Electric vehicle charging locations for Uber in New York City

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Introduction

Paris Agreement – Dec 2015

- 196 governments agreed to work to keep the world's average temperature well below rising to 2◦C
- committed to take actions to reduce their Greenhouse Gas emissions
- zero emissions by 2050

U.S. Energy Information Administration

- 29 percent of the country's green house gas emissions
- Transportation accounts for nearly 70 percent of U.S. oil consumption

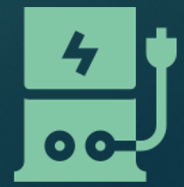
2. Analyze the charging and Uber pick-up data

Which improvements of **charging station locations** are needed to prepare **Uber** to drive electric cars in **New York City**?

Sub-questions:

1. How are the pick-up locations and charging stations distributed?

2. What are the smallest distances between the pick-up locations and the nearest charging station?

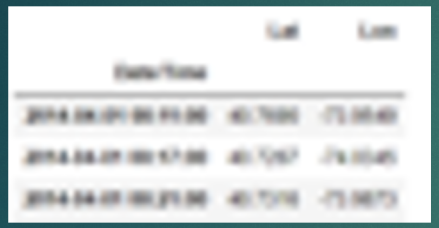


Borough map

Databases Exploration and Feature Selection

Uber pick-up data for New York

- 4 534 327 records
- 2014 April to September data



Electric Vehicle Charging Stations in New York

- 1000 records
- Up to date (Jan 29th, 2021)

	latitude	longitude	city
10	40.764608	-73.969355	New York
24	40.811206	-73.963782	New York
39	40.734817	-73.989198	New York

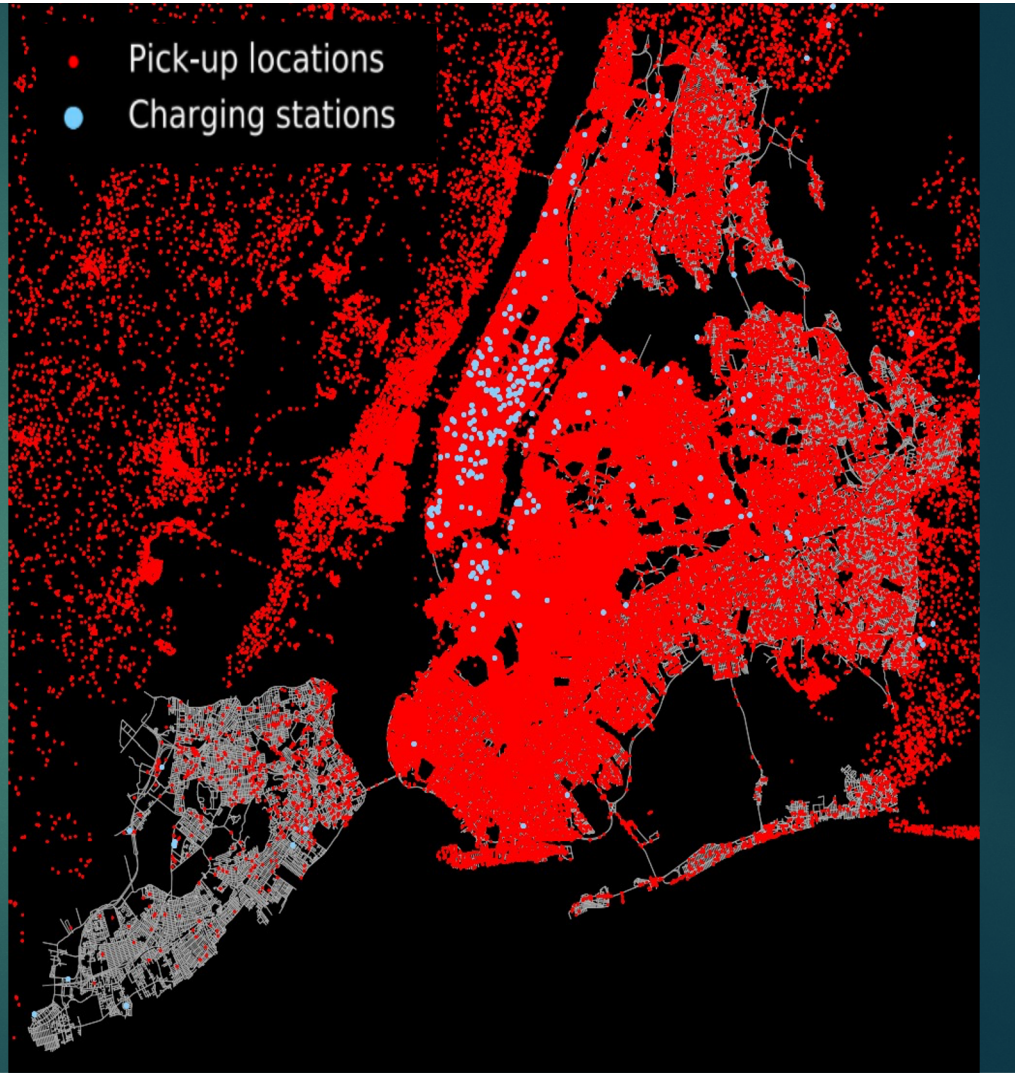
Geopandas

- GeoDataFrame conversion
- Geometry objects
- Plotting on real world maps

	geometry	latitude	longitude
10	POINT (-73.96936 40.76461)	40.764608	-73.969355
24	POINT (-73.96378 40.81121)	40.811206	-73.963782
39	POINT (-73.98920 40.73482)	40.734817	-73.989198

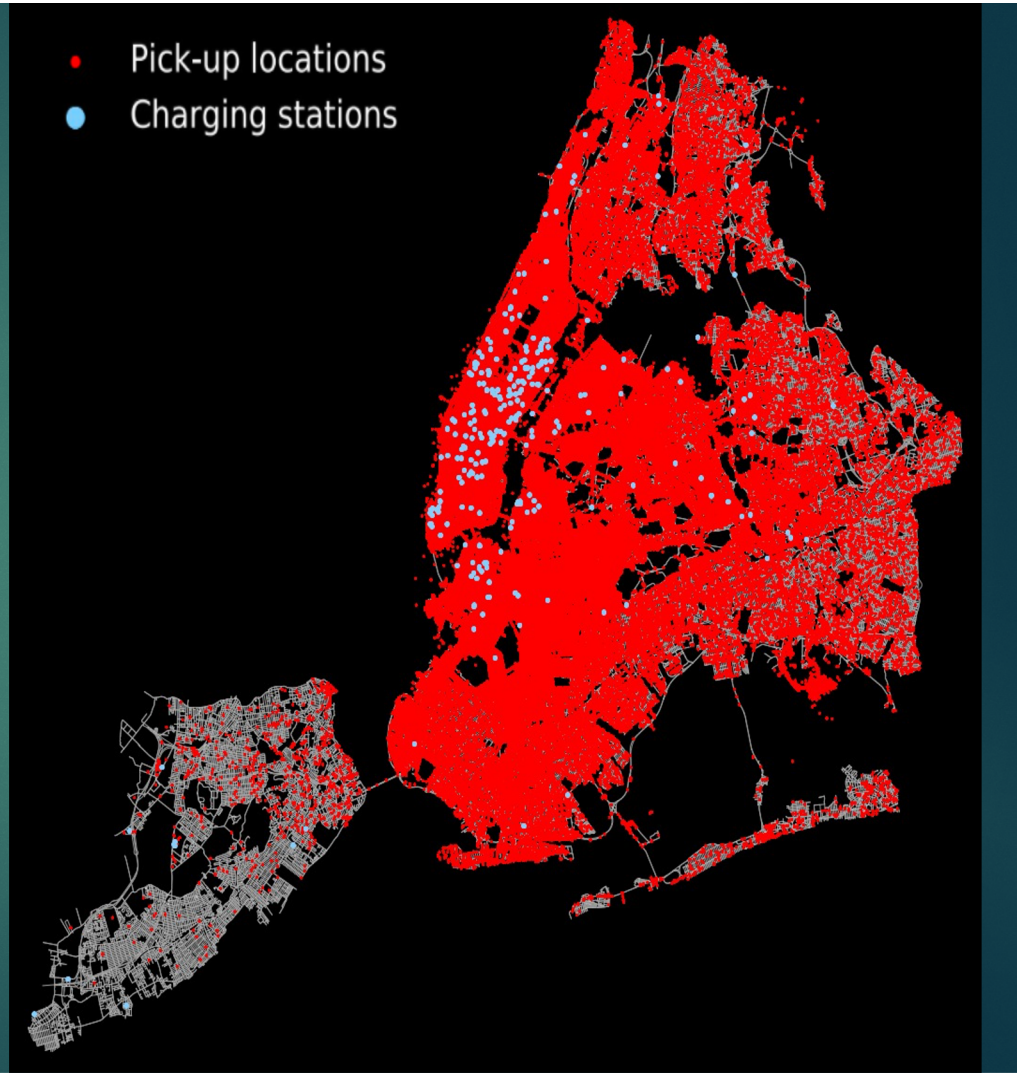
Remove outside New York City

- Converting coordinates to GPS earth system
- 4 534 327 pick-up points
- 1 000 charging locations



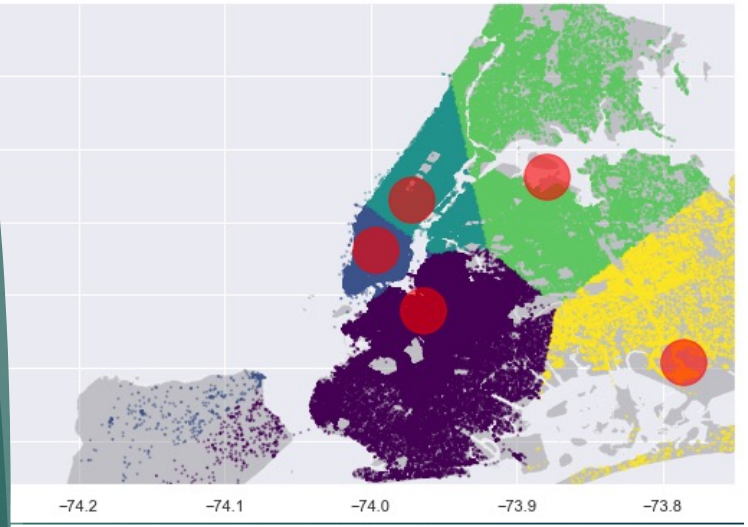
Remove outside New York City

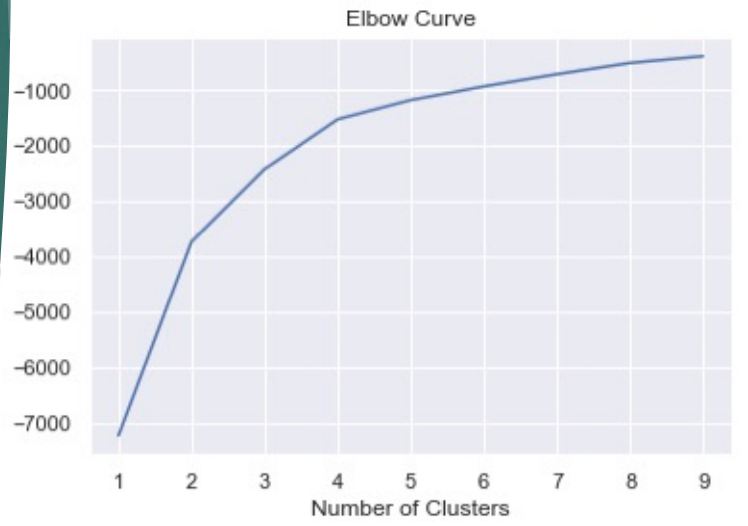
- 4 413 113 pick-up points
  - -2.67% (121 214 records)
- 266 charging stations
  - -73.4% (734 records)



Hot spots for Uber pick-ups

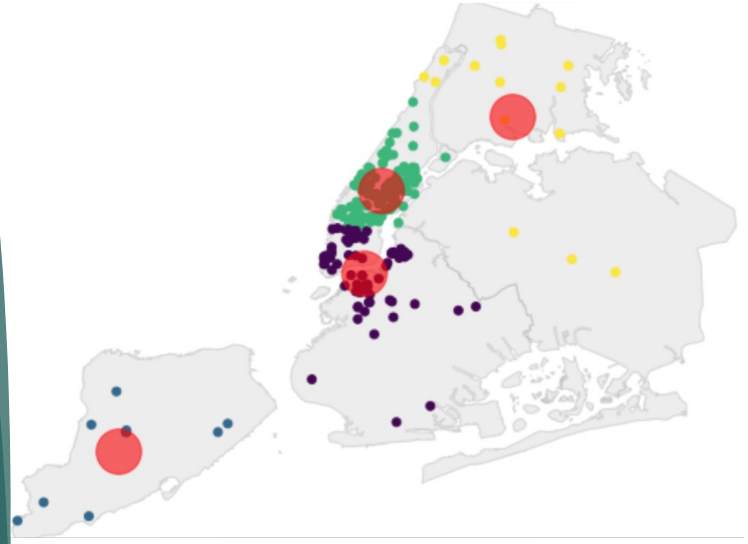
- Uber pick-up dataset from April to September 2014
- Make clusters using K-means clustering
- Marking the centroids of each cluster, showing a pick-up hot spot
- Elbow curve to tune and optimize the K hyperparameter

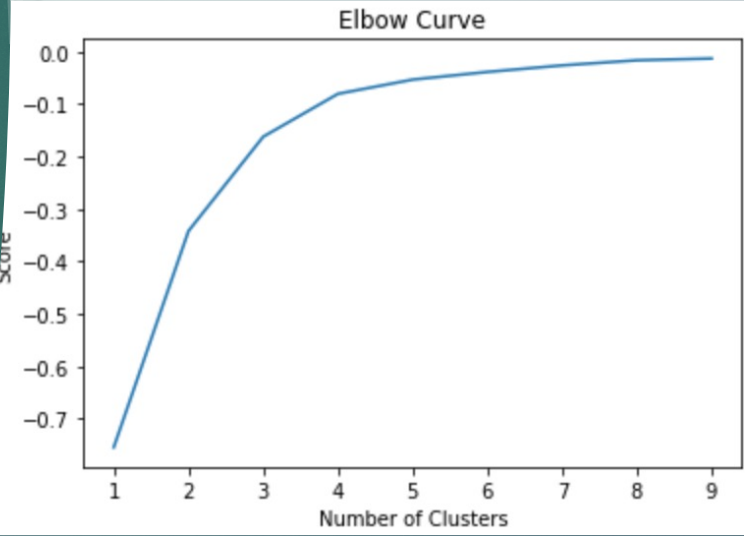


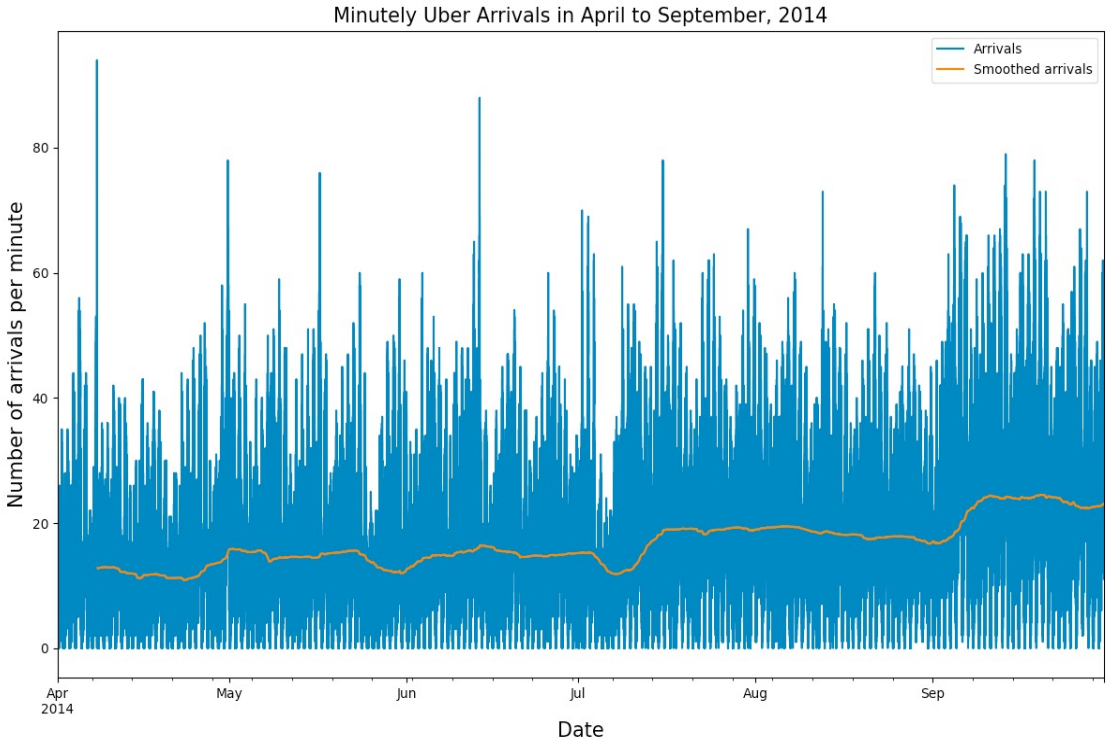


Hot spots for charging stations

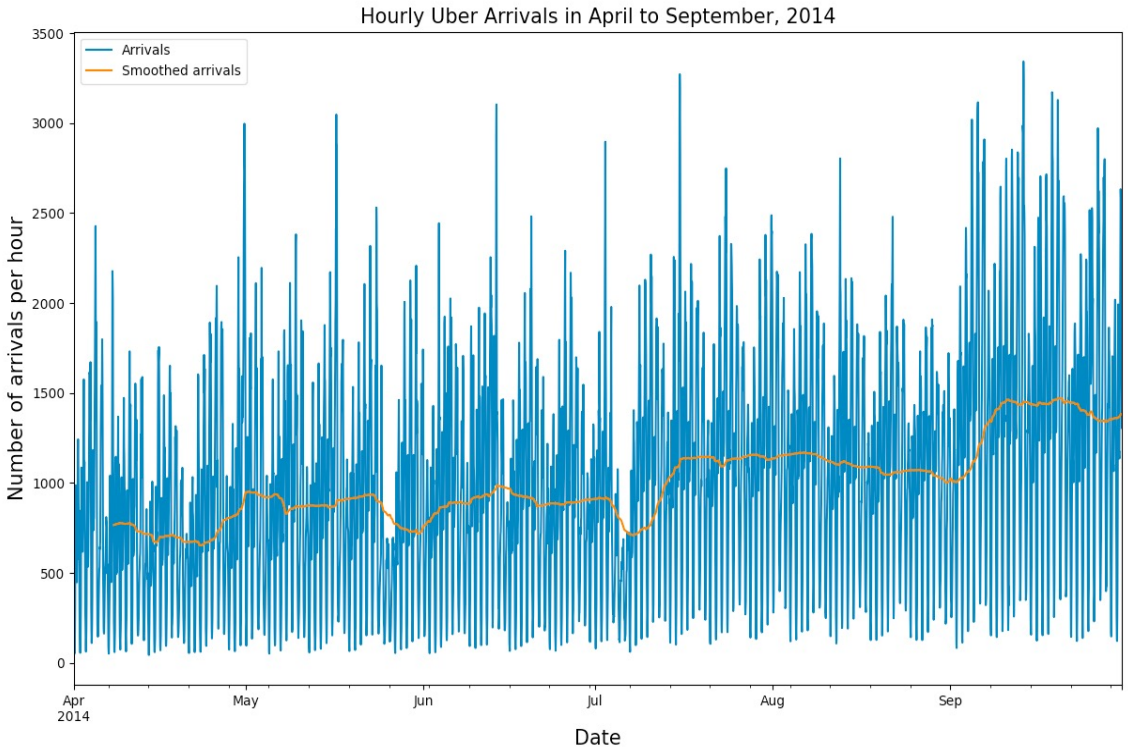
- Charing stations dataset
- K-means clustering
- Centroids of charging stations hot spots
- Elbow curve to tune and optimize the K hyperparameter



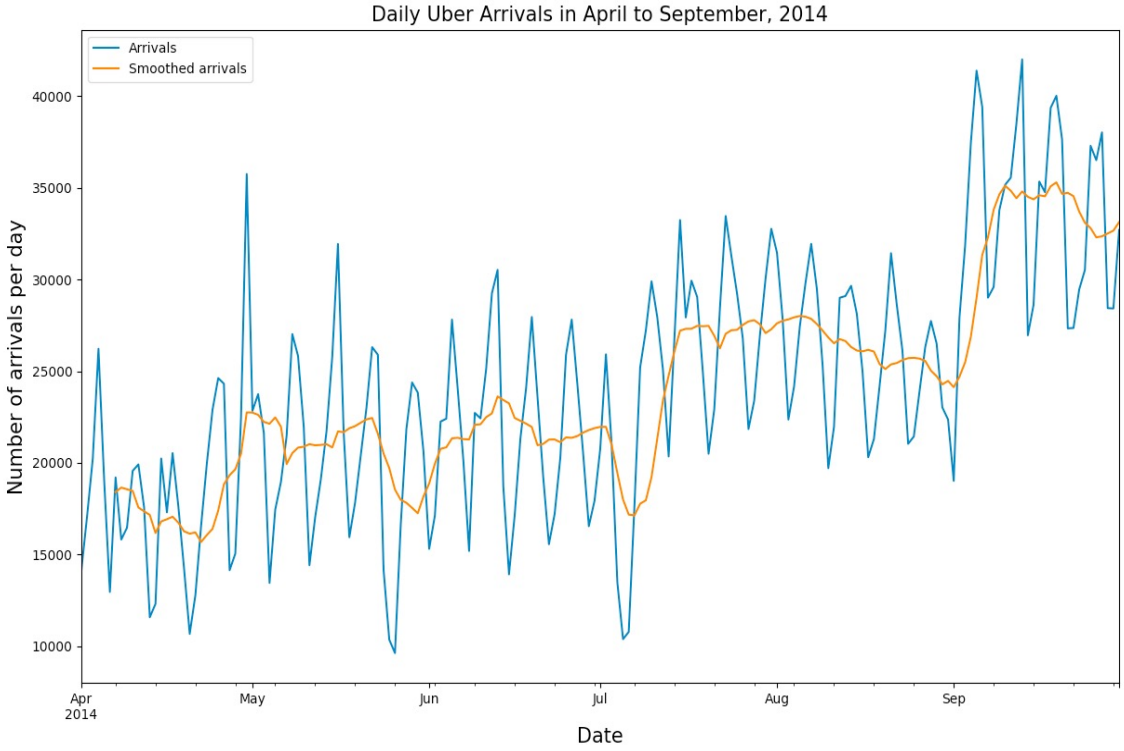




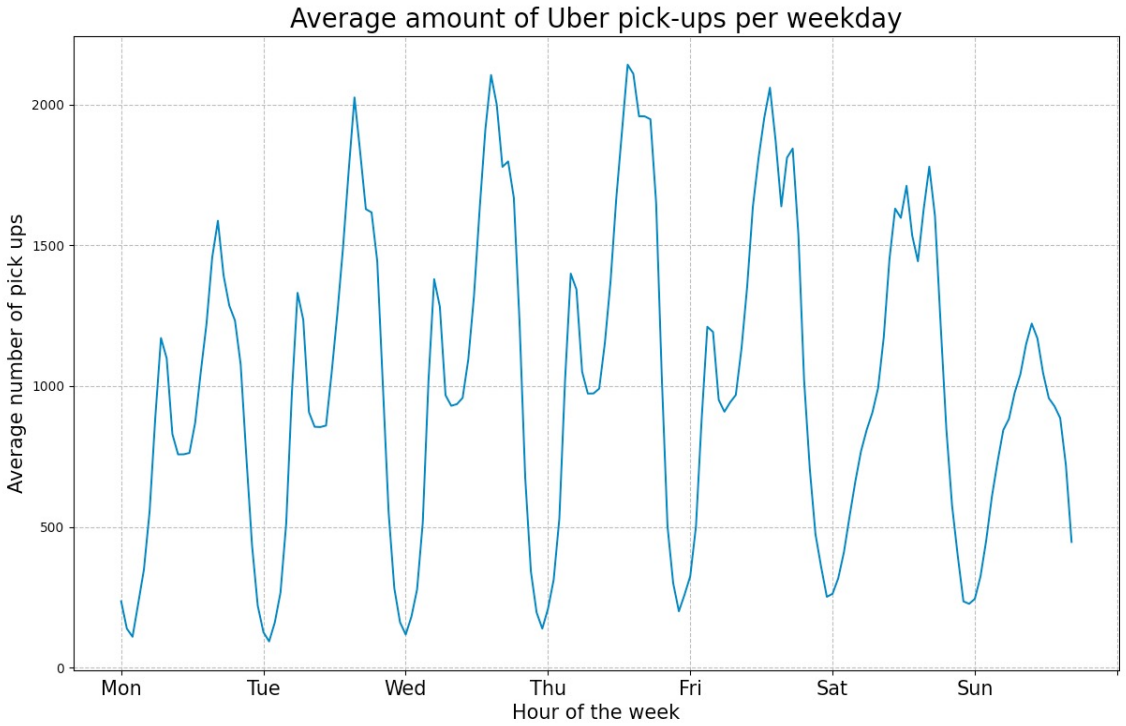
Minutely Uber Arrivals Apr – Sept 2014



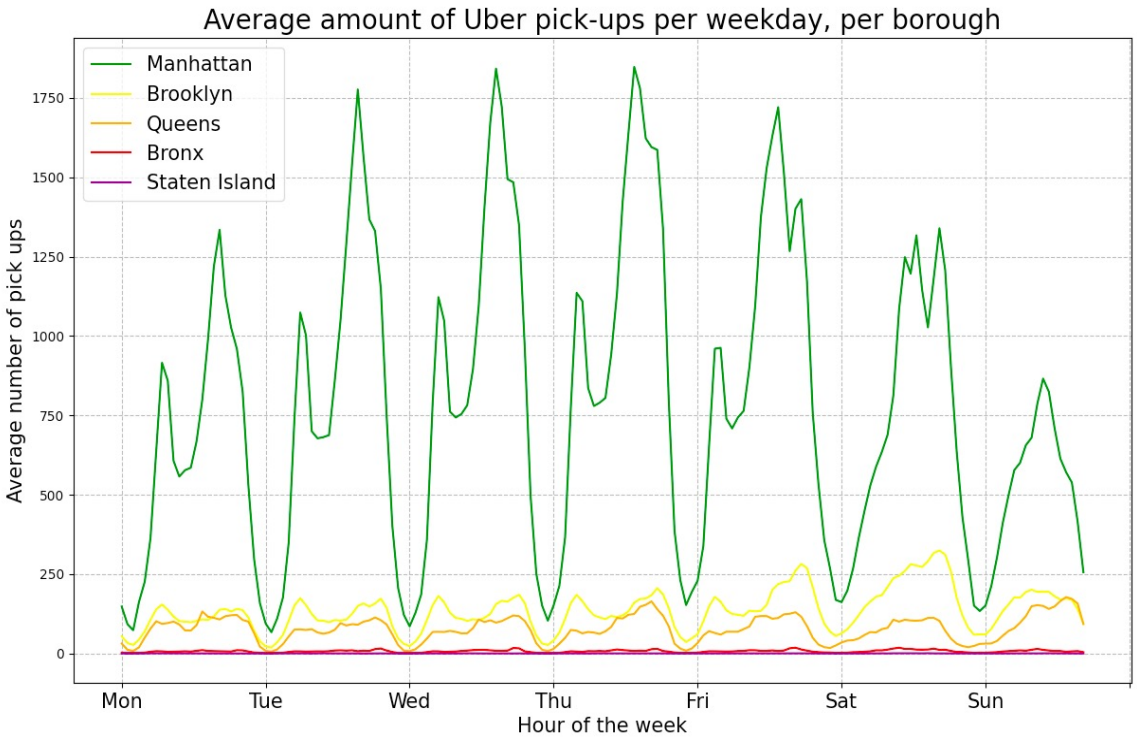
Hourly Uber Arrivals Apr – Sept 2014



Daily Uber Arrivals Apr – Sept 2014



Average Amount of Uber Pick-ups per weekday



Average amount of Uber pick-ups per weekday in each borough

3. Investigate distances

New York City street map

- Nodes = intersections
- Edges = street segments

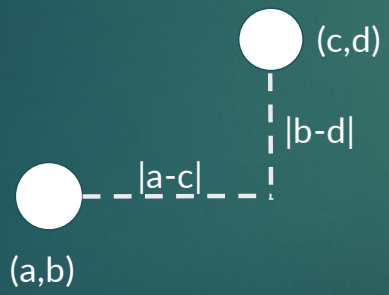
Calculate shortest distances

1. Allocate the coordinate to the nearest node in the graph
2. Minimize the travel times between pick-up and charging locations
   - Dijkstra's algorithm

Over 13 years of run time

Calculate shortest distances

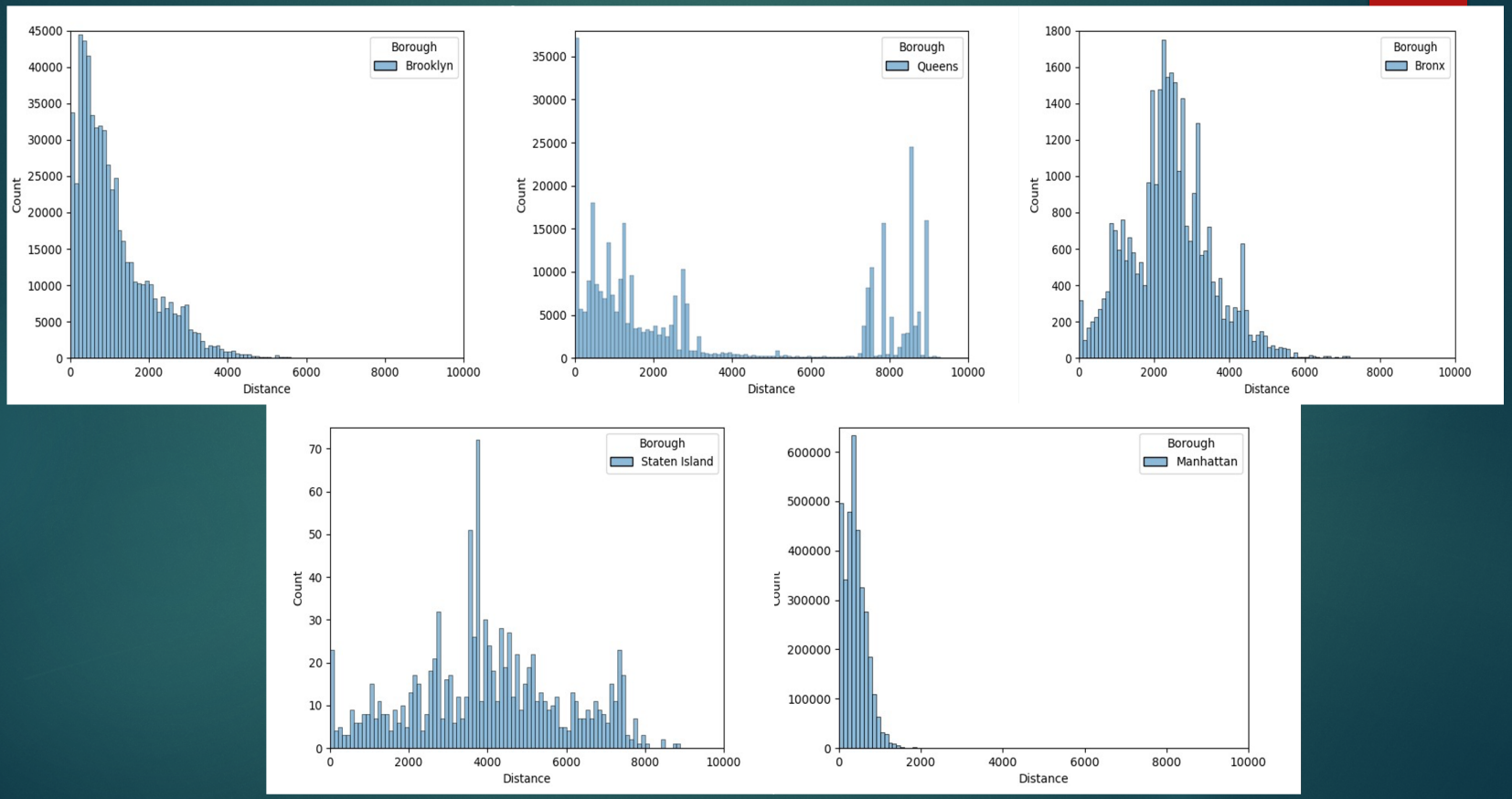
1. Find nearest polygon with the **ball tree algorithm**
2. **Approximate** the **10 nearest charging locations** with the **Manhattan distance**
   - Run Dijkstra's on these 10 nearest charging locations



Distance = |a-c| + |b-d|

Run time reduction from 13 years to 3.5 days

Shortest distances per borough

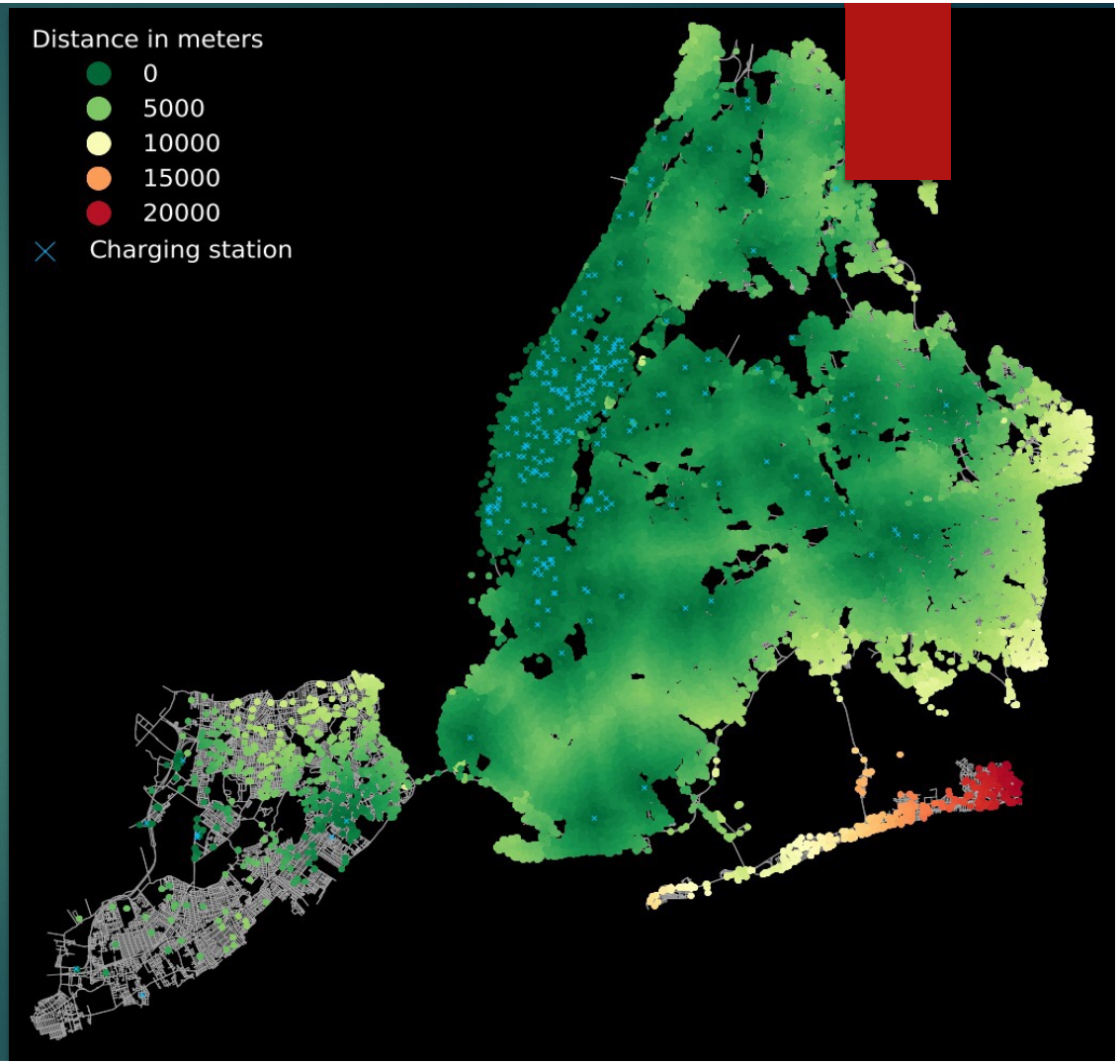


Charging location utility

- More charging locations needed at
  - the south side of Manhattan
  - the west side of Brooklyn
  - the center of Queens

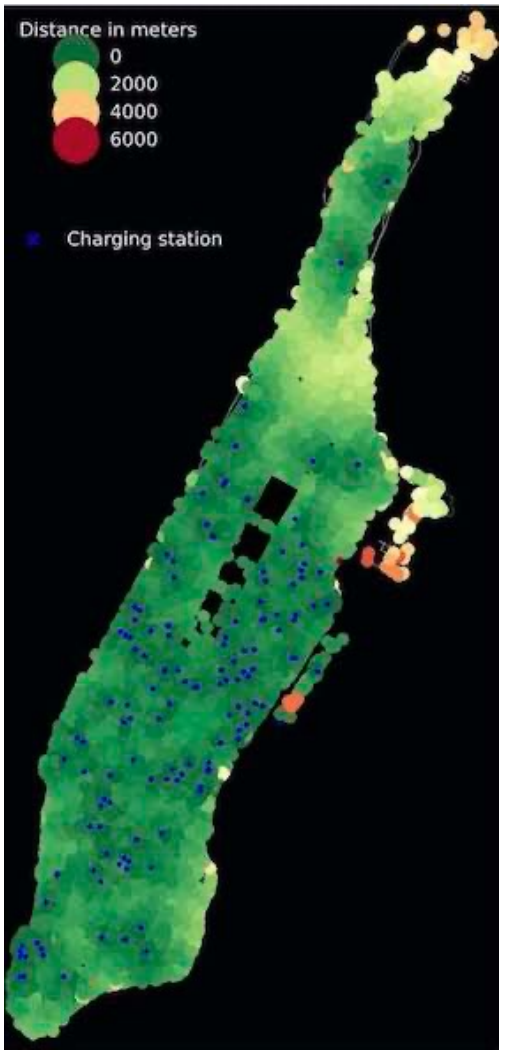
Nearest distance charging location

- Manhattan small distances
- More charging locations needed in East and South Queens and North of Staten Island



Nearest distance charging location

- Manhattan small distances
- Upper Manhattan
- East Harlem



Smallest Manhattan distance

Rank	1	2	3	4	5	6	7	8	9	10
% Smallest Road distance	61.64%	19.28%	8.50%	6.67%	1.98%	0.99%	0.48%	0.22%	0.16%	0.07%

Conclusion

"Which improvements of charging station locations are needed to prepare Uber to drive electric cars in New York City?"

More charging station locations needed in

- **North-West Brooklyn** (hot spots, charging station utility)
- **Lower Manhattan** (hot spots, charging station utility)
- **Middle Bronx** (hot spots)
- **South-West Queens** (hot spots and pick-up location distance)
- **North Staten Island** (pick-up location distance)

Middle Manhattan is ready for electric driving

- short distances, low utility

Future studies

- Destination data to find the optimal Uber dispatch
- Optimize exact charging locations and times
- NYC dynamic energy pricing
- 4.4 millions Uber pick up for 6 months
- NYC taxi dataset ~ 175 millions per year in 2013