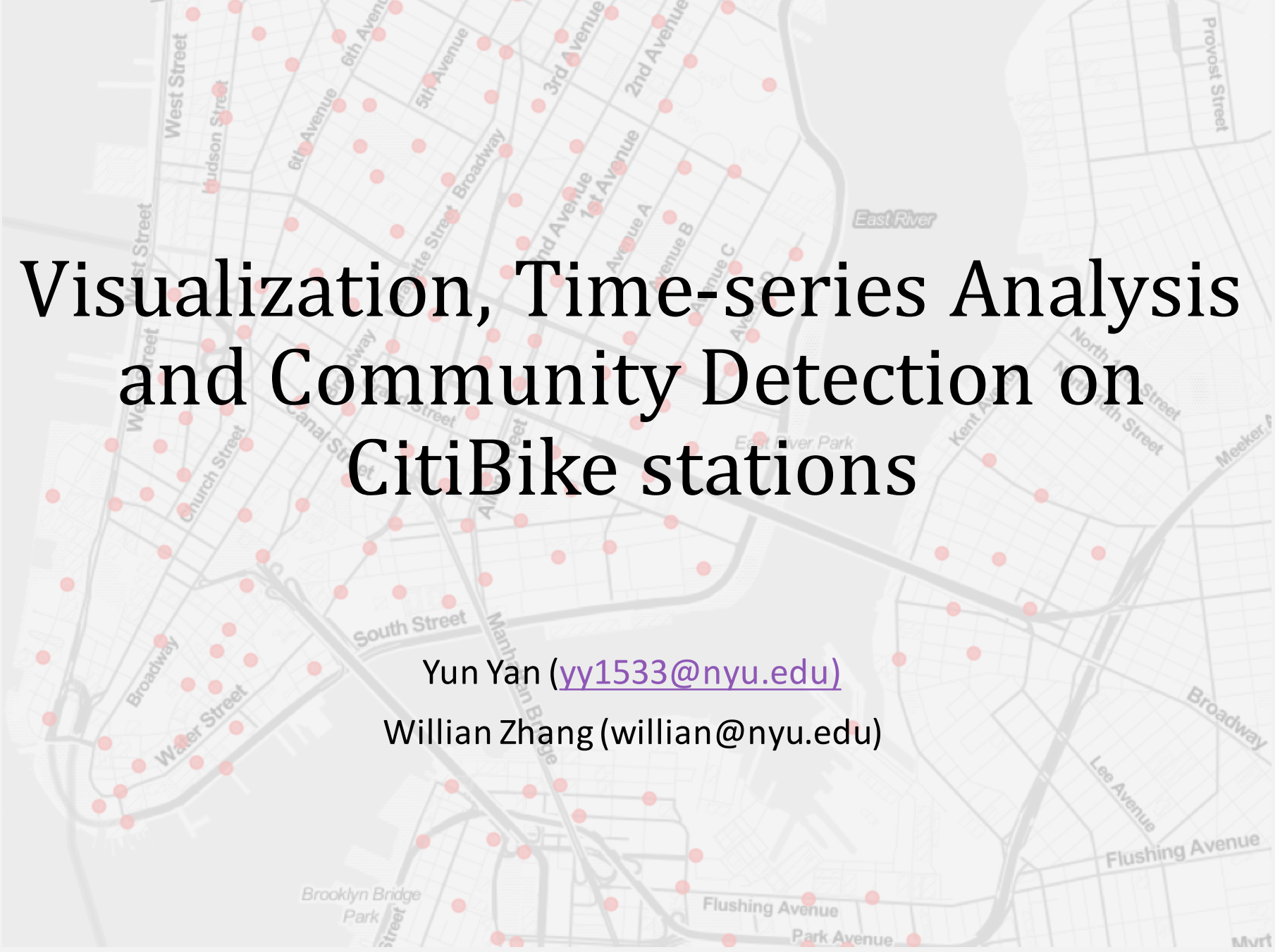


Visualization, Time-series Analysis and Community Detection on CitiBike stations

Yun Yan (yy1533@nyu.edu)

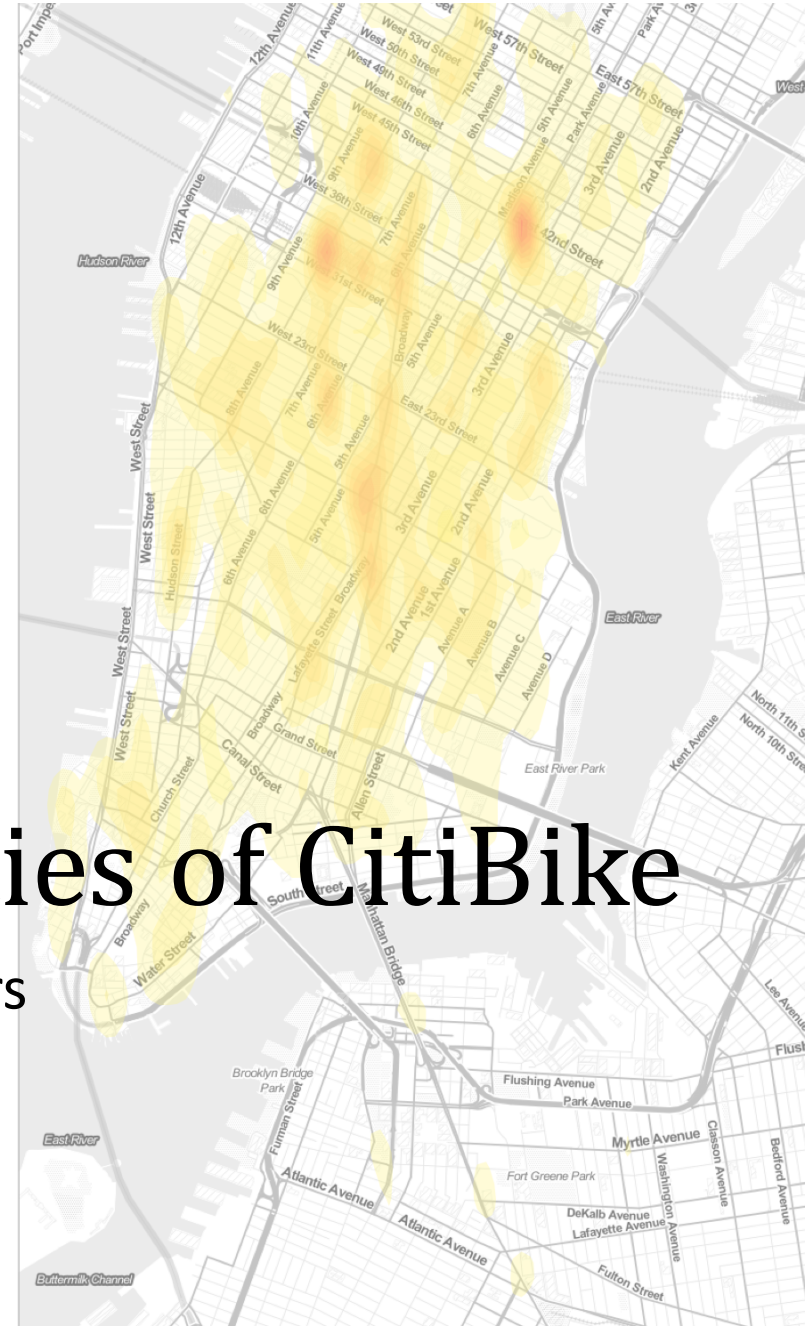
Willian Zhang (willian@nyu.edu)

Outline

- Introduction to Citibike dataset and possible tasks
- What does the Citibike activity looks like within 24-hour?
- Is there any specific purpose of using Citibike depending on stations?
- Can we model / forecast the daily usage?
- Is there any community of stations?

Visualizing Activities of CitiBike

Picking during weekdays of all users

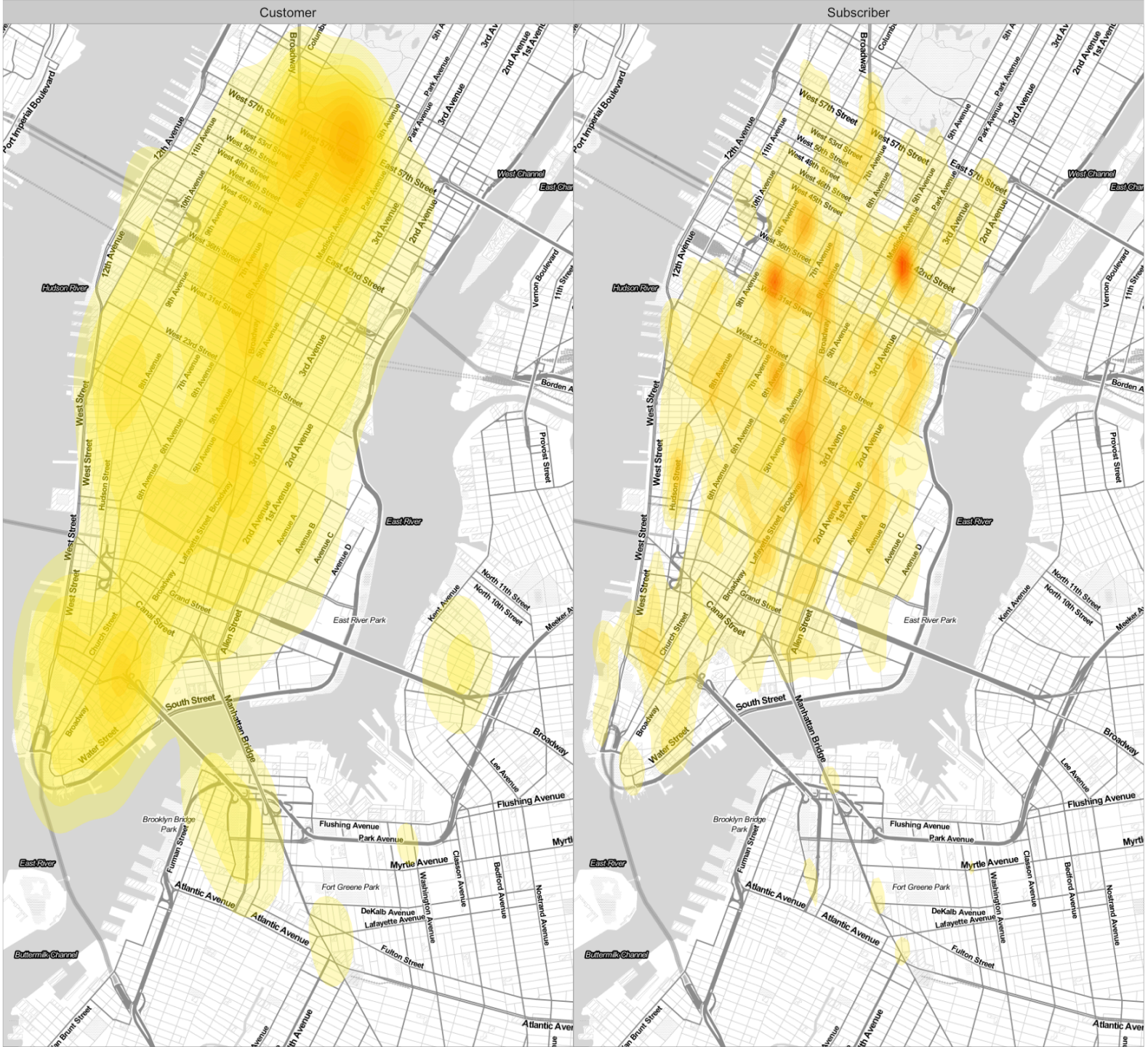


Trips of CitiBike

1. Activity: Picking / Docking
2. Day: all days / Weekdays / Weekends
3. Type: all users / Member / One-time Customer

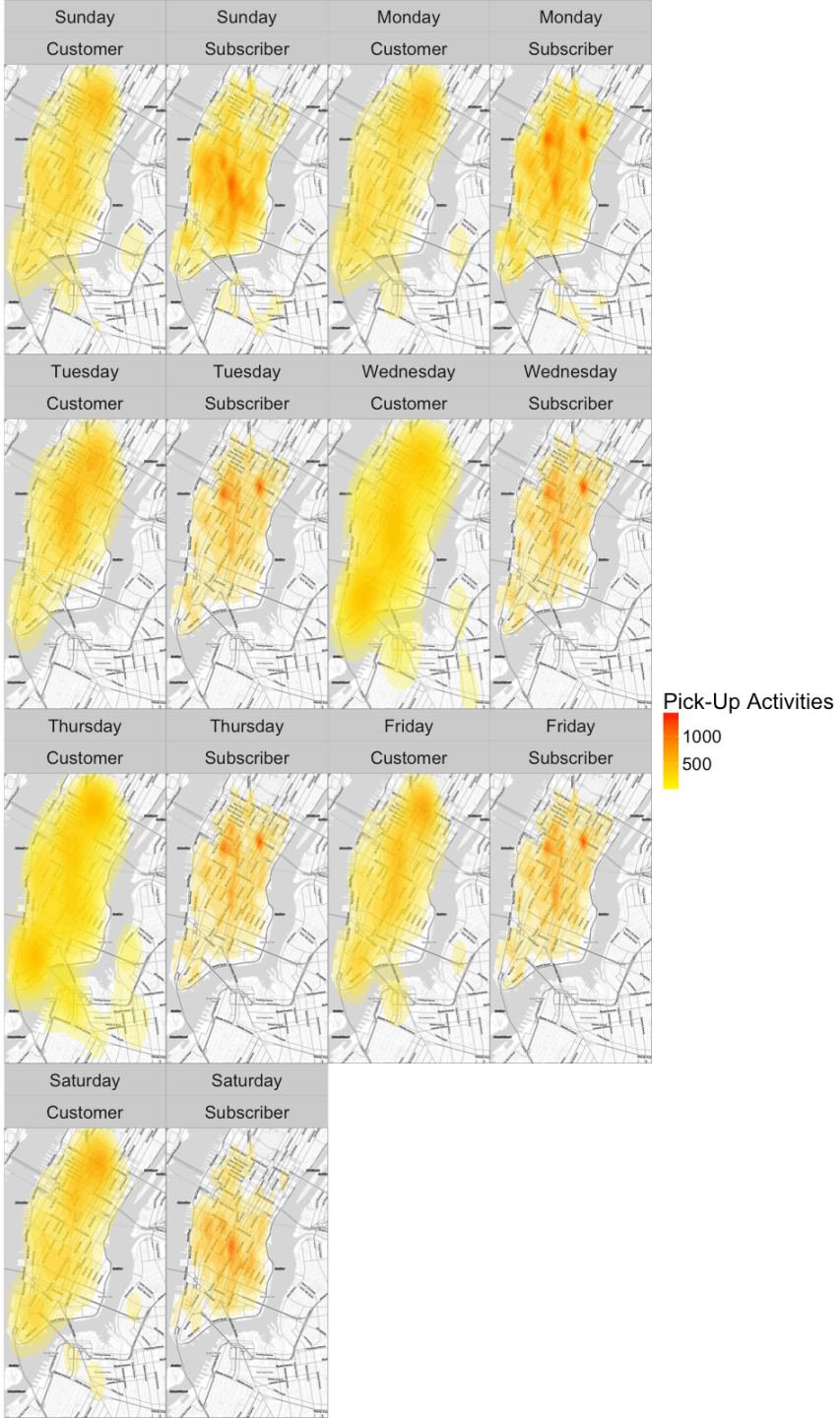
All Activities of CitiBike

- Picking during all days
- One-time Customer v.s. Members


Customer
Subscriber
Pick-Up Activities
2000
1500
1000
500
Broadway
West 57th Street
East 57th Street
12th Avenue
11th Avenue
10th Avenue
9th Avenue
8th Avenue
7th Avenue
6th Avenue
5th Avenue
Park Avenue
3rd Avenue
2nd Avenue
1st Avenue
West 53rd Street
West 50th Street
West 48th Street
West 46th Street
West 45th Street
West 36th Street
West 31st Street
West 23rd Street
East 42nd Street
East 23rd Street
Madison Avenue
Hudson River
West Channel
East Channel
Port Imperial Boulevard
Vernon Boulevard
11th Street
Borden Avenue
West Street
Hudson Street
Provost Street
East River
East River Park
Avenue A
Avenue B
Avenue C
Avenue D
Kent Avenue
North 11th Street
North 10th Street
Meeker Avenue
Lafayette Street
Grand Street
Canal Street
Church Street
Allen Street
South Street
Manhattan Bridge
Water Street
Lee Avenue
Flushing Avenue
Brooklyn Bridge Park
Park Avenue
Myrtle Avenue
Fort Greene Park
Classon Avenue
Bedford Avenue
Nostrand Avenue
Washington Avenue
Furman Street
Atlantic Avenue
DeKalb Avenue
Lafayette Avenue
Fulton Street
Buttermilk Channel
Van Brunt Street

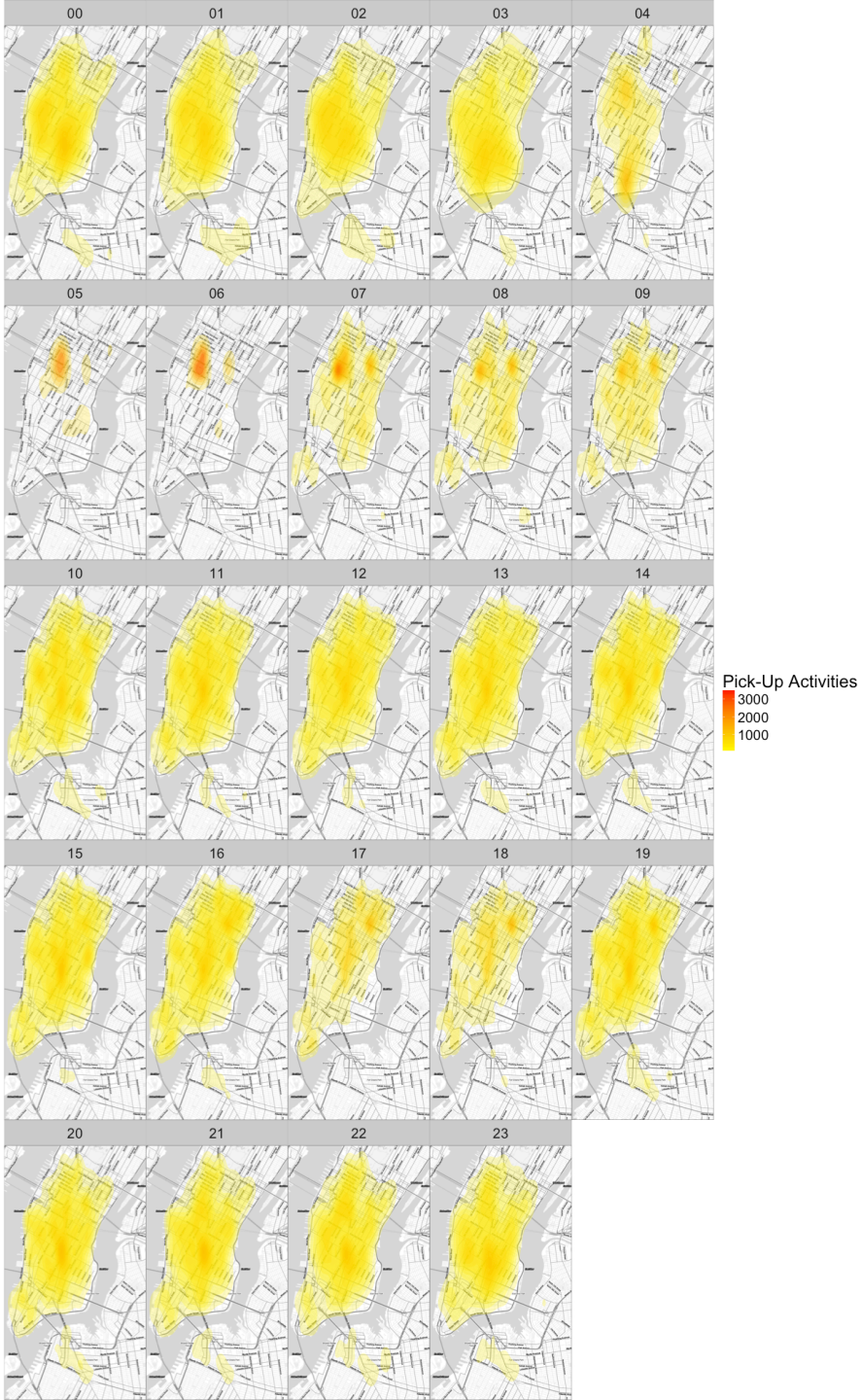
Weekly Activities

- Picking up during weekdays and weekends
- One-time customer v.s. Members


Sunday
Customer
Sunday
Subscriber
Monday
Customer
Monday
Subscriber
Tuesday
Customer
Tuesday
Subscriber
Wednesday
Customer
Wednesday
Subscriber
Thursday
Customer
Thursday
Subscriber
Friday
Customer
Friday
Subscriber
Saturday
Customer
Saturday
Subscriber
Pick-Up Activities
1000
500

24-hour Activities

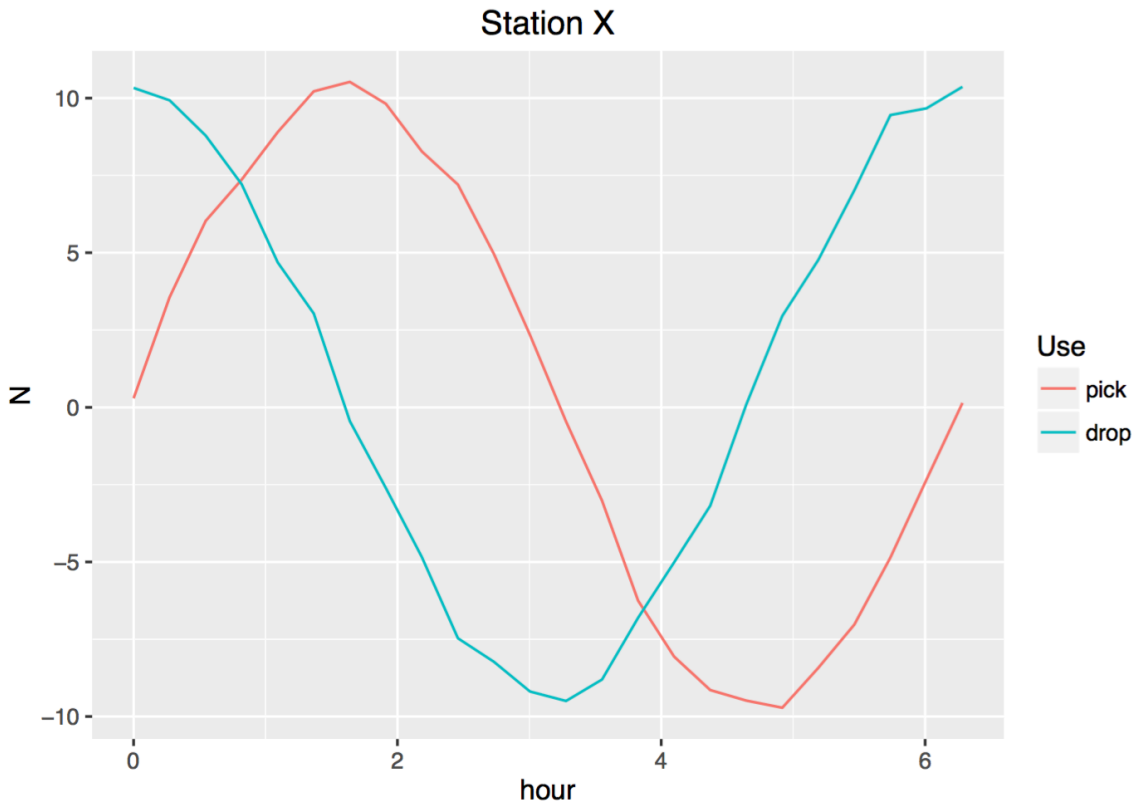
- Picking up during weekdays
- All users


00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Pick-Up Activities
3000
2000
1000

Section Summary

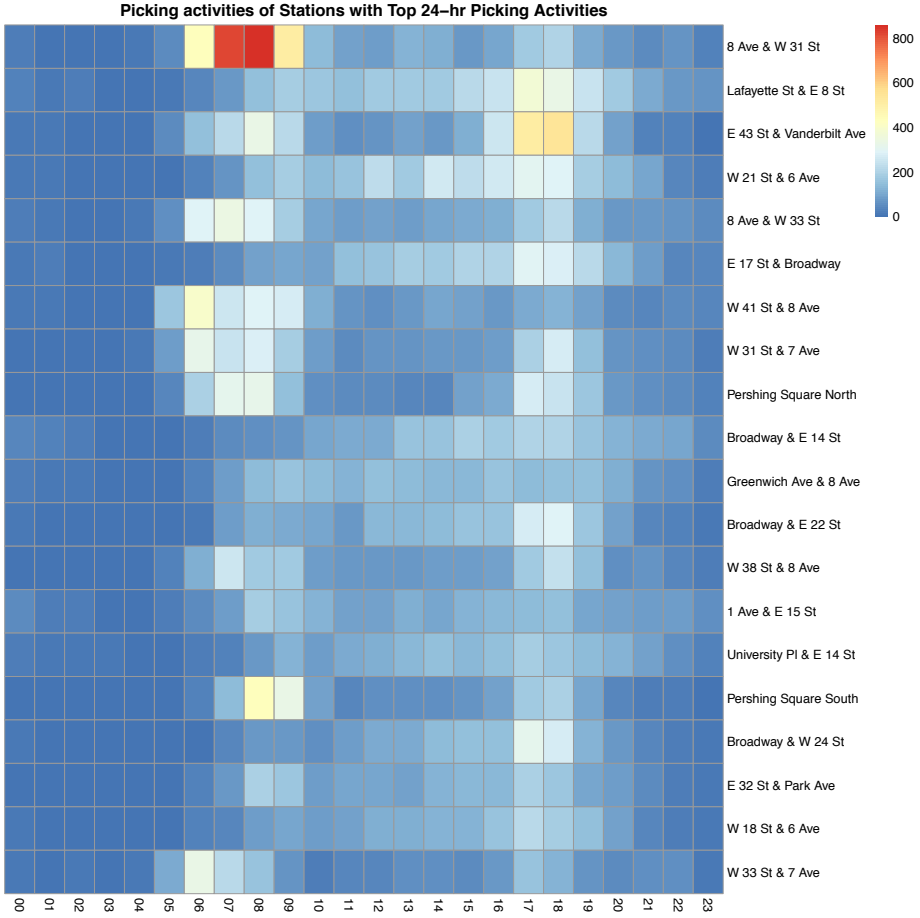
- Monitor the 24-hour activities in New York City

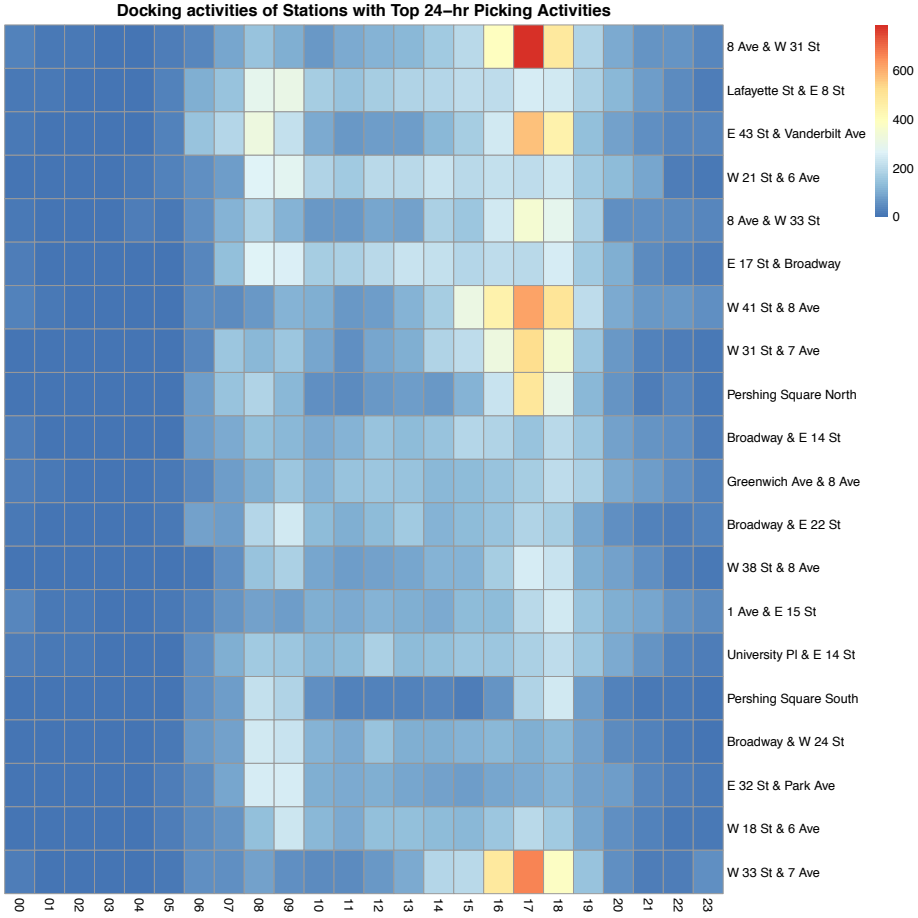
- Different behaviors between annual members and one-time customers
  - Member consider CitiBike for commuting
  - One-time customer ride for fun



Temporal properties

Do uses have specific reasons to take bikes depending on stations?


Picking activities of Stations with Top 24–hr Picking Activities
8 Ave & W 31 St
Lafayette St & E 8 St
E 43 St & Vanderbilt Ave
W 21 St & 6 Ave
8 Ave & W 33 St
E 17 St & Broadway
W 41 St & 8 Ave
W 31 St & 7 Ave
Pershing Square North
Broadway & E 14 St
Greenwich Ave & 8 Ave
Broadway & E 22 St
W 38 St & 8 Ave
1 Ave & E 15 St
University Pl & E 14 St
Pershing Square South
Broadway & W 24 St
E 32 St & Park Ave
W 18 St & 6 Ave
W 33 St & 7 Ave
800
600
400
200
0
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23


Docking activities of Stations with Top 24–hr Picking Activities
8 Ave & W 31 St
Lafayette St & E 8 St
E 43 St & Vanderbilt Ave
W 21 St & 6 Ave
8 Ave & W 33 St
E 17 St & Broadway
W 41 St & 8 Ave
W 31 St & 7 Ave
Pershing Square North
Broadway & E 14 St
Greenwich Ave & 8 Ave
Broadway & E 22 St
W 38 St & 8 Ave
1 Ave & E 15 St
University Pl & E 14 St
Pershing Square South
Broadway & W 24 St
E 32 St & Park Ave
W 18 St & 6 Ave
W 33 St & 7 Ave
600
400
200
0
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Hidden preference towards stations

- Example of “8 Ave & W 31 St”: high picking in the morning while high docking in the nightfall

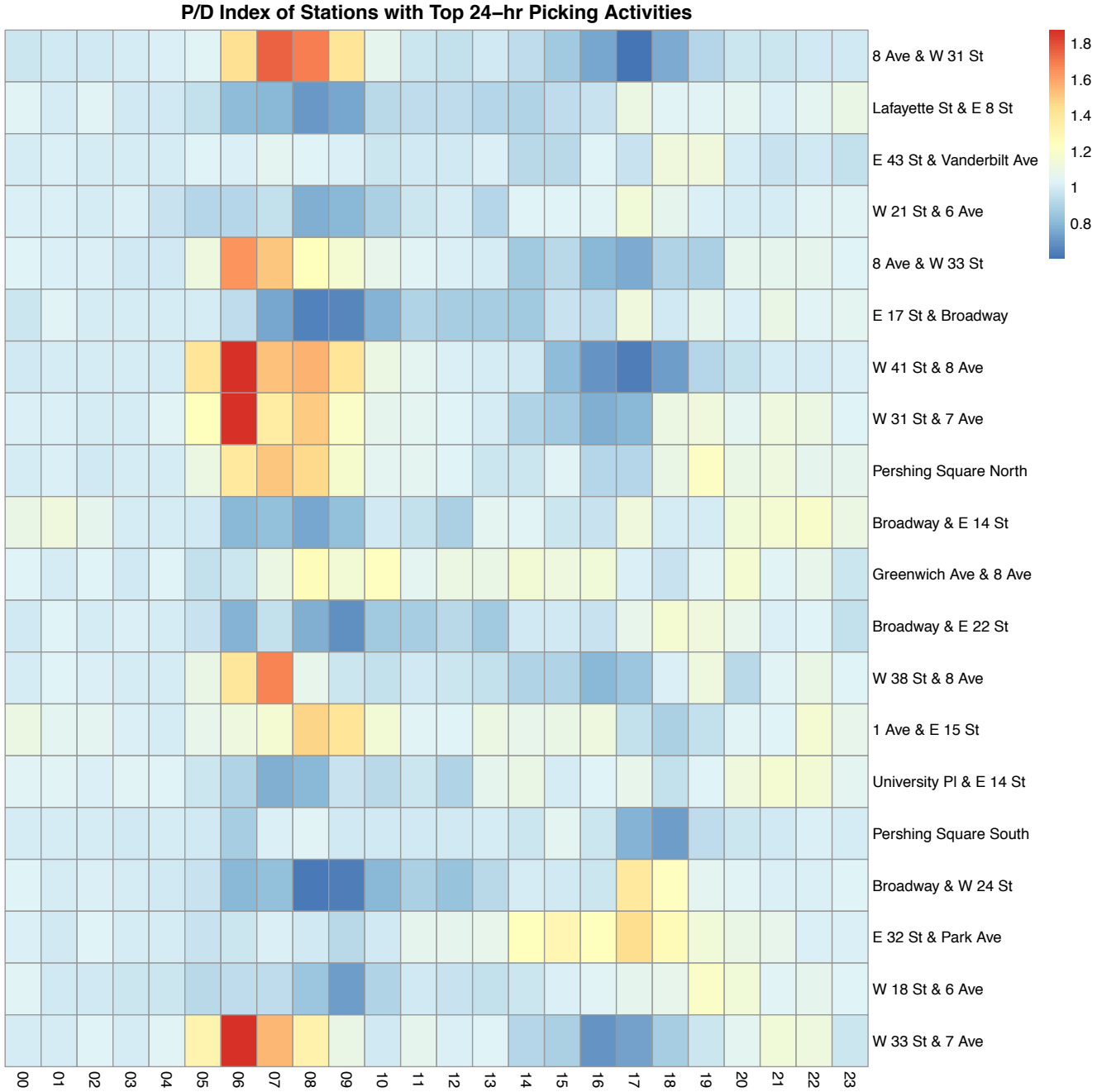
- How to integrate picking and docking activities together, instead of examining two figures side-by-side?

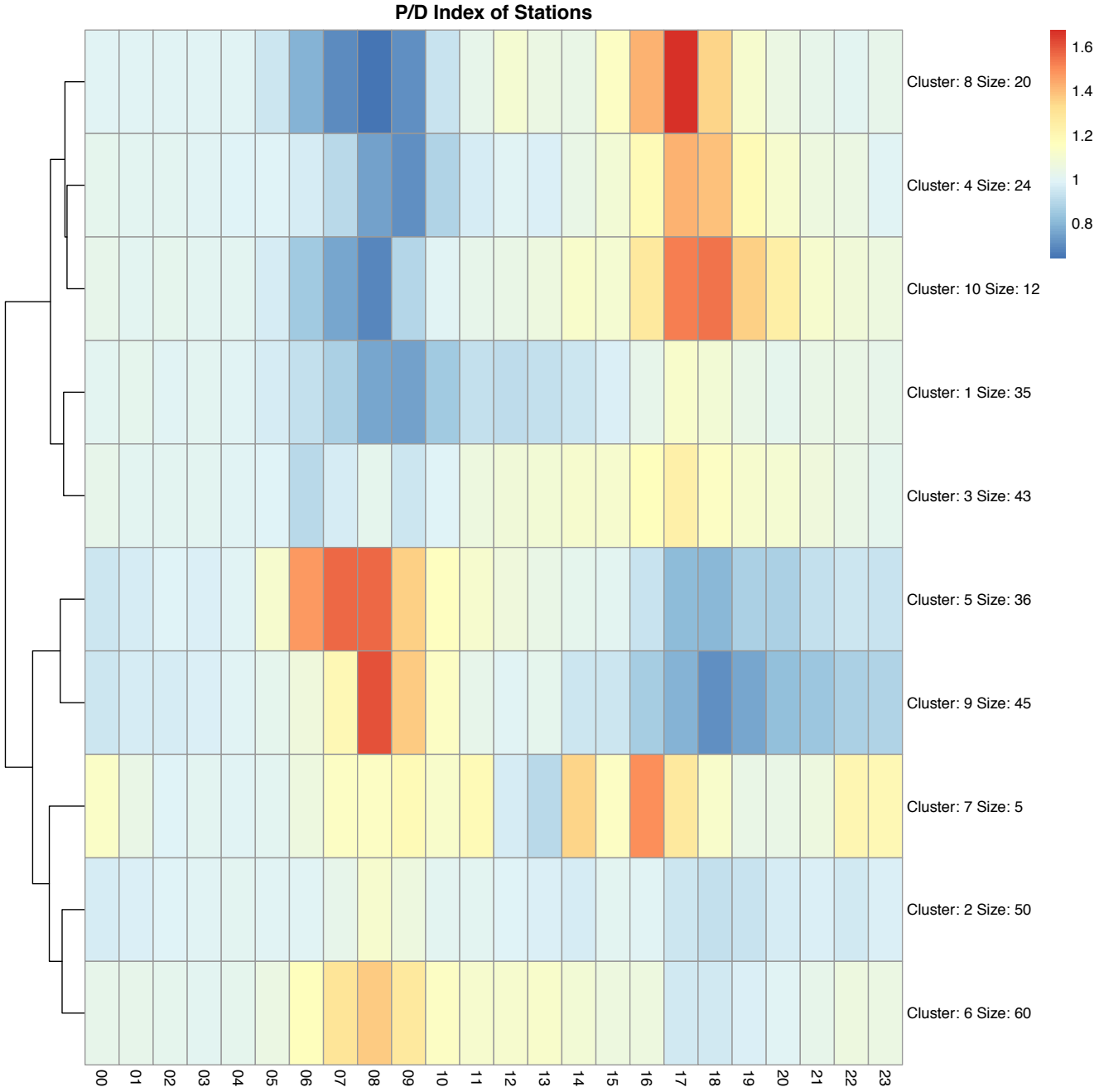
- P/D Index = Picking / Docking
  1. Matrix with stations on rows and hour point on columns;
  2. For each row, each element is divided by its max, e.g. [0, 1, 5] -> [0, 0.2, 1.0];
  3. Perform Step1 and Step2 on picking matrix and docking matrix;
  4. P/D index = (P + 1) / (D + 1).

P/D Index

- Higher P/D Index, it suggests high picking or low docking, i.e. the specific station is start-point of biking trip, and vice-versa.

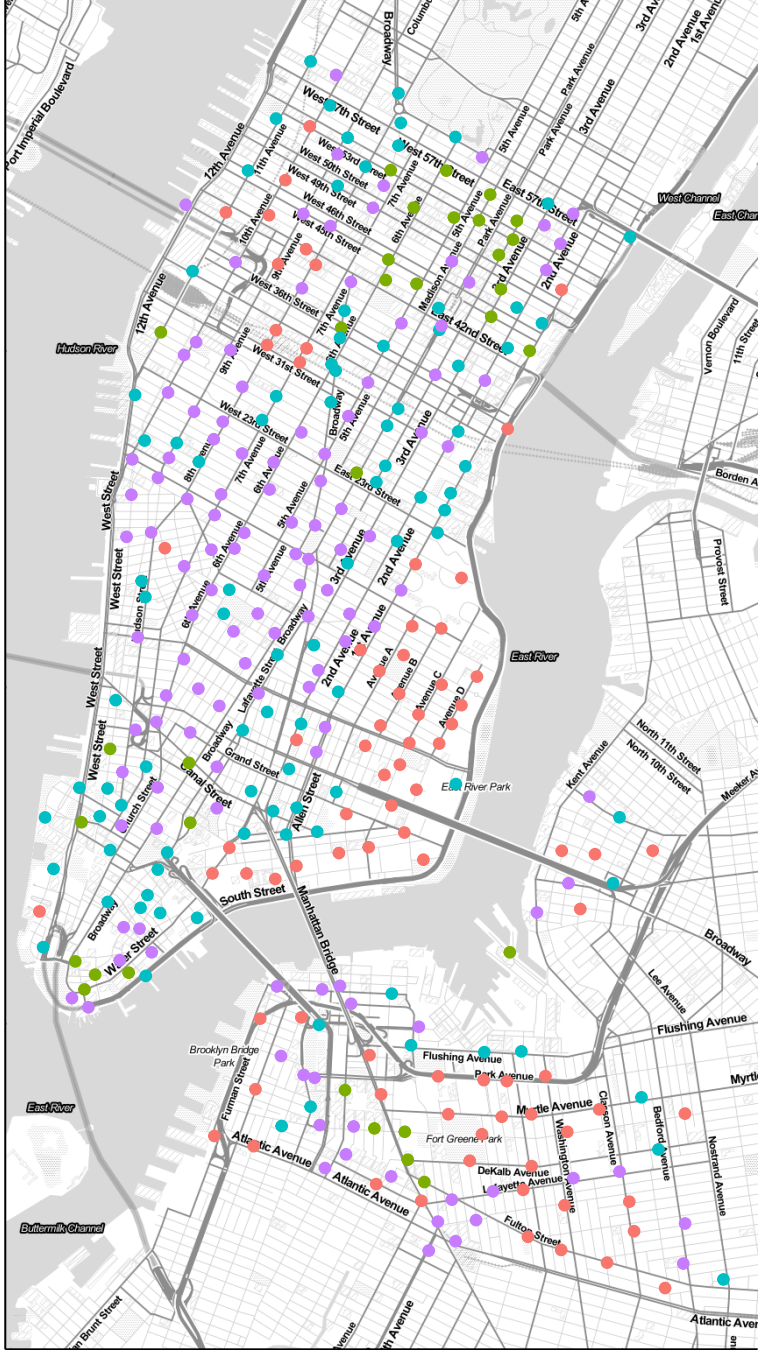
- Globally, the average should be (close to) 1.00.

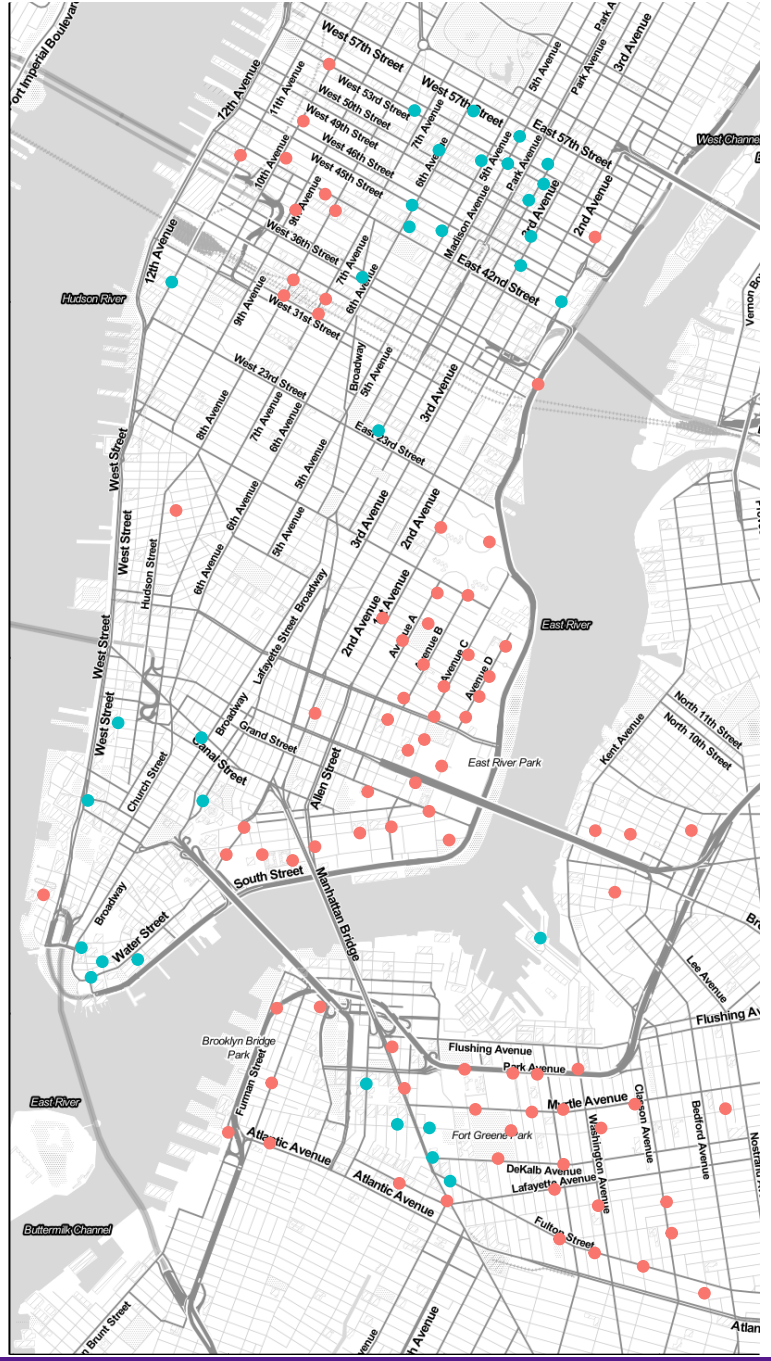

P/D Index of Stations with Top 24–hr Picking Activities
8 Ave & W 31 St
Lafayette St & E 8 St
E 43 St & Vanderbilt Ave
W 21 St & 6 Ave
8 Ave & W 33 St
E 17 St & Broadway
W 41 St & 8 Ave
W 31 St & 7 Ave
Pershing Square North
Broadway & E 14 St
Greenwich Ave & 8 Ave
Broadway & E 22 St
W 38 St & 8 Ave
1 Ave & E 15 St
University Pl & E 14 St
Pershing Square South
Broadway & W 24 St
E 32 St & Park Ave
W 18 St & 6 Ave
W 33 St & 7 Ave
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1.8
1.6
1.4
1.2
1
0.8


P/D Index of Stations
Cluster: 8 Size: 20
Cluster: 4 Size: 24
Cluster: 10 Size: 12
Cluster: 1 Size: 35
Cluster: 3 Size: 43
Cluster: 5 Size: 36
Cluster: 9 Size: 45
Cluster: 7 Size: 5
Cluster: 2 Size: 50
Cluster: 6 Size: 60
1.6
1.4
1.2
1
0.8
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23

Type of stations

- Type A: high P/D index in the morning but low at nightfall
- Type B: low P/D index in the morning but high at nightfall
- Type C: Normal P/D index throughout the day
- Type X: the rest

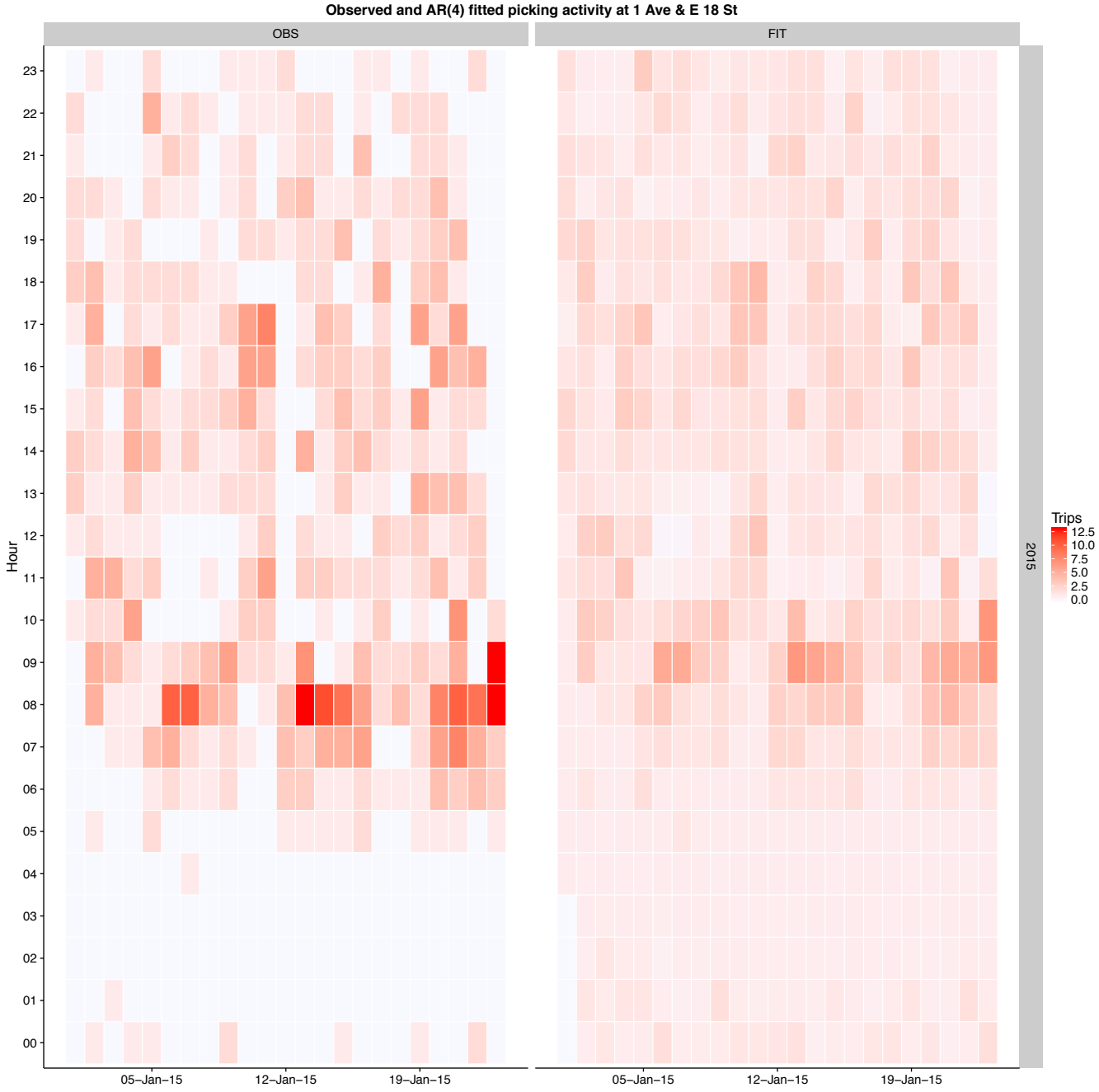

TYPE
A
B
C
X
Hudson River
East River
West Street
Broadway
Flushing Avenue
Atlantic Avenue
Manhattan Bridge
South Street
Canal Street
Grand Street
Fort Greene Park
Brooklyn Bridge Park
Buttermilk Channel
East River Park
West Channel


TYPE
A
B
Hudson River
East River
West Street
Broadway
Flushing Avenue
Atlantic Avenue
Manhattan Bridge
South Street
Canal Street
Grand Street
Fort Greene Park
Brooklyn Bridge Park
Buttermilk Channel
East River Park
West Channel

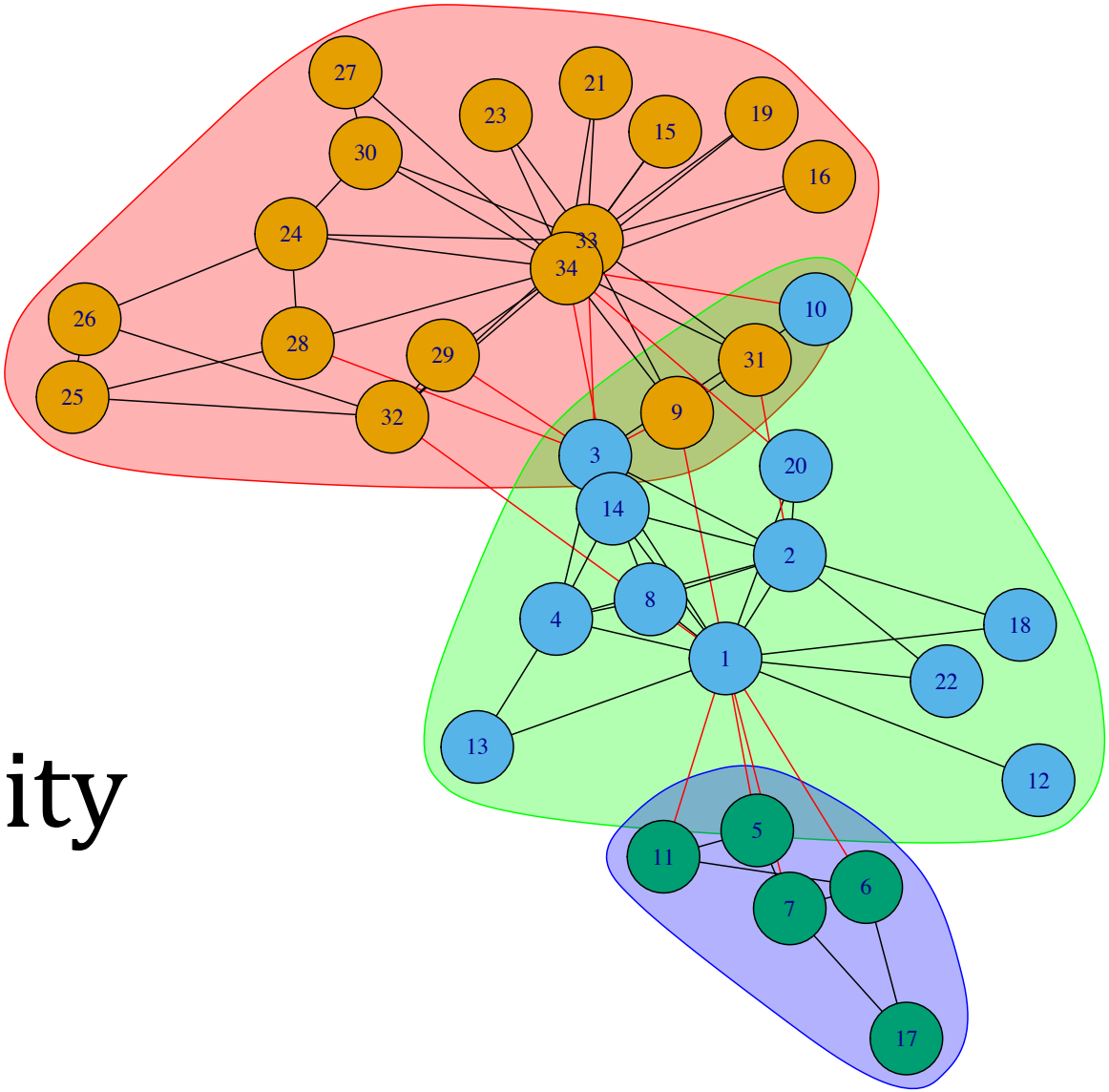
Section Summary

- There are hidden preferences of users towards stations
- P/D Index captured the preference differences

Time-series Analysis


Observed and AR(4) fitted picking activity at 1 Ave & E 18 St
OBS
FIT
Hour
23
22
21
20
19
18
17
16
15
14
13
12
11
10
09
08
07
06
05
04
03
02
01
00
05–Jan–15
12–Jan–15
19–Jan–15
2015
Trips
12.5
10.0
7.5
5.0
2.5
0.0

Community


27
21
23
19
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30
16
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33
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26
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2
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1
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13
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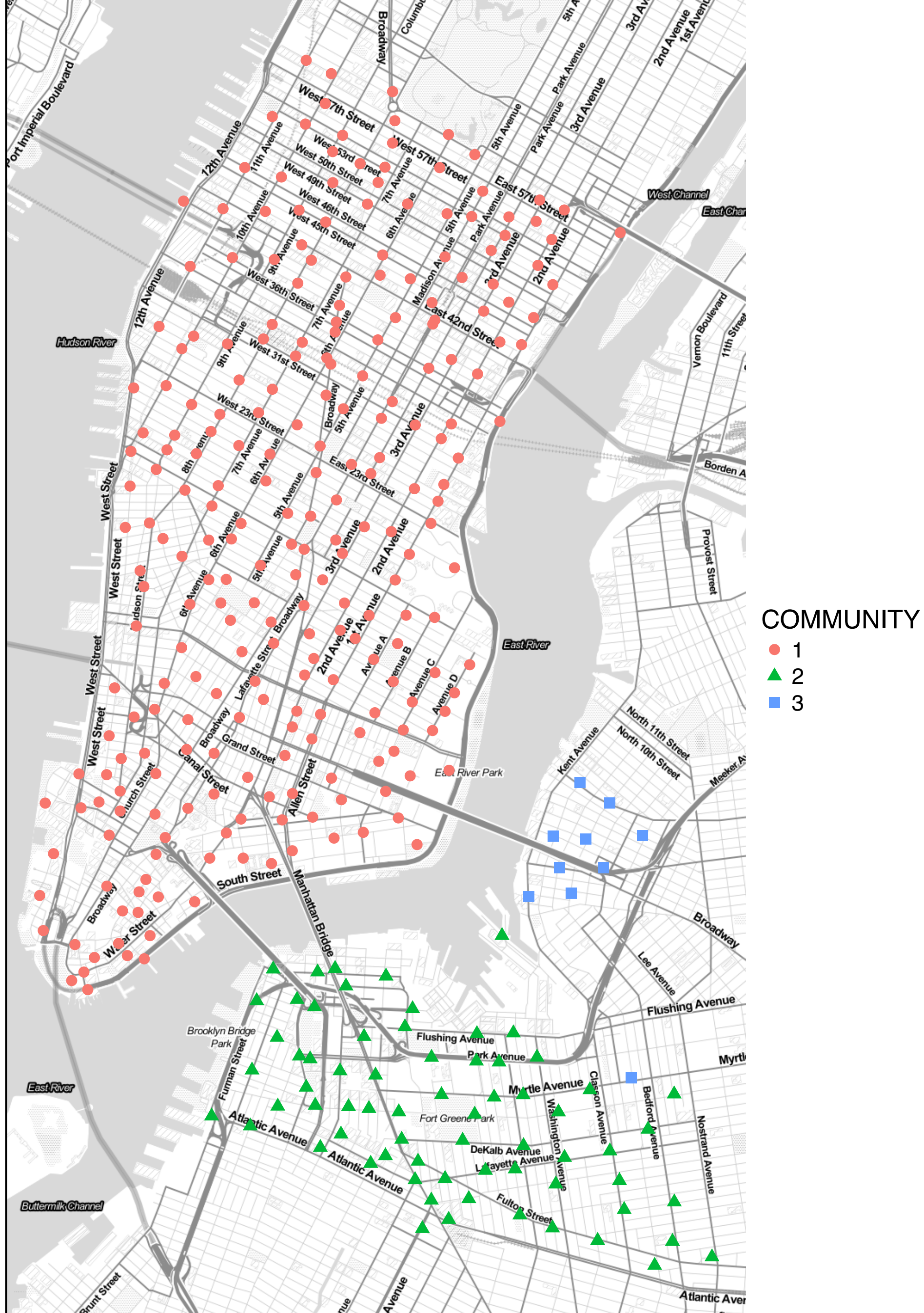
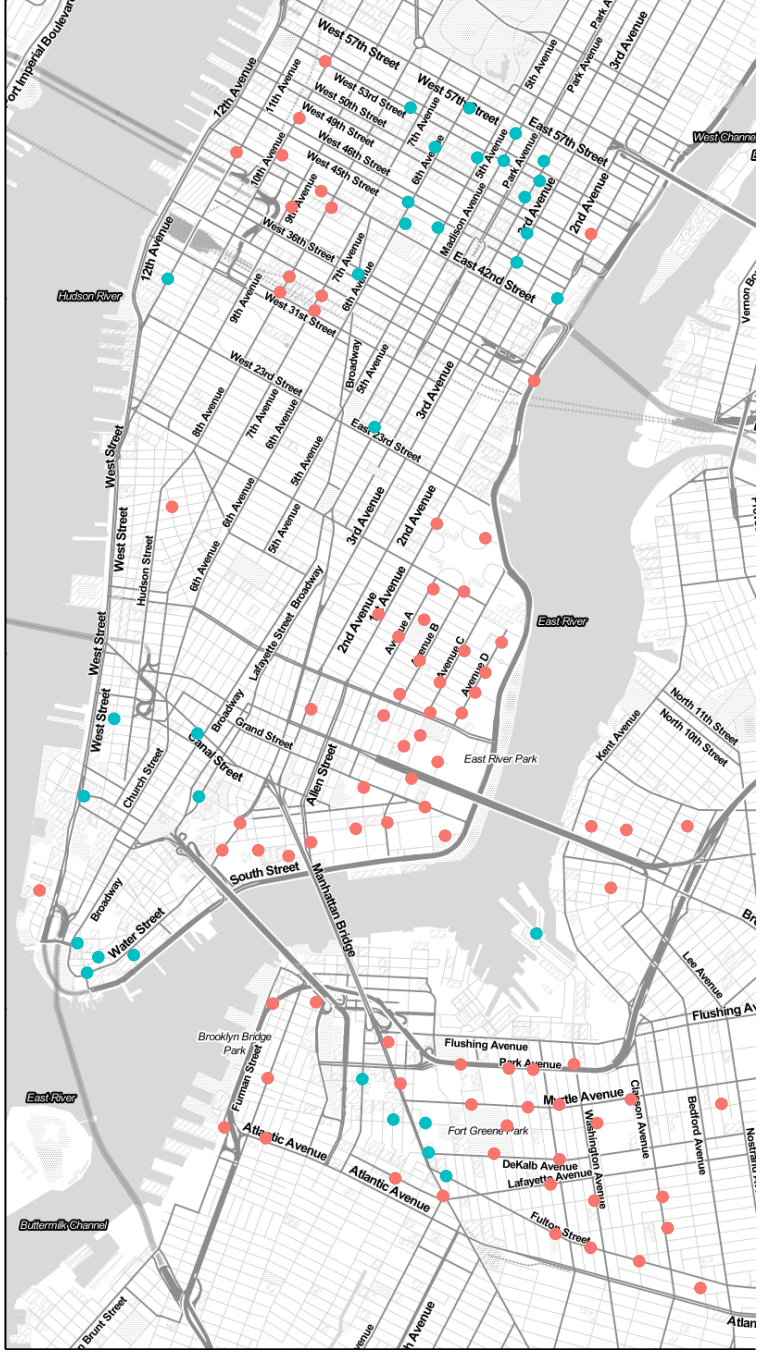
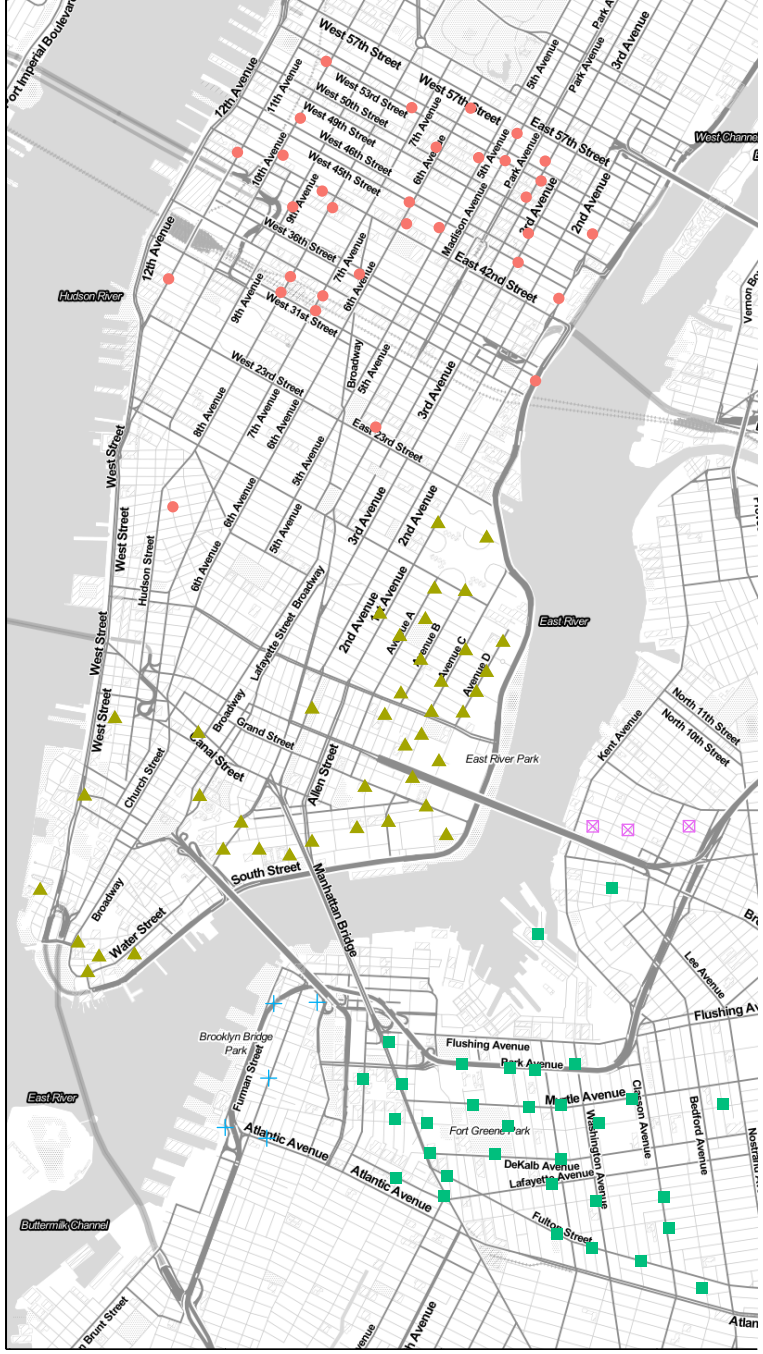
5
11
6
7
17

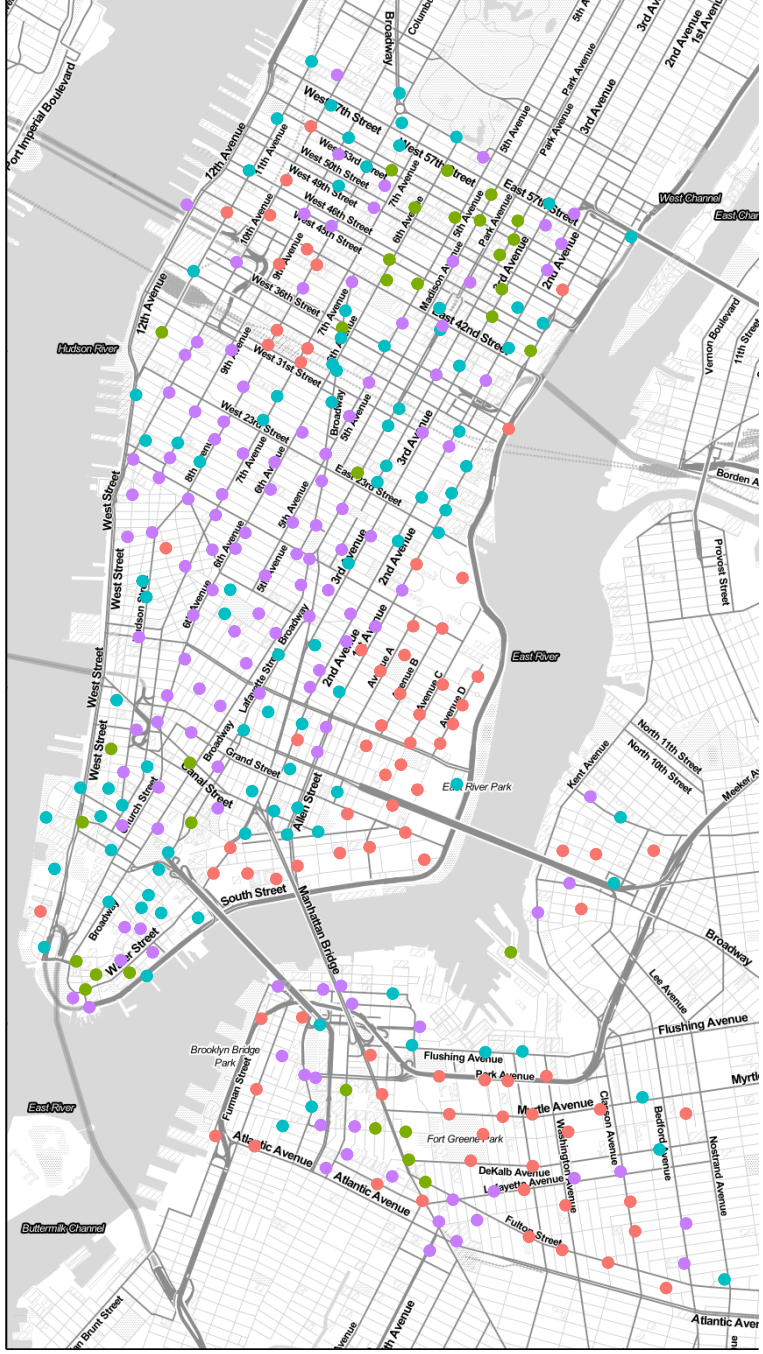

COMMUNITY
1
2
3
Hudson River
East River
Manhattan Bridge
South Street
Canal Street
Grand Street
Broadway
Flushing Avenue
Myrtle Avenue
Atlantic Avenue
Fulton Street
DeKalb Avenue
Fort Greene Park
Brooklyn Bridge Park
East River Park
Buttermilk Channel



TYPE
- A
- B



COMMUNITY
- 1
- 2
- 3
- 4
- 5


TYPE
A
B
C
X
Hudson River
East River
West Channel
Buttermilk Channel
Brooklyn Bridge Park
Fort Greene Park
East River Park
Manhattan Bridge
West 7th Street
West 57th Street
East 42nd Street
West 23rd Street
East 23rd Street
Broadway
Flushing Avenue
Myrtle Avenue
Atlantic Avenue
DeKalb Avenue
Fulton Street
South Street
Water Street
Canal Street
Grand Street
Lafayette Street
Kent Avenue
Bedford Avenue
Nostrand Avenue
Washington Avenue
Classon Avenue
Park Avenue
Madison Avenue
Vernon Boulevard
Borden A
Provost Street
Meeker A
Lee Avenue
Furman Street
Church Street
Hudson St
Columbus
Fort Imperial Boulevard
Brunt Street
Atlantic Aver
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West Street
North 10th Street
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West 53rd Street
West 50th Street
West 49th Street
West 46th Street
West 45th Street
West 36th Street
West 31st Street
East 57th Street
Park Avenue
Broadway
11th Street


COMMUNITY
1
2
3
4
Hudson River
East River
West Channel
Buttermilk Channel
Brooklyn Bridge Park
Fort Greene Park
East River Park
Manhattan Bridge
West 7th Street
West 57th Street
East 42nd Street
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East 23rd Street
Broadway
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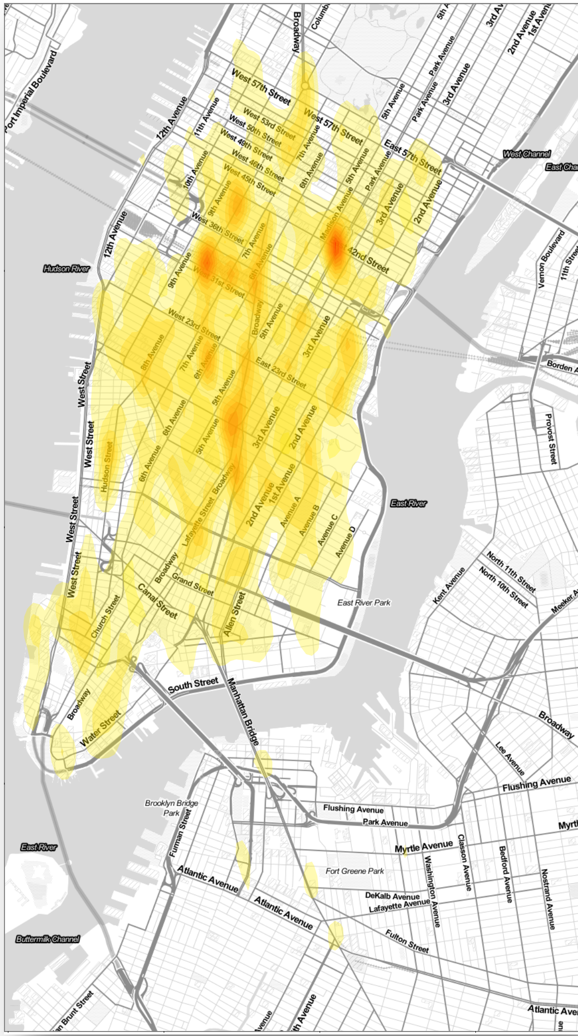
West 53rd Street
West 50th Street
West 49th Street
West 46th Street
West 45th Street
West 36th Street
West 31st Street
East 57th Street
Park Avenue
Broadway
11th Street

Section Summary

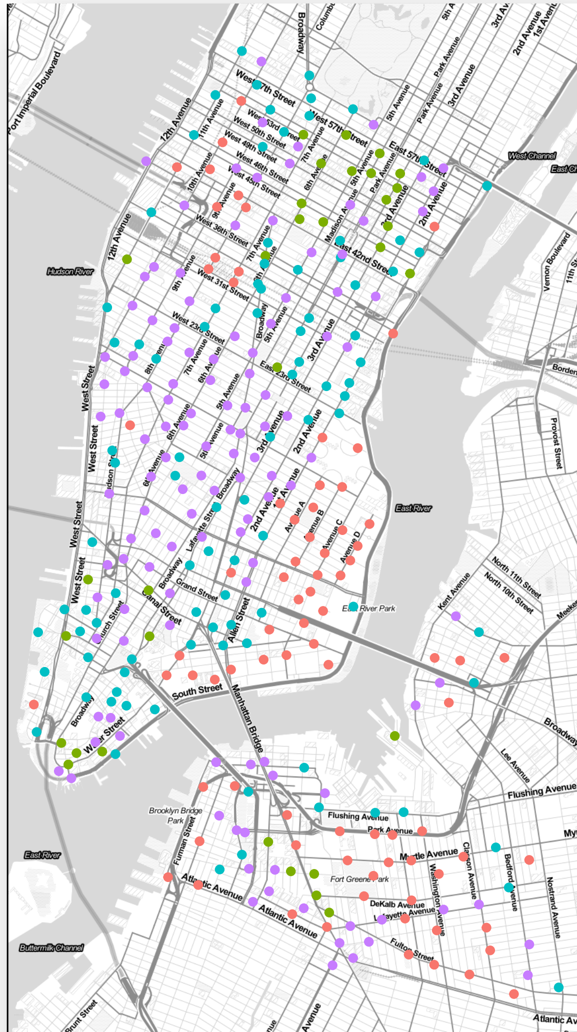
- Distinct communities are identified by InfoMap algorithms of igraph package

- The general direction of flow of CitiBike

Summary



West 57th Street
Hudson River
East River
South Street
Canal Street
Manhattan Bridge
Flushing Avenue
Atlantic Avenue



West 57th Street
Hudson River
East River
South Street
Canal Street
Manhattan Bridge
Flushing Avenue
Atlantic Avenue

West 57th Street
Hudson River
East River
South Street
Canal Street
Manhattan Bridge
Flushing Avenue
Atlantic Avenue

Contributions

- Y. Yan designed and finished the project;
- Y. Yan wrote the doc and slide.

- W. Zhang joined discussions.

- All are deployed at https://github.com/Puriney/ineedabike

Session-Info

```
attached base packages:

[1] stats     graphics  grDevices utils
datasets  methods   base

other attached packages:

[1] igraph_1.0.1       ggmap_2.6.1
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timeDate_3012.100

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scales_0.4.1       readr_1.0.0
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dplyr_0.5.0
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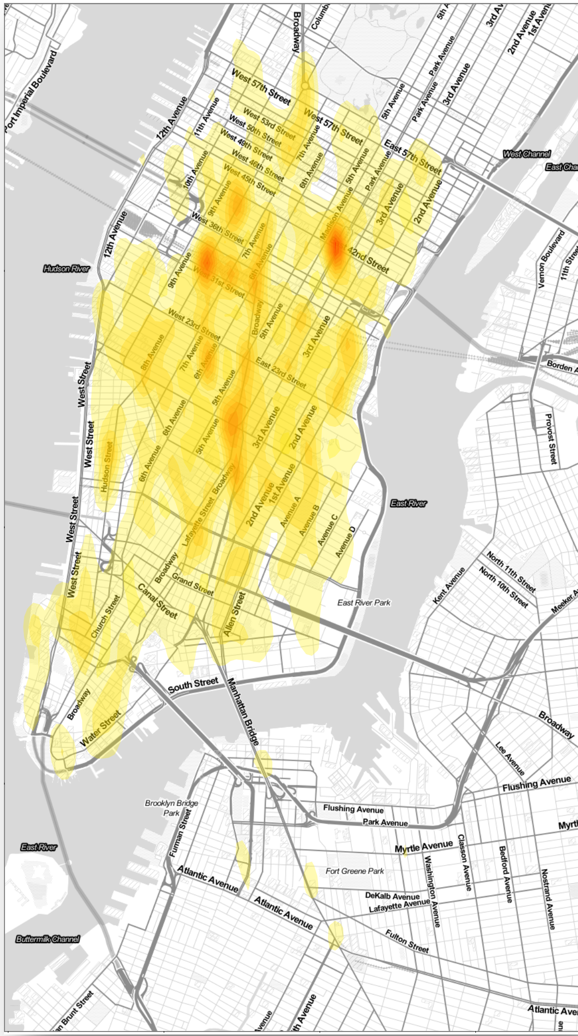
Questions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Classon Avenue
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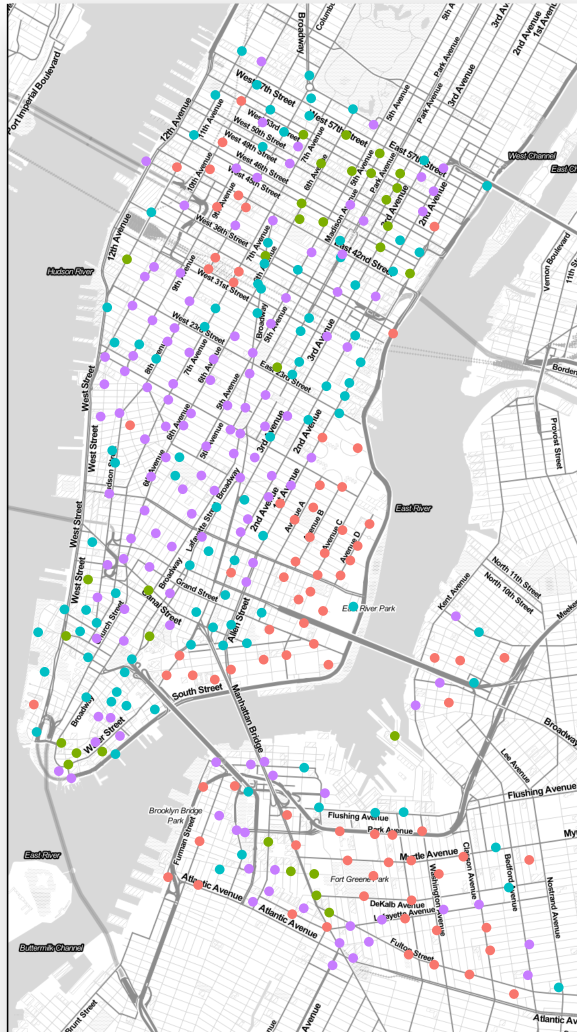
Nostrand Avenue
Buttermilk Channel
Port Imperial Boulevard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Fulton Street
Bedford Avenue
Nostrand Avenue
Buttermilk Channel


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Hudson Street
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Avenue B
Avenue C
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Allen Street
South Street
Water Street
Manhattan Bridge
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North 10th Street
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Park Avenue
Myrtle Avenue
Fort Greene Park
DeKalb Avenue
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Atlantic Avenue
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Washington Avenue
Classon Avenue
Bedford Avenue
Buttermilk Channel