



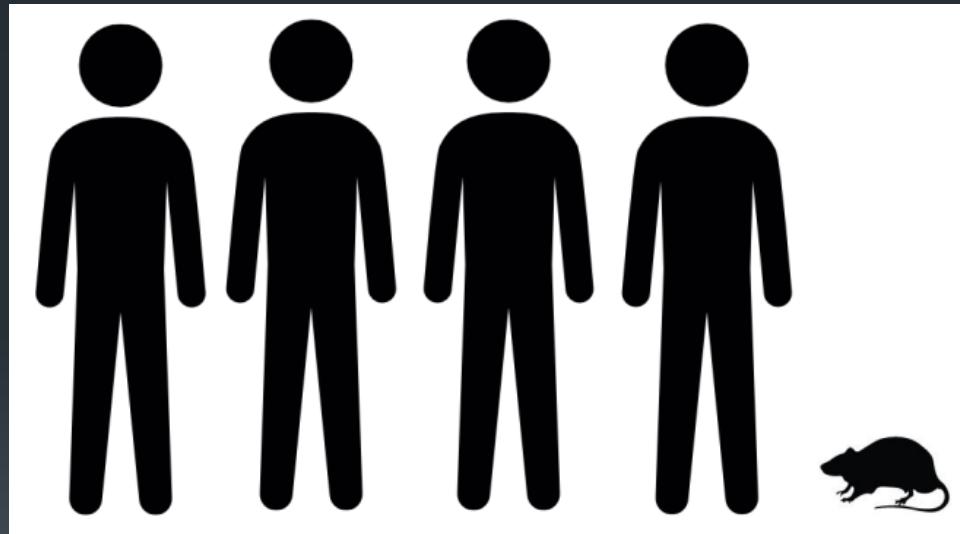
New York City rat population

Liam O'Brien

Huy Phan

Statistics

- New York City population:
 - 8.538 million (as of 2016)
- New York City rat population:
 - Estimated to be approximately 2 million



- Roughly 4 New Yorkers for every 1 rat

Collection

- New Yorkers can call 3-1-1 and report rats to NY DOHMH or do so online
- DOHMH adds information to their database
- City sends exterminators to remove vermin... eventually
- DOHMH released their database as a .csv file to Kaggle
- Data is from January 2010 to Sept 2017

Information on rats

- Rats can carry diseases
 - E. coli, salmonella, pathogens, etc...
- Rats can squeeze through holes the size of a quarter
 - Their skull is not plated, so it can change shape
- Rats can jump as high as 4 feet and fall up to 5 stories without serious injury
- Rats can tread water for up to 3 days
- They reproduce every 2 months
- They can have a litter size up to 12 rats
- Life span of a rat is approximately 1 year



CSV file

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
1	Unique Key	Created Date	Closed Date	Agency	Agency Nam	Complaint Ty	Descriptor	Location Typ	Incident Zip	Incident Add Street Name	Cross Street	Cross Street	Intersection	Intersection	Address Type	City	Landmark	Facility Type	Status	Due Date	Resol	
2	31464015	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Mi	10006					TRINITY PLAC	RECTOR STR	INTERSECTIC	NEW YORK		N/A	Closed	#####	#####	
3	31464024	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Commercial	10306	2270 HYLAN	HYLAN BOULEVARD			LATLONG	STATEN ISLAND	N/A	Closed	#####	#####	#####	#####		
4	31464025	9/4/15 0:00	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	10310	758 POST AV	POST AVENUE	CARY AVENUE	GREENLEAF AVENUE			ADDRESS	STATEN ISLAND	N/A	Assigned	#####	#####	#####	
5	31464026	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11206	198 SCHOLE	SCHOLE ST	HUMBOLDT	BUSHWICK AVENUE			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	#####	
6	31464027	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Mi	10462	2138 WALLA	WALLACE AV	BRADY AVEN	LYDIG AVENUE			ADDRESS	BRONX	N/A	Closed	#####	#####	#####	
7	31464188	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11231	179 LUQUER	LUQUER STR	CLINTON STF	COURT STREET			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	#####	
8	31464195	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11354	33-38 PARSC	PARSONS BC	33 AVENUE	34 AVENUE			ADDRESS	FLUSHING	N/A	Closed	#####	#####	#####	
9	31464199	9/4/15 0:00	DOHMH	Department	Rodent	Rat Sighting	3+ Family Mi	11205	143 CLASSON	CLASSON AV	PARK AVENUE	MYRTLE AVENUE			ADDRESS	BROOKLYN	N/A	Assigned	#####	#####	#####	
10	31464220	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Public Stairs	10010					PARK AVENUE EAST	23 STR	INTERSECTIC	NEW YORK	N/A	Pending	#####	#####	#####	#####
11	31464802	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	10303	30 ANDROS	ANDROS AVE	RICHMOND	CHRISTOPHER STREET			ADDRESS	STATEN ISLAND	N/A	Closed	#####	#####	#####	
12	31464803	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Commercial	11226	608 EAST	1 EAST	16 ST	NEWKIRK AV	FOSTER AVENUE			ADDRESS	BROOKLYN	N/A	Pending	#####	#####	#####
13	31464858	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11238	CLIFTON PLA	CLIFTON PLA	GRAND AVEN	CLASSEN AVENUE			BLOCKFACE	BROOKLYN	N/A	Closed	#####	#####	#####	
14	31464871	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Other (Explai	11201	80 DEKALB A	DEKALB AVE	HUDSON AV	NAVY STREET			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	#####	
15	31464877	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Mi	10003	315 EAST	5 EAST	5 STR	2 AVENUE	1 AVENUE			ADDRESS	NEW YORK	N/A	Closed	#####	#####	#####
16	31464880	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11217	680 DEGRAW	DEGRAW STR	4 AVENUE	5 AVENUE			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	#####	
17	31464881	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11217	706 DEGRAW	DEGRAW STR	4 AVENUE	5 AVENUE			ADDRESS	BROOKLYN	N/A	Pending	#####	#####	9/4/15	
18	31464899	9/4/15 0:00 9/15 0:00	DOHMH	Department	Rodent	Rat Sighting	3+ Family Mi	10474	541 COSTER	COSTER STR	OAK POINT A	RANDALL AVENUE			ADDRESS	BRONX	N/A	Pending	#####	#####	9/15/00	
19	31464977	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10468	135 EAST KIN	EAST KINGSB	CRESTON AV	GRAND CONCOURSE			ADDRESS	BRONX	N/A	Closed	#####	#####	#####	
20	31465664	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11201	177 COLUM	EAST COLUMBIA	HEIGHTS			LATLONG	BROOKLYN	N/A	Closed	#####	#####	#####		
21	31465666	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10034	4915 BROAD	BROADWAY	WEST 204 ST	WEST 207 STREET			ADDRESS	NEW YORK	N/A	Closed	#####	#####	#####	
22	31465667	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10458	2644 MARIO	MARION AVE	EAST 194 ST	EAST 195 STREET			ADDRESS	BRONX	N/A	Closed	#####	#####	#####	
23	31465721	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11363	344 MANOR	MANOR ROA	EAST DRIVE	DOUGLAS ROAD			ADDRESS	Little Neck	N/A	Closed	#####	#####	#####	
24	31465722	9/4/15 0:00 9/4/15 0:00	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10457	2239 ADAMS	ADAMS PLA	EAST 182 ST	EAST 183 STREET			ADDRESS	BRONX	N/A	Closed	#####	#####	#####	
25	31465723	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Commercial	11238	15 BUTLER P	BUTLER PLA	PLAZA STREE	STERLING PLACE			ADDRESS	BROOKLYN	N/A	Pending	#####	#####	#####	
26	31465787	9/4/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11215	456 5 STREET	5 STREET	6 AVENUE	7 AVENUE			ADDRESS	BROOKLYN	N/A	Pending	#####	#####	#####	
27	31466360	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Vacant Lot	10453					MORTON PL	UNIVERSITY	INTERSECTIC	BRONX	N/A	Closed	#####	#####	#####	
28	31466388	9/5/15 0:00 9/9/15 0:00	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10472	1420 HARRO	HARRO AVE	EAST 174 ST	CROSS BRONX EXPRESSWAY			ADDRESS	BRONX	N/A	Closed	#####	#####	9/9/15	
29	31467192	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11361	211-49 45 DF	45 DRIVE	211 STREET	BELL BOULEVARD			ADDRESS	Bayside	N/A	Closed	#####	#####	#####	
30	31467223	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Other (Explai	10468	2337 GRAND	GRAND CON	EAST 183 ST	FIELD PLACE			ADDRESS	BRONX	N/A	Closed	#####	#####	#####	
31	31467230	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	10302	18 MONTELL	MONTELL ST	DECKER AVE	LA GRANGE PLACE			ADDRESS	STATEN ISLAND	N/A	Closed	#####	#####	#####	
32	31467245	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10035	149 EAST	11 EAST	118 ST	LEXINGTON / 3 AVENUE			ADDRESS	NEW YORK	N/A	Pending	#####	#####	#####	
33	31467251	9/5/15 0:00 9/9/15 0:00	DOHMH	Department	Rodent	Rat Sighting	Construction	11215	566 CARROL	CARROLL STR	4 AVENUE	5 AVENUE			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	9/9/15	
34	31468004	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10458	2454 TIEBOU	TIEBOU AVE	EAST 187 ST	EAST 188 STREET			ADDRESS	BRONX	N/A	Closed	#####	#####	#####	
35	31468015	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Hospital	11212					AMBOY STRE	LINDEN BOU	INTERSECTIC	BROOKLYN	N/A	Closed	#####	#####	#####	
36	31468100	9/5/15 0:00	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11207	556 CENTRA	CENTRAL AVENUE			LATLONG	BROOKLYN	N/A	Assigned	#####	#####	#####	#####		
37	31468121	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10011	156 WEST	2 WEST	20 ST AVENUE OF	7 AVENUE			ADDRESS	NEW YORK	N/A	Closed	#####	#####	#####	
38	31468153	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11385	59-05 DECAT	DECATUR STREET			LATLONG	RIDGEWOOD	N/A	Closed	#####	#####	#####	#####		
39	31468177	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Other (Explai	10007					LAFAYETTE S	DUANE STRE	INTERSECTIC	NEW YORK	N/A	Closed	#####	#####	#####	
40	31468894	9/5/15 0:00 9/9/15 0:00	DOHMH	Department	Rodent	Rat Sighting	Other (Explai	10026	2082 FREDEF	FREDERICK D	WEST 112 ST	WEST 113 STREET			ADDRESS	NEW YORK	N/A	Closed	#####	#####	9/9/15	
41	31468978	9/5/15 0:00	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11207	558 CENTRA	CENTRAL AVENUE			LATLONG	BROOKLYN	N/A	Assigned	#####	#####	#####	#####		
42	31468979	9/5/15 0:00 9/9/15 0:00	DOHMH	Department	Rodent	Rat Sighting	Other (Explai	10027	147 WEST 12	WEST 123RD STREET			LATLONG	NEW YORK	N/A	Closed	#####	#####	9/9/15	#####		
43	31469063	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	11203	874 LENOX R	LENOX ROAD	EAST 53 STR	EAST 54 STREET			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	#####	
44	31469075	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	1-2 Family D	11207	519 WARWI	WARWICK ST	SUTTER AVE	BLAKE AVENUE			ADDRESS	BROOKLYN	N/A	Closed	#####	#####	#####	
45	31469076	9/5/15 0:00 8/4/15 0:00	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10026	312 WEST	1 WEST	114 S	8 AVENUE	MANHATTAN AVENUE			ADDRESS	NEW YORK	N/A	Pending	#####	#####	#####
46	31469077	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	3+ Family Ap	10460	1015 EAST	1 EAST	179 ST	BRYANT AVE	BOSTON ROAD			ADDRESS	BRONX	N/A	Pending	#####	#####	#####
47	31469081	9/5/15 0:00 #####	DOHMH	Department	Rodent	Rat Sighting	Commercial	10027	WEST 120 ST	WEST 120 ST	ADAM CLAY	ST NICHOLAS AVENUE			BLOCKFACE	NEW YORK	N/A	Closed	#####	#####	#####	

Thanks Kaggle!

What's in the CSV?

- 101,914 entries
 - Roughly 8,492 rats/year, 707 rats/month, 36 rats/day
- 42 columns
 - Open date
 - Closed date
 - Location type
 - Address
 - Intersection
 - Borough
 - ZIP
 - Status
 - open, closed, pending
 - Resolution date
 - Latitude
 - Longitude

Things to note

- Data is only from people who reported rats to DOHMH
- Does not include public spaces (subway, parks, trains)
- Some columns missing information
 - Closed date most prevalent ...?

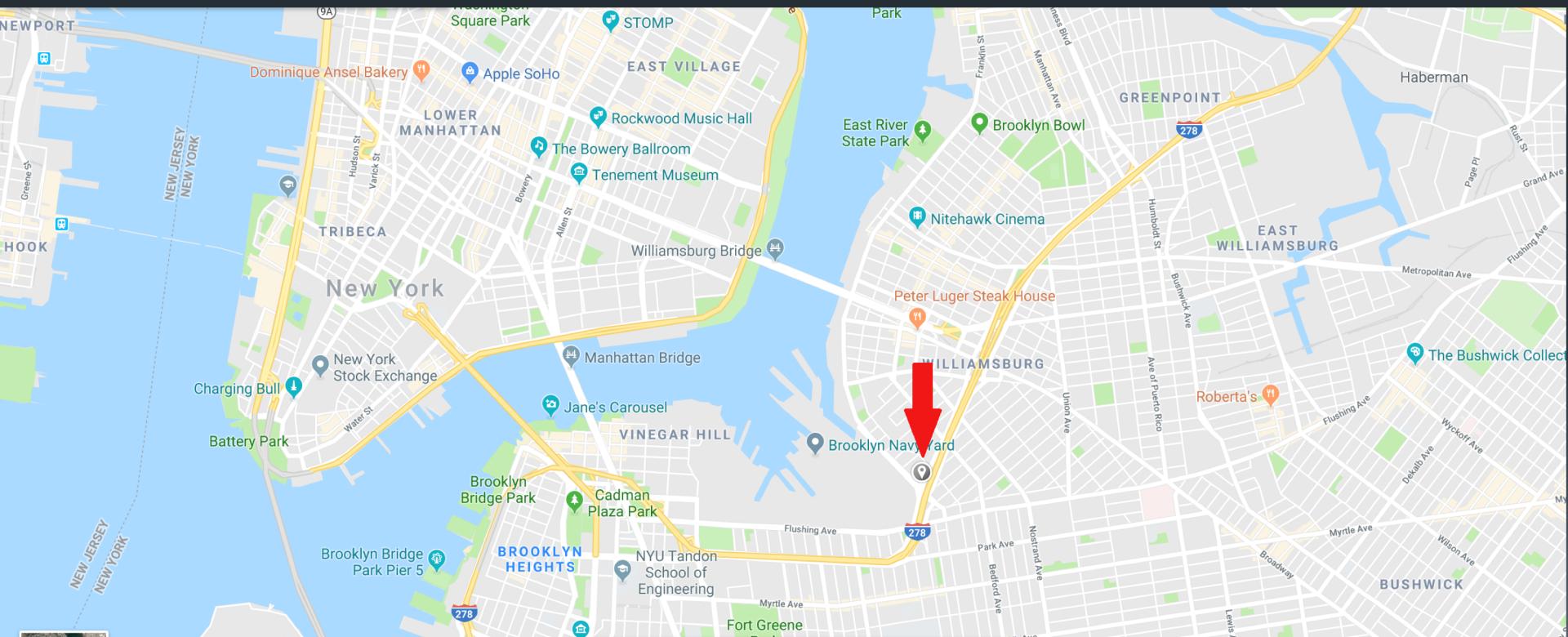
Initial plan

- Where in the city are you most likely to see a rat?
- What kind of building are you most likely to spot a rat?
- Can we correlate the rat sightings to anything?
- Can we generate a heatmap?
- With python libraries and all the data up to this point, could we predict future rat spottings/hotspots?



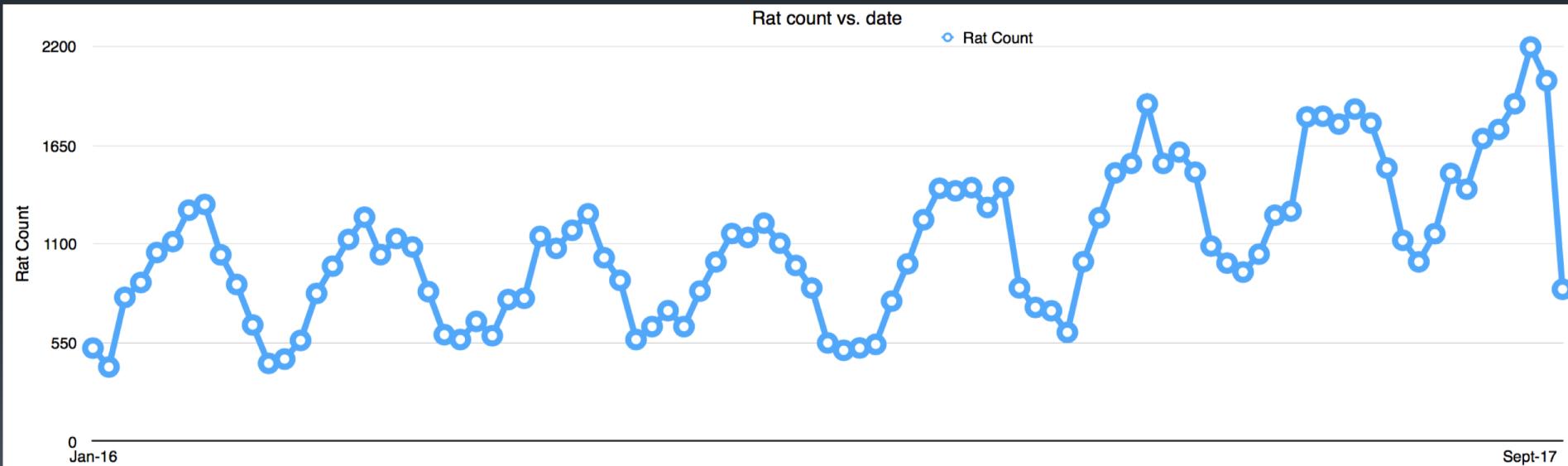
Initial statistics

- Most frequent type of building to spot a rat:
 - 3+ family apartment building
- Most likely spot to be in the city and see a rat:
 - $40.70208224559943^{\circ}\text{N}$, $-73.96489794921877^{\circ}\text{W}$



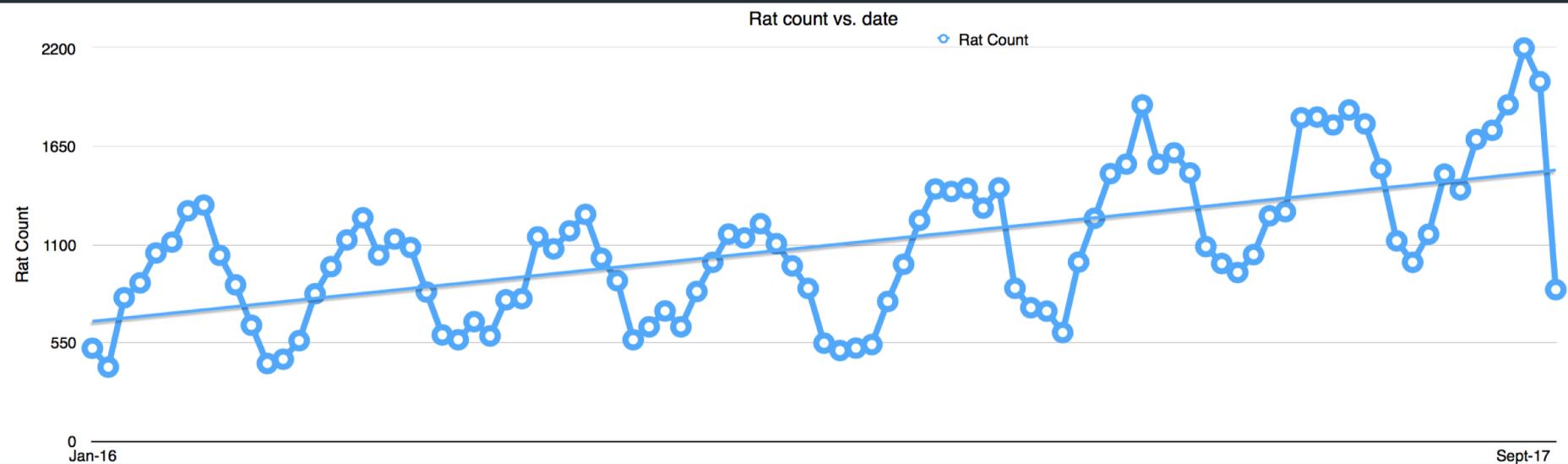
BP Gas Station – 677 Kent Ave, Brooklyn, NY 11249

Initial findings



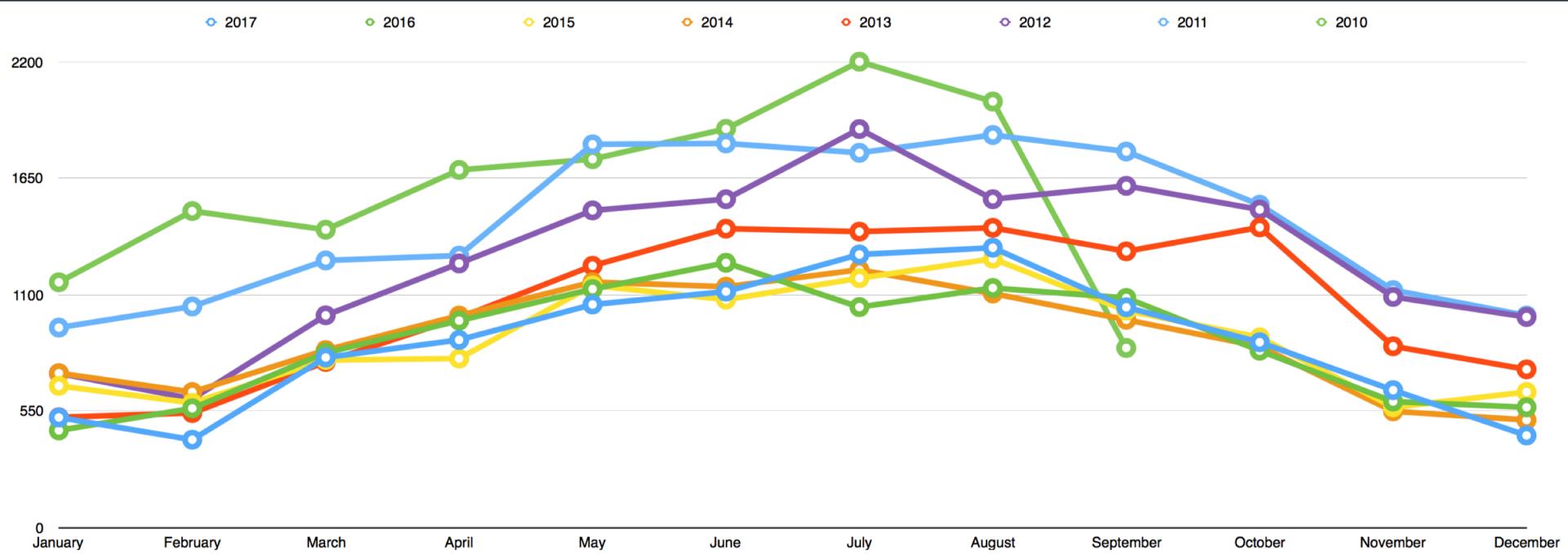
Line graph of rats per month for every month

Initial findings



Line graph of rats per month for every month with linear average

Initial findings



Line graph of rat count for each year

Correlation

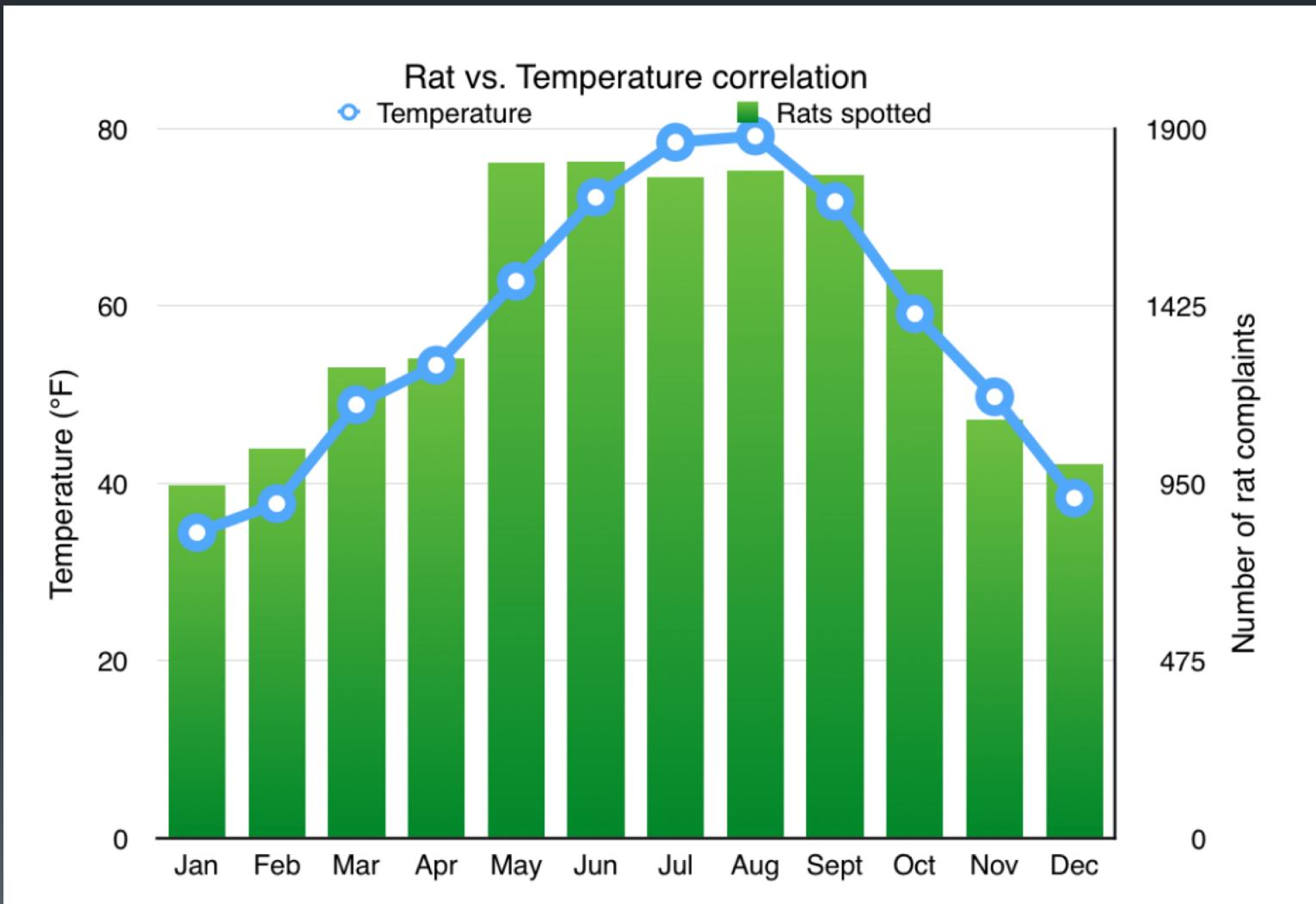
▪ Weather data in New York City - 2016

date	maximum tem	minimum tem	average tem	precipitation	snow fall	snow depth
1/1/16	42	34	38	0	0	0
1/2/16	40	32	36	0	0	0
1/3/16	45	35	40	0	0	0
1/4/16	36	14	25	0	0	0
1/5/16	29	11	20	0	0	0
1/6/16	41	25	33	0	0	0
1/7/16	46	31	38.5	0	0	0
1/8/16	46	31	38.5	0	0	0
1/9/16	47	40	43.5	T	0	0
1/10/16	59	40	49.5	1.8	0	0
1/11/16	40	26	33	0	0	0
1/12/16	44	25	34.5	0 T	0	0
1/13/16	30	22	26	0	0	0
1/14/16	38	22	30	0 T	0	0
1/15/16	51	34	42.5	T	0	0
1/16/16	52	42	47	0.24	0	0
1/17/16	42	30	36	0.05	0.4	0
1/18/16	31	18	24.5	T	T	T
1/19/16	28	16	22	0	0 T	0
1/20/16	37	27	32	0	0 T	0
1/21/16	36	26	31	0	0	0
1/22/16	30	21	25.5	0.01	0.2	0
1/23/16	27	24	25.5	2.31	27.3	6
1/24/16	35	20	27.5	T	T	22
1/25/16	39	28	33.5	0	0	19
1/26/16	48	38	43	0	0	17
1/27/16	47	34	40.5	T	0	9
1/28/16	42	32	37	0	0	6
1/29/16	41	30	35.5	0	0	6
1/30/16	39	28	33.5	0	0	6
1/31/16	56	36	46	0	0	4
2/1/16	59	44	51.5	0.01	0	2
2/2/16	50	38	44	0	0 T	0
2/3/16	59	42	50.5	0.73	0	0
2/4/16	59	44	51.5	T	0	0
2/5/16	44	31	37.5	0.53	2.5	1
2/6/16	40	30	35	0	0	0
2/7/16	47	33	40	0	0	0
2/8/16	29	29	33.5	0.05	0.1	0

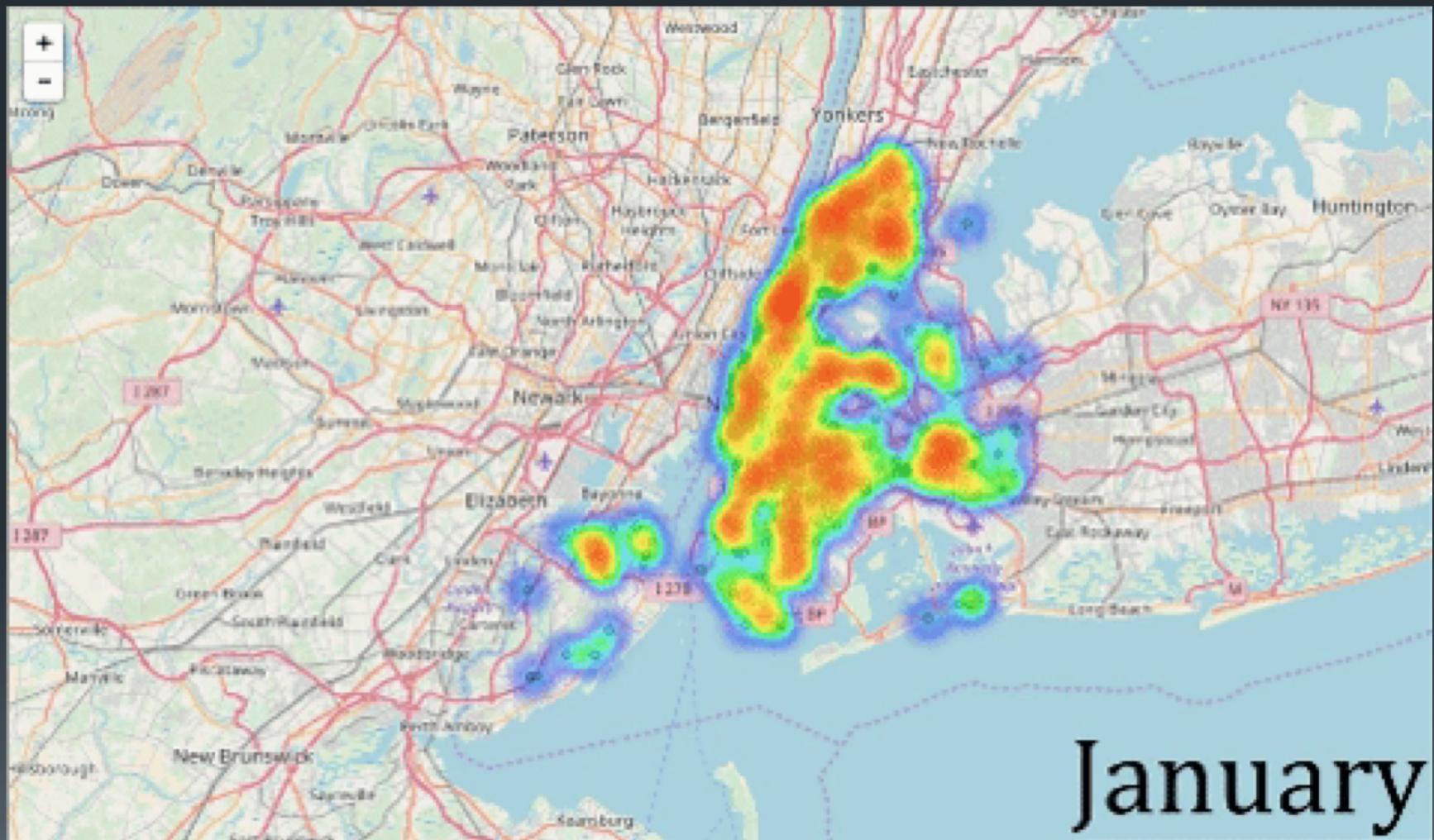
- Date
- Maximum temperature
- Minimum temperature
- Average temperature
- Precipitation
- Snow fall
- Snow depth

Thanks again, Kaggle!

Correlation



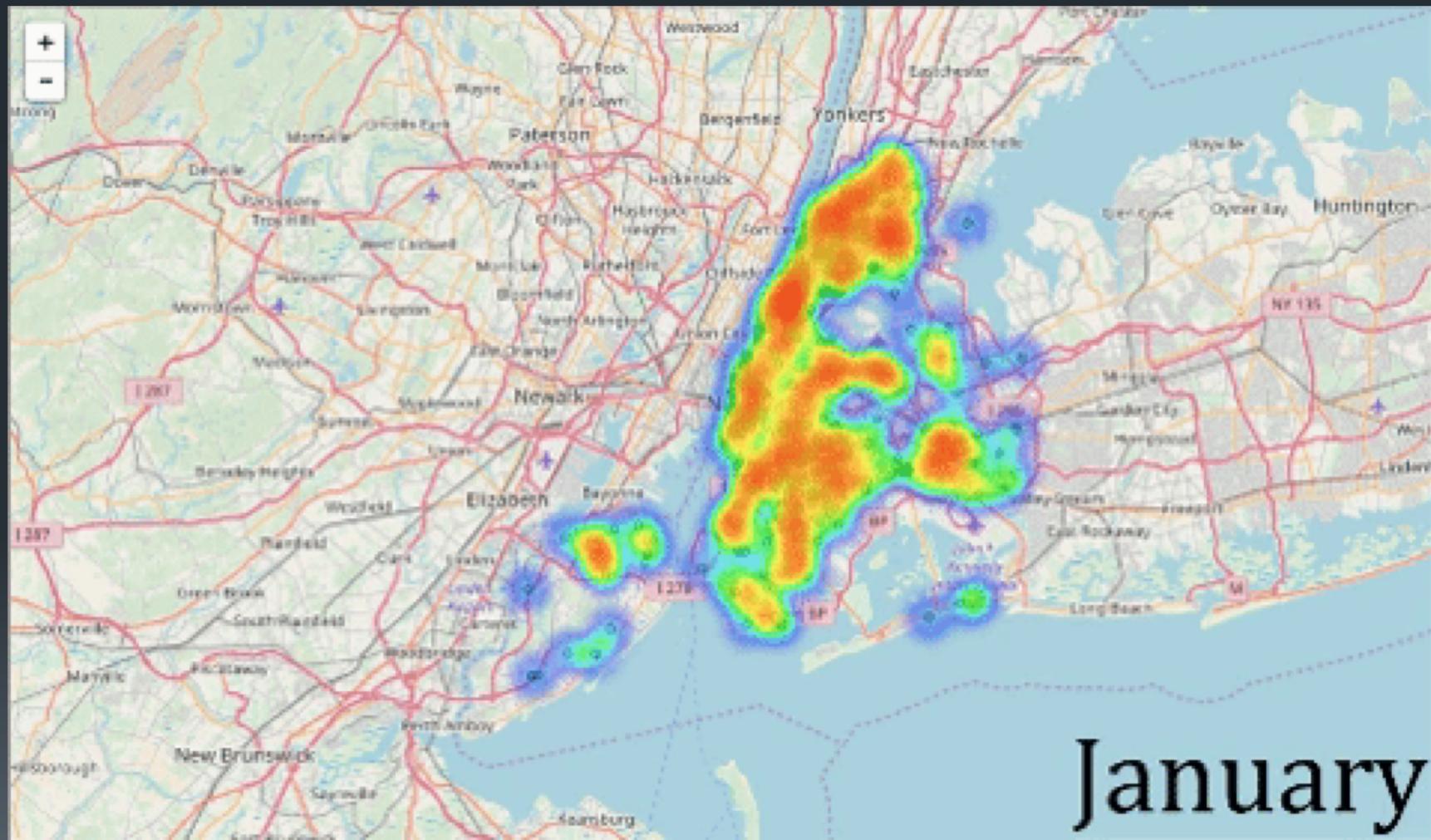
Heat map



January

2016 by month (15 radius): 1 second

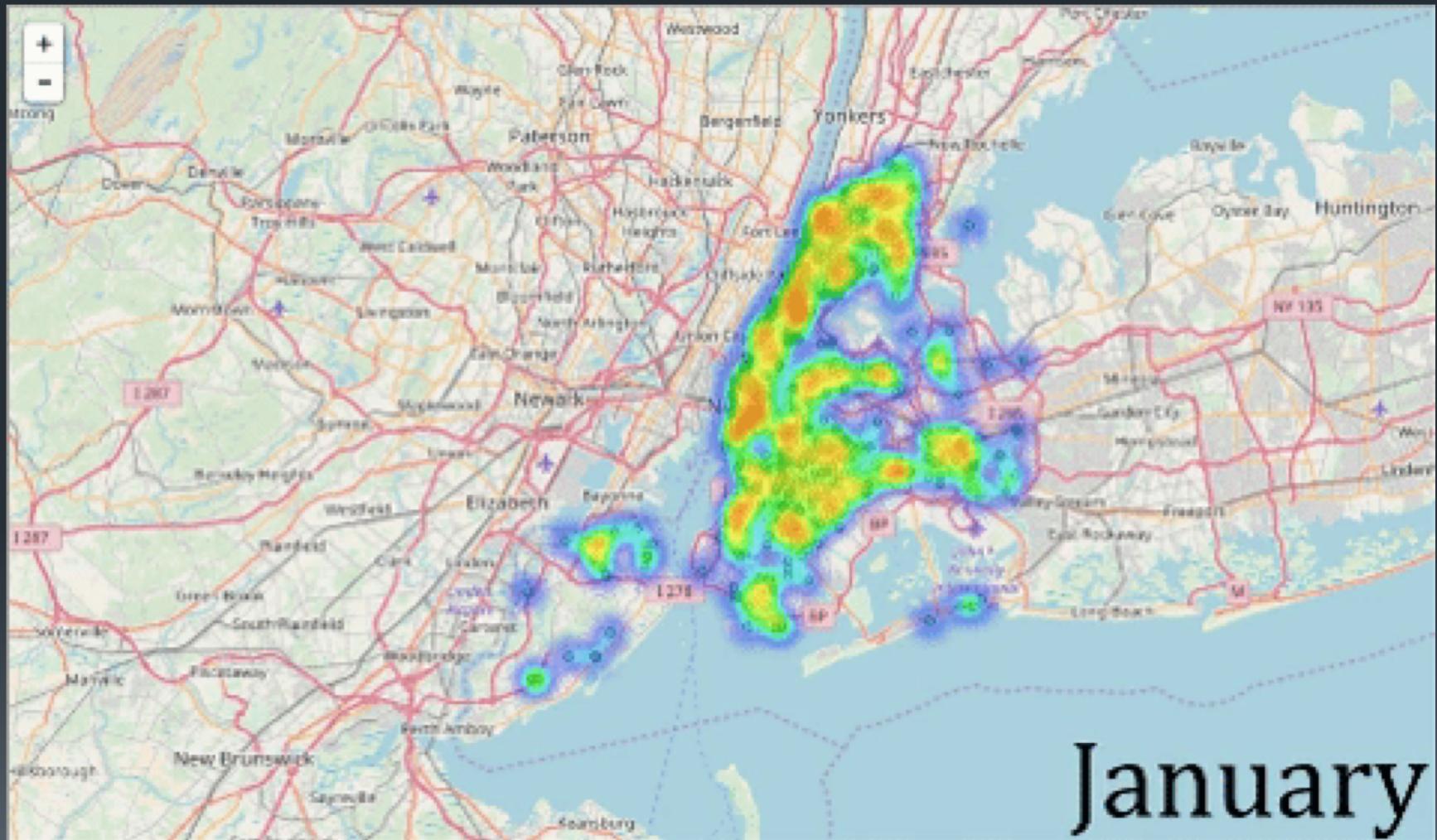
Heat map



January

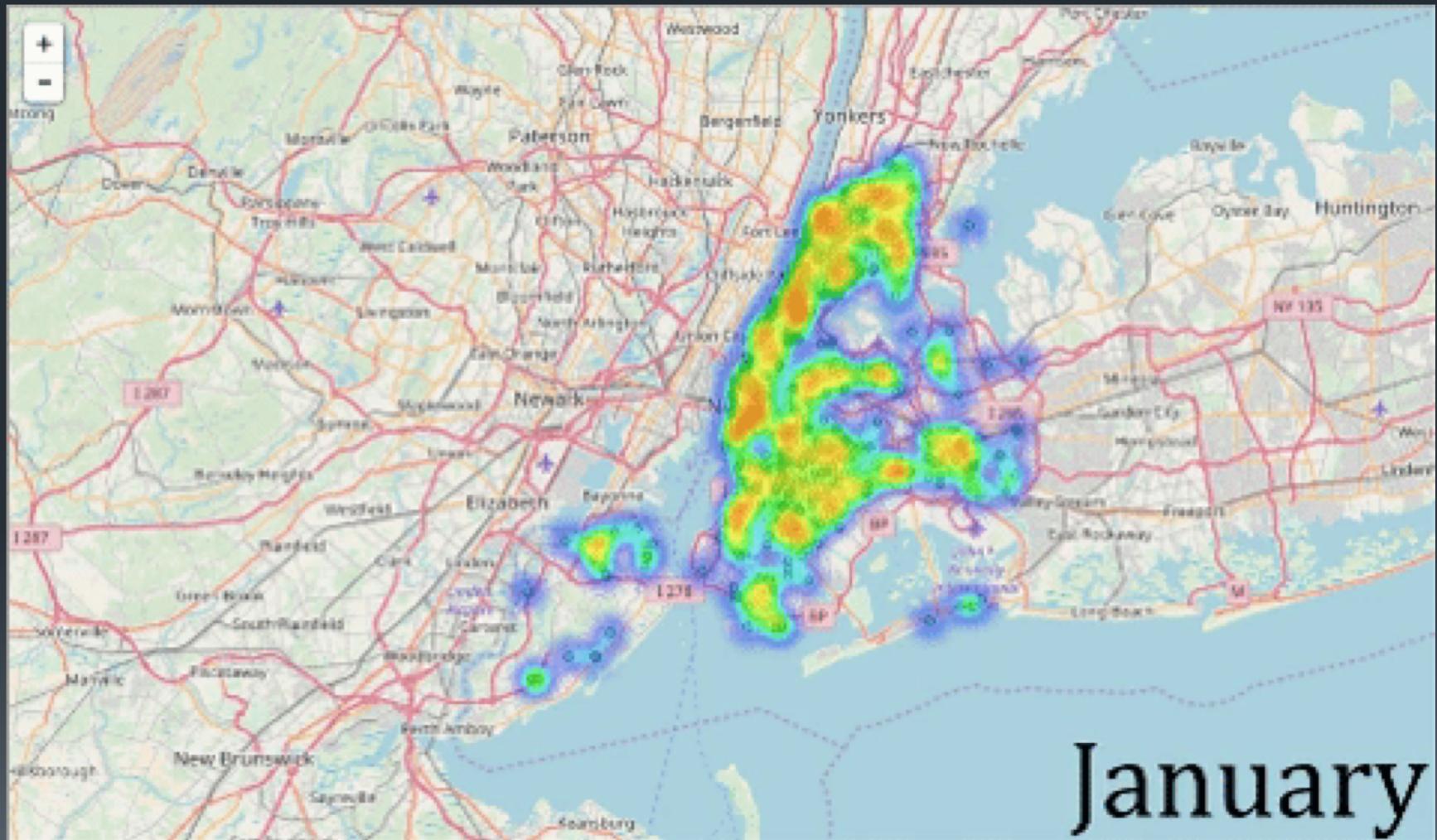
2016 by month (15 radius) – half second

Heat map



2016 by month (12 radius): 1 second

Heat map



January

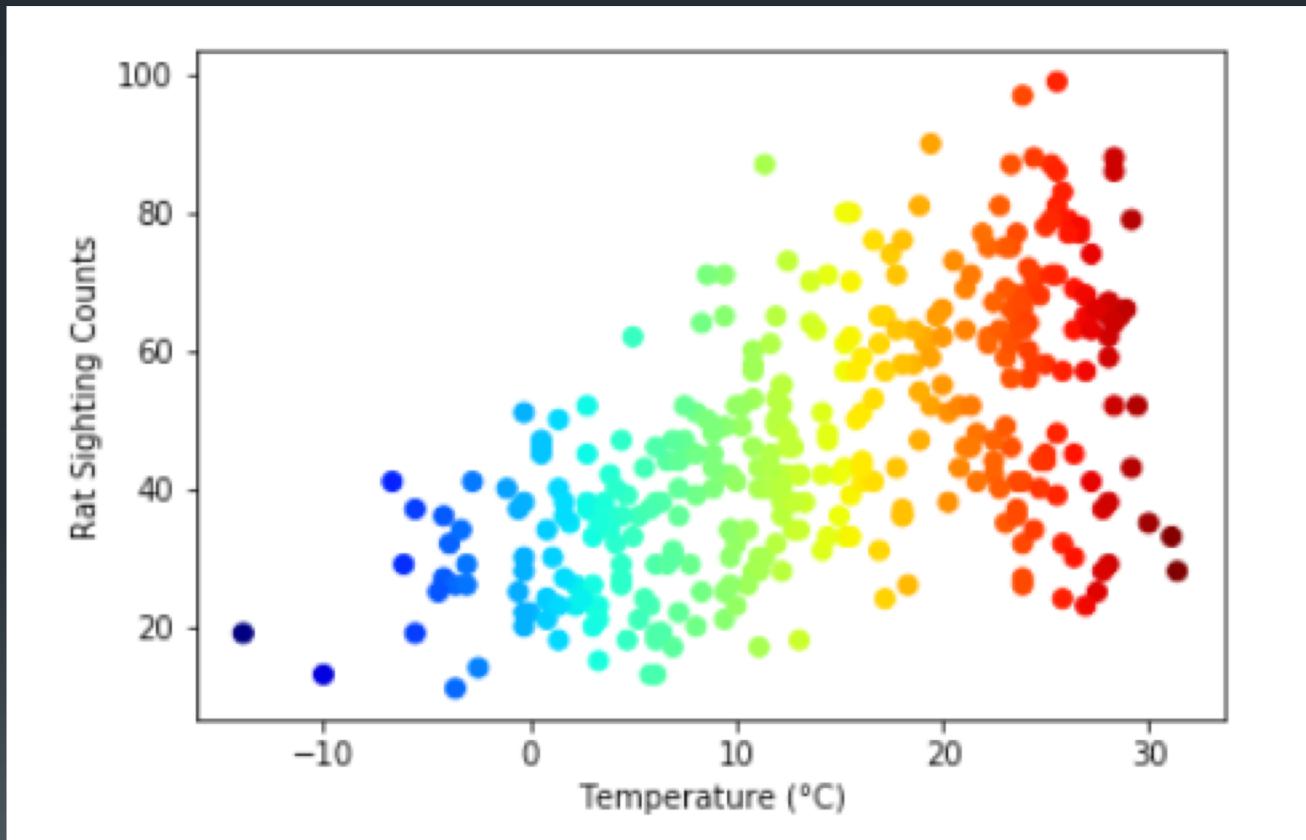
2016 by month (12 radius): half second

Heat map results

- Generated interesting images, but no clear pattern
- In the future, possibly make a gif for each day

Machine learning

- Plot rat counts vs temp



Machine learning

New Zealand: hot summer leads to a tenfold explosion in rat population

Fertile breeding conditions caused by hottest summer since records began leads to surge of rats and mice



▲ A ship rat attacks a fantail nest in New Zealand. The country is committed to becoming predator-free by 2050.
Photograph: NZ Department of Conservation/ Nga Manu Images

A record-breaking long, hot summer has led to a tenfold explosion in New Zealand's rodent population, with the country's urban areas worst hit.

Machine learning

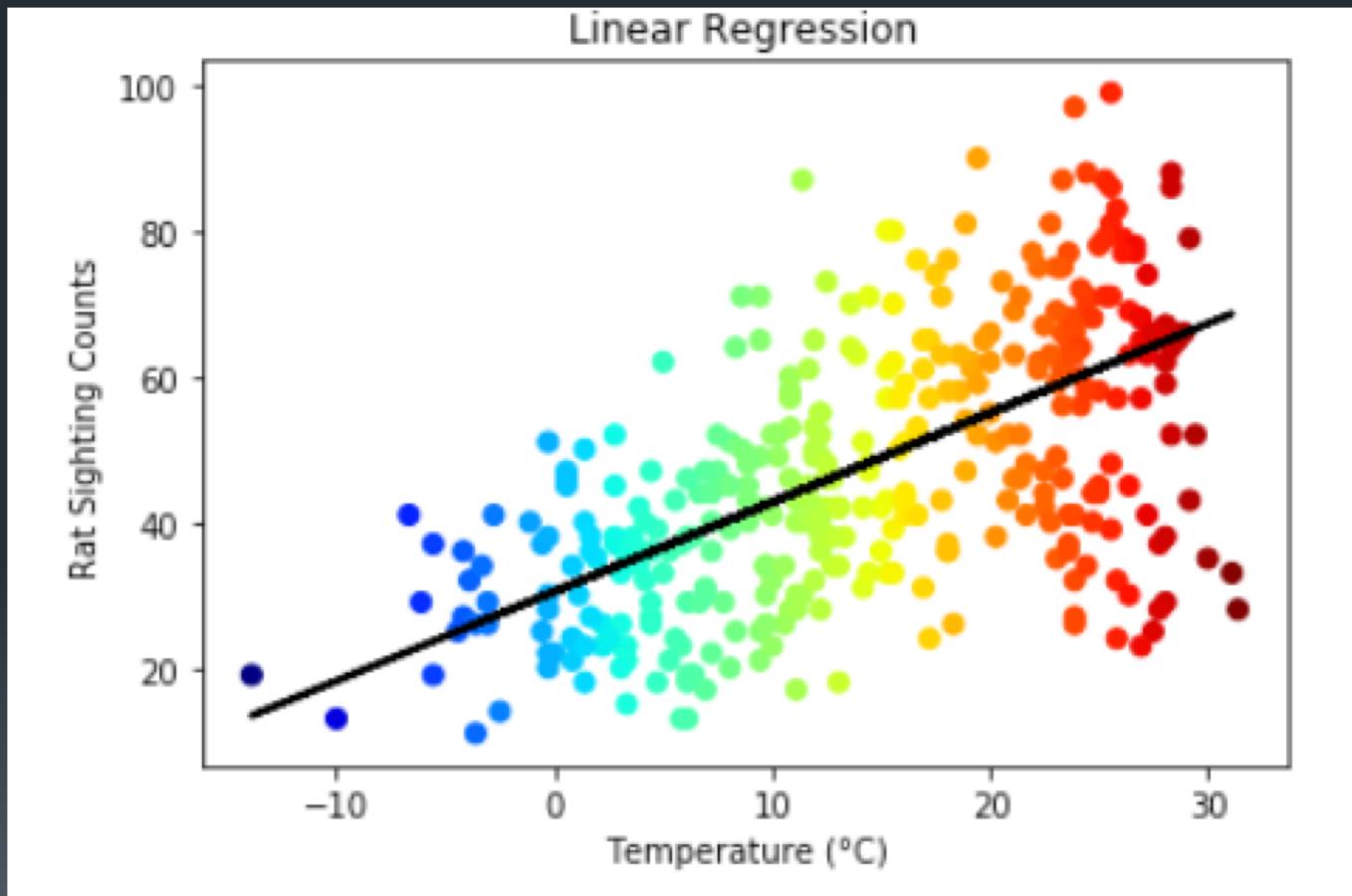
```
from sklearn.svm import SVR

linear_model = SVR(kernel='linear').fit(X_train, y_train)
rbf_model = SVR(kernel='rbf').fit(X_train, y_train)
poly_model = SVR(kernel='poly', degree=2).fit(X_train, y_train)

print("Linear model R2 score is: ", linear_model.score(X_test, y_test))
print("RBF model R2 score is: ", rbf_model.score(X_test, y_test))
print("Poly model R2 score is: ", poly_model.score(X_test, y_test))
print("\nLinear model gives the best results")
```

```
Linear model R2 score is:  0.468202843807
RBF model R2 score is:  0.264715423777
Poly model R2 score is:  0.390602295049
```

Machine learning



Sources

- Rat data:
 - <https://www.kaggle.com/new-york-city/nyc-rat-sightings>
- Weather data:
 - <https://www.kaggle.com/mathijs/weather-data-in-new-york-city-2016>
- New York City population:
 - <http://worldpopulationreview.com/us-cities/new-york-city-population/>
- New York City rat population:
 - <https://www.mnn.com/earth-matters/animals/stories/turns-out-rats-dont-outnumber-people-in-nyc>

End



- Questions?

