New York City Transportation:

Assessing the Use of the Citi Bike System Alongside the Taxi System

CSC-475: Seminar in Computer Science

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Problem

- New York City is a large city that is densely laid out but the environment is suffering from it
- 30% of city-wide emissions come from the transportation sector
- Identify areas of improvement in the Citi Bike Share system as a way to decrease taxi use
- Analyzing data from the 2021 timeframe

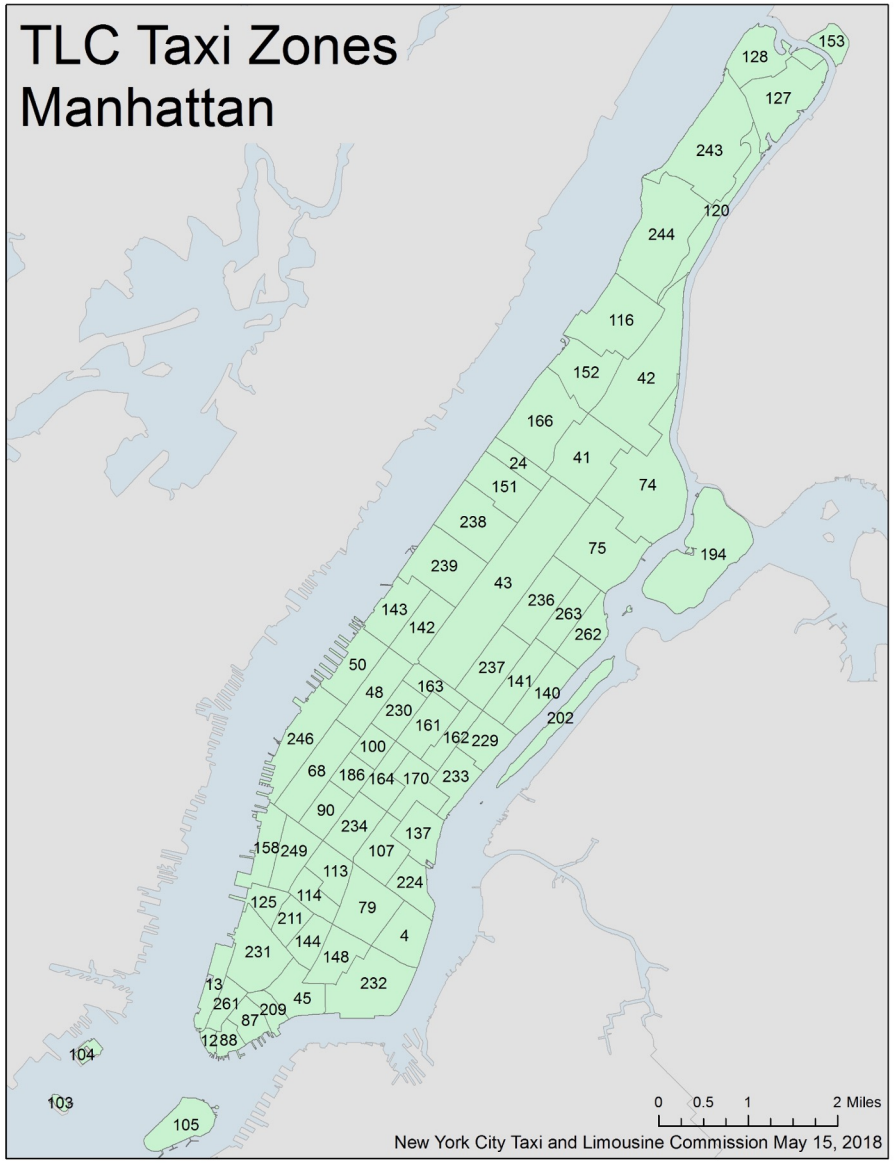
Taxi Data

- The NYC Taxi and Limousine Commission provides public records of every instance of a taxi trip taken.
- From 2021, there were 30,904,380 trips account for.

PU Datetime	DO Datetime	Passenger #	Trip Distance	PU Location	DO Location
2022-01-01 00:35:40	2022-01-01 00:53:29	2.0	3.80	142	236
2022-02-12 05:33:43	2022-02-12 05:42:07	1.0	2.10	236	42
2022-08-03 08:33:26	2022-08-03 09:01:32	1.0	1.09	114	68

Taxi Data

- The pick up and dropoff location was provided in terms of the zone the trip started and ended in.
- A zone is meant to approximate a neighborhoods within the city.
- Maps available Manhattan, Bronx, Brooklyn, Queens, and Staten Island



Provided by the NYC Taxi and Limousine Commission

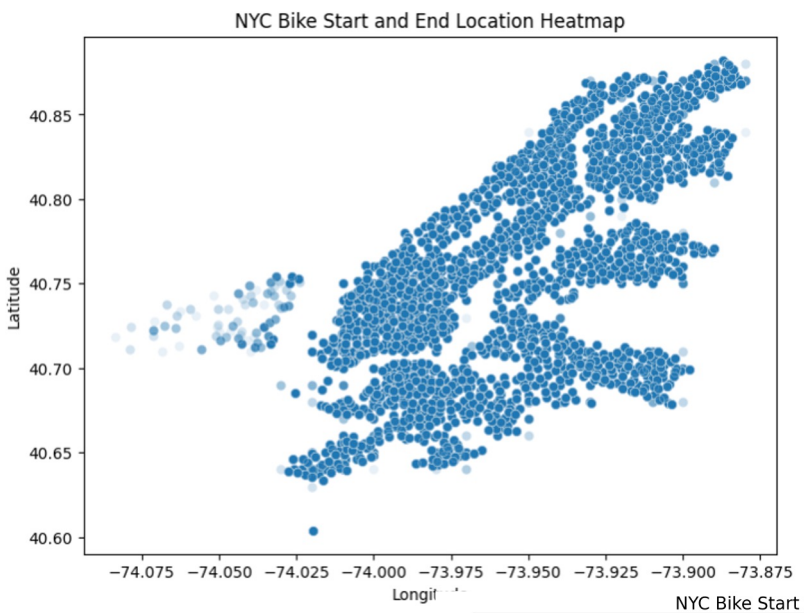
Bike Data

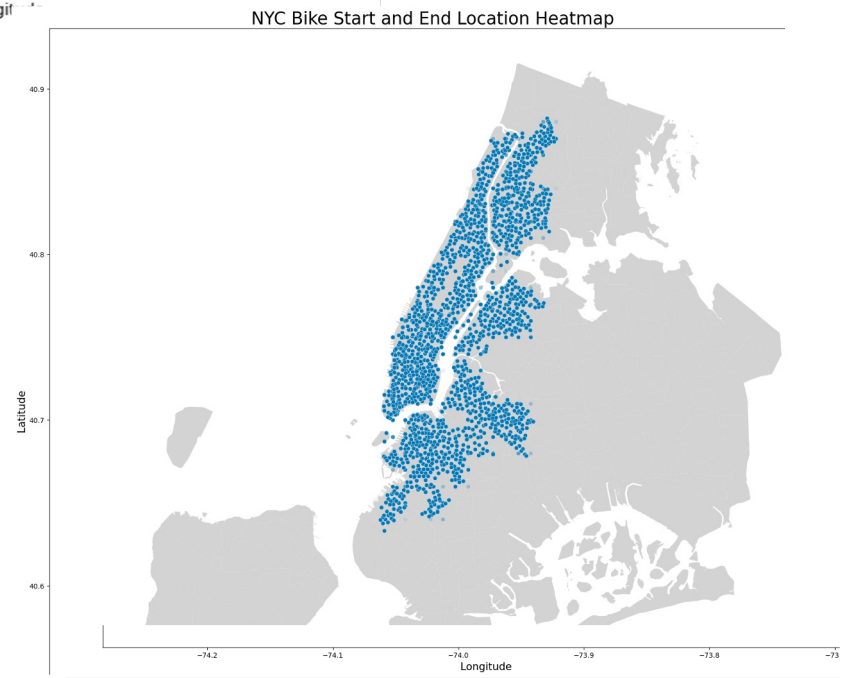
- The Citibike Bike Share system tracks ever instance of a bike being taken out of a dock.
- From 2021, there were 27,661,451 occurrences of this.

Rideable Type	Started At	Ended At	Start Station	Start Latitude	Start Longitude
electric_bike	2021-01-26 18:50:39	2021-01-26 18:58:53	12 St & Sinatra Dr	40.750604	-74.024020
classic_bike	2021-08-28 12:25:43	2021-08-28 1:09:44	Essex Light Rail	40.7122774	-74.036486
classic_bike	2021-10-02 21:44:01	2021-10-02 21:45:57	Christ Hospital	40.734786	-74.050444

Bike Data

- Mistake trips were removed by Citi Bike already
- Points in New Jersey were excluded.
- Trips with the same start and end location were removed
- After this, there were 25,818,629 trips to use.



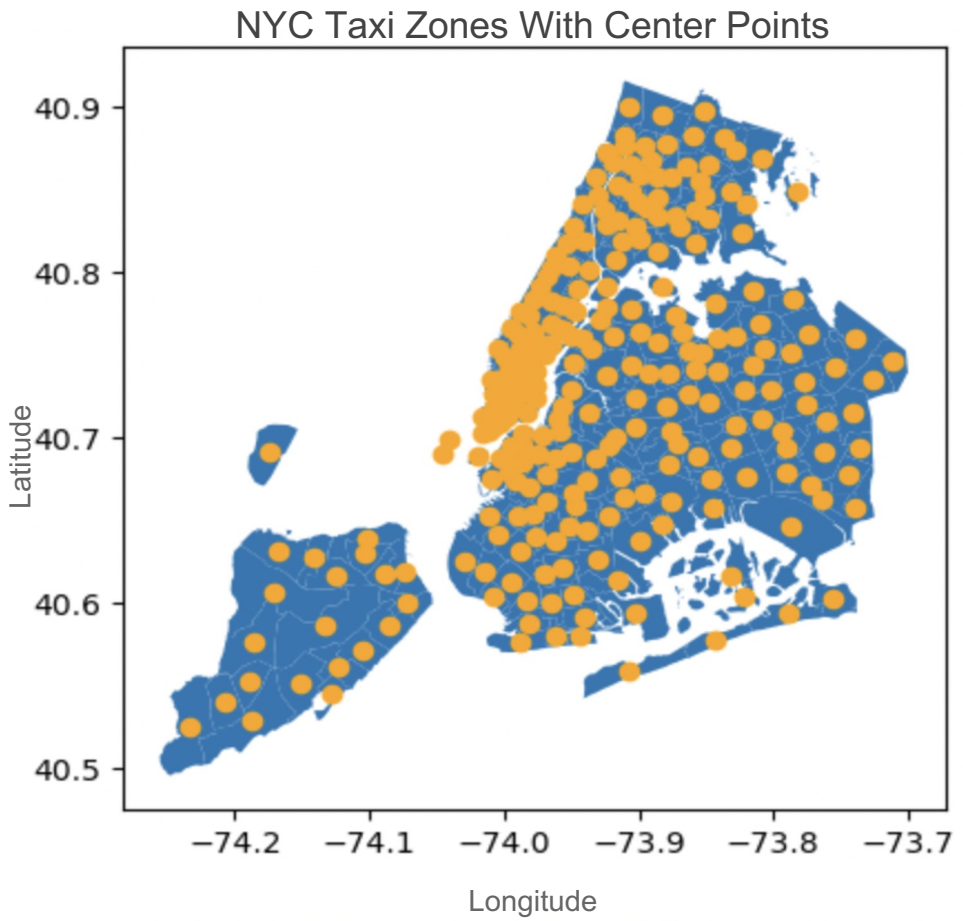


Methods

- To start comparing the data, it had to be compatible.
  - Taxi data had the distance of the trip but no geographical coordinates.
  - Bike data contained exact latitude and longitude values but no total distance for the trip.

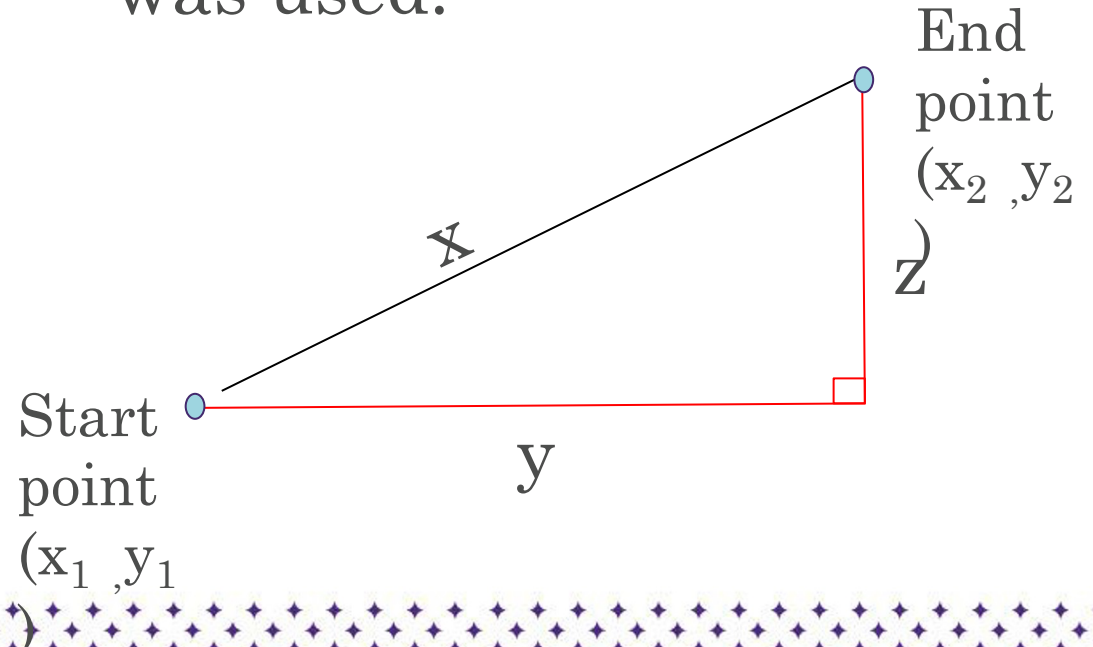
Assigning Location for Taxi Rides

- Assigning latitude and longitude points for taxi trips used the center point of the zones.
- There are 263 total zones in the map.
- This was an estimation since the exact geographical coordinates were not provided.
- Columns for starting and ending latitude and longitude were added for each trip.



Calculating Bike Distances

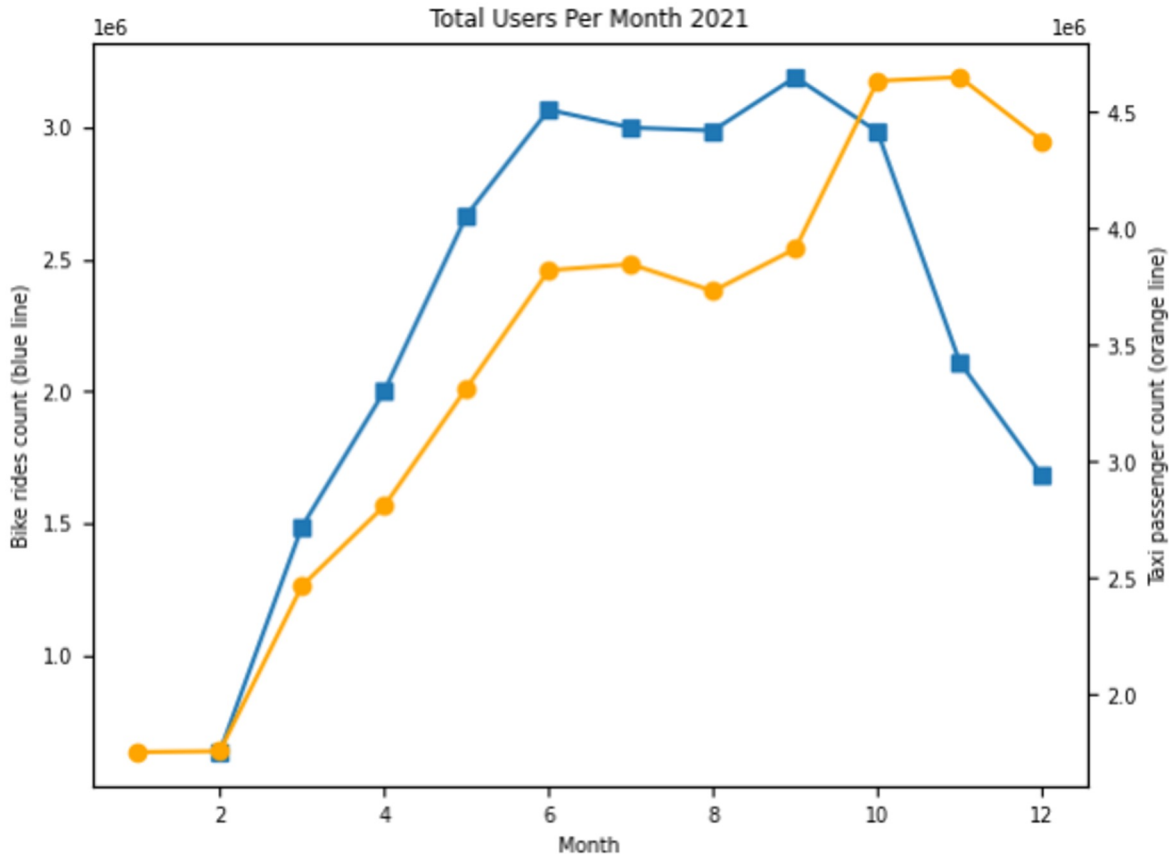
- Using the provided latitude and longitude coordinates, the distance of the bike rides could be calculated.
- To mimic the layout of the city, the Manhattan distance was used.



Manhattan Distance = $|x_1 - x_2| + |y_1 - y_2|$

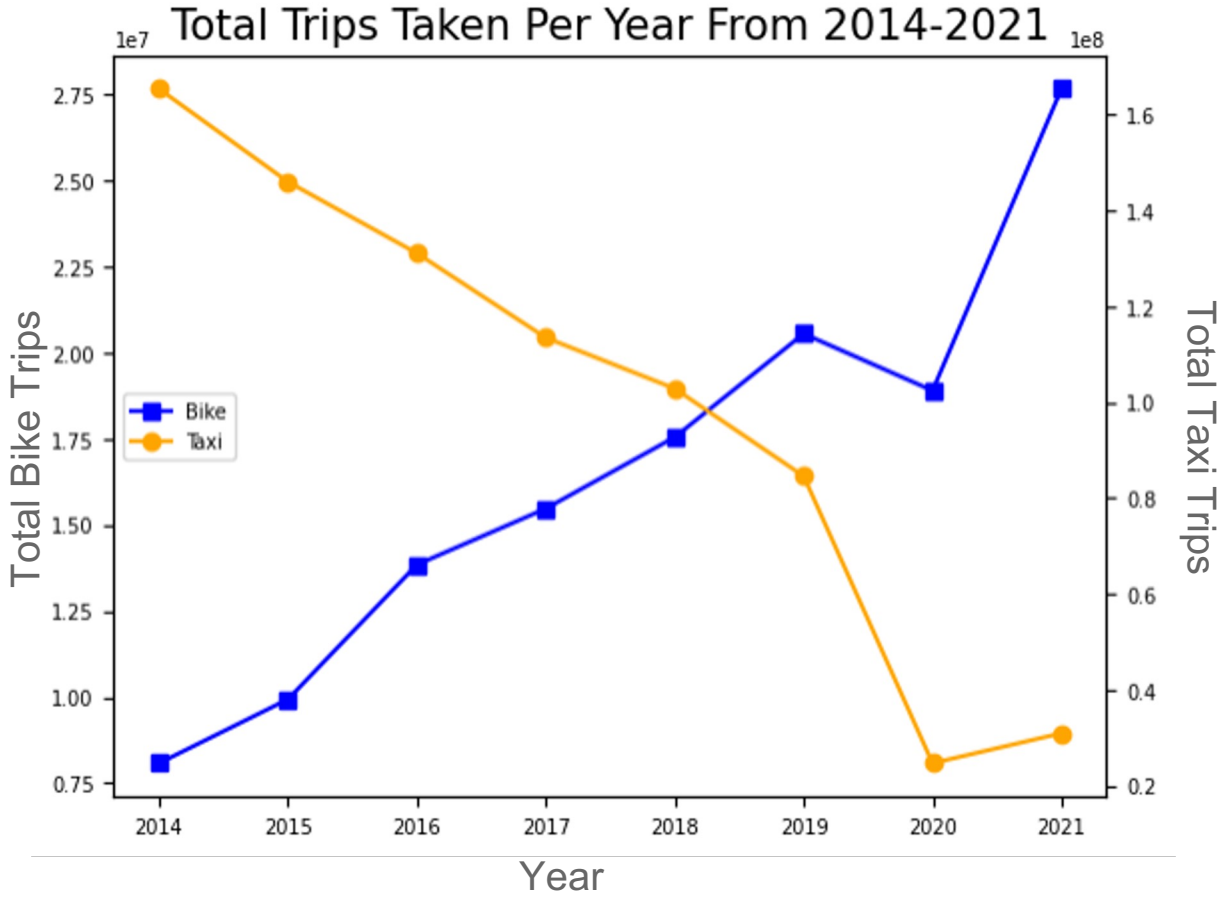
Monthly Users

- The image on the right is the total number of rides of bikes each month and the total number of passengers who rode in a taxi each month
- Weather impacts the usage
- High tourism rates occur in the summer which could be helping the high rates of bikes from June to September.



Annual Users

- From 2014-2021, there is a downward trend in taxi rides and an increase in bike rides.
- As the Citi Bike system is being improved, more people are using this transportation system



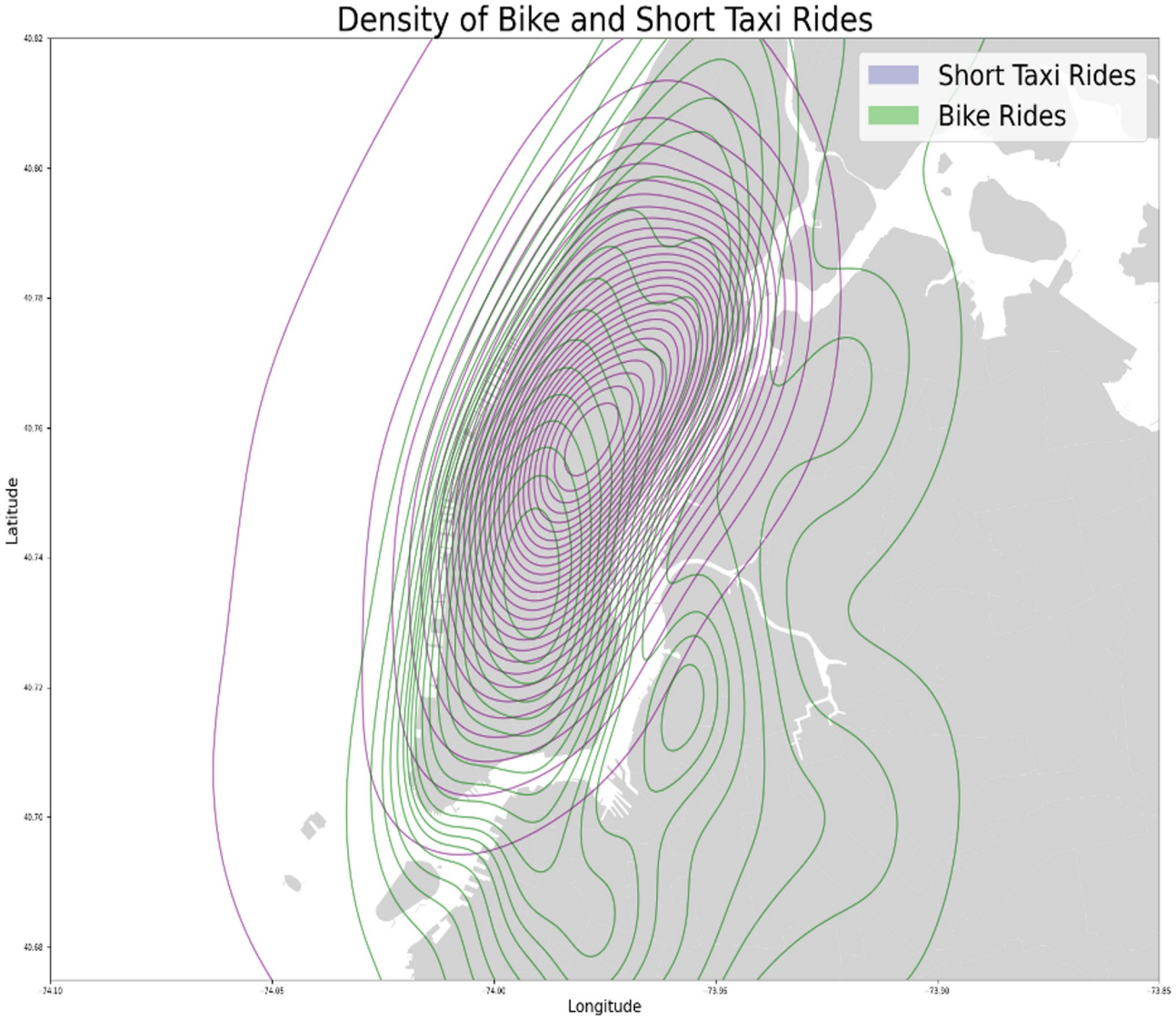
Quantifying Taxi Distance

- Once the bike trips were assigning distances, the mean distance was found to be 1.554 miles which I rounded to be 1.5 miles.
- Comparing this distance to the taxi rides, there were 11,699,913 rides that were less than or equal to a mile and a half
- This totaled to be 11,082,139 miles travelled from these trips
- The top 20 most common trips occurred in Manhattan around Central Park

Density of Rides

Bike rides are most common in the southern part of Manhattan and short taxi trips occur a little north

- Location is around Central Park
- Popular location for tourists to visit



Environmental Cost

- The NYC Taxis in 2021 could be one of five models of cars, each with a similar fuel economy of 27 mpg and an emissions rate of 2.3 kg/m

$$\text{CO2 Emissions (kg)} = \left(\frac{TotalMiles}{FuelEfficiency(MPG)}\right) * CO_2/mile$$

$$\text{CO2 Emissions for 2021 (kg)} = \left(\frac{11{,}082{,}139}{27(MPG)}\right) * 2.3kg/mile = 429{,}639\ \text{kg}$$

- 429,639 kg of CO2 or rough;y 429 metric tons of carbon was released from these short taxi trips.

Conclusion

- There are positive trends in the quantities of bike and taxi rides.
- The top 20 most common taxi rides occurred in areas where there are numerous bike stations
- There is opportunity to continue to decrease this number of short taxi rides
- Continuing to expand the bikeshare system could continue to decrease the number of on-road vehicles.

Future Work

- Include other bike share system in place
- Look at other rideshare services, if data exists
  - Uber, Lyft, ARRO
- Analyze the area around Central park to find ways to make the area more bike friendly to promote use
- Look at other years to see if there has been change in location popularity

Thank You

Sources:

- "The City of New York. Inventory of new york city greenhouse gas emissions in 2016." pages 7–28, 2017

- Wahyu, Andy Prastyabudi. "Finding frequent routes from taxi trips with time windows: Nyc case. In Proceedings of the 2019 5th International Conference on Computing and Artificial Intelligence", pages 1–5, 2019