Untitled

Are citibikes actually used for commuting?

In thi part, we will try to identify geographical trends and see whether they can constitute evidence that citibikes are used by new yorkers as a way of commuting. To do so, we will mainly focus on geographical features (stations locations for the start and end of the trip) while discarding aspects such as seasonnality.

```
library(readr)
library(sp)
## Warning: package 'sp' was built under R version 3.4.4
library(plyr)
library(dplyr)
## Warning: package 'dplyr' was built under R version 3.4.4
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:plyr':
##
##
       arrange, count, desc, failwith, id, mutate, rename, summarise,
##
       summarize
## The following objects are masked from 'package:stats':
##
##
       filter, lag
## The following objects are masked from 'package:base':
##
       intersect, setdiff, setequal, union
##
library(ggmap)
## Loading required package: ggplot2
## Warning: package 'ggplot2' was built under R version 3.4.4
## Google Maps API Terms of Service: http://developers.google.com/maps/terms.
## Please cite ggmap if you use it: see citation("ggmap") for details.
library(ggplot2)
concise_trips <- read_csv("concise_trips.csv")</pre>
## Parsed with column specification:
## cols(
##
     tripduration = col_integer(),
##
     starttime = col_datetime(format = ""),
     stoptime = col_datetime(format = ""),
##
     `start station id` = col_integer(),
##
##
     `end station id` = col_integer(),
     bikeid = col_integer(),
##
##
     usertype = col_character(),
     `birth year` = col_integer(),
##
##
     gender = col_integer()
```

```
## )
head(concise_trips)
## Warning in as.POSIXlt.POSIXct(x, tz): unknown timezone 'zone/tz/2018g.1.0/
## zoneinfo/America/New_York'
## # A tibble: 6 x 9
                                                            `start station ~
    tripduration starttime
##
                                       stoptime
##
            <int> <dttm>
                                       <dttm>
                                                                       <int>
              771 2018-02-01 00:14:16 2018-02-01 00:27:08
                                                                          72
## 1
              264 2018-02-01 05:14:45 2018-02-01 05:19:09
                                                                           72
## 2
## 3
             819 2018-02-01 06:48:55 2018-02-01 07:02:35
                                                                          72
              646 2018-02-01 07:12:50 2018-02-01 07:23:36
                                                                          72
             1312 2018-02-01 07:46:48 2018-02-01 08:08:41
                                                                          72
## 5
              435 2018-02-01 07:50:45 2018-02-01 07:58:00
                                                                          72
## # ... with 5 more variables: `end station id` <int>, bikeid <int>,
      usertype <chr>, `birth year` <int>, gender <int>
colnames(concise_trips)[4] <- 'start_station_id'</pre>
colnames(concise_trips)[5] <- 'end_station_id'</pre>
concise_trips <- subset(concise_trips, select=-c(starttime,stoptime,bikeid,gender))</pre>
stations_info <- read_csv("~/Desktop/Columbia/data_viz/project_edav/edav_fall_2018/stations_info.csv")</pre>
## Parsed with column specification:
## cols(
##
     id = col_integer(),
     name = col_character(),
##
##
     latitude = col_double(),
##
     longitude = col_double()
## )
colnames(stations_info)[1] = 'start_station_id'
concise_trips_merged <- merge(x = concise_trips, y = stations_info, by = 'start_station_id')</pre>
colnames(stations info)[1] = 'end station id'
concise_trips_merged <- merge(x = concise_trips_merged, y = stations_info, by = 'end_station_id')</pre>
Including Plots
```

```
#COMPUTING THE MOST STARTED STATIONS
colnames(stations_info)[1] = 'start_station_id'
most_started <- count(concise_trips_merged, c(concise_trips_merged$start_station_id))</pre>
## Warning: package 'bindrcpp' was built under R version 3.4.4
colnames(most_started)[1] = 'start_station_id'
most_started_merged <- merge(x = most_started, y = stations_info, by = 'start_station_id')
most_started_merged <- most_started_merged[order(-most_started_merged$n),]</pre>
#COMPUTING THE MOST ENDED STATIONS
colnames(stations_info)[1] = 'end_station_id'
most_ended <- count(concise_trips_merged, c(concise_trips_merged$end_station_id))</pre>
colnames(most ended)[1] = 'end station id'
```

```
most_ended_merged <- merge(x = most_ended, y = stations_info, by = 'end_station_id')
most_ended_merged <- most_ended_merged[order(-most_ended_merged$n),]

#AGGREGATING THE TWO TO SEE THE MOST ACTIVE STATIONS

colnames(most_started_merged)[1] = 'station_id'

colnames(most_started_merged)[2] = 'n_s'

colnames(most_ended_merged)[2] = 'n_e'

most_active <- merge(x = most_started_merged, y = most_ended_merged, by = 'station_id')
most_active$n <- most_active$n_e + most_active$n_s
most_active <- subset(most_active, select=-c(n_s,n_e,longitude.y,latitude.y,name.y))
most_active <- most_active[order(-most_active$n),]
colnames(most_active)[2] <- 'names'
colnames(most_active)[3] <- 'latitude'
colnames(most_active)[4] <- 'longitude'</pre>
```

First of all, we can visualize the stations that are the most 'active': those are the stations that have the highest traffic of citibikes (in terms of start and end for each station)

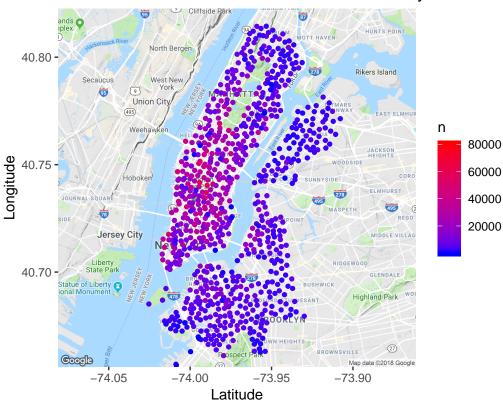
```
apiKey <- 'AIzaSyBlArTIZYpahLCoMaIdV4pQn1GxCHk9XR8'
register_google(apiKey, account_type = "premium", day_limit = 100000)

nyc_base <- ggmap::get_map(location = c(lon = mean(most_active$longitude), lat = mean(most_active$latit

FALSE Source : https://maps.googleapis.com/maps/api/staticmap?center=40.73938,-73.971375&zoom=12&size=6

ggmap(nyc_base) + geom_point(data=most_active, aes(x=longitude, y=latitude,color=n), size=1.2)+
    scale_colour_gradient(low = "blue", high = "red")+
    xlab("Latitude")+
    ylab("Longitude")+
    ggtitle("The most active Citibike stations in New York City")+
    theme(plot.title = element_text(hjust = 0.5))+ scale_fill_discrete(name = "Activity (in number of cus"))</pre>
```

The most active Citibike stations in New York City



From the map, we can see that the there are multiple 'active' zones but the general trend is that Midtown is the most active part of Manhattan. There is also quite a bit of activity in Downtown, along Central Park and in the neighborhoods of Brooklyn that are close to Manhattan. Areas close to Central Park, or in Brooklyn are zones mostly visited by tourists. However, the high activity of citibikes in Midtown could be evidence that citibikes are used for commuting since Midtown is a working area of Manhattan. Furthermore, the activity in Downtown also seems more likely to be the result of commuting then visiting.

To go further in our analysis, we can visualize the most common trips to see whether we can identify trips indicative of either commuting or not.

```
concise_trips_merged_shorted <- count_(concise_trips_merged, vars=c('start_station_id','end_station_id'
concise_trips_merged_shorted <- concise_trips_merged_shorted[order(-concise_trips_merged_shorted$n),]
concise_trips_merged_shorted <- concise_trips_merged_shorted[1:1000,]

colnames(stations_info)[1] = 'start_station_id'
concise_trips_merged_shorted <- merge(x = concise_trips_merged_shorted, y = stations_info, by = 'start_
colnames(stations_info)[1] = 'end_station_id'
concise_trips_merged_shorted <- merge(x = concise_trips_merged_shorted, y = stations_info, by = 'end_station_id'
concise_trips_merged_shorted <- concise_trips_merged_shorted[order(-concise_trips_merged_shorted$n),]

concise_trips_merged_shorted['from'] <- paste(concise_trips_merged_shorted$latitude.x,',', concise_trips_merged_shorted$latitude.y,',', concise_trips_merged_shorted$latitude.y,',',
```

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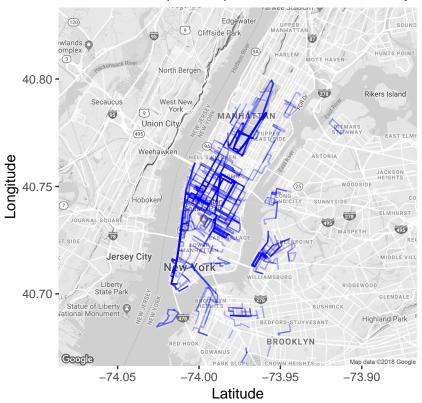
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FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.69878%2C-73.99712&destina
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.6828003%2C-73.99990419&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.75510267%2C-73.97498696&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7153379%2C-74.01658354&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.736502%2C-73.97809472&des
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7190095%2C-73.95852515&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.76915505%2C-73.98191841&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73291553%2C-74.00711384&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7770575%2C-73.97898475&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.745038%2C-73.957539&desti
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.75640548%2C-73.9900262&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7239567849954%2C-73.94984
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73266%2C-73.95826&destina
```

```
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.77801203%2C-73.95407149&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7403432%2C-73.98955109&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.78307%2C-73.95939&destina
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.76590936%2C-73.97634151&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7302066052995%2C-73.99102
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.71534825%2C-73.96024116&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.71774592%2C-73.95600096&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7796680900731%2C-73.98093
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.75594159%2C-74.0021163&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.69221589%2C-73.9842844&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7770575%2C-73.97898475&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.71427487%2C-73.98990025&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.74232744%2C-73.95411749&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73532427%2C-73.99800419&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.75466591%2C-73.99138152&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.74173969%2C-73.99415556&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7505853470215%2C-73.99468
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.75640548%2C-73.9900262&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.72066442%2C-73.98517977&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7505853470215%2C-73.99468
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73935542%2C-73.99931783&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.751873%2C-73.977706&desti
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7462009%2C-73.98855723&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.6847514%2C-73.99917254&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73172428%2C-74.00674436&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73454567%2C-73.99074142&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.746745%2C-74.007756&desti
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.71774592%2C-73.95600096&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.749156%2C-73.9916&destina
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.771522%2C-73.990541&desti
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.76590936%2C-73.97634151&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7153379%2C-74.01658354&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73172428%2C-74.00674436&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73291553%2C-74.00711384&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.75513557%2C-73.98658032&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.766368%2C-73.971518&desti
```

```
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.69580705%2C-73.97355569&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.71427487%2C-73.98990025&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73827428%2C-73.98751968&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.749156%2C-73.9916&destina
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.70463334%2C-74.01361706&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.70905623%2C-74.01043382&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7462009%2C-73.98855723&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.768254%2C-73.988639&desti
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7428687731211%2C-73.98918
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7801839724239%2C-73.97728
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73454567%2C-73.99074142&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.736502%2C-73.97809472&des
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7734066%2C-73.97782542&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7652654%2C-73.98192338&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.74765947%2C-73.98490707&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7923272%2C-73.9383&destin
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.7903051%2C-73.94755757&de
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73652889%2C-74.00618026&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.68415748%2C-73.96922273&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.74096374%2C-73.98602213&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.713126%2C-73.984844&desti
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.70569254%2C-74.01677685&d
FALSE Source: https://maps.googleapis.com/maps/api/directions/json?origin=40.73223272%2C-73.98889957&d
FALSE geom path: Each group consists of only one observation. Do you need to
FALSE adjust the group aesthetic?
```

The most frequent trips around New York City



The above map provides some interesting information:

- There are some main zones where the trips are done: around Central Park, in Midtown as well as along the Hudson River
- Touristic zones can be identified: Central Park, Governor's island for instance
- However, for instance the bike lane along the Hudson River can be either commuting or visiting: this is the fastest way of going north/south
- Finally, it seems that an important part of the trips that are done in Midtown are mostly longitudinal: this might be a clue that people are using citibikes to compensate for the lack of subways in the East-West direction.

Finally, from latitude/longitude data from each trip, we can extract useful information to see if there are some patterns: maybe subscribers use citibikes

```
colnames(stations_info)[1] = 'start_station_id'
concise_trips <- merge(x = concise_trips, y = stations_info, by = 'start_station_id')
head(concise_trips)</pre>
```

```
start_station_id tripduration end_station_id
##
                                                       usertype birth year
## 1
                    72
                                 771
                                                 379 Subscriber
                                                                       1952
## 2
                    72
                                 264
                                                 478 Subscriber
                                                                       1965
## 3
                    72
                                 819
                                                 405 Subscriber
                                                                       1968
## 4
                    72
                                 646
                                                2006 Subscriber
                                                                       1990
## 5
                    72
                               1312
                                                 435 Subscriber
                                                                       1957
##
   6
                    72
                                 435
                                                 173 Subscriber
                                                                       1983
##
                  name latitude longitude
## 1 W 52 St & 11 Ave 40.76727 -73.99393
## 2 W 52 St & 11 Ave 40.76727 -73.99393
## 3 W 52 St & 11 Ave 40.76727 -73.99393
```

```
## 4 W 52 St & 11 Ave 40.76727 -73.99393
## 5 W 52 St & 11 Ave 40.76727 -73.99393
## 6 W 52 St & 11 Ave 40.76727 -73.99393
colnames(stations_info)[1] = 'end_station_id'
concise_trips <- merge(x = concise_trips, y = stations_info, by = 'end_station_id')</pre>
head(concise trips)
##
     end_station_id start_station_id tripduration
                                                      usertype birth year
## 1
                 72
                                  524
                                               575 Subscriber
## 2
                 72
                                  490
                                               971 Subscriber
                                                                      1975
## 3
                 72
                                 3178
                                               1553
                                                      Customer
                                                                      1969
## 4
                 72
                                  427
                                               1656 Subscriber
                                                                      1982
                 72
                                               789 Subscriber
## 5
                                  466
                                                                      1991
                                  279
## 6
                 72
                                               2276 Subscriber
                                                                      1993
##
                     name.x latitude.x longitude.x
                                                               name.y
## 1
            W 43 St & 6 Ave
                               40.75527
                                          -73.98317 W 52 St & 11 Ave
## 2
            8 Ave & W 33 St
                               40.75155
                                          -73.99393 W 52 St & 11 Ave
## 3 Riverside Dr & W 78 St
                               40.78414
                                          -73.98362 W 52 St & 11 Ave
                                          -74.01394 W 52 St & 11 Ave
## 4
        Bus Slip & State St
                               40.70191
                               40.74395
                                          -73.99145 W 52 St & 11 Ave
## 5
            W 25 St & 6 Ave
                               40.70787
                                          -74.00167 W 52 St & 11 Ave
## 6
       Peck Slip & Front St
##
     latitude.y longitude.y
## 1
       40.76727
                  -73.99393
       40.76727
                  -73.99393
## 2
## 3
       40.76727
                  -73.99393
## 4
       40.76727
                  -73.99393
## 5
       40.76727
                  -73.99393
## 6
       40.76727
                  -73.99393
concise_trips$dirNS <- abs(concise_trips$longitude.y - concise_trips$longitude.x)</pre>
concise_trips$dirWE <- abs(concise_trips$latitude.y - concise_trips$latitude.x)</pre>
head(concise_trips)
##
     end_station_id start_station_id tripduration
                                                      usertype birth year
## 1
                 72
                                  524
                                                575 Subscriber
                                                                      1979
## 2
                 72
                                                971 Subscriber
                                                                      1975
                                  490
## 3
                 72
                                 3178
                                                      Customer
                                                                      1969
                                               1553
## 4
                 72
                                  427
                                               1656 Subscriber
                                                                      1982
                 72
## 5
                                  466
                                               789 Subscriber
                                                                      1991
## 6
                 72
                                  279
                                               2276 Subscriber
                                                                      1993
##
                     name.x latitude.x longitude.x
                                                               name.v
## 1
            W 43 St & 6 Ave
                               40.75527
                                          -73.98317 W 52 St & 11 Ave
## 2
            8 Ave & W 33 St
                               40.75155
                                          -73.99393 W 52 St & 11 Ave
## 3 Riverside Dr & W 78 St
                               40.78414
                                          -73.98362 W 52 St & 11 Ave
        Bus Slip & State St
                               40.70191
                                          -74.01394 W 52 St & 11 Ave
## 5
            W 25 St & 6 Ave
                               40.74395
                                          -73.99145 W 52 St & 11 Ave
       Peck Slip & Front St
                               40.70787
                                          -74.00167 W 52 St & 11 Ave
## 6
##
     latitude.y longitude.y
                                  dirNS
                                              dirWE
                  -73.99393 0.01075952 0.01199909
## 1
       40.76727
       40.76727
## 2
                  -73.99393 0.00000512 0.01572116
## 3
       40.76727
                  -73.99393 0.01030396 0.01687256
## 4
                  -73.99393 0.02001312 0.06536516
       40.76727
## 5
       40.76727
                  -73.99393 0.00248017 0.02331805
```

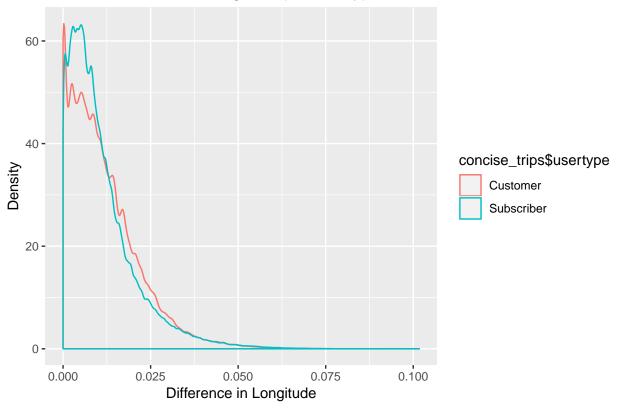
-73.99393 0.00774112 0.05939916

6

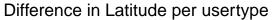
40.76727

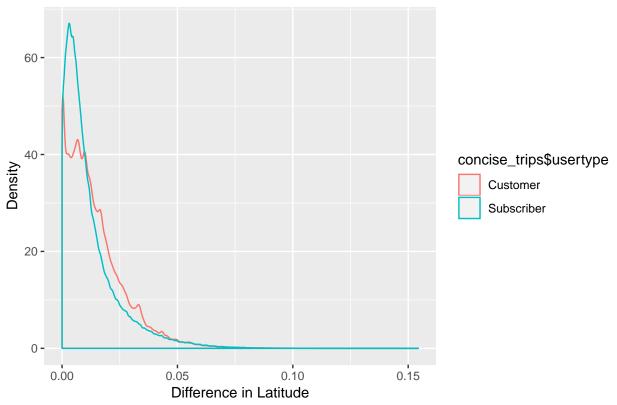
```
p <- ggplot(concise_trips,aes(x=concise_trips$dirNS,color=concise_trips$usertype)) +geom_density()
p+
    xlab("Difference in Longitude")+
    ylab("Density")+
    ggtitle("Difference in Longitude per usertype")+
    theme(plot.title = element_text(hjust = 0.5))</pre>
```

Difference in Longitude per usertype



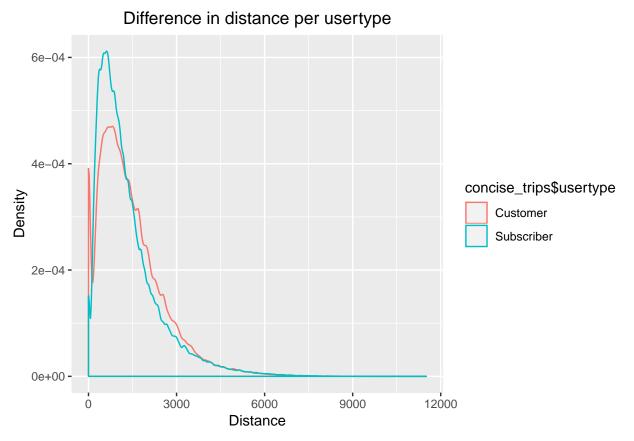
```
p <- ggplot(concise_trips,aes(x=concise_trips$dirWE,color=concise_trips$usertype)) +geom_density()
p+
    xlab("Difference in Latitude")+
    ylab("Density")+
    ggtitle("Difference in Latitude per usertype")+
    theme(plot.title = element_text(hjust = 0.5))</pre>
```





Here we have plotted the absolute difference in longitude between start and finish. Because of the layout fo New York, we can approximate longitude difference as a North/South difference and latitude difference as a East/West difference. We can see that for both latitude and longitude, subscribers have a much higher peak close to low values. This is more visible for latitude. It reveals that subscribers and customers have a different use of the citibikes: subscribers usually do shorter rides (in terms of distance) specially if it is for a North/South difference. This seems to follow the logic of commuting: commuters will not do lengthy North/South rides since it is slower than taking the subway. However, for short rides, it can be quicker to take a bike.

```
library(geosphere)
```



If we plot the distribution of distance for both customers and subscribers, it confirms what we previously saw with latitude and longitude: subscribers tend to do shorter rides.

Therefore, this discrepancy between subscribers and customers shows that there are two different ways of using citibikes: small short rides or more length rides, and it confirms that citibikes are not only used by tourists, but also by new yorkers as a way of commuting.