
# UChicago | MSCA 31012
## Data Engineering Platforms for Analytics

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# Outline

- Executive Summary
- Business Use Case
- Relational database and tools
- Data Analysis and Visualization
- Tableau Visualization
- Summary

# Executive Summary

## INTRODUCTION

**Goal**
Invest US$50 million to:
- Expand stations to all **50 city wards**
- Add **175** stations and **10,500** bikes

***2021***

***2019 - 2020***
- 2019: More than **20k rides** per day in peak seasons.
- March 2019, **Lyft** took over Divvy
- Early 2020: Plan to pass **20 millionth rides** mark.

***2017 -2018***

**Second expansion**
*(107 new stations)*
Provided its 15 millionth rides in 2018

***2015 - 2016***

**First expansion**
*(175 new stations)*

**Officially launched**
in June 2013
*(75 stations and 750 bikes)*

***2013***

DIVVY

***Bikeshare system***

**6,000** bikes

**608** stations

***Chicagoans' regular mode of transportation***

## RESEARCH OBJECTIVES

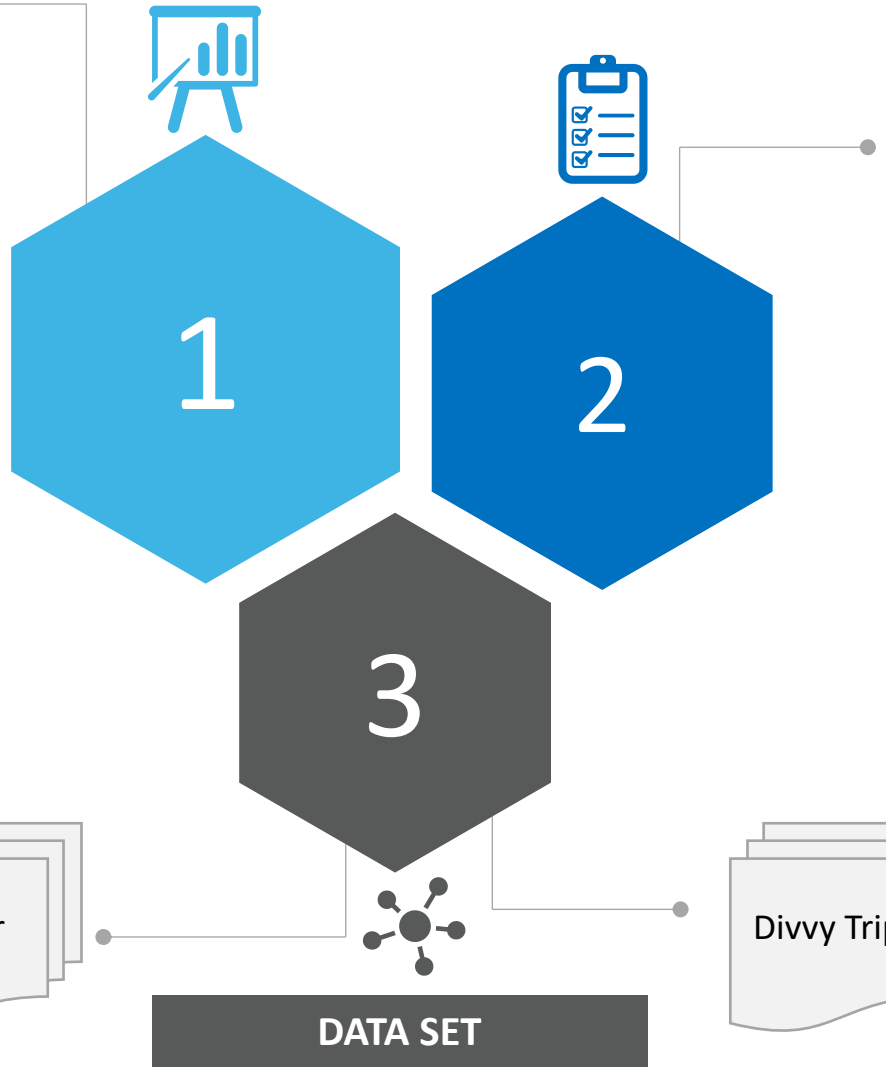
- To assist with the expansion plan, our team developed a relational database that will enable quick response and analysis on the current state Divvy operations in regard to ridership, station locations and various other factors affecting them. And:
  - Provide methodologies and various tools used in the process
  - Provide data analysis and visualization
  - Put forward a future state blueprint for the new stations and bikes allocation process

# Business use case

## PROPOSED FINDING

**Our final deliverables will enable Divvy leadership to:**

- Understand current ridership and station locations
- Understand various factors that impact ridership. i.e
  - Demographic
  - Traffic volume
  - Bike racks / lanes
  - Weather
- Develop dashboards and KPIs to gauge overall business / operation performance
- Plan for future station & bikes allocation




## METHODOLOGY

- Develop a scoring model to determine optimal number of stations and bikes by zip codes based on various factors
- Visualize findings from analysis - trends, outliers, patterns and predictions

# Data Source

| Dataset | Source | | File Format | Size |
|---|---|---|---|---|
| Trip | Divvy | https://www.divvybikes.com/system-data | CSV | > 1mil rows |
| Station | City of Chicago | https://data.cityofchicago.org/Transportation/Divvy-Bicycle-Stations/bbyy-e7gq | CSV | > 600 rows |
| Station_zip | Divvy | https://feeds.divvybikes.com/stations/stations.json | JSON | > 600 rows |
| Weather | National Weather Service Forecast Office | https://w2.weather.gov/climate/xmacis.php?wfo=lot | CSV | > 12k rows |
| Bike racks | City of Chicago | https://data.cityofchicago.org/Transportation/Bike-Racks/cbyb-69xx | CSV | > 5k rows |
| Population | City of Chicago | https://catalog.data.gov/dataset?res_format=CSV&organization=city-of-chicago | CSV | < 100 rows |
| Bike route | City of Chicago | https://data.cityofchicago.org/Transportation/Bike-Routes/3w5d-sru8 | CSV | < 1k rows |
| Zip code | Chicago Data Type | http://robparal.blogspot.com/2013/07/chicago-community-area-and-zip-code.html | CSV | < 100 rows |

# Relational Database and Tools

# Fact and dimensional table

| Table Name | Table Type | Cardinality | Additional Details |
|---|---|---|---|
| fact_trip | Fact Table | M:1 Relationship with Station and Weather Table | Contains information about each trip including the start/end station, total time, age, gender of the customer |
| dim_station | Dimensional Table | 1:M relationship with Fact Table | Contains information like station address, total number of docks available, date the station became available. |
| dim_weather | Dimensional Table | 1:M relationship with Fact Table | Contains temperature, rain/snow, wind information in hourly format. Also, contains the sunset and sunrise time. |
| dim_population | Dimensional Table | 1:M relationship with Location Table | Contains information about the population (age, gender) demographics zip wise. |
| dim_location | Dimensional Table | M:1 relationship with Population Table | Contains the location of all the stations, traffic routes, bike routes. Zip code is a must have for each address. |
| dim_traffic | Dimensional Table | 1:M relationship with Location Table | Contains the traffic flow information daily including the direction (Northbound, Southbound, Westward, Eastward) on streets. |
| dim_bike_racks | Dimensional Table | 1:M relationship with Location Table | Contains information about the non-divvy bike racks scattered across Chicago city |
| dim_bike_lane | Dimensional Table | 1:1 relationship with Location Table | Contains information about the bike routes in the city, including their length and the streets they run on. |

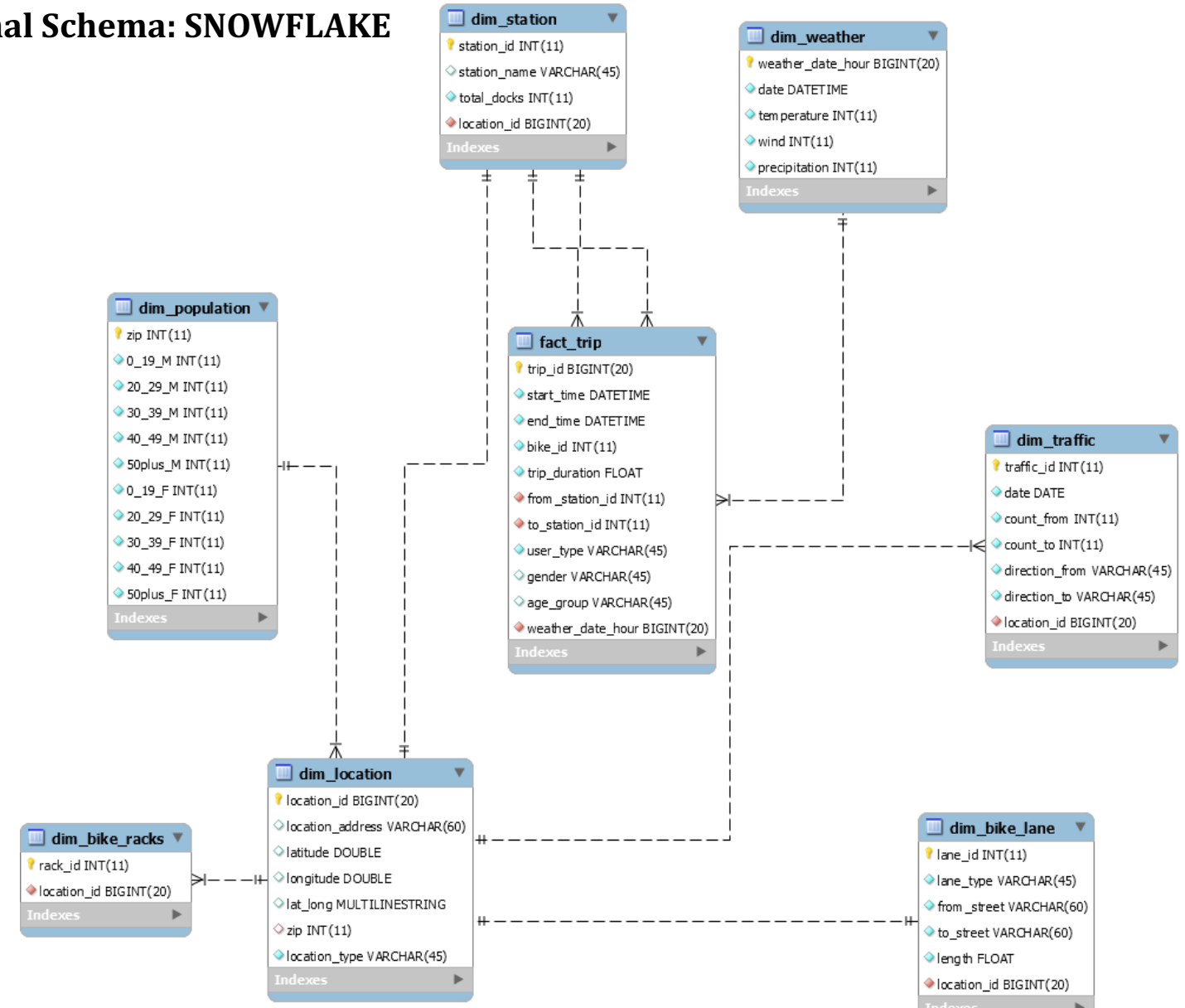
Fact table joined with Dimension tables provides interesting insights into how variables interact. Fact Table can be sliced by time and diced by stations, gender and age variables.

# Database Design: Enhanced Entity Relational Diagram

## DDL

## DML

## Dimensional Schema: SNOWFLAKE



# Tools

1

**Data**

Data from various sources

2

**ETL Process**

3

**Data Warehouse**

Google Cloud Platform

4

**Data Analysis**

5

**Data Visualization**

6

**Findings and Recommendations**

# Data extraction, Cleaning, Normalization

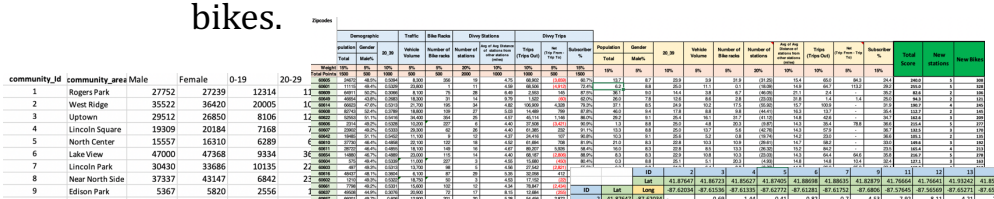
- Create and and load database
- Produce queries to support project's analysis purpose

```
# Number of trips by hour by weekay and weekend.
SELECT
CASE WHEN dayname(start_time) IN ("Saturday", "Sunday") THEN "Weekend" ELSE "Weekday" END AS DateType,
HOUR(start_time) AS TimeOfDay,
COUNT(trip_id) as NoOfTrips
FROM fact_trip
GROUP BY TimeOfDay, DateType
ORDER BY TimeOfDay DESC;
```

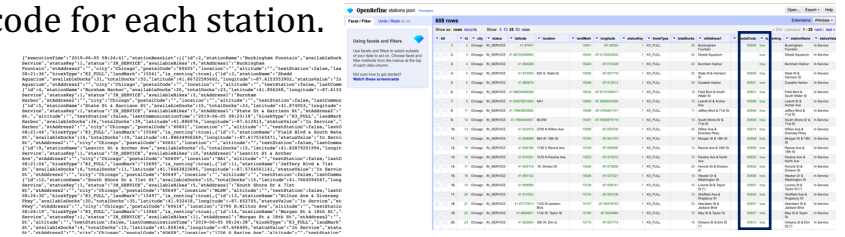
```
#8. Number of TripIn per zip
SELECT
    dl.zip,
    COUNT(ft.to_station_id) AS TripIn
FROM
    fact_trip ft
    INNER JOIN dim_station ds ON ds.station_id = ft.to_stati
    LEFT JOIN dim_location dl   ON dl.location_id = ds.locat
GROUP BY zip
ORDER BY TripIn DESC;
```

```
SELECT
TripFrom.station_id,
TripFrom.stationName AS stationName,
TripFrom.TimeofDay AS timeFrom,
TripTo.TimeofDay AS timeTo,
TripFrom.tripFrom,
TripTo.tripTo,
(TripFrom.tripFrom - TripTo.tripTo) AS NetTrip,
(TripFrom.totalDocks - TripFrom.tripFrom + TripTo.tripTo) AS docksNeededgaps
FROM
((SELECT
ds.station_id,
ds.station_name AS stationName,
ds.total_docks AS totalDocks,
HOUR(ft.start_time) AS TimeOfDay,
COUNT(ft.from_station_id) as tripFrom
FROM fact_trip ft
INNER JOIN dim_station ds
ON ds.station_id = ft.from_station_id
GROUP BY ds.station_id, TimeOfDay
ORDER BY ds.station_id,TimeOfDay ASC) AS TripFrom
INNER JOIN
((SELECT
ds.station_id,
ds.station_name AS stationName,
ds.total_docks AS totalDocks,
HOUR(ft.end_time) AS TimeOfDay,
COUNT(ft.to_station_id) as tripTo
FROM fact_trip ft
INNER JOIN dim_station ds
ON ds.station_id = ft.to_station_id
GROUP BY ds.station_id, TimeOfDay
ORDER BY ds.station_id,TimeOfDay ASC) AS TripTo
ON TripFrom.station_id = TripTo.station_id
WHERE TripFrom.TimeOfDay= TripTo.TimeOfDay;
```

- Clean all dimensional tables to import to mySQL
- Analyze descriptive data: customer profiling, zip, stations
- Build the scoring system for research objectives' purpose: add more stations and bikes.



- Import, clean, and extract real-time station data from Divvy to get the zip code for each station.



- Get the zipcode using longitude and latitude for dim_location table
- Estimated the distance between trips
- Stack the distance data to produce an adaptable format for tableau visualization purpose
- Conduct some correlation between trips and other factors: weekday, bike racks, weather…

```
install.packages("revgeo")
library(revgeo)

dataPath <- "/Users/tammy/Tammy/UChicago/Data_Engineering_Platform/FinalProject/Processing/"

#Rack1
rack1 <- read.csv(paste(dataPath,"rack1.csv",sep="/"))
rack1_zip <- revgeo(longitude=rack1$longitude, latitude=rack1$latitude,
                    output='frame', item='zip')
write.table(rack1_zip, file = paste(dataPath,'rack1_zip.csv',sep = '/'), row.names = F)

#Rack2
rack2 <- read.csv(paste(dataPath,"rack2.csv",sep="/"))
rack2_zip <- revgeo(longitude=rack2$longitude, latitude=rack2$latitude,
                    output='frame', item='zip')
write.table(rack2_zip, file = paste(dataPath,'rack2_zip.csv',sep = '/'), row.names = F)

#Rack3
rack3 <- read.csv(paste(dataPath,"rack3.csv",sep="/"))
rack3_zip <- revgeo(longitude=rack3$longitude, latitude=rack3$latitude,
                    output='frame', item='zip')
write.table(rack3_zip, file = paste(dataPath,'rack3_zip.csv',sep = '/'), row.names = F)
```

```
```{r distance}
#library(geosphere)
#distance<-c()
#for(i in 1:5){
#  distance<-c(distance,distVincentyEllipsoid(c(geo$lat1[i],geo$long1[i]),c(geo$lat2[i],geo$long2[i])))
#}
```
```

```
```{r distance}
distance<-read.csv("C:/Users/wehrm/OneDrive/Documents/UChicago/Quarter 1/Data Engineering Platforms/Final project/Data/distance.csv",header=TRUE,sep=',')
```
```

```
```{r distance}
dim_distance<-data.frame(geo,distance)
head(dim_distance)
```

# Average distance per station

```{r distance}
avg_distance<-aggregate(dim_distance[,11],list(dim_distance$station_id), mean)
head(avg_distance)
```
```

```
```{r distance}
mySQL<-"SELECT
  fr5.station_id,
  fr5.zip,
  fr5.trip_id,
  fr5.latitude AS lat1,
  fr5.longitude AS long1,
  fr5.station_id,
  fr5.zip,
  fr5.trip_id,
  fr5.latitude AS lat2,
  fr5.longitude AS long2
FROM
(SELECT
  ds.station_id,
  dl.zip,
  ft.trip_id,
  dl.latitude,
  dl.longitude
FROM
  dim_location dl
  INNER JOIN
  dim_station ds ON dl.location_id=ds.location_id
  INNER JOIN
  fact_trip ft ON ds.station_id=ft.from_station_id) AS fr5
  INNER JOIN
(SELECT
  ds.station_id,
  dl.zip,
  ft.trip_id,
  dl.latitude,
  dl.longitude
FROM
  dim_location dl
  INNER JOIN
  dim_station ds ON dl.location_id=ds.location_id
  INNER JOIN
  fact_trip ft ON ds.station_id=ft.to_station_id) AS fr5 ON fr5.trip_id=fr5.trip_id
WHERE
  fr5.station_id != fr5.station_id;"
geo<-dbGetQuery(connection, myQuery)
head(geo)
```
```

- Construct fact_trip table to import to my SQL:
  - Calculate the age group of Divvy users
  - Add in new column as a foreign key using in mySQL.

```
In [34]: def age_groups(age):
    if age < 20:
        return '0_19'
    elif 20 <= age < 30:
        return '20-29'
    elif 30 <= age < 40:
        return '30-39'
    elif 40 <= age < 50:
        return '40-49'
    elif 50 <= age:
        return '50+'

fact_trip1['age_group'] = fact_trip1['age'].apply(age_groups)

fact_trip1['age_group'].value_counts(sort=False)

Out[34]: 20-29    267525
         30-39    346995
         0_19       1342
         50+      129777
         40-49    126001
         Name: age_group, dtype: int64

In [35]: fact_trip1.head()

Out[35]:
   trip_id  start_time  end_time  bike_id  trip_duration  \
0  18005527  2018-04-01 00:04:44  2018-04-01 00:13:03  3819  499.0
1  18005528  2018-04-01 00:06:42  2018-04-01 00:27:07  5098  1,225.0
2  18005529  2018-04-01 00:07:19  2018-04-01 00:23:19  5165  960.0
3  18005530  2018-04-01 00:07:23  2018-04-01 00:14:47  3851  424.0
4  18005531  2018-04-01 00:10:23  2018-04-01 00:22:12  5965  709.0

   from_station_id  to_station_id  user_type  gender  birthyear  age  \
0               20            22  Customer     NaN        NaN  NaN
1              157           171  Subscriber  Male     1994.0  25.0
2              157           190  Subscriber  Male     1965.0  54.0
3              106           106  Customer    NaN        NaN  NaN
4              228           219  Subscriber  Male     1983.0  36.0
```

```
In [37]: fact_trip1['date','time']=fact_trip['start_time'].str.split(expand=True)
         fact_trip1['hour']=fact_trip['start_time'].dt.hour
         fact_trip1['day']=fact_trip['start_time'].dt.weekday_name
         fact_trip1['weather_date_hour']=fact_trip['month']+fact_trip['day']+fact_trip['year']+fact_trip['hour']
         fact_trip1.head()

         /Users/tammy/anaconda3/lib/python3.7/site-packages/pandas/core/frame.py:3140: SettingWithCopyWarning:
         A value is trying to be set on a copy of a slice from a DataFrame.
         Try using .loc[row_indexer,col_indexer] = value instead

         See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#indexing-view-versus-copy
           self[k1] = value[k2]

Out[37]:
   trip_id  start_time  end_time  bike_id  trip_duration  from_station_id  to_station_id  user_type  gender  age_group  date  time  year  month  day  hour
0  18005527  2018-04-01 00:04:44  2018-04-01 00:13:03  3819  499.0  22  171  Subscriber  Male  20-29  2018-04-01  00:04:44  2018  04  01  00
1  18005528  2018-04-01 00:06:42  2018-04-01 00:27:07  5098  1,225.0  157  190  Subscriber  Male  50+  2018-04-01  00:06:42  2018  04  01  00
2  18005529  2018-04-01 00:07:19  2018-04-01 00:23:19  5165  960.0  106  106  Customer  NaN  NaN  2018-04-01  00:07:19  2018  04  01  00
3  18005530  2018-04-01 00:07:23  2018-04-01 00:14:47  3851  424.0  241  171  Subscriber  Male  20-29  2018-04-01  00:07:23  2018  04  01  00
4  18005531  2018-04-01 00:10:23  2018-04-01 00:22:12  5965  709.0  228  219  Subscriber  Male  30-39  2018-04-01  00:10:23  2018  04  01  00
```

```
In [15]: fact_trip = fact_trip[['trip_id', 'start_time', 'end_time', 'bike_id', 'trip_duration',
                                'from_station_id', 'to_station_id',
                                'user_type', 'gender', 'age_group', 'weather_date_hour']]

         fact_trip.head()

Out[15]:
   trip_id  start_time  end_time  bike_id  trip_duration  from_station_id  to_station_id  user_type  gender  age_group  weather_date_hour
0  18005527  2018-04-01 00:04:44  2018-04-01 00:13:03  3819  499.0  22  171  Subscriber  Male  20-29  40101400
```

# Sample Queries

## Net influx per station and hour

```sql
SELECT
    TripFrom.station_id,
    TripFrom.stationName AS stationName,
    TripFrom.TimeofDay AS tripTime,
    TripFrom.tripFrom,
    TripTo.tripTo,
    (TripFrom.tripFrom - TripTo.tripTo) AS NetTrip
FROM
    (SELECT
        ds.station_id,
        ds.station_name AS stationName,
        ds.total_docks AS totalDocks,
        HOUR(ft.start_time) AS TimeOfDay,
        COUNT(ft.from_station_id) as tripFrom
    FROM
        fact_trip ft
            INNER JOIN
        dim_station ds ON ds.station_id = ft.from_station_id
    GROUP BY
        ds.station_id, TimeOfDay
    ORDER BY
        ds.station_id,TimeOfDay ASC) AS TripFrom
        INNER JOIN
     (SELECT
         ds.station_id,
         ds.station_name AS stationName,
         ds.total_docks AS totalDocks,
         HOUR(ft.end_time) AS TimeOfDay,
         COUNT(ft.to_station_id) as tripTo
     FROM
         fact_trip ft
             INNER JOIN
         dim_station ds ON ds.station_id = ft.to_station_id
     GROUP BY
         ds.station_id, TimeOfDay
     ORDER BY ds.station_id,TimeOfDay ASC) AS TripTo ON TripFrom.station_id = TripTo.station_id
WHERE TripFrom.TimeofDay = TripTo.TimeofDay;
```

## Average distance travelled per station and zip code

```sql
SELECT

    FrS.station_id,
    FrS.trip_id,
    FrS.latitude AS lat1,
    FrS.longitude AS long1,
    TrS.station_id,
    TrS.trip_id,
    TrS.latitude AS lat2,
    TrS.longitude AS long2
FROM
(SELECT
    ds.station_id,
    ft.trip_id,
    dl.latitude,
    dl.longitude
FROM
    dim_location dl
        INNER JOIN
    dim_station ds ON dl.location_id=ds.location_id
        INNER JOIN
    fact_trip ft ON ds.station_id=ft.from_station_id) AS FrS
    INNER JOIN
(SELECT
    ds.station_id,
    ft.trip_id,
    dl.latitude,
    dl.longitude
FROM
    dim_location dl
        INNER JOIN
    dim_station ds ON dl.location_id=ds.location_id
        INNER JOIN
    fact_trip ft ON ds.station_id=ft.to_station_id) AS TrS ON FrS.trip_id=TrS.trip_id
WHERE
    FrS.station_id != TrS.station_id;
```

# Data Analysis and Visualization

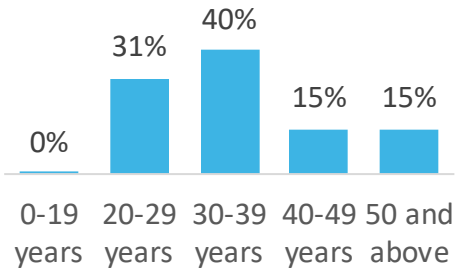
# Customer Profiling

## Users Type


## Gender

74% 26%

## Age Group



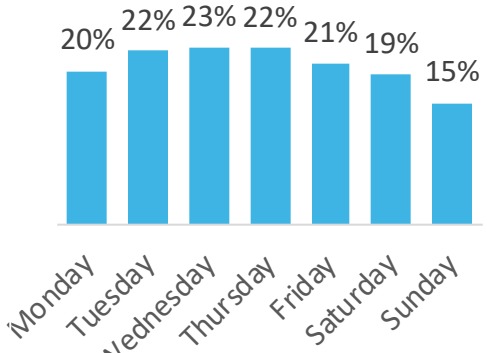

## Average Distance Travel

**0.95 miles**

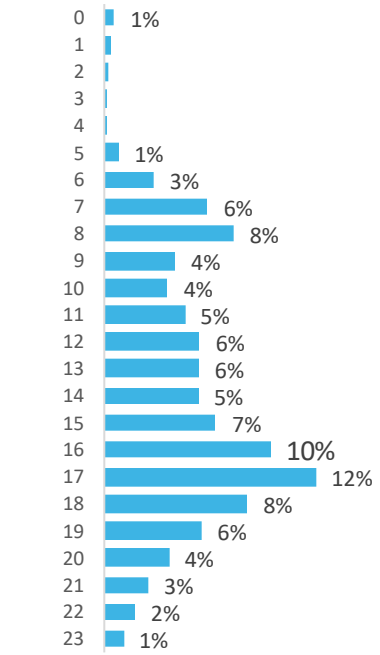
## Average Trip Duration

**24 minutes/trip**

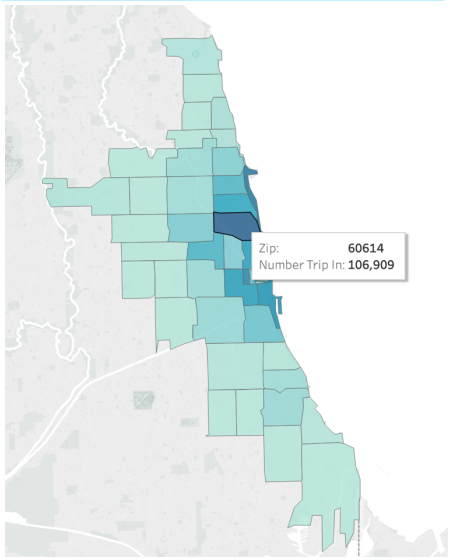
## Trip by day



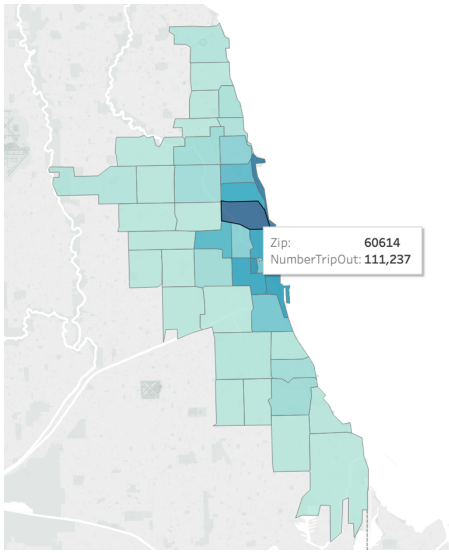

## Trip by hour



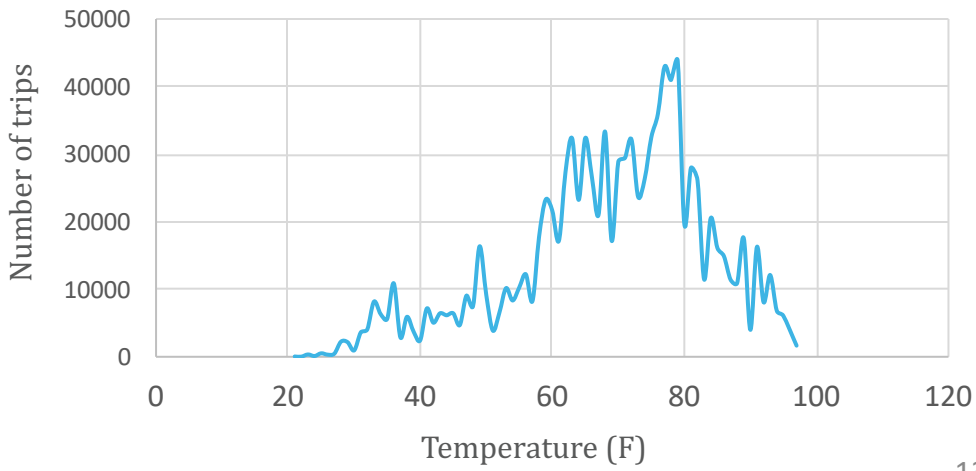

## Trip-in by area




## Trip-out by area




## Trip by weather




*Base: Divvy Trips data Q2-2018 (N = 1.05 million)*

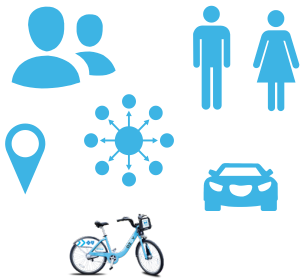
# Findings by zip code

Zipcode Analysis

| | Population | Gender | | Age | | | | | | | | | | Traffic | Bike Racks | Divvy Stations | | | | Divvy Trips | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Male% | Female% | 0_19_M | 20_29_M | 30_39_M | 40_49_M | 50plus_M | 0_19_F | 20_29_F | 30_39_F | 40_49_F | 50plus_F | Vehicle Volume | Number of Bike racks | Number of stations | Total # of docks | Avg # of docks | Avg of Avg Distance of stations from other stations (miles) | Trips Out | Trips In | Net | % of total trips | Subscriber % |
| 60605 | 24672 | 48.5% | 51.5% | 0.0678 | 0.138 | 0.1094 | 0.0565 | 0.1134 | 0.0719 | 0.1451 | 0.1169 | 0.0603 | 0.1206 | 8,300 | 356 | 19 | 550 | 28.9 | 4.75 | 68,902 | 65,243 | (3,659) | 6.33% | 60.7% |
| 60601 | 11115 | 49.4% | 50.6% | 0.0639 | 0.1702 | 0.093 | 0.0505 | 0.1103 | 0.0716 | 0.1744 | 0.0953 | 0.0517 | 0.113 | 23,800 | 1 | 11 | 364 | 33.1 | 4.59 | 68,506 | 63,594 | (4,912) | 6.23% | 72.4% |
| 60609 | 64911 | 50.2% | 49.8% | 0.1753 | 0.079 | 0.0748 | 0.0623 | 0.11 | 0.1737 | 0.0785 | 0.0743 | 0.062 | 0.11 | 8,100 | 75 | 28 | 314 | 11.2 | 6.49 | 2,553 | 2,698 | 145 | 0.25% | 87.5% |
| 60649 | 46654 | 43.8% | 56.2% | 0.1172 | 0.0612 | 0.0563 | 0.0539 | 0.1434 | 0.1503 | 0.0785 | 0.0723 | 0.0769 | 0.184 | 18,300 | 31 | 14 | 170 | 12.1 | 9.79 | 1,522 | 1,462 | (60) | 0.14% | 62.0% |
| 60614 | 66623 | 47.6% | 52.4% | 0.0751 | 0.1642 | 0.0888 | 0.0527 | 0.0951 | 0.0827 | 0.191 | 0.0975 | 0.0581 | 0.1049 | 21,700 | 195 | 34 | 638 | 18.8 | 4.82 | 106,909 | 111,237 | 4,328 | 10.29% | 73.3% |
| 60608 | 82743 | 52.4% | 47.6% | 0.1509 | 0.1084 | 0.0693 | 0.0658 | 0.1067 | 0.1355 | 0.0868 | 0.0618 | 0.0598 | 0.1004 | 19,800 | 109 | 27 | 370 | 13.7 | 5.03 | 14,489 | 15,288 | 799 | 1.41% | 87.8% |
| 60622 | 52553 | 51.5% | 48.3% | 0.0882 | 0.1414 | 0.1354 | 0.0592 | 0.0868 | 0.0845 | 0.1353 | 0.1295 | 0.0566 | 0.0831 | 34,400 | 354 | 25 | 465 | 18.6 | 4.57 | 45,114 | 46,260 | 1,146 | 4.31% | 86.0% |
| 60606 | 2314 | 49.2% | 50.8% | 0.0843 | 0.1517 | 0.1106 | 0.0519 | 0.0938 | 0.0869 | 0.1564 | 0.1141 | 0.0536 | 0.0968 | 10,200 | #N/A | 6 | 170 | 28.3 | 4.40 | 37,508 | 34,087 | (3,421) | 3.38% | 90.9% |
| 60607 | 23302 | 49.2% | 50.8% | 0.0867 | 0.1485 | 0.1137 | 0.0522 | 0.0906 | 0.0897 | 0.1535 | 0.1176 | 0.054 | 0.0936 | 29,300 | 62 | 26 | 453 | 17.4 | 4.40 | 61,385 | 61,617 | 232 | 5.80% | 91.1% |
| 60642 | 19485 | 51.1% | 48.9% | 0.0858 | 0.1424 | 0.1361 | 0.059 | 0.0874 | 0.0821 | 0.1364 | 0.1303 | 0.0565 | 0.094 | 11,100 | 9 | 12 | 217 | 18.1 | 4.37 | 24,418 | 24,523 | 107 | 2.31% | 90.8% |
| 60610 | 37730 | 46.4% | 53.6% | 0.0397 | 0.1339 | 0.0915 | 0.0533 | 0.1456 | 0.0459 | 0.1547 | 0.1057 | 0.0615 | 0.1682 | 22,100 | 122 | 18 | 403 | 22.4 | 4.52 | 61,694 | 62,402 | 708 | 5.86% | 81.9% |
| 60611 | 28722 | 46.4% | 53.6% | 0.0394 | 0.1337 | 0.0915 | 0.0533 | 0.146 | 0.0456 | 0.1545 | 0.1058 | 0.0616 | 0.1687 | 18,100 | 149 | 16 | 372 | 23.3 | 4.67 | 89,207 | 95,133 | 5,926 | 8.70% | 58.4% |
| 60654 | 14880 | 46.7% | 53.3% | 0.0421 | 0.1342 | 0.0941 | 0.0536 | 0.1426 | 0.0476 | 0.1534 | 0.1072 | 0.0613 | 0.1638 | 23,000 | 115 | 14 | 356 | 25.4 | 4.40 | 68,187 | 65,381 | (2,806) | 6.30% | 88.9% |
| 60604 | 575 | 49.4% | 50.6% | 0.0696 | 0.1704 | 0.0939 | 0.0504 | 0.1096 | 0.0713 | 0.1739 | 0.0957 | 0.0522 | 0.113 | #N/A | #N/A | 3 | 85 | 28.3 | 4.55 | 15,680 | 15,230 | (450) | 1.46% | 70.4% |
| 60603 | 497 | 49.3% | 50.7% | 0.0704 | 0.169 | 0.0926 | 0.0503 | 0.1107 | 0.0724 | 0.1751 | 0.0946 | 0.0523 | 0.1127 | 13,700 | 38 | 5 | 135 | 27.0 | 4.56 | 27,542 | 24,721 | (2,821) | 2.47% | |
| 60616 | 48437 | 48.1% | 51.9% | 0.0956 | 0.0954 | 0.0776 | 0.0622 | 0.1499 | 0.1025 | 0.1036 | 0.0838 | 0.0668 | 0.1626 | 6,100 | 87 | 29 | 447 | 15.4 | 5.35 | 32,058 | 32,470 | 412 | 3.05% | |
| 60602 | 1210 | 49.3% | 50.7% | 0.0702 | 0.1702 | 0.0926 | 0.0504 | 0.1099 | 0.0719 | 0.1744 | 0.095 | 0.0521 | 0.1132 | #N/A | #N/A | 3 | 77 | 25.7 | 4.53 | 17,152 | 17,130 | (22) | 1.62% | |
| 60661 | 7736 | 49.2% | 50.8% | 0.0882 | 0.1464 | 0.1157 | 0.0524 | 0.0887 | 0.0913 | 0.1514 | 0.1196 | 0.0542 | 0.0916 | 15,600 | 102 | 12 | 354 | 29.5 | 4.34 | 78,847 | 76,413 | (2,434) | 7.33% | 93 |
| 60637 | 49508 | 44.9% | 55.1% | 0.1343 | 0.0778 | 0.061 | 0.0545 | 0.121 | 0.1663 | 0.094 | 0.0748 | 0.0672 | 0.1484 | 20,900 | 72 | 17 | 264 | 15.5 | 8.15 | 12,684 | 12,429 | (255) | 1.19% | 81 |
| 60657 | 66001 | 49.7% | 50.3% | 0.0525 | 0.1862 | 0.1358 | 0.0675 | 0.0532 | 0.188 | 0.1165 | 0.0565 | 0.0885 | 0.1295 | 12,900 | 201 | 20 | 371 | 18.6 | 5.28 | 54,456 | 57,328 | 2,872 | 5.28% | 80.5% |
| 60647 | 87297 | 50.4% | 49.6% | 0.1187 | 0.1217 | 0.1112 | 0.0616 | 0.0911 | 0.1172 | 0.1193 | 0.109 | 0.0606 | 0.0837 | 10,600 | 204 | 24 | 376 | 15.7 | 5.43 | 26,516 | 27,351 | 835 | 2.54% | 82.6% |
| 60612 | 33478 | 48.4% | 51.6% | 0.1148 | 0.1163 | 0.0933 | 0.0559 | 0.0979 | 0.1248 | 0.1217 | 0.1041 | 0.0598 | 0.1054 | 29,500 | 76 | 19 | 335 | 17.6 | 4.68 | 13,200 | 12,552 | (648) | 1.22% | 91.3% |
| 60615 | 40608 | 44.9% | 55.1% | 0.0991 | 0.0974 | 0.0659 | 0.0529 | 0.1336 | 0.1239 | 0.1159 | 0.0909 | 0.0656 | 0.1648 | 10,800 | 64 | 11 | 177 | 16.1 | 7.54 | 10,823 | 10,907 | 84 | 1.03% | 76.7% |
| 60618 | 92089 | 50.2% | 49.8% | 0.1238 | 0.0956 | 0.1017 | 0.0701 | 0.1107 | 0.1223 | 0.095 | 0.1014 | 0.0697 | 0.1097 | 18,700 | 193 | 21 | 308 | 14.7 | 5.95 | 10,973 | 11,778 | 805 | 1.07% | 85.2% |
| 60613 | 46285 | 50.4% | 49.6% | 0.0602 | 0.164 | 0.1156 | 0.0628 | 0.1016 | 0.0783 | 0.1625 | 0.1133 | 0.0612 | 0.0992 | 11,600 | 76 | 23 | 426 | 18.5 | 5.90 | 43,431 | 44,295 | 864 | 4.14% | 79.5% |
| 60653 | 29912 | 43.2% | 56.8% | 0.1143 | 0.0672 | 0.0641 | 0.0549 | 0.1315 | 0.1517 | 0.0872 | 0.0846 | 0.0725 | 0.1721 | 19,900 | 59 | 3 | 123 | 13.7 | 6.62 | 2,101 | 2,277 | 176 | 0.21% | 73.3% |
| 60625 | 78654 | 50.0% | 50.0% | 0.119 | 0.0959 | 0.1004 | 0.0676 | 0.1173 | 0.1179 | 0.0958 | 0.1007 | 0.0677 | 0.1178 | 23,800 | 286 | 19 | 285 | 15.0 | 6.85 | 11,857 | 12,247 | 390 | 1.14% | 87.8% |
| 60640 | 65796 | 51.8% | 48.2% | 0.0779 | 0.1109 | 0.1109 | 0.0783 | 0.1399 | 0.0727 | 0.1031 | 0.1032 | 0.0729 | 0.1301 | 16,700 | 205 | 14 | 282 | 20.1 | 6.71 | 22,613 | 23,060 | 447 | 2.16% | 80.4% |
| 60619 | 63630 | 43.6% | 56.4% | 0.1177 | 0.0521 | 0.0497 | 0.0572 | 0.1535 | 0.152 | 0.0674 | 0.0642 | 0.074 | 0.2063 | 17,800 | 31 | 17 | 163 | 10.8 | 9.86 | 638 | 684 | 46 | 0.06% | 77.6% |
| 60634 | 74302 | 49.1% | 50.9% | 0.1233 | 0.0657 | 0.0711 | 0.0693 | 0.1588 | 0.1273 | 0.0721 | 0.0736 | 0.0708 | 0.165 | 21,800 | 112 | 1 | 19 | 19.0 | 5.33 | 3,164 | 3,693 | 529 | 0.52% | 79.8% |
| 60626 | 50144 | 50.4% | 49.6% | 0.1136 | 0.1076 | 0.0951 | 0.0715 | 0.1165 | 0.1116 | 0.1057 | 0.0935 | 0.0703 | 0.1145 | 7,100 | 145 | 15 | 233 | 15.5 | 8.92 | 7,235 | 7,295 | 60 | 0.69% | 84.5% |
| 60621 | 35916 | 44.8% | 55.2% | 0.1517 | 0.0654 | 0.0505 | 0.0543 | 0.1253 | 0.187 | 0.0806 | 0.0623 | 0.067 | 0.1553 | 15,000 | 28 | 12 | 130 | 10.8 | 8.28 | 395 | 381 | (14) | 0.04% | 86.3% |
| 60624 | 36109 | 46.6% | 53.4% | 0.161 | 0.0633 | 0.0607 | 0.0589 | 0.1163 | 0.1844 | 0.0732 | 0.0694 | 0.0674 | 0.1334 | 11,800 | 35 | 8 | 88 | 11.0 | 5.71 | 339 | 320 | (19) | 0.03% | 68.1% |
| 60623 | 92112 | 53.7% | 46.4% | 0.1948 | 0.0931 | 0.0851 | 0.0674 | 0.1001 | 0.1638 | 0.0834 | 0.0775 | 0.0579 | 0.0898 | 13,700 | 109 | 6 | 66 | 11.0 | 5.88 | 560 | 588 | 28 | 0.06% | 82.0% |
| 60645 | 45280 | 49.5% | 50.5% | 0.1342 | 0.0763 | 0.078 | 0.0683 | 0.1404 | 0.1369 | 0.0777 | 0.0774 | 0.0696 | 0.1433 | 11,400 | 55 | 7 | 95 | 12.1 | 8.99 | 1,296 | 1,297 | 1 | 0.12% | 77.2% |
| 60659 | 38109 | 49.1% | 50.9% | 0.1325 | 0.0713 | 0.0704 | 0.0661 | 0.1507 | 0.1372 | 0.0739 | 0.0729 | 0.0685 | 0.1565 | 44,000 | 19 | 4 | 44 | 11.0 | 7.79 | 601 | 687 | 86 | 0.06% | 75.5% |
| 60660 | 42757 | 51.2% | 48.8% | 0.0844 | 0.1033 | 0.0959 | 0.0791 | 0.1496 | 0.0806 | 0.0982 | 0.0912 | 0.0753 | 0.1424 | 35,200 | 42 | 5 | 91 | 18.2 | 7.57 | 5,215 | 5,686 | 471 | 0.51% | 79.7% |
| 60641 | 71668 | 49.6% | 50.4% | 0.1358 | 0.0791 | 0.0803 | 0.0637 | 0.1312 | 0.1377 | 0.0802 | 0.0815 | 0.0708 | 0.1398 | 33,900 | 81 | 6 | 78 | 13.0 | 7.21 | 1,173 | 1,110 | (63) | 0.11% | 77.2% |
| 60630 | 54099 | 49.2% | 50.8% | 0.1214 | 0.0715 | 0.0766 | 0.0715 | 0.1439 | 0.1253 | 0.0733 | 0.0789 | 0.0741 | 0.1563 | 12,300 | 37 | 2 | 26 | 13.0 | 7.28 | 240 | 239 | 9 | 0.02% | 73.5% |
| 60651 | 64273 | 47.3% | 52.7% | 0.1552 | 0.0734 | 0.0646 | 0.0538 | 0.1201 | 0.1724 | 0.0814 | 0.0717 | 0.0667 | 0.1348 | 34,900 | 31 | 4 | 44 | 11.0 | 6.25 | 804 | 795 | (9) | 0.08% | 70.0% |
| 60644 | 48852 | 45.3% | 54.1% | 0.1412 | 0.0647 | 0.0573 | 0.0594 | 0.136 | 0.1667 | 0.0764 | 0.0677 | 0.0701 | 0.1605 | 9,800 | 43 | 13 | 139 | 10.7 | 6.89 | 278 | 259 | (19) | 0.03% | 69.4% |
| 60636 | 40323 | 46.5% | 53.4% | 0.1587 | 0.0671 | 0.0527 | 0.0587 | 0.1287 | 0.1818 | 0.0769 | 0.0603 | 0.0673 | 0.1479 | 18,200 | 20 | 8 | 80 | 10.0 | 8.10 | 105 | 109 | 4 | 0.01% | 76.2% |
| 60617 | 94161 | 46.5% | 53.5% | 0.1439 | 0.0596 | 0.0573 | 0.0595 | 0.1458 | 0.1643 | 0.0681 | 0.0654 | 0.0674 | 0.1596 | 8,600 | 190 | 6 | 62 | 10.3 | 10.84 | 191 | 189 | (2) | 0.02% | 90.1% |
| 60201 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | 9 | 135 | 15.0 | 11.62 | 3,783 | 3,729 | (54) | 0.36% | 77.3% |
| 60202 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | 3 | 45 | 15.0 | 10.36 | 1,141 | 1,243 | 102 | 0.11% | 80.5% |
| 60208 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | 2 | 30 | 15.0 | 11.80 | 1,876 | 1,850 | (26) | 0.18% | 80.5% |
| 60639 | 39411 | 49.5% | 50.5% | 0.1627 | 0.0802 | 0.0752 | 0.0642 | 0.1128 | 0.1657 | 0.0815 | 0.0764 | 0.0655 | 0.1166 | 12,500 | 45 | 1 | 11 | 11.0 | 6.04 | 200 | 191 | (9) | 0.02% | 75.5% |

## Factors considered for analysis. For each zip code we found:

- Total population
- Male & Female %
- %s of different age groups
- Vehicle volume
- Number of bike racks
- Number of stations
- Number of docks
- Avg of avg distance of stations from other stations
- Trip Out, Trip In, Net
- % of subscribers



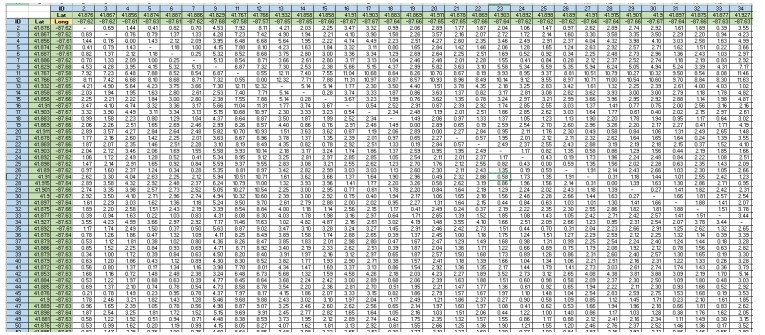
## Sample zip code findings

| | |
|---|---|
| Zip code | 60605 |
| Total Population | 24672 |
| Male% | 0.4852 |
| Female% | 0.5148 |
| 0_19_M | 0.0678 |
| 20_29_M | 0.138 |
| 30_39_M | 0.1094 |
| 40_49_M | 0.0565 |
| 50plus_M | 0.1134 |
| 0_19_F | 0.0719 |
| 20_29_F | 0.1451 |
| 30_39_F | 0.1169 |
| 40_49_F | 0.0603 |
| 50plus_F | 0.1206 |
| Vehicle Volume | 8300 |
| Number of Bike racks | 356 |
| Number of stations | 19 |
| Total # of docks | 550 |
| Avg # of docks | 28.94736842 |
| Avg of Avg Distance of stations from other stations (miles) | 4.754563244 |
| Trips Out | 68902 |
| Trips In | 65243 |
| Net | -3659 |
| % of total trips | 0.063305521 |
| Subscriber % | 0.606542626 |

## Sample calculation

**** Sample calculation***

- Distance between stations



- Latitude & Longitude for 608 existing stations
- Used complex formula involving trigonometry to find distances
  - *=IFERROR(6371*ACOS(COS(RADIANS(90-$B563))*COS(RADIANS(90-VS$2))+SIN(RADIANS(90-$B563))*SIN(RADIANS(90-VS$2))*COS(RADIANS($C563-VS$3)))/1.609,0)*
- Resulting in over 30k distance values for each pair of stations

# Score based approach

## Current station locations (Before expansion plan)

Where are the stations?

- CTA, Metra stations
- employment centers, shopping districts, medical centers, schools
- other popular destinations.

How were the locations chosen?

- population density
- business permits
- other stations in the surrounding network.

## Our scoring methodology

- When Divvy first launched, it focused more on the popular destinations (tourist attraction areas, shopping centers, offices etc.)
- The expansion plan is focused more on expanding to the areas where there are currently *no Divvy stations*
- Priority = underserved communities (in terms of number of Divvy stations).
- Score based system for the allocation of the stations and the bikes taking into consideration the below factors. New station allocation determined based on overall score (i.e. higher score = more stations)

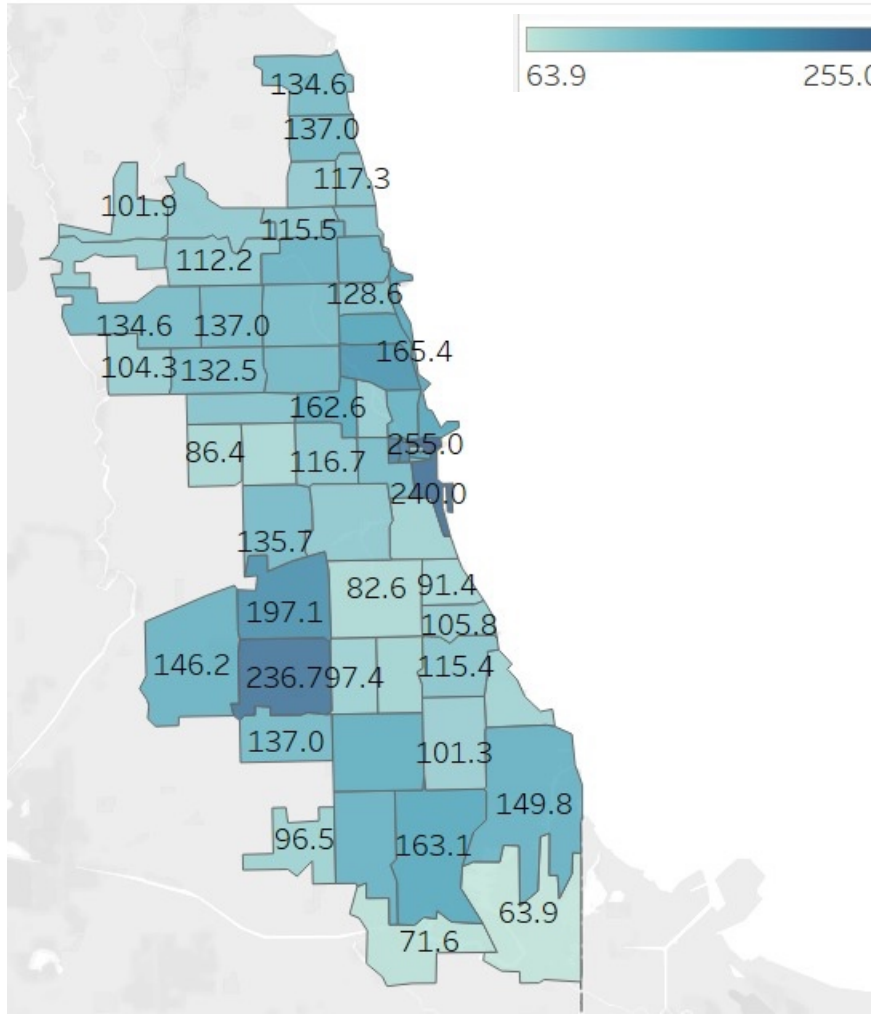
| Category | Score Description | | Weight | Comments |
|---|---|---|---|---|
| Divvy Stations (existing) | less number of stations = more points | ↓ ↑ | 20% | More weight assigned to zip codes with no stations.<br>Points deducted to zip codes with stations |
| Trips (Trips Out) | more number of trips = more points | ↑ ↑ | 10% | - |
| Net (Trip From - Trip To) | lower Net value = more points | ↓ ↑ | 5% | Points only added to zip codes with a negative net value |
| Subscriber% | higher % of subscribers = more points | ↑ ↑ | 15% | - |
| Population Total | higher population = more points | ↑ ↑ | 15% | - |
| Male% | higher male % = more points | ↑ ↑ | 5% | - |
| 20_39 Age Group | higher % of 20_39 age group = more points | ↑ ↑ | 10% | - |
| Average Distance to other stations | higher avg distance to other stations = more points | ↑ ↑ | 10% | - |
| Traffic | higher vehicle volume = more points | ↑ ↑ | 5% | - |
| Bike racks | more number of bike racks (bike friendliness score) = more points | ↑ ↑ | 5% | - |

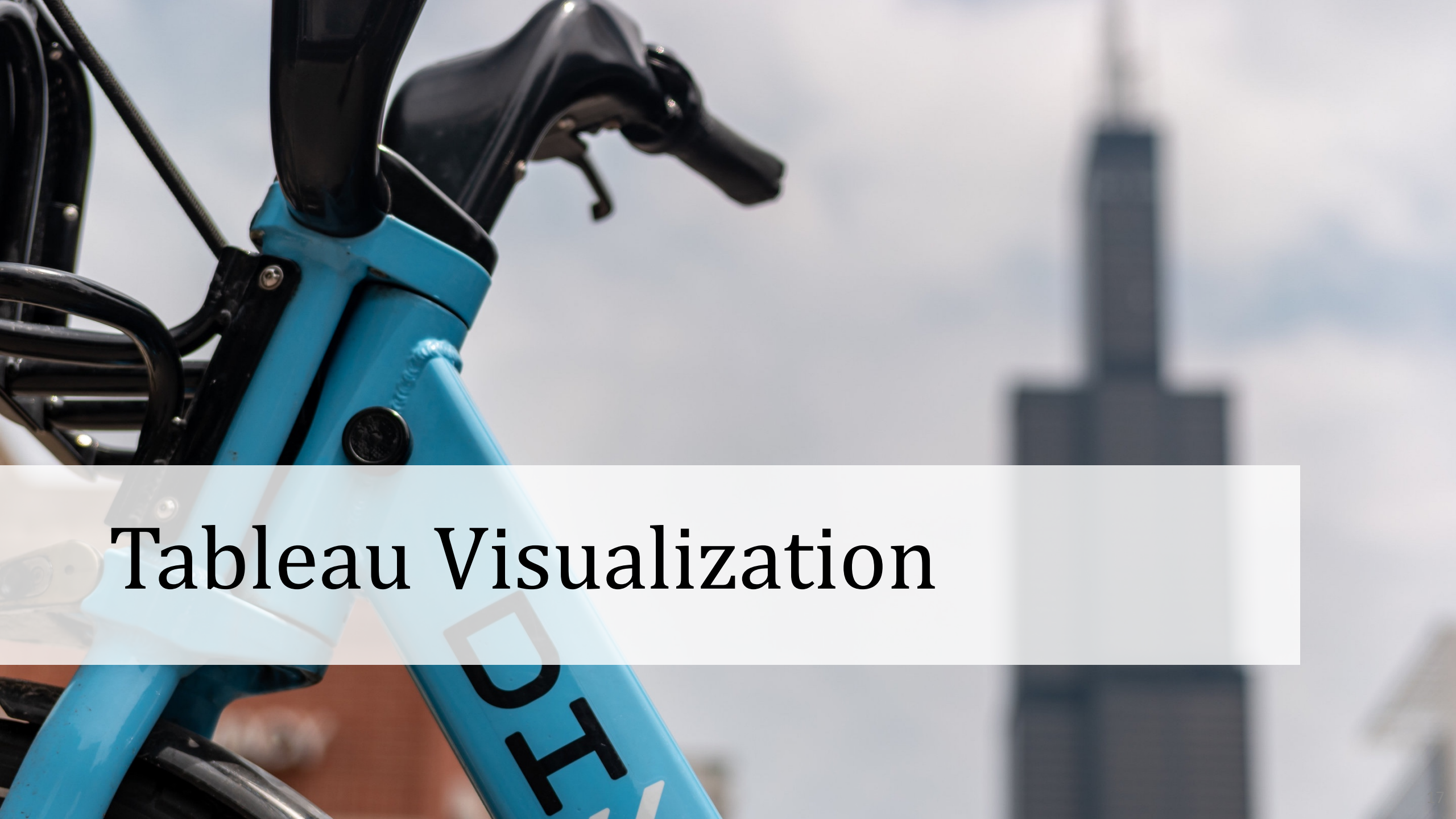
# Scores by zip code

## Scoring by zip calculation

| | Demographic | | | Traffic | Bike Racks | Divvy Stations | | Divvy Trips | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Population | Gender | 20_39 | Vehicle Volume | Number of Bike racks | Number of stations | Avg of Avg Distance of stations from other stations (miles) | Trips (Trips Out) | Net (Trip From - Trip To) | Subscriber % | Population | Gender | 20_39 | Vehicle Volume | Number of Bike racks | Number of stations | Avg of Avg Distance of stations from other stations (miles) | Trips (Trips Out) | Net (Trip From - Trip To) | Subscriber % | Total Score | New stations | New Bikes |
| | Total | Male% | | | | | | | | | Total | Male% | | | | | | | | | | | | |
| Weight | 15% | 5% | 10% | 5% | 5% | 20% | 10% | 10% | 5% | 15% | 15% | 5% | 10% | 5% | 5% | 20% | 10% | 10% | 5% | 15% | | | |
| Total Points | 1500 | 500 | 1000 | 500 | 500 | 2000 | 1000 | 1000 | 500 | 1500 | | | | | | | | | | | | | |
| 60605 | 24672 | 48.5% | 0.5094 | 8,300 | 356 | 19 | 4.75 | 68,902 | (3,659) | 60.7% | 13.7 | 8.7 | 23.9 | 3.9 | 31.9 | (31.25) | 15.4 | 65.0 | 84.3 | 24.4 | 240.0 | 5 | 308 |
| 60601 | 11115 | 49.4% | 0.5329 | 23,800 | 1 | 11 | 4.59 | 68,506 | (4,312) | 72.4% | 6.2 | 8.8 | 25.0 | 11.1 | 0.1 | (18.09) | 14.9 | 64.7 | 113.2 | 29.2 | 255.0 | 5 | 328 |
| 60609 | 64911 | 50.2% | 0.3066 | 8,100 | 75 | 28 | 6.49 | 2,553 | 145 | 87.5% | 36.1 | 9.0 | 14.4 | 3.8 | 6.7 | (46.05) | 21.1 | 2.4 | - | 35.2 | 82.6 | 2 | 106 |
| 60649 | 46654 | 43.8% | 0.2683 | 18,300 | 31 | 14 | 9.79 | 1,522 | (60) | 62.0% | 26.0 | 7.8 | 12.6 | 8.6 | 2.8 | (23.03) | 31.8 | 1.4 | 1.4 | 25.0 | 94.3 | 2 | 121 |
| 60614 | 66823 | 47.6% | 0.5313 | 21,700 | 195 | 34 | 4.82 | 106,909 | 4,328 | 79.3% | 37.1 | 8.5 | 24.9 | 10.2 | 17.5 | (55.92) | 15.7 | 100.9 | - | 31.9 | 190.7 | 4 | 245 |
| 60608 | 82743 | 52.4% | 0.3789 | 18,800 | 109 | 27 | 5.03 | 14,489 | 799 | 87.8% | 46.0 | 9.4 | 17.8 | 8.8 | 9.8 | (44.41) | 16.3 | 13.7 | - | 35.4 | 112.7 | 2 | 145 |
| 60622 | 52553 | 51.1% | 0.5416 | 34,400 | 354 | 25 | 4.57 | 45,114 | 1,146 | 86.0% | 29.2 | 9.1 | 25.4 | 16.1 | 31.7 | (41.12) | 14.8 | 42.6 | - | 34.7 | 162.6 | 3 | 209 |
| 60606 | 2314 | 49.2% | 0.5328 | 10,200 | 227 | 6 | 4.40 | 37,508 | (3,421) | 90.9% | 1.3 | 8.8 | 25.0 | 4.8 | 20.3 | (9.87) | 14.3 | 35.4 | 78.8 | 36.6 | 215.4 | 5 | 277 |
| 60607 | 23902 | 49.2% | 0.5333 | 28,300 | 62 | 26 | 4.40 | 61,385 | 232 | 91.1% | 13.3 | 8.8 | 25.0 | 13.7 | 5.6 | (42.76) | 14.3 | 57.9 | - | 36.7 | 132.5 | 3 | 170 |
| 60642 | 18485 | 51.1% | 0.5452 | 11,100 | 9 | 12 | 4.37 | 24,416 | 107 | 90.8% | 10.3 | 9.1 | 25.6 | 5.2 | 0.8 | (19.74) | 14.2 | 23.0 | - | 36.6 | 105.1 | 2 | 135 |
| 60610 | 37730 | 46.4% | 0.4958 | 22,100 | 122 | 18 | 4.52 | 61,694 | 708 | 81.9% | 21.0 | 8.3 | 22.8 | 10.3 | 10.8 | (29.61) | 14.7 | 58.2 | - | 33.0 | 149.6 | 3 | 192 |
| 60611 | 28722 | 46.4% | 0.4855 | 18,100 | 149 | 16 | 4.67 | 69,207 | 5,926 | 58.4% | 16.0 | 8.3 | 22.8 | 8.5 | 13.3 | (26.32) | 15.2 | 84.2 | - | 23.5 | 165.4 | 4 | 213 |
| 60654 | 14880 | 46.7% | 0.4889 | 23,000 | 115 | 14 | 4.40 | 68,187 | (2,806) | 88.9% | 8.3 | 8.3 | 22.9 | 10.8 | 10.3 | (23.03) | 14.3 | 64.4 | 64.6 | 35.8 | 216.7 | 5 | 278 |
| 60604 | 575 | 49.4% | 0.5339 | 11,000 | 227 | 3 | 4.55 | 15,680 | (450) | 80.4% | 0.3 | 8.8 | 25.1 | 5.1 | 20.3 | (4.93) | 14.8 | 14.8 | 10.4 | 32.4 | 127.1 | 3 | 163 |
| 60603 | 497 | 49.3% | 0.5313 | 13,700 | 98 | 5 | 4.56 | 27,542 | (2,821) | 55.5% | 0.3 | 8.8 | 24.9 | 6.4 | 8.8 | (8.22) | 14.8 | 26.0 | 65.0 | 22.4 | 169.2 | 4 | 217 |
| 60616 | 48437 | 48.1% | 0.3604 | 6,100 | 97 | 29 | 5.35 | 32,058 | 412 | 77.6% | 27.0 | 8.6 | 16.9 | 2.9 | 7.8 | (47.70) | 17.4 | 30.3 | - | 31.2 | 94.3 | 2 | 121 |
| 60602 | 1210 | 49.3% | 0.5322 | 18,750 | 50 | 3 | 4.53 | 17,152 | (22) | 79.3% | 0.7 | 8.8 | 25.0 | 8.8 | 4.4 | (4.93) | 14.7 | 16.2 | 0.5 | 31.9 | 106.1 | 2 | 136 |
| 60661 | 7798 | 49.2% | 0.5331 | 15,600 | 102 | 12 | 4.34 | 78,847 | (2,434) | 93.3% | 4.3 | 8.8 | 25.0 | 7.3 | 9.1 | (19.74) | 14.1 | 74.4 | 56.1 | 37.6 | 217.0 | 5 | 279 |
| 60637 | 49508 | 44.9% | 0.3076 | 20,900 | 72 | 17 | 8.15 | 12,684 | (255) | 81.4% | 27.5 | 8.0 | 14.4 | 9.8 | 6.4 | (27.96) | 26.5 | 12.0 | 5.9 | 32.8 | 115.4 | 2 | 148 |
| 60657 | 66001 | 49.7% | 0.606 | 12,900 | 201 | 20 | 5.28 | 54,456 | 2,872 | 80.5% | 36.7 | 8.9 | 28.4 | 6.0 | 18.0 | (32.89) | 17.1 | 51.4 | - | 32.4 | 166.2 | 4 | 214 |
| 60647 | 87297 | 50.4% | 0.4612 | 10,600 | 204 | 24 | 5.43 | 26,516 | 835 | 82.6% | 48.6 | 9.0 | 21.6 | 5.0 | 18.3 | (39.47) | 17.6 | 25.0 | - | 33.3 | 138.9 | 3 | 178 |
| 60612 | 33478 | 48.4% | 0.4414 | 29,500 | 76 | 19 | 4.68 | 13,200 | (648) | 91.3% | 18.6 | 8.7 | 20.7 | 13.8 | 6.8 | (31.25) | 15.2 | 12.5 | 14.9 | 36.8 | 116.7 | 2 | 150 |
| 60615 | 40608 | 44.9% | 0.3601 | 10,800 | 64 | 11 | 7.54 | 10,823 | 84 | 76.7% | 22.6 | 8.0 | 16.9 | 5.1 | 5.7 | (18.09) | 24.5 | 10.2 | - | 30.9 | 105.8 | 2 | 136 |
| 60618 | 92089 | 50.2% | 0.3937 | 18,700 | 193 | 21 | 5.95 | 10,973 | 805 | 85.2% | 51.2 | 9.0 | 18.5 | 8.7 | 17.3 | (34.54) | 19.3 | 10.4 | - | 34.3 | 134.2 | 3 | 172 |
| 60613 | 48285 | 50.4% | 0.556 | 11,600 | 76 | 23 | 5.90 | 43,431 | 864 | 79.5% | 26.9 | 9.0 | 26.1 | 5.4 | 6.8 | (37.83) | 19.2 | 41.0 | - | 32.0 | 128.6 | 3 | 165 |
| 60653 | 29912 | 43.2% | 0.3031 | 19,900 | 59 | 9 | 6.62 | 2,101 | 176 | 73.3% | 16.6 | 7.7 | 14.2 | 9.3 | 5.3 | (14.80) | 21.5 | 2.0 | - | 29.5 | 91.4 | 2 | 117 |
| 60625 | 78654 | 50.0% | 0.3928 | 23,800 | 286 | 19 | 6.85 | 11,857 | 390 | 87.8% | 43.8 | 8.9 | 18.4 | 11.1 | 25.6 | (31.25) | 22.2 | 11.2 | - | 35.4 | 145.5 | 3 | 187 |
| 60640 | 65796 | 51.8% | 0.4281 | 16,700 | 205 | 14 | 6.71 | 22,613 | 447 | 80.4% | 36.6 | 9.3 | 20.1 | 7.8 | 18.4 | (23.03) | 21.8 | 21.3 | - | 32.4 | 144.6 | 3 | 186 |
| 60619 | 63830 | 43.6% | 0.2334 | 17,800 | 31 | 17 | 9.86 | 638 | 46 | 77.6% | 35.5 | 7.8 | 11.0 | 8.3 | 2.8 | (27.96) | 32.0 | 0.6 | - | 31.2 | 101.3 | 2 | 130 |
| 60634 | 74302 | 49.1% | 0.2865 | 21,800 | 112 | 1 | 5.33 | 3,164 | 529 | 79.8% | 41.3 | 8.8 | 13.4 | 10.2 | 10.0 | (1.64) | 17.3 | 3.0 | - | 32.1 | 134.6 | 3 | 173 |
| 60626 | 50144 | 50.4% | 0.4019 | 7,100 | 145 | 15 | 8.92 | 7,235 | 60 | 84.5% | 27.9 | 9.0 | 18.9 | 3.3 | 13.0 | (24.67) | 29.0 | 6.8 | - | 34.0 | 117.3 | 3 | 151 |
| 60621 | 35916 | 44.8% | 0.2588 | 15,000 | 28 | 12 | 8.28 | 395 | (14) | 86.3% | 20.0 | 8.0 | 12.1 | 7.0 | 2.5 | (19.74) | 26.9 | 0.4 | 0.3 | 34.8 | 92.3 | 2 | 119 |
| 60624 | 38109 | 46.6% | 0.2786 | 11,800 | 35 | 8 | 5.71 | 339 | (19) | 68.1% | 21.2 | 8.3 | 13.1 | 5.5 | 3.1 | (13.16) | 18.5 | 0.3 | 0.4 | 27.4 | 84.8 | 2 | 109 |
| 60623 | 92112 | 53.7% | 0.3391 | 13,700 | 109 | 6 | 5.88 | 560 | 28 | 82.0% | 51.3 | 9.6 | 15.9 | 6.4 | 9.8 | (9.87) | 19.1 | 0.5 | - | 33.0 | 135.7 | 3 | 174 |
| 60645 | 45280 | 49.5% | 0.3074 | 11,400 | 55 | 7 | 8.99 | 1,296 | 1 | 77.2% | 25.2 | 8.9 | 14.4 | 5.3 | 4.9 | (11.51) | 29.2 | 1.2 | - | 31.1 | 108.7 | 2 | 140 |
| 60659 | 38109 | 49.1% | 0.2885 | 44,000 | 19 | 4 | 7.79 | 601 | 86 | 75.5% | 21.2 | 8.8 | 13.5 | 20.6 | 1.7 | (6.58) | 25.3 | 0.6 | - | 30.4 | 115.5 | 2 | 148 |
| 60660 | 42757 | 51.2% | 0.3886 | 35,200 | 42 | 5 | 7.57 | 5,215 | 471 | 79.7% | 23.8 | 9.2 | 18.2 | 16.5 | 3.8 | (8.22) | 24.6 | 4.9 | - | 32.1 | 124.8 | 3 | 160 |
| 60641 | 71668 | 49.6% | 0.3211 | 39,900 | 81 | 6 | 7.21 | 1,173 | (63) | 77.2% | 39.9 | 8.9 | 15.1 | 18.7 | 7.3 | (9.87) | 23.4 | 1.1 | 1.5 | 31.1 | 137.0 | 3 | 176 |
| 60630 | 54099 | 49.2% | 0.3003 | 12,300 | 37 | 2 | 7.28 | 230 | 9 | 73.5% | 30.1 | 8.8 | 14.1 | 5.8 | 3.3 | (3.29) | 23.6 | 0.2 | - | 29.6 | 112.2 | 2 | 144 |
| 60651 | 64273 | 47.3% | 0.2911 | 34,900 | 31 | 4 | 6.25 | 804 | (9) | 70.0% | 35.8 | 8.5 | 13.7 | 16.3 | 2.8 | (6.58) | 20.3 | 0.8 | 0.2 | 28.2 | 119.9 | 3 | 154 |
| 60644 | 40852 | 45.9% | 0.2661 | 9,800 | 49 | 13 | 6.89 | 278 | (19) | 69.4% | 27.1 | 8.2 | 12.5 | 4.6 | 4.4 | (21.38) | 22.4 | 0.3 | 0.4 | 28.0 | 86.4 | 2 | 111 |
| 60636 | 40923 | 46.6% | 0.257 | 18,200 | 20 | 8 | 8.10 | 105 | 4 | 76.2% | 22.8 | 8.3 | 12.1 | 8.5 | 1.8 | (13.16) | 26.3 | 0.1 | - | 30.7 | 97.4 | 2 | 125 |
| 60617 | 84161 | 46.5% | 0.2504 | 8,600 | 190 | 6 | 10.84 | 191 | (2) | 90.1% | 46.8 | 8.3 | 11.8 | 4.0 | 17.0 | (9.87) | 35.2 | 0.2 | 0.0 | 36.3 | 149.8 | 3 | 192 |
| 60201 | #N/A | #N/A | #N/A | #N/A | #N/A | 9 | 11.62 | 3,783 | (54) | 77.9% | #N/A | #N/A | #N/A | #N/A | #N/A | (14.80) | 37.7 | 3.6 | 1.2 | 31.4 | 134.6 | 3 | 173 |
| 60202 | #N/A | #N/A | #N/A | #N/A | #N/A | 3 | 10.36 | 1,141 | 102 | 80.5% | #N/A | #N/A | #N/A | #N/A | #N/A | (4.93) | 33.6 | 1.1 | - | 32.4 | 137.0 | 3 | 176 |
| 60208 | #N/A | #N/A | #N/A | #N/A | #N/A | 2 | 11.80 | 1,876 | (26) | 80.5% | #N/A | #N/A | #N/A | #N/A | #N/A | (3.29) | 38.3 | 1.8 | 0.6 | 32.4 | 91.4 | 2 | 117 |
| 60639 | 90411 | 49.5% | 0.3133 | 12,500 | 45 | 1 | 6.04 | 200 | (9) | 75.5% | 50.3 | 8.8 | 14.7 | 5.8 | 4.0 | (1.64) | 19.6 | 0.2 | 0.2 | 30.4 | 132.5 | 3 | 170 |
| 60628 | 72206 | 44.8% | 0.2338 | 12,500 | 103 | - | - | - | - | - | 40.2 | 8.0 | 11.0 | 5.8 | 9.2 | 88.89 | - | - | - | - | 163.1 | 3 | 210 |
| 60643 | 49957 | 45.9% | 0.2177 | 27,800 | 93 | - | - | - | - | - | 27.8 | 8.2 | 10.2 | 13.0 | 8.3 | 80.89 | - | - | - | - | 148.4 | 3 | 191 |
| 60620 | 72220 | 44.0% | 0.2335 | 12,300 | 55 | - | - | - | - | - | 40.2 | 7.9 | 11.0 | 5.8 | 4.9 | 93.45 | - | - | - | - | 153.2 | 3 | 197 |
| 60655 | 28552 | 48.3% | 0.2528 | 7,300 | 46 | - | - | - | - | - | 15.9 | 8.6 | 11.9 | 3.4 | 4.1 | 52.58 | - | - | - | - | 96.5 | 2 | 124 |
| 60633 | 8726 | 49.8% | 0.2484 | 4,400 | 18 | - | - | - | - | - | 4.9 | 8.9 | 11.7 | 2.1 | 1.6 | 34.83 | - | - | - | - | 63.9 | 1 | 82 |
| 60629 | 113921 | 49.3% | 0.3115 | 14,600 | 157 | - | - | - | - | - | 63.4 | 8.8 | 14.6 | 6.8 | 14.1 | 128.37 | - | - | - | - | 236.7 | 5 | 304 |
| 60652 | 40965 | 48.0% | 0.2614 | 33,300 | 35 | - | - | - | - | - | 22.8 | 8.6 | 12.3 | 15.6 | 3.1 | 74.66 | - | - | - | - | 137.0 | 3 | 176 |
| 60707 | 18043 | 47.9% | 0.2801 | 22,300 | 59 | - | - | - | - | - | 10.0 | 8.6 | 13.1 | 10.4 | 5.3 | 56.83 | - | - | - | - | 104.3 | 2 | 134 |
| 60632 | 91332 | 51.1% | 0.322 | 27,800 | 18 | - | - | - | - | - | 50.8 | 9.1 | 15.1 | 13.0 | 1.6 | 107.38 | - | - | - | - | 197.1 | 4 | 253 |
| 60631 | 28206 | 47.6% | 0.2335 | 12,300 | 61 | - | - | - | - | - | 15.7 | 8.5 | 11.0 | 5.8 | 5.5 | 55.55 | - | - | - | - | 101.9 | 2 | 131 |
| 60646 | 27162 | 48.1% | 0.2161 | 27,600 | 44 | - | - | - | - | - | 15.1 | 8.6 | 10.1 | 12.9 | 3.9 | 60.71 | - | - | - | - | 111.4 | 2 | 143 |
| 60656 | 26870 | 48.7% | 0.2907 | 17,500 | 20 | - | - | - | - | - | 15.0 | 8.7 | 13.6 | 8.2 | 1.8 | 56.61 | - | - | - | - | 103.9 | 2 | 133 |
| 60638 | 50977 | 48.7% | 0.2743 | 28,700 | 35 | - | - | - | - | - | 28.4 | 8.7 | 12.9 | 13.4 | 3.1 | 79.64 | - | - | - | - | 146.2 | 3 | 188 |
| 60827 | 6489 | 41.1% | 0.2688 | 18,636 | 4 | - | - | - | - | - | 3.6 | 7.4 | 12.5 | 9.7 | 0.4 | 38.99 | - | - | - | - | 71.5 | 2 | 92 |

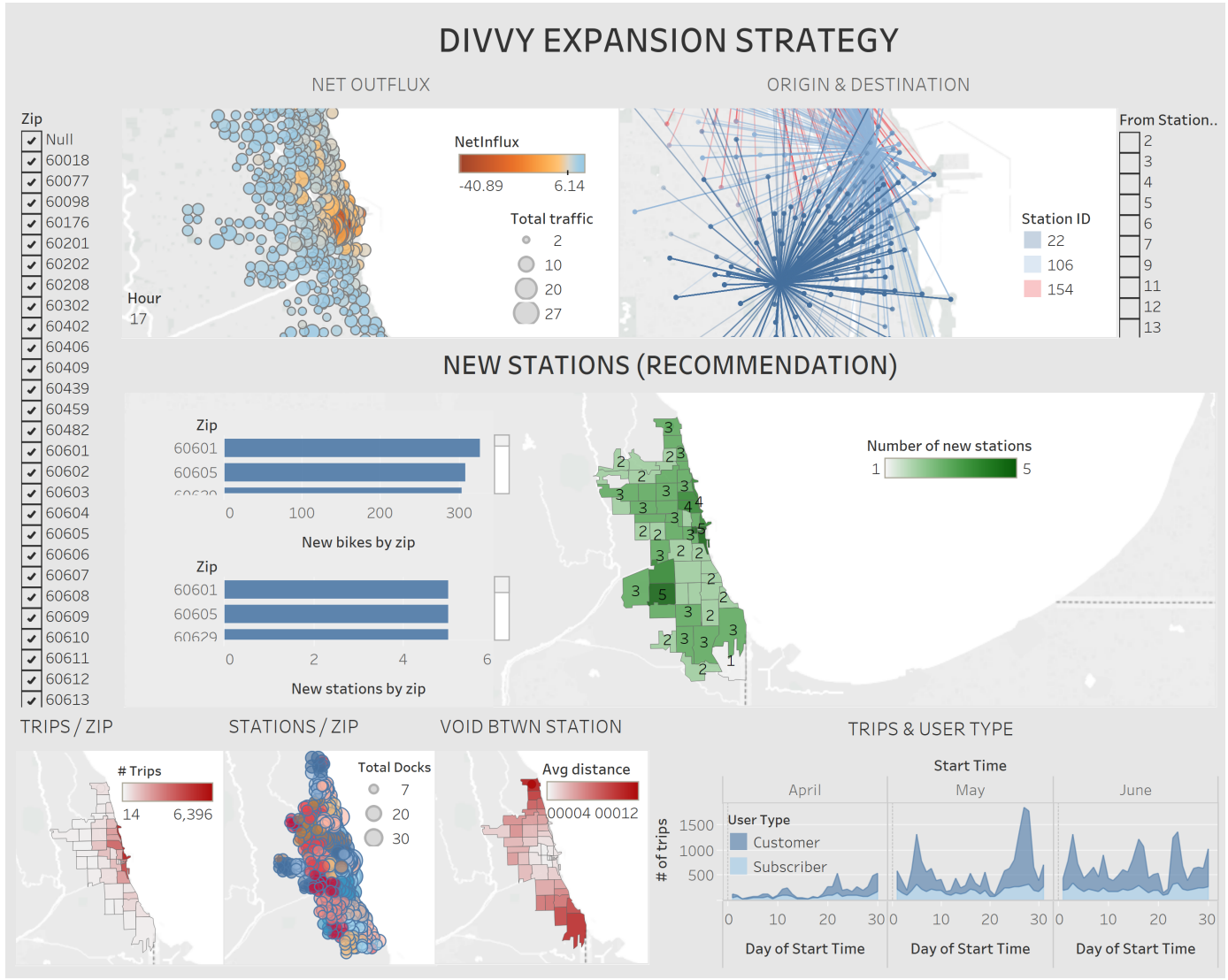
## Scoring by zip visualization





# Tableau Visualization

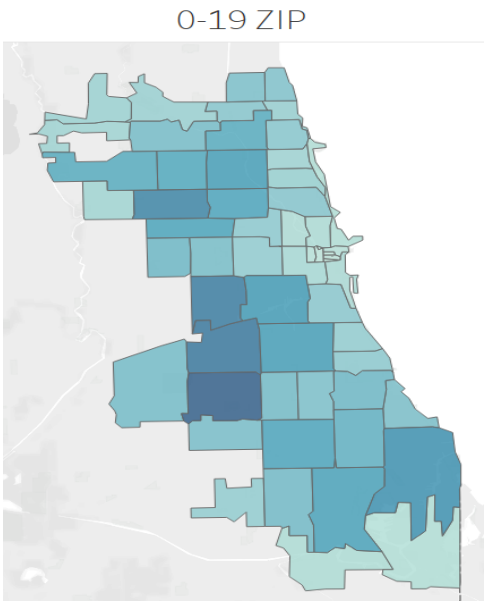
# Dashboard

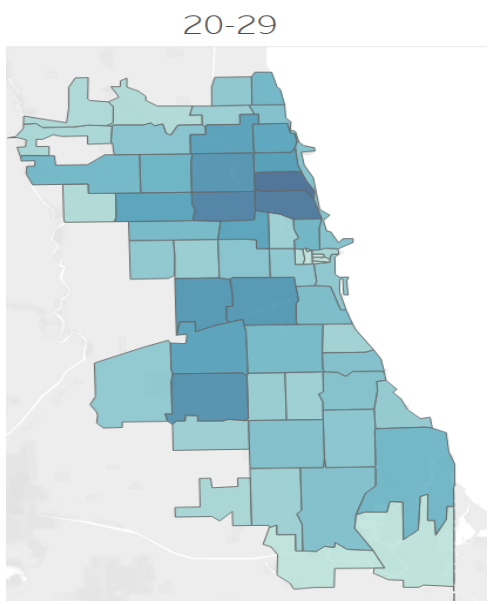


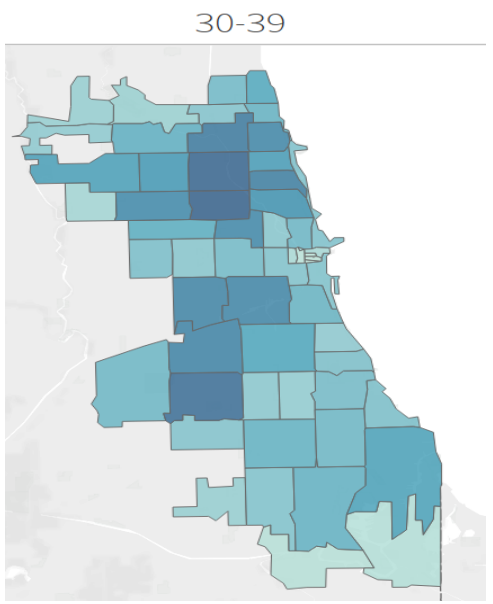

## Derived recommendation from trip and zip demographics:

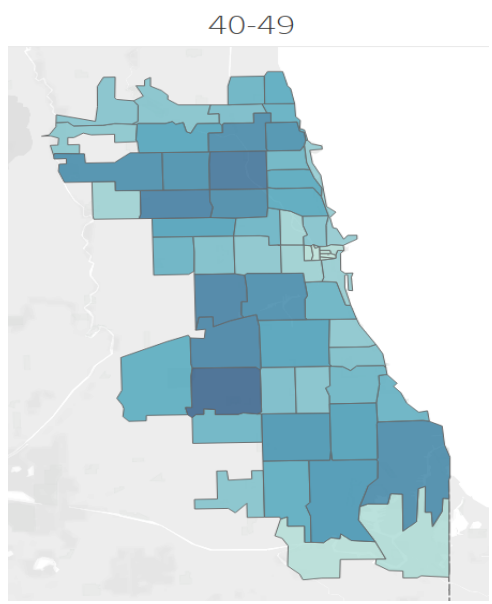
- ***Net Outflux:*** Number of bikes stalled minus number of bikes taken for each station and filtered by hour
- ***Origin & Destination:*** All destinations of the trips taken from a respective station
- ***New Stations (Recommendation):*** Suggested number of new stations per zip code, based on the previously described scoring methodology (+ Number of suggested new bikes and stations per zip code as bar chart)
- ***Trips / Zip:*** Average number of trips started in a respective zip code
- ***Stations / Zip:*** All divvy stations filtered by zip code (color wise) and number of docks (bubble size)
- ***Void Btwn Station:*** Average distance in 100 meters between stations within one zip code
- ***Trips & User Type:*** Number of trips taken filtered by subscribers and non-subscribers ('customers')

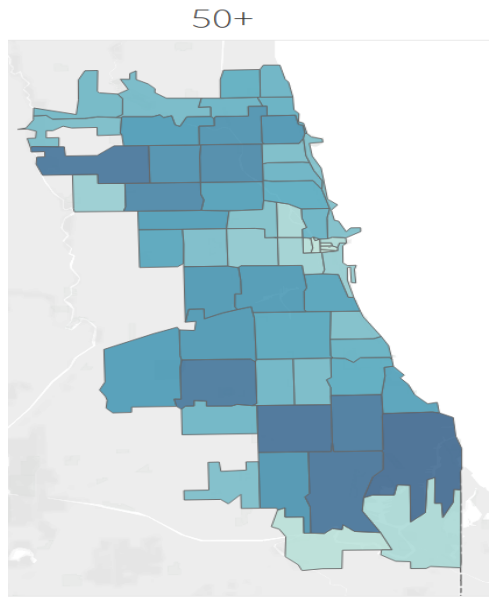
# Demographics by Zip Code



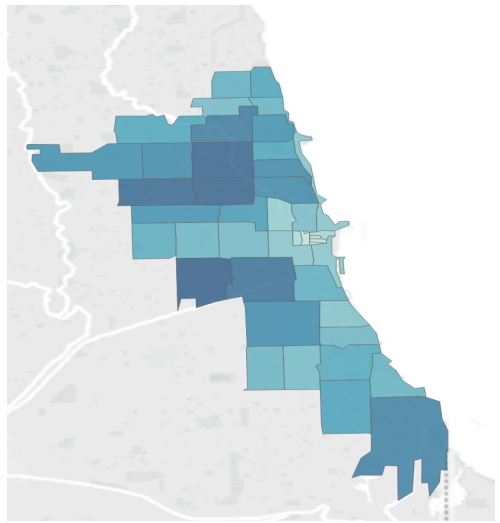



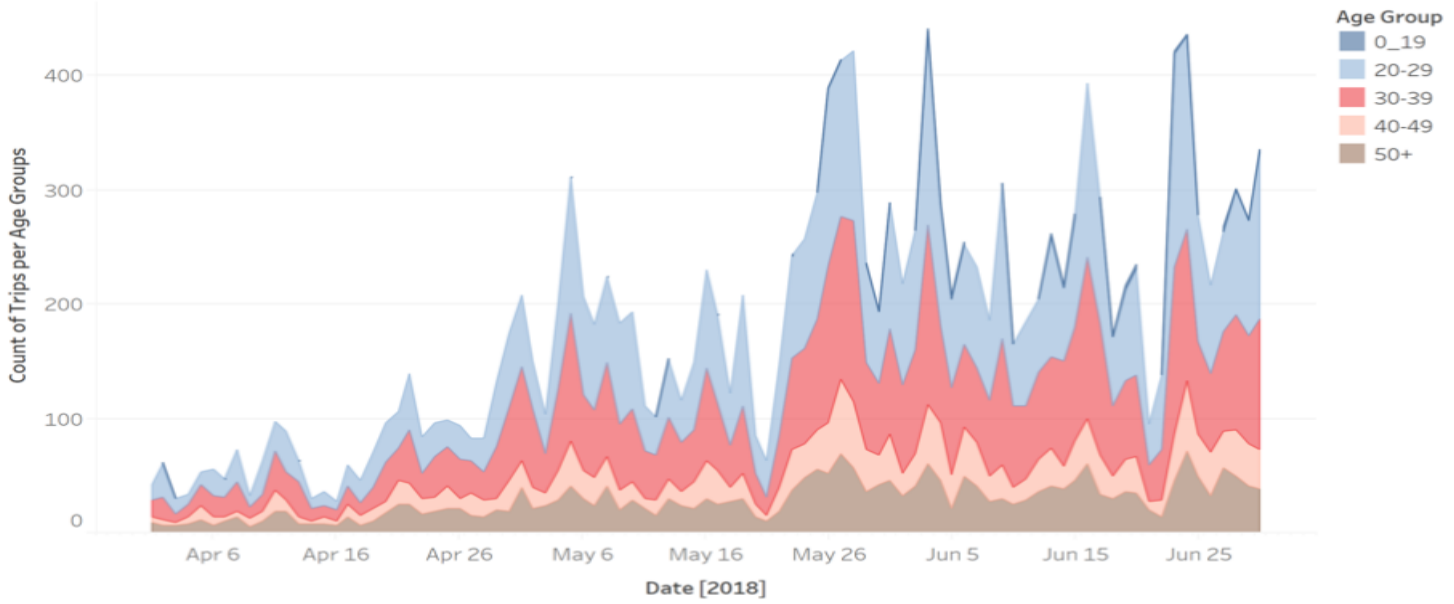




Total population by zip



Number of trips taken by age groups




# Summary

# Summary

## Recommendations and Future Vision:

- Increase stations in ZIPs father from downtown Chicago based on scoring variables to serve the needs of local residents better
- Allocate more bikes to stations with higher net outflux (especially during summer)
- More advance analysis based on variables like customer feedback, commercial footprints, real estate bike scores etc.
- Capitalize on the existing bike rack network in Chicago
- Expand to OLTP framework to support real time trip information.
- Scaling out to support the ever increasing data repository.

## Lessons Learned:

- Choose your data sources carefully, every data source has its own conventions and business case.
- Make sure geographic data from different sources is coherent.
- Don't over normalize for OLAP - keep it simple!
- Split up data sources / use views for faster processing in tableau.
- Excel is a very powerful tool.


# THANK YOU!