATTAN	10016	40.7437832	-73.973508	(40.7437832, -73.973508)	EAST 34 ST	1 AVENUE		0
10/18/16	8:10	MANHATTAN	10011	40.7458255	-74.001812	(40.7458255, -74.001812)	WEST 22 ST	9 AVENUE		0
10/18/16	8:10	MANHATTAN	10003	40.7317985	-73.982114	(40.7317985, -73.9821143)		251 1 AVI		0
10/18/16	8:10	BROOKLYN	11234	40.6166112	-73.926628	(40.6166112, -73.926628)	UTICA AVENUE	AVENUE O		0
10/18/16	8:10	BROOKLYN	11222	40.7317513	-73.945513	(40.7317513, -73.945513)	RUSSELL STR	GREENPOINT AVENUE		0
10/18/16	8:10	BROOKLYN	11206	40.707655	-73.939838	(40.707655, -73.939838)	BUSHWICK A	MONTROSE AVENUE		0
10/18/16	8:10	BRONX	10468	40.8716697	-73.897797	(40.8716697, -73.897797)	WEST 197 ST	RESERVOIR AVENUE		0



- Download the data as a CSV file and store on your computer.

Extracting Data for a Map

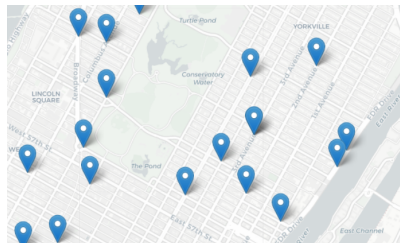
A	B	C	D	E	F	G	H	I	J	K
DATE	TIME	BOROUGH	ZIP CODE	LATITUDE	LONGITUDE	LOCATION	ON STREET	CROSS STREET	OFF STREET	NUMBER OF
10/18/16	8:10	STATEN ISLA	10312	40.5405508	-74.193197	(40.5405508, -74.193197)	RATHBUN AVE	NIPPON AVENUE		1
10/18/16	8:10	BROOKLYN	11228	40.6864547	-73.9681071	(40.6864547, -73.9681071)		GREE		1
10/18/16	8:10	BROOKLYN	11234	40.6261739	-73.922234	(40.6261739, -73.922234)		5515 AVE		1
10/18/16	8:10	BROOKLYN	11218	40.6312756	-73.976049	(40.6312756, -73.976049)	18 AVENUE	EAST 2 STREET		1
10/18/16	8:10	BROOKLYN	11217	40.6827366	-73.972234	(40.6827366, -73.972234)			718	ATLA
10/18/16	8:10			40.7741706	-73.82933	(40.7741706, -73.82933)				0
10/18/16	8:10			40.7713758	-73.877131	(40.7713758, -73.877131)				0
10/18/16	8:10			40.7415268	-73.78455	(40.7415268, -73.78455)				0
10/18/16	8:10			40.7365373	-73.856099	(40.7365373, -73.856099)				0
10/18/16	8:10			40.7361484	-73.9265043	(40.7361484, -73.9265043)				0
10/18/16	8:10	QUEENS	11426	40.7351801	-73.718346	(40.7351801, -73.718346)	HILLSIDE AVE	249 STREET		0
10/18/16	8:10	QUEENS	11417	40.6719314	-73.851635	(40.6719314, -73.851635)	NORTH CONE	84 STREET		0
10/18/16	8:10	QUEENS	11355	40.7606728	-73.821007	(40.7606728, -73.821007)			144-20	41
10/18/16	8:10	QUEENS	11103	40.7623893	-73.911797	(40.7623893, -73.911797)	44 STREET	30 AVENUE		0
10/18/16	8:10	QUEENS	11101	40.7462958	-73.930409	(40.7462958, -73.930409)	34 STREET	43 AVENUE		0
10/18/16	8:10	MANHATTAN	10035	40.8050573	-73.939034	(40.8050573, -73.939034)	EAST 125 ST	PARK AVENUE		0
10/18/16	8:10	MANHATTAN	10018	40.7556432	-73.990962	(40.7556432, -73.990962)			607	8 AVI
10/18/16	8:10	MANHATTAN	10016	40.7437832	-73.973508	(40.7437832, -73.973508)	EAST 34 ST	1 AVENUE		0
10/18/16	8:10	MANHATTAN	10013	40.7458255	-74.003812	(40.7458255, -74.003812)	WEST 22 ST	9 AVENUE		0
10/18/16	8:10	MANHATTAN	10003	40.7317985	-73.982114	(40.7317985, -73.982114)			251	1 AVI
10/18/16	8:10	BROOKLYN	11234	40.6166112	-73.926628	(40.6166112, -73.926628)	UTICA AVENUE			0
10/18/16	8:10	BROOKLYN	11222	40.7317513	-73.945513	(40.7317513, -73.945513)	RUSSELL STR	GREENPOINT AVENUE		0
10/18/16	8:10	BROOKLYN	11206	40.707655	-73.939838	(40.707655, -73.939838)	BUSHWICK A	MONTROSE AVENUE		0
10/18/16	8:10	BRONX	10468	40.8716697	-73.897797	(40.8716697, -73.897797)	WEST 197 ST	RESERVOIR AVENUE		0



- Download the data as a CSV file and store on your computer.
- Filter for latitude and longitude not blank.

Extracting Data for a Map

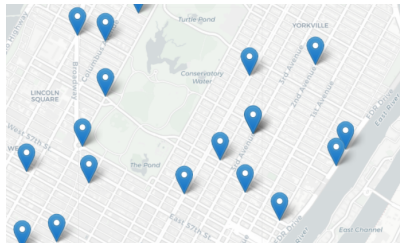
A	B	C	D	E	F	G	H	I	J	K
DATE	TIME	BOROUGH	ZIP CODE	LATITUDE	LONGITUDE	LOCATION	ON STREET	CROSS STREET	OFF STREET	NUMBER OF
10/18/16	8:10	STATEN ISLA	10312	40.5405508	-74.193197	(40.5405508 RATHBUN AVE NIPPON AVENUE				1
10/18/16	8:10	BROOKLYN	11228	40.6864547	-73.968107	(40.6864547, -73.9681074)			107 GREE	1
10/18/16	8:10	BROOKLYN	11234	40.6261739	-73.922234	(40.6261739, -73.9222336)			5515 AVE	1
10/18/16	8:10	BROOKLYN	11218	40.6312756	-73.976049	(40.6312756, -73.976049)			EAST 2 STREET	1
10/18/16	8:10	BROOKLYN	11217	40.6827366	-73.972234	(40.6827366, -73.9722339)			718 ATLA	1
10/18/16	8:10			40.7741706	-73.82933	(40.7741706, -73.8293296)				0
10/18/16	8:10			40.7713758	-73.877131	(40.7713758, -73.8771311)				0
10/18/16	8:10			40.7415268	-73.78455	(40.7415268, -73.7845496)				0
10/18/16	8:10			40.7365373	-73.856099	(40.7365373, -73.8560987)				0
10/18/16	8:10			40.7361484	-73.926504	(40.7361484, -73.9265043)				0
10/18/16	8:10	QUEENS	11426	40.7351801	-73.718346	(40.7351801, -73.718346)			HILLSIDE AVE 249 STREET	0
10/18/16	8:10	QUEENS	11417	40.6719314	-73.851635	(40.6719314, -73.851635)			NORTH CONE 84 STREET	0
10/18/16	8:10	QUEENS	11355	40.7606728	-73.821007	(40.7606728, -73.8210074)			144-20 41	0
10/18/16	8:10	QUEENS	11103	40.7623893	-73.911797	(40.7623893, -73.911797)			30 AVENUE	0
10/18/16	8:10	QUEENS	11101	40.7462958	-73.930409	(40.7462958, -73.930409)			43 AVENUE	0
10/18/16	8:10	MANHATTAN	10035	40.8050573	-73.939034	(40.8050573, -73.939034)			EAST 125 ST PARK AVENUE	0
10/18/16	8:10	MANHATTAN	10018	40.7556432	-73.990962	(40.7556432, -73.9909619)			607 8 AVI	0
10/18/16	8:10	MANHATTAN	10016	40.7437832	-73.973508	(40.7437832, -73.973508)			EAST 34 STR 1 AVENUE	0
10/18/16	8:10	MANHATTAN	10011	40.7458255	-74.001812	(40.7458255, -74.001812)			WEST 22 STR 9 AVENUE	0
10/18/16	8:10	MANHATTAN	10003	40.7317985	-73.982114	(40.7317985, -73.9821143)			251 1 AVI	0
10/18/16	8:10	BROOKLYN	11234	40.6166112	-73.926628	(40.6166112, -73.926628)			UTICA AVENUE O	0
10/18/16	8:10	BROOKLYN	11222	40.7317513	-73.945513	(40.7317513, -73.945513)			RUSSELL STR GREENPOINT AVENUE	0
10/18/16	8:10	BROOKLYN	11206	40.707655	-73.939838	(40.707655, -73.939838)			BUSHWICK A MONTROSE AVENUE	0
10/18/16	8:10	BRONX	10468	40.8716697	-73.897797	(40.8716697, -73.897797)			WEST 197 ST RESERVOIR AVENUE	0



- Download the data as a CSV file and store on your computer.
- Filter for latitude and longitude not blank.
- Use pandas to read in data.

Extracting Data for a Map

A	B	C	D	E	F	G	H	I	J	K
DATE	TIME	BOROUGH	ZIP CODE	LATITUDE	LONGITUDE	LOCATION	ON STREET	CROSS STREET	OFF STREET	NUMBER OF
10/18/16	8:10	STATEN ISLA	10312	40.5405508	-74.193197	(40.5405508 RATHBUN AVE	NIPPOON AVENUE			1
10/18/16	8:10	BROOKLYN	11238	40.6864547	-73.968107	(40.6864547, -73.9681074)		107	GREE	1
10/18/16	8:10	BROOKLYN	11234	40.6261739	-73.922234	(40.6261739, -73.9222336)		5515	AVEI	1
10/18/16	8:10	BROOKLYN	11218	40.6312756	-73.976049	(40.6312756 18 AVENUE	EAST 2 STREET			1
10/18/16	8:10	BROOKLYN	11217	40.6827366	-73.972234	(40.6827366, -73.9722339)		718	ATLA	1
10/18/16	8:10			40.7741706	-73.82933	(40.7741706, -73.8293296)				0
10/18/16	8:10			40.7713758	-73.877131	(40.7713758, -73.8771311)				0
10/18/16	8:10			40.7415268	-73.784655	(40.7415268, -73.7846496)				0
10/18/16	8:10			40.7365373	-73.856099	(40.7365373, -73.8560987)				0
10/18/16	8:10			40.7361484	-73.926504	(40.7361484, -73.9265043)				0
10/18/16	8:10	QUEENS	11426	40.7351801	-73.718346	(40.7351801 HILLSIDE AVE	249 STREET			0
10/18/16	8:10	QUEENS	11417	40.6719314	-73.851635	(40.6719314 NORTH CONI	84 STREET			0
10/18/16	8:10	QUEENS	11355	40.7606728	-73.821007	(40.7606728, -73.8210074)		144-20	41	0
10/18/16	8:10	QUEENS	11103	40.7623893	-73.911797	(40.7623893 44 STREET	30 AVENUE			0
10/18/16	8:10	QUEENS	11101	40.7462958	-73.930409	(40.7462958 34 STREET	43 AVENUE			0
10/18/16	8:10	MANHATTAN	10035	40.8050573	-73.939034	(40.8050573 EAST 125 ST	PARK AVENUE			0
10/18/16	8:10	MANHATTAN	10018	40.7556432	-73.990962	(40.7556432, -73.9909619)		607	8 AVI	0
10/18/16	8:10	MANHATTAN	10016	40.7437832	-73.973508	(40.7437832 EAST 34 STR	1 AVENUE			0
10/18/16	8:10	MANHATTAN	10011	40.7458255	-74.003812	(40.7458255 WEST 22 STR	9 AVENUE			0
10/18/16	8:10	MANHATTAN	10003	40.7317985	-73.982114	(40.7317985, -73.9821143)		251	1 AVI	0
10/18/16	8:10	BROOKLYN	11234	40.6166112	-73.926628	(40.6166112 UTICA AVENUE	O			0
10/18/16	8:10	BROOKLYN	11222	40.7317513	-73.945513	(40.7317513 RUSSELL STR	GREENPOINT AVENUE			0
10/18/16	8:10	BROOKLYN	11206	40.707655	-73.939838	(40.707655, BUSHWICK A	MONROSE AVENUE			0
10/18/16	8:10	BRONX	10468	40.8716697	-73.897797	(40.8716697 WEST 197 ST	RESERVOIR AVENUE			0



- Download the data as a CSV file and store on your computer.
- Filter for latitude and longitude not blank.
- Use pandas to read in data.
- Many ways to extract from pandas:

Since we are going row-by-row to create objects, will iterate through the df.

Extracting Data for a Map

- Python program:

Extracting Data for a Map

- Python program:

```
#Mapping Collisions
```

```
#Libraries
```

```
import folium
```

```
import pandas as pd
```

Extracting Data for a Map

- Python program:

```
#Mapping Collisions

#Libraries
import folium
import pandas as pd

#Getting file names:
inF = input('Enter CSV file name: ')
outF = input('Enter output file: ')
coll = pd.read_csv(inF)
```


Extracting Data for a Map

- Python program:

```
#Mapping Collisions

#Libraries
import folium
import pandas as pd

#Getting file names:
inF = input('Enter CSV file name: ')
outF = input('Enter output file: ')
coll = pd.read_csv(inF)

#Setting up the map:
mapCollisions = folium.Map(location=[40.768731, -73.964915],\
                             tiles="Cartodb Positron",zoom_start=11)
```

Extracting Data for a Map

- Python program:

```
#Mapping Collisions

#Libraries
import folium
import pandas as pd

#Getting file names:
inF = input('Enter CSV file name: ')
outF = input('Enter output file: ')
coll = pd.read_csv(inF)

#Setting up the map:
mapCollisions = folium.Map(location=[40.768731, -73.964915],\
                             tiles="Cartodb Positron",zoom_start=11)

#Looping through the file:
for index,row in coll.iterrows():
    lat = row["LATITUDE"]
    lon = row["LONGITUDE"]
    popname = row["CRASH TIME"]
    newMarker = folium.CircleMarker([lat, lon], popup=popname,\
                                     radius=5,color='blue')
    newMarker.add_to(mapCollisions)
```

Extracting Data for a Map

- Python program:

```
#Mapping Collisions

#Libraries
import folium
import pandas as pd

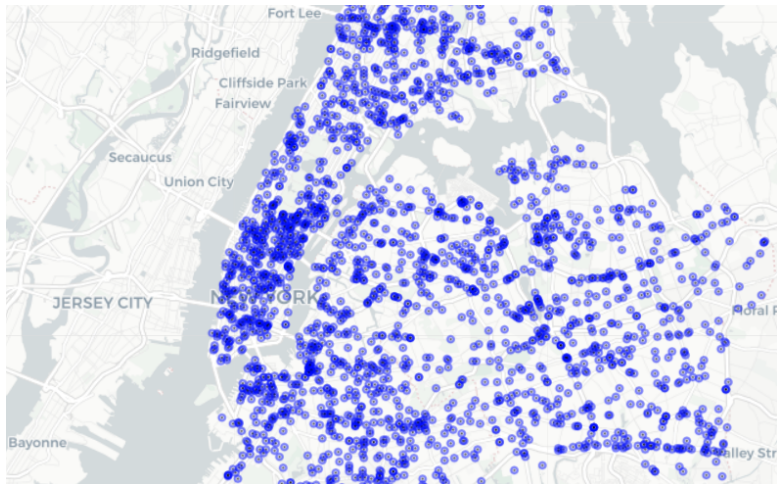
#Getting file names:
inF = input('Enter CSV file name: ')
outF = input('Enter output file: ')
coll = pd.read_csv(inF)

#Setting up the map:
mapCollisions = folium.Map(location=[40.768731, -73.964915],\
                             tiles="Cartodb Positron",zoom_start=11)

#Looping through the file:
for index,row in coll.iterrows():
    lat = row["LATITUDE"]
    lon = row["LONGITUDE"]
    popname = row["CRASH TIME"]
    newMarker = folium.CircleMarker([lat, lon], popup=popname,\
                                     radius=5,color='blue')
    newMarker.add_to(mapCollisions)

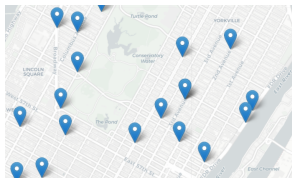
#Saving the HTML file:
mapCollisions.save(outfile=outF)
```

Extracting Data



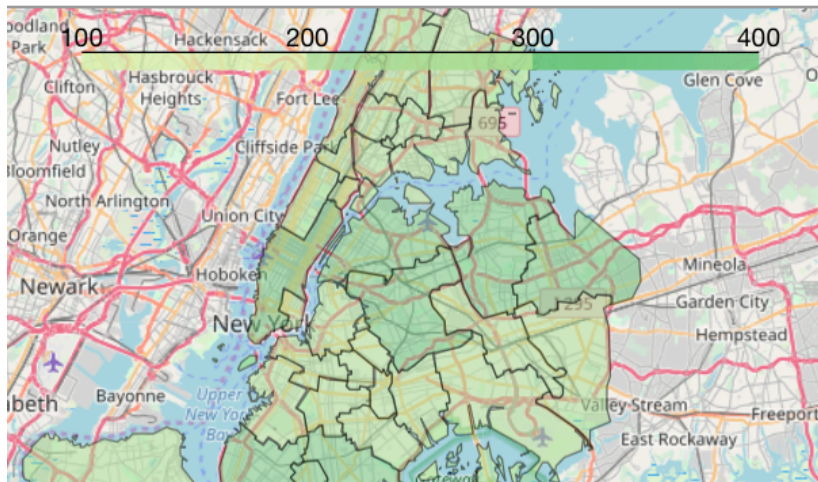
Make a map with only the accidents during evening rush hour.

Outline



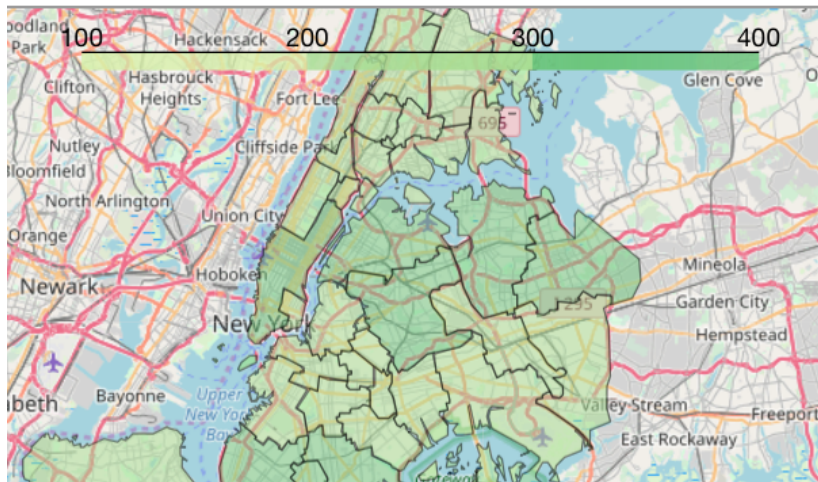
- Recap
- HTML-Scalable Maps: Folium
- Extracting Data
- **geoJSON Format & Choropleth Maps**
- Break
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- Wrap Up

geoJSON Format & Choropleth Maps



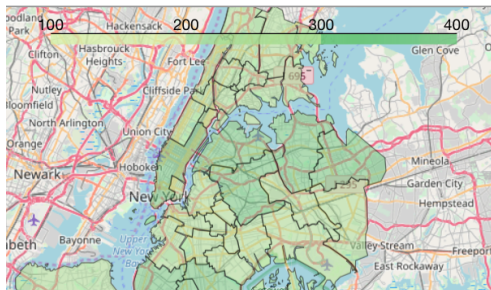
School districts shaded by math test scores.

geoJSON Format & Choropleth Maps



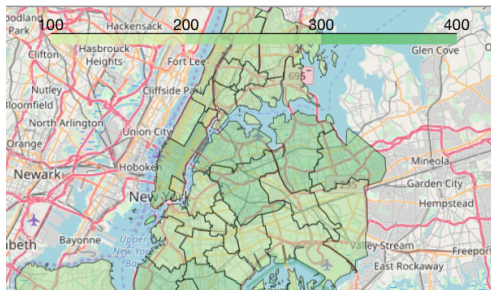
School districts shaded by math test scores.

geoJSON Format & Choropleth Maps



School districts shaded by math test scores.

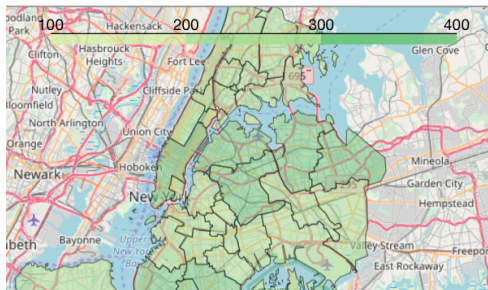
geoJSON Format & Choropleth Maps



School districts shaded by math test scores.

Two data files:

geoJSON Format & Choropleth Maps

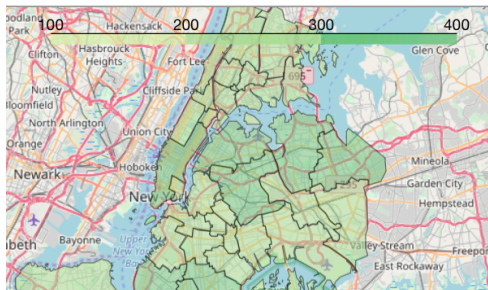


School districts shaded by math test scores.

Two data files:

- geoJSON file with polygonal regions (from OpenData NYC Planning)

geoJSON Format & Choropleth Maps



School districts shaded by math test scores.

Two data files:

- geoJSON file with polygonal regions (from OpenData NYC Planning)
- CSV file with test scores (NYC Department of Education)

geoJSON Format & Choropleth Maps

```
#Import folium for maps and pandas for data wrangling
import folium
import pandas as pd

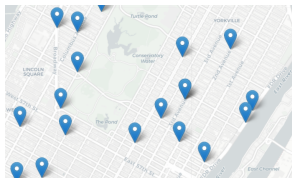
#Read in the test scores
fullData = pd.read_csv('math20132016.csv', skiprows = 6)
#Grab only 2016 data:
scores2016 = fullData[fullData.Year == 2016]
#Focus on 8th grade:
scores8th2016 = scores2016[fullData.Grade == "8"]
print(scores8th2016)

#Create a map:
schoolMap = folium.Map(location=[40.75, -74.125])

#Create a layer, shaded by test scores:
schoolMap.choropleth(geo_path="schoolDistricts.json",
                    fill_color='YlGn', fill_opacity=0.5, line_opacity=0.5,
                    threshold_scale = [100,200,300,400],
                    data = scores8th2016,
                    key_on='feature.properties.SchoolDist',
                    columns = ['district', 'Mean Scale Score']
                    )

#Output the map to an .html file:
schoolMap.save(outfile='testScores.html')
```

Outline

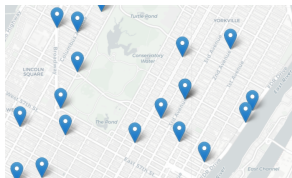


- Recap
- HTML-Scalable Maps: Folium
- Extracting Data
- geoJSON Format & Choropleth Maps
- **Break**
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- Wrap Up

Break

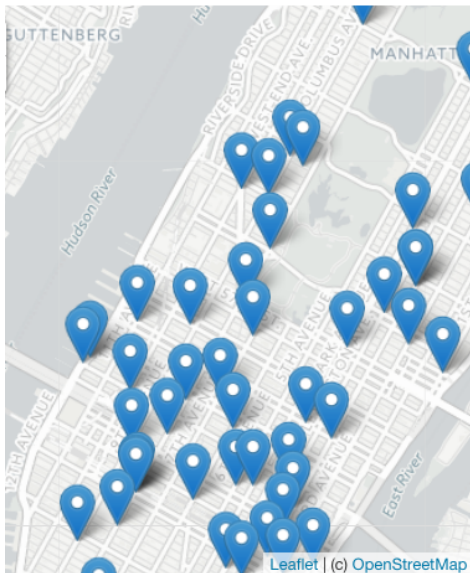


Outline

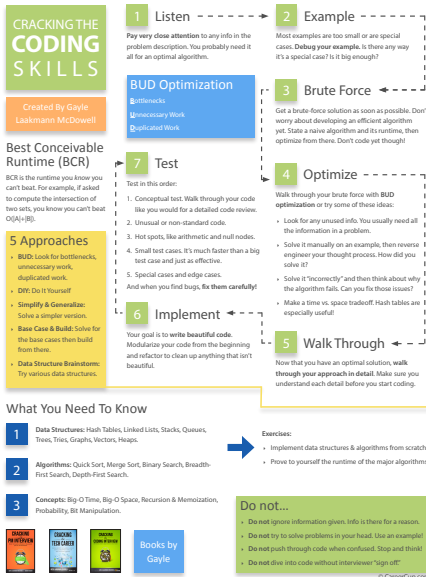


- Recap
- HTML-Scalable Maps: Folium
- Extracting Data
- geoJSON Format & Choropleth Maps
- Break
- **Design Challenge: Catchment Areas**
- Design Challenge: Clustering Data
- Wrap Up

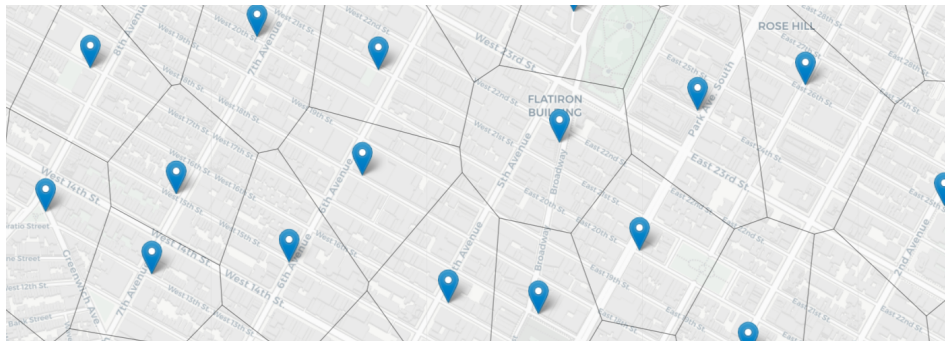
Design Challenge: Catchment Areas



Design Challenge: Approaching Problems

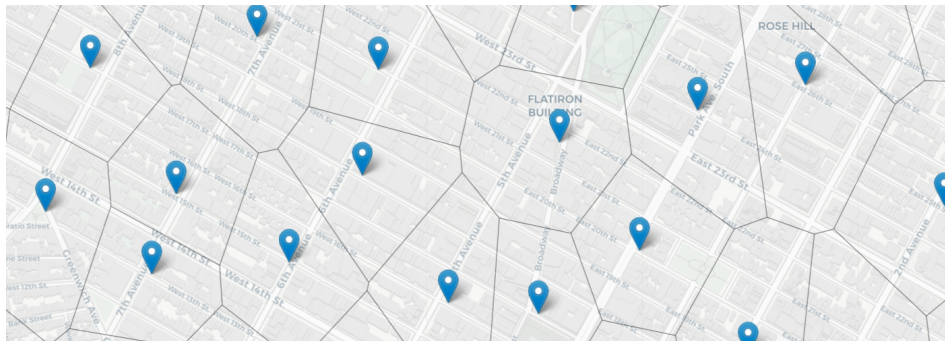


Design Challenge: Catchment Areas



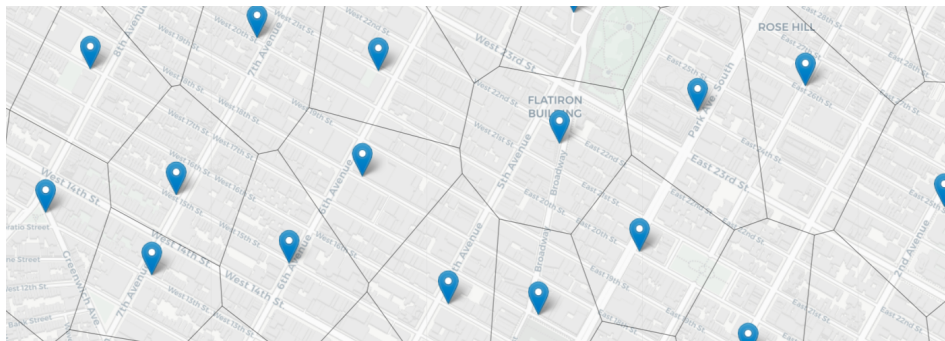
- Called **Voronoi Diagrams**.

Design Challenge: Catchment Areas



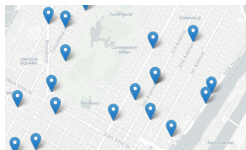
- Called **Voronoi Diagrams**.
- Can be computed in $O(n^2)$ time: many different approaches.

Design Challenge: Catchment Areas



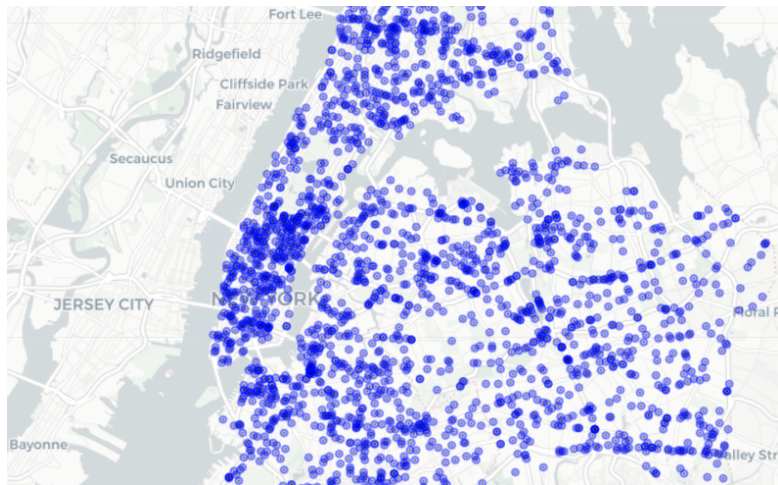
- Called **Voronoi Diagrams**.
- Can be computed in $O(n^2)$ time: many different approaches.
- Share your approaches.

Outline



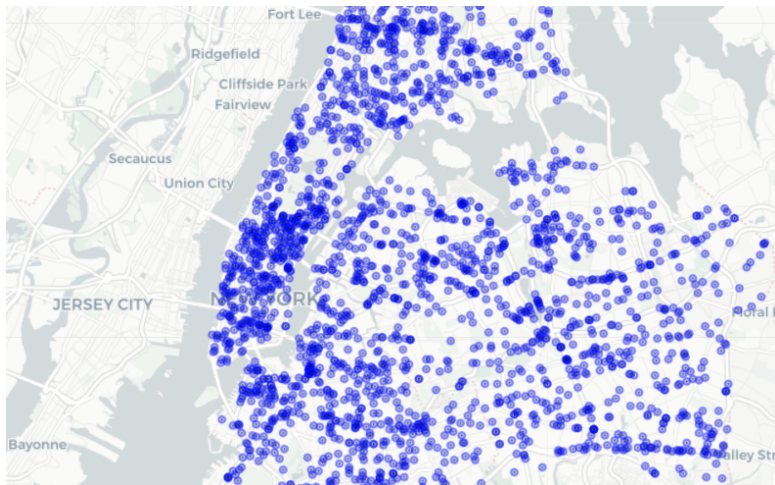
- Recap
- HTML-Scalable Maps: Folium
- Extracting Data
- geoJSON Format & Choropleth Maps
- Break
- Design Challenge: Catchment Areas
- **Design Challenge: Clustering Data**
- Wrap Up

Design Challenge: Clustering Data



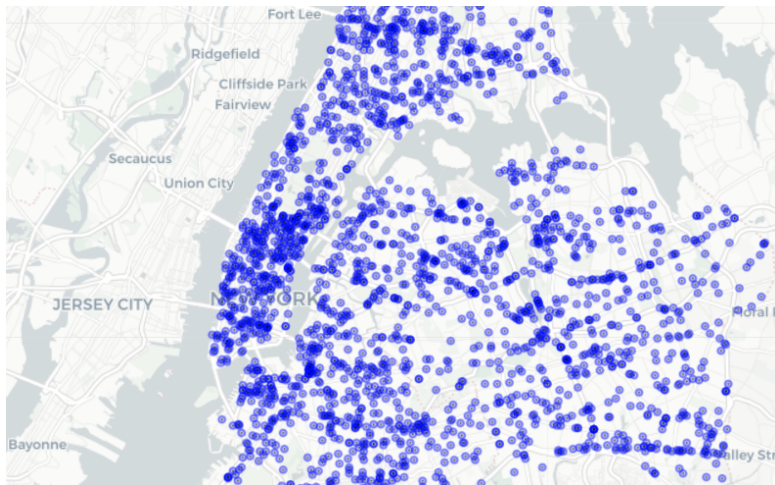
You have 3 emergency service trucks.

Design Challenge: Clustering Data



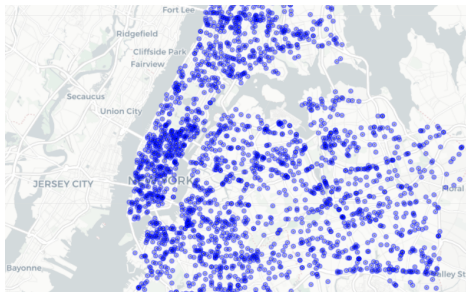
*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

Design Challenge: Clustering Data



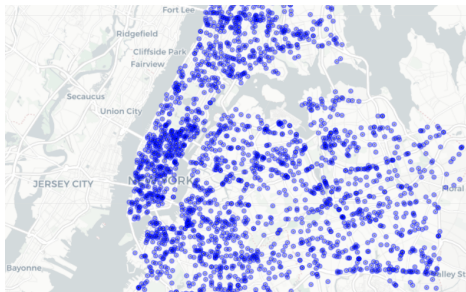
*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

Design Challenge: Clustering Data



*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

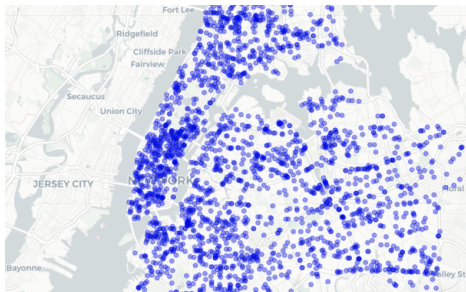
Design Challenge: Clustering Data



*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

- Called ***k*-means clustering**.

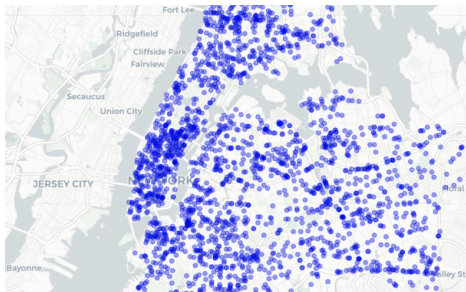
Design Challenge: Clustering Data



*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

- Called ***k*-means clustering**.
- Computationally hard to compute.

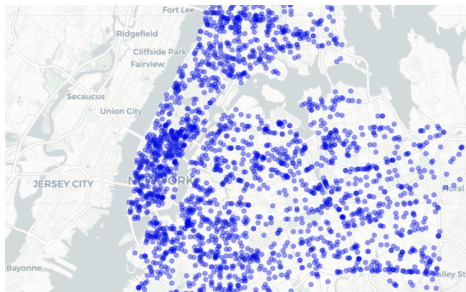
Design Challenge: Clustering Data



*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

- Called ***k*-means clustering**.
- Computationally hard to compute.
- Intuition for why: allowed to place the trucks anywhere (not restricted to inputted points) so many, many possible locations.

Design Challenge: Clustering Data

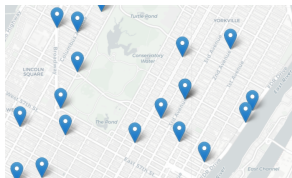


*You have 3 emergency service trucks.
Where to put them to minimize distances to collisions?*

- Called ***k*-means clustering**.
- Computationally hard to compute.
- Intuition for why: allowed to place the trucks anywhere (not restricted to inputted points) so many, many possible locations.
- Approximations used instead.

Wrap Up

Outline



- Recap
- HTML-Scalable Maps: Folium
- Extracting Data
- geoJSON Format & Choropleth Maps
- Break
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data
- **Wrap Up**

Wrap-Up



- Three sessions:
 - ① Flood Maps (arrays & images)
 - ② School Attendance (structured data, file I/O)
 - ③ Mapping Collisions (using objects, mapping coordinates)
- HTML-Scalable Maps: Folium
- Extracting Data: more on pandas
- geoJSON Format & Choropleth Maps
- Design Challenge: Catchment Areas
- Design Challenge: Clustering Data