

# Citibike and its Impact in NYC

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Data Incubator Interview

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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

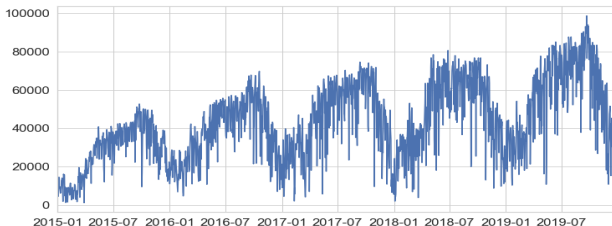


Figure 1: Number of trips per-hour, 2015-2019

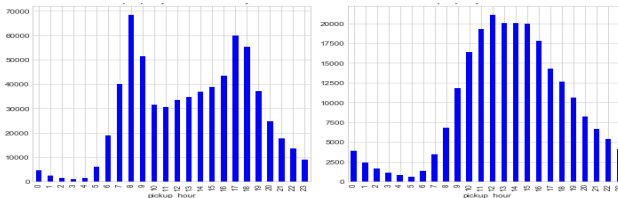


Figure 2: Daily Seasonality: Trips per-hour week day (left) vs weekend (right)

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

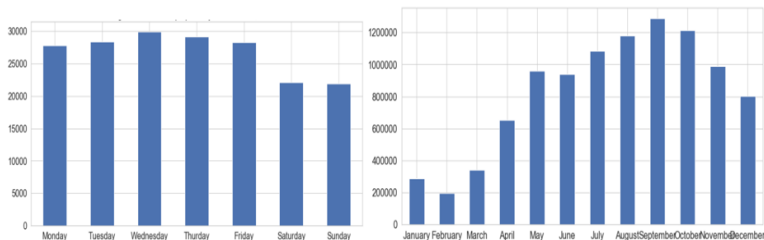


Figure 3: Monthly (left) and Weekly (right) Seasonalities: average number of trips

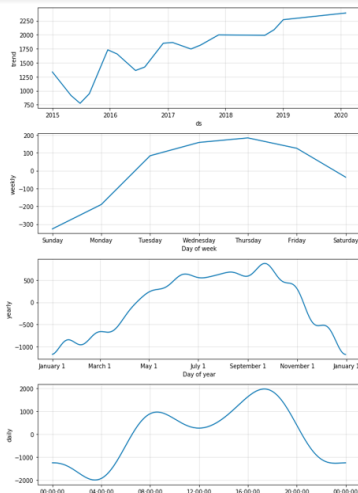
## ► Prophet, Time Series Forecasting:

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

## ► 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



Model	Specification	RMSE errors
SARIMAX	(1,2,1)x(4,0,2,12)	9.1565
LSTM	(2,2)	8.6743
Prophet		8.2320

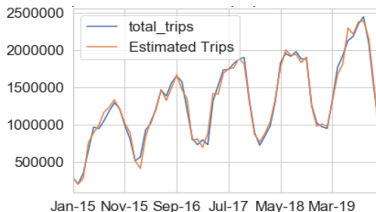
Figure 4: Prophet's Forecasting (left) and Model evaluation (right)

# 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

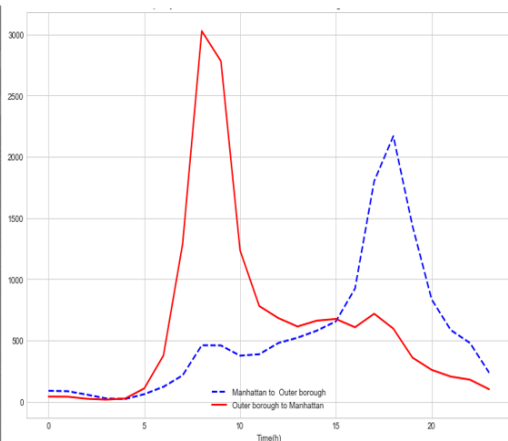
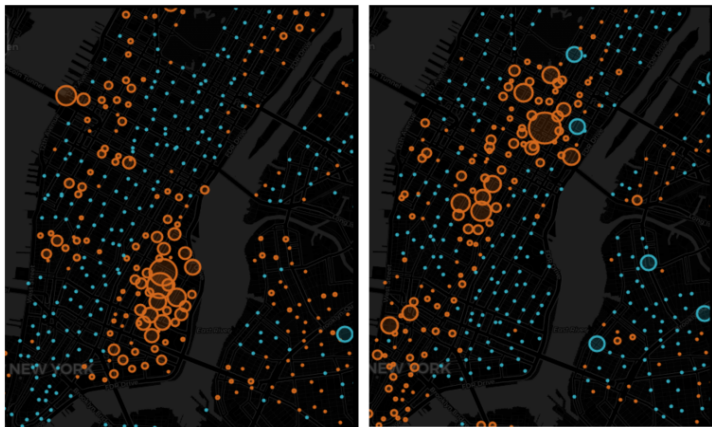


Figure 6: Relevance of routes (left) and trips among borough (right)

## 1.c Microanalysis and Optimization of Resources

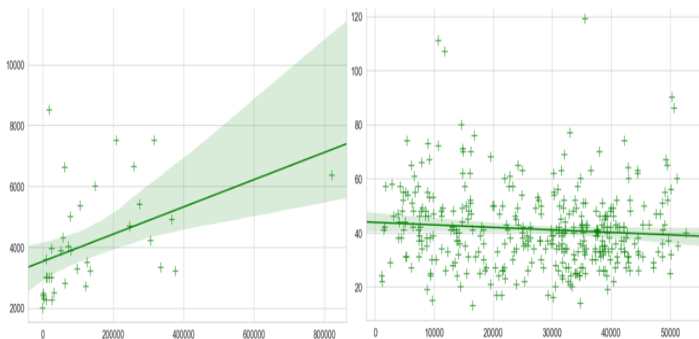


**Figure 7:** Net Departures by station, 9am (left) vs. 6pm (right). (Orange: departures > arrivals ; Blue: otherwise)



## 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. Taxi 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

