

Citibike and its Impact in NYC

Maikol Cerda (Postdoc, Yale University)

Data Project: Yale Seminar PCE

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Goals and Databases

1. Understand the Demand's Dynamics and Demand's Forecasting

- ▶ Final User: Lyft.
- ▶ Optimization of Resources and Better Competitive Position

2. Quantify the impact of bike-paths on City's Development (2020 expansion to the Bronx)

- ▶ Final user: Government (NYC) and Lyft
- ▶ Urban economics and strategic expansion

▶ Time period: 2015-2019

Dataset	Freq	Size	Features
1. Citibike Trips	Daily	13.3GB	Trips duration, start-stop times/stations
2. Taxis and ridesharing trips	Monthly	0.8GB	Trips per-day, vehicles per-day, avg minute per-trip
3. Weather conditions	Daily	1.5GB	Temperature, wind speed, precipitation, humidity
4. Tourists-passengers	Monthly	40MB	Number of domestic and international visitors
5. Pollution and rental prices	Daily-Monthly	400MB	Main pollutants, overall AQI

1.a Demand's Dynamics and Demand's Forecasting

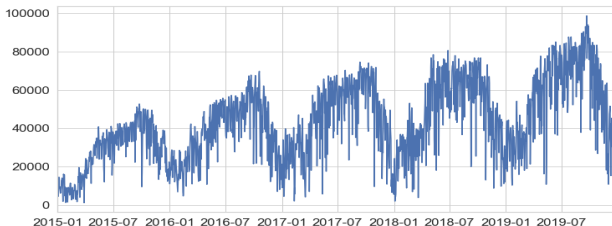


Figure 1: Number of trips per-hour, 2015-2019

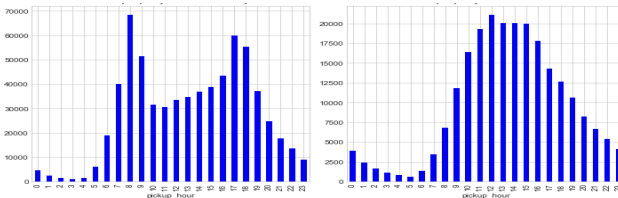


Figure 2: Daily Seasonality: Trips per-hour week day (left) vs weekend (right)

1.a Demand's Dynamics and Demand's Forecasting

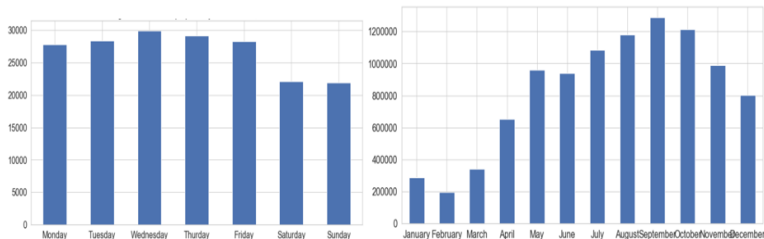


Figure 3: Monthly (left) and Weekly (right) Seasonalities: average number of trips

► Prophet, Time Series Forecasting:

$$y(t) = g(t) + s(t) + h(t) + \epsilon_t$$

► Includes:

- $g(\cdot)$: aggregate long-term trend
- $s(\cdot)$: seasonalities with Fourier series
- $h(\cdot)$: impact of holidays

1.a Demand's Dynamics and Demand's Forecasting

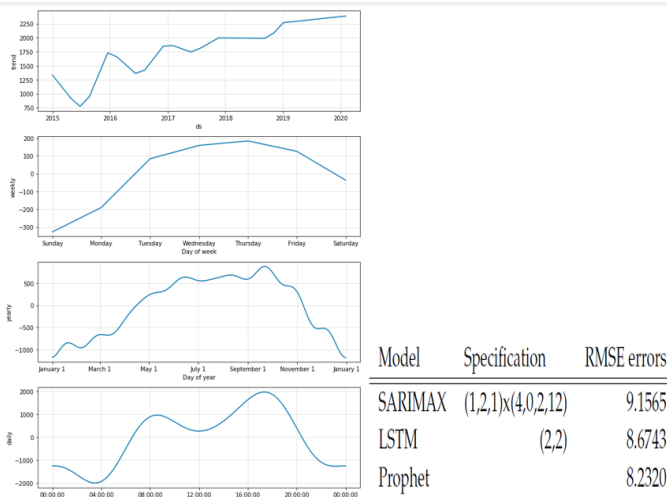


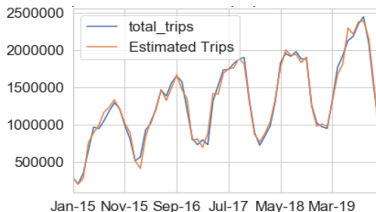
Figure 4: Prophet's Forecasting (left) and Model evaluation (right)

1.b Explanatory Analysis

- Model for the number of trips:

$$y = f(\vec{x}) = f(\text{\# visitors, } T, \text{rain, substitutes, season, gender})$$

- Approximation: f is quadratic



total_trips	Robust		
	Coef.	Std. Err.	t
dom_passengers	.1790183	.1414179	1.27
int_passengers	-.1756811	.1350174	-1.30
t_avg	.2654983	.0942052	2.82
rain	-.0510522	.0241002	-2.12
taxi_vehicles_per_day	-.2307219	.1378688	-1.67
_cons	.2542904	.0292383	8.70

Figure 5: Estimation fitting (left) and results (right)

- Gradient boosting decision tree
 - Combine several simple tree models to achieve optimized prediction performance
 - Interpretation of the model results by identifying the key explanatory variables

1.c Microanalysis and Optimization of Resources

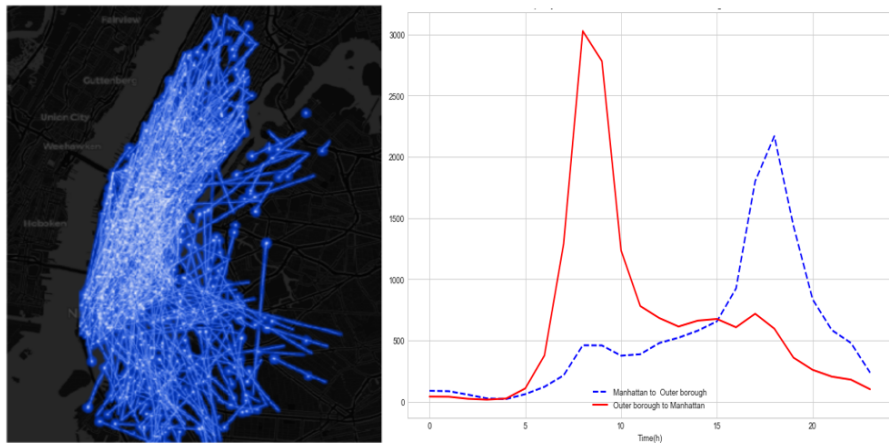


Figure 6: Relevance of routes (left) and trips among borough (right)

1.c Microanalysis and Optimization of Resources

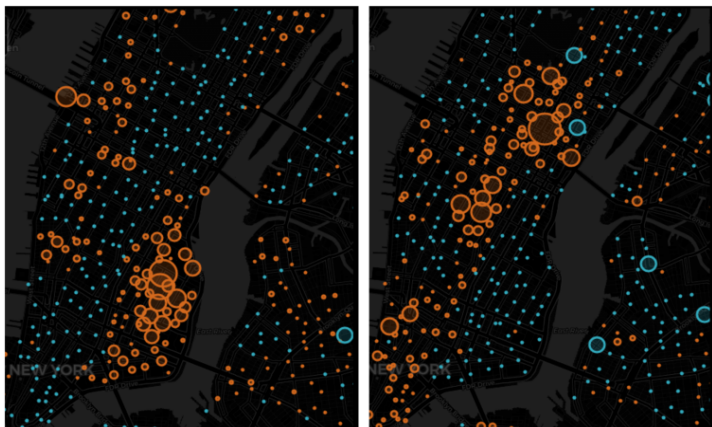


Figure 7: Net Departures by station, 9am (left) vs. 6pm (right). (Orange: $\text{departures} > \text{arrivals}$; Blue: otherwise)

2.a Citibike and City's Development

- Citibike and its impact on other variables of interest:

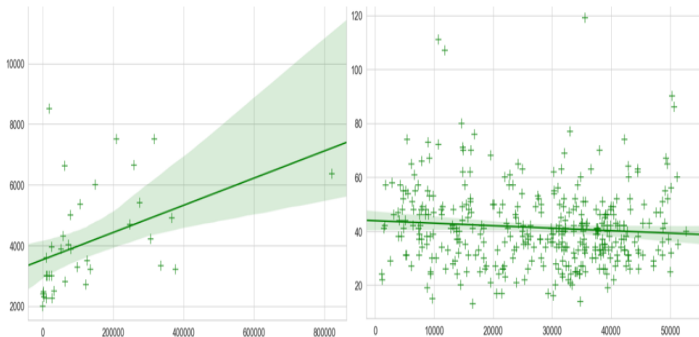


Figure 8: Avg. rental prices by neighborhood (left) and daily NO2 pollutant level as a function of the number of trips

2.b Citibike and Expansion's Plan

- ▶ Lyft vs. Taxis rides:

	service_zone	Zone	Borough
PULocationID			
168	1368	Mott Haven/Port Morris	Bronx
247	891	West Concourse	Bronx
69	668	East Concourse/Concourse Village	Bronx
213	639	Soundview/Castle Hill	Bronx
159	636	Melrose South	Bronx

- ▶ The planned expansion through 2023 will include the following neighborhoods in the Bronx:
 - ▶ Mott Haven, Melrose, Port Morris, Highbridge, Claremont, Morrisania, Longwood, Concourse, and Mt. Eden
 - ▶ Source: <https://www.citibikenyc.com/blog/major-citi-bike-expansion-map-revealed>

2.b Citibike and Expansion's Plan

- Search Problem:

$$\begin{aligned} \{y_i\}_{i=1}^N &= \arg \min \sum_{i=1}^N n_i \sum_{j=1}^3 \omega_{ij} d_{ij} \\ \text{s.t. } \sum_{j=1}^3 \omega_{ij} &= 1 ; \sum_{i=1}^N y_i \leq S ; \omega_{i1} > \omega_{i2} > \omega_{i3} \end{aligned}$$

- where: N =neighborhoods ; $y_i \in \{0, 1\}$; S =max of stations

