Data Story

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Analysis on Public Crime That violate Pedestrians in New York City

Introduction

Public Order Crime is an act that deviate the society's general ideas of normal social behavior and moral values. Different types of public crime can happen anywhere in the city, some borough have more crimes, other have less. By idenitifying the hotspots from the past criminal activities, it will bring caution to tourists and locals to be aware of a certain areas during certain times.

This project aim to explore and solve:

*Have the public crime activity in New York City increased or decreased at the end of 2017?

*Which borough in New York City have the most public crime activity that violate pedestrians?

*Is there any correlation between public crime activity and weather temperature?

*Which time period of the day (00:00 - 08:00, 08:01 - 16:00, or 16:01 - 24:00) has the most crime activity?

*Where are the hotspots for public crimes that violate pedestrians?

Data Acquisition

Datasets from Crime reports in NYC are availabe at NYC Opendata. I will be using the datasets of Incident Level Complaint Data - 2006 through 2017 The dataset contains: the incident level complaint from the beginning of January 2010 to the end of December 2017. The variables that I will be working on will be the boroughs, date of the complaints, time of the complaints, level of offenses, description of the offenses, description of the premises, suspect's age group, suspect's race, suspect's sex, victim's age group, victim's race, and victim's sex.

Dataset of daily average temperature from 2010 to 2017 in New York City is obtained from Weather Underground.

Important Fields and Information

According to the NY Police Department post on the The New York Job Source, the NYPD shifts are divided by three 8-hours and 35 minute shifts: 11:15 PM to 7:50 AM, 7:05 AM to 3:40 PM, and 3:00 PM tp 11:35 PM. But to simplify they call the shifts: (12 to 8), (8 to 4), and (4 to 12). I will be creating 3 time period of the day correspond to the police shifts to test out whih time period of the day has the most crime.

Data Limitations

Since there isn't a specific whole area weather temperature for the entire New York City that includes all five boroughs on the historical data on the Weather Underground website. I took the average temperature of the most centered borough (Manhattan).

There are limited data on the suspect's age, race, and sex because there might be a case where the suspect was never caught. As well as there are limited data on the victim's age, race and sex because of the protection of personal information.

None of the murder crimes have any premises description in the dataset of NYC Opendata, therefore none of them was included in this project. Since this crime is one of the most serious crime and the worst crime that can happen to a pedestrian, without the data of this crime can impact the attention that the locals and tourists would have give.

Data Cleaning and wrangling

The following packages was used for data cleaning and wrangling: `tidyr`, `dplyr`, `lubridate`, `chron`, and `zoo`.

*Deleting useless columns by using e.g. df[, -c(1,2,3,4)].

*Rearranging the columns by using e.g. df[, c(2,1,3,4)].

*Renaming the columns to become more readible by using colnames.

*Used the `select()` and `filter()` function from the `dplyr` package to filter out all premises except public premises: "PARK/PLAYGROUND", "PARKING LOT/GARAGE(PUBLIC)", "BUS (NYC TRANSIT)", "OPEN AREAS (OPEN LOTS)", "BUS STOP", "STREET", "TRANSIT - NYC SUBWAY", "PUBLIC BUILDING".

*Used the `select()` and `filter()` function from the `dplyr` package to filter out all offensive except the ones that affects pedestrians: "ARSON", "ASSAULT & RELATED OFFENSES", "DANGEROUS WEAPONS", "FELONY ASSAULT", "HARRASSMENT", "KIDNAPPING", "MURDER & NON-NEGL. MANSLAUGHTER", "RAPE", "ROBBERY", "SEX CRIMES".

*Used the `year` function from the `lubridate` package to add a new column for the year.

*Used the `yearmon` function from the `zoo` package to add a new column for the year with month.

*Used the `chron` function from the `chron` package to convert the rows in the Complaint time column into the formate of "h:m:s"

Preliminary exploration

Load the library

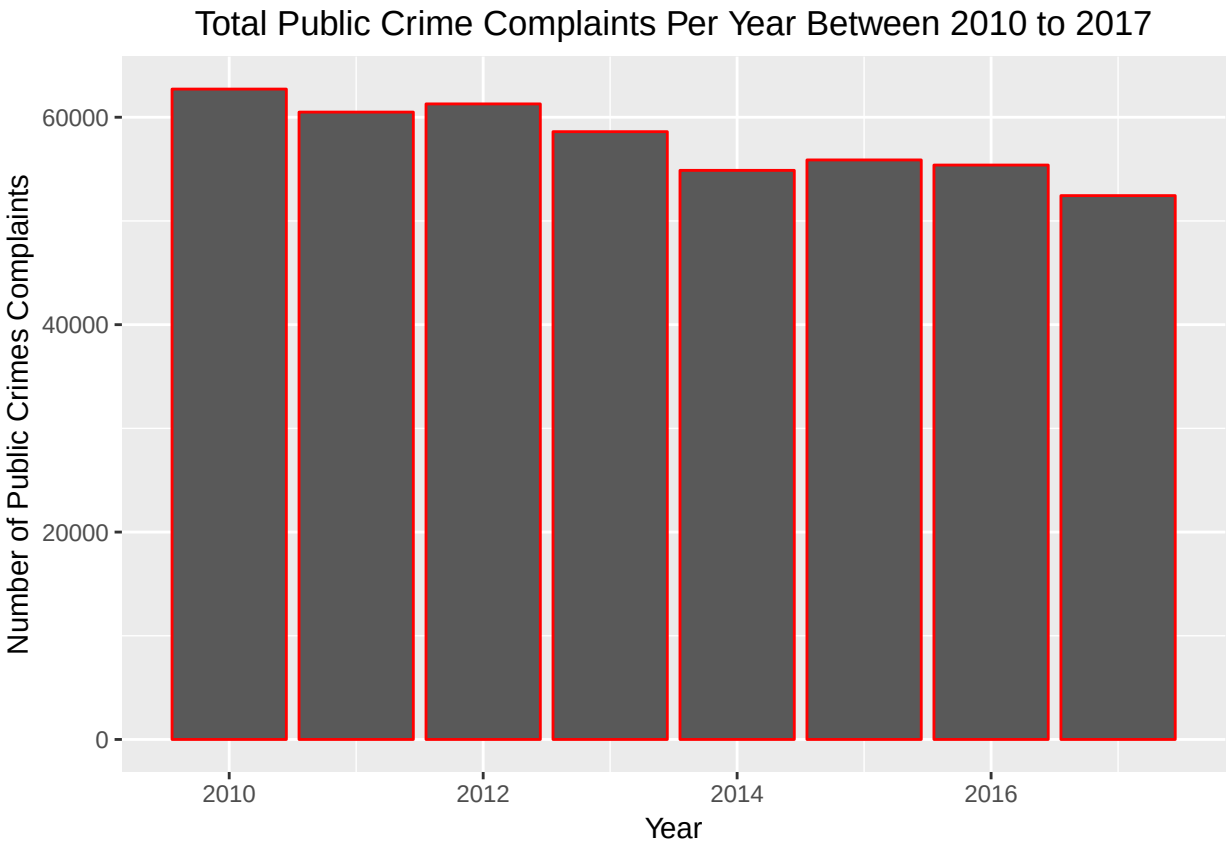
```
library(dplyr)
library(tidyr)
library(scales)
library(ggplot2)
library(plyr)
library(lubridate)
library(zoo)
library(gtools)
library(chron)
```

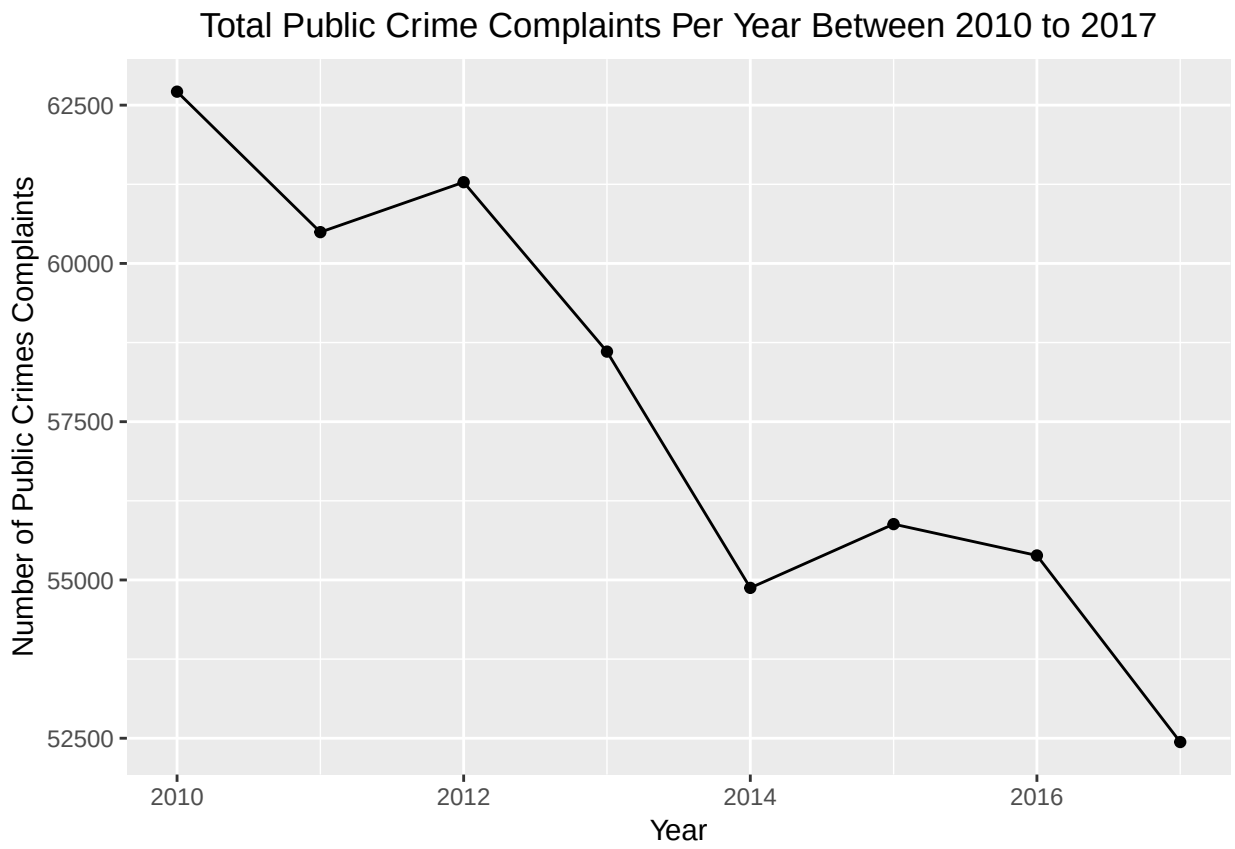
Load the dataframe

The dataframe only included the reported complaints of crimes that violates other people in the public. The public premises includes: "bus stop", "open areas (open lots)", "park/playground", "public buildings", "street", "transit (bus)", and "transit (subway)". The public crimes includes: "arson", "assault and related offenses", "danagerous weapons", "felony assault", "harrassment", "kidnapping", "rape", "robbery", and "sex crimes". The complaint reported for public crimes are 11.8% of all reported crimes between 2010 to 2017.

Analysis of Crime Complaints that Violates Other People In The Public

Looking at the total public crime complaints annually between 2010 to 2017






```
#Number of public crime complaints in 2010
length(which(AllComplaint$Year == 2010))
```

```
## [1] 62713
```

```
#Number of public crime complaints in 2017
length(which(AllComplaint$Year == 2017))
```

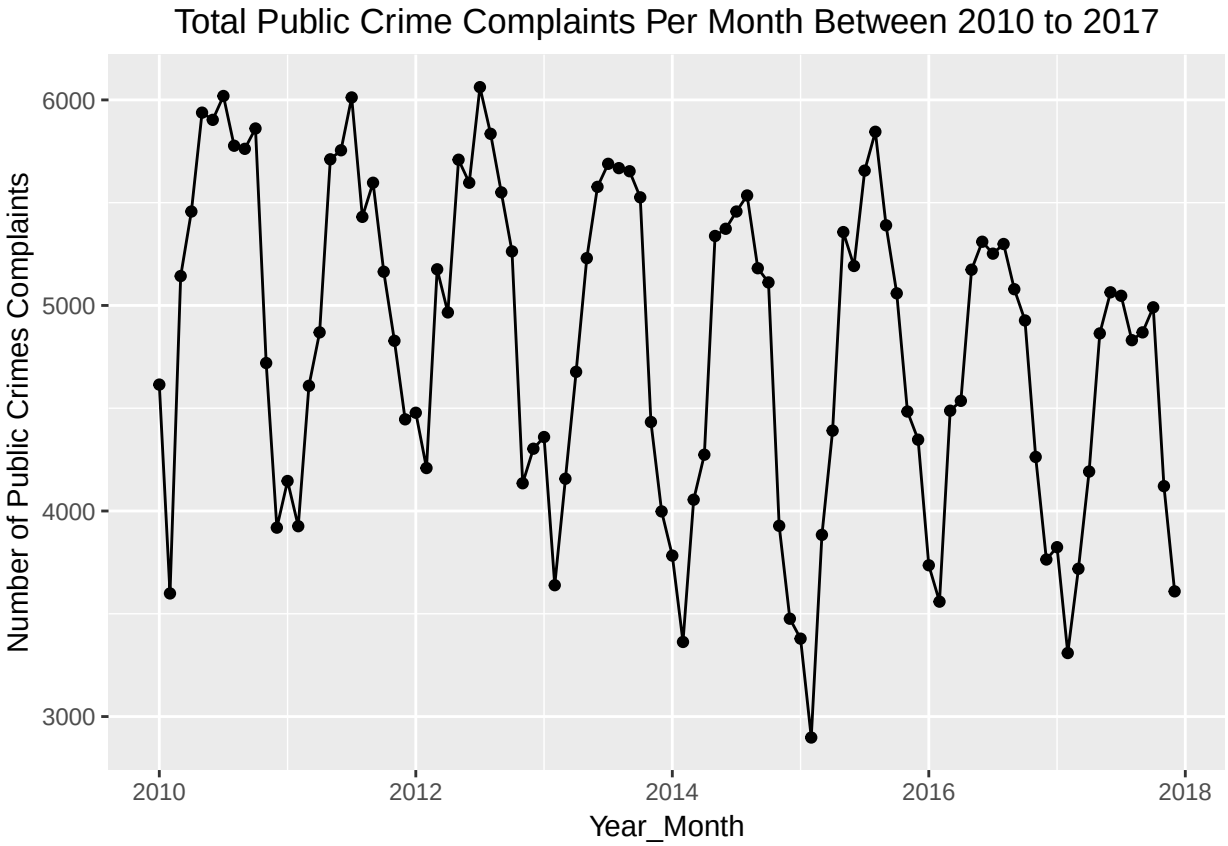
```
## [1] 52440
```

```
#The percentage change in public crime complaints from 2010 to 2017
A <- length(which(AllComplaint$Year == 2010))
B <- length(which(AllComplaint$Year == 2017))
(A-B)/A
```

```
## [1] 0.1638097
```

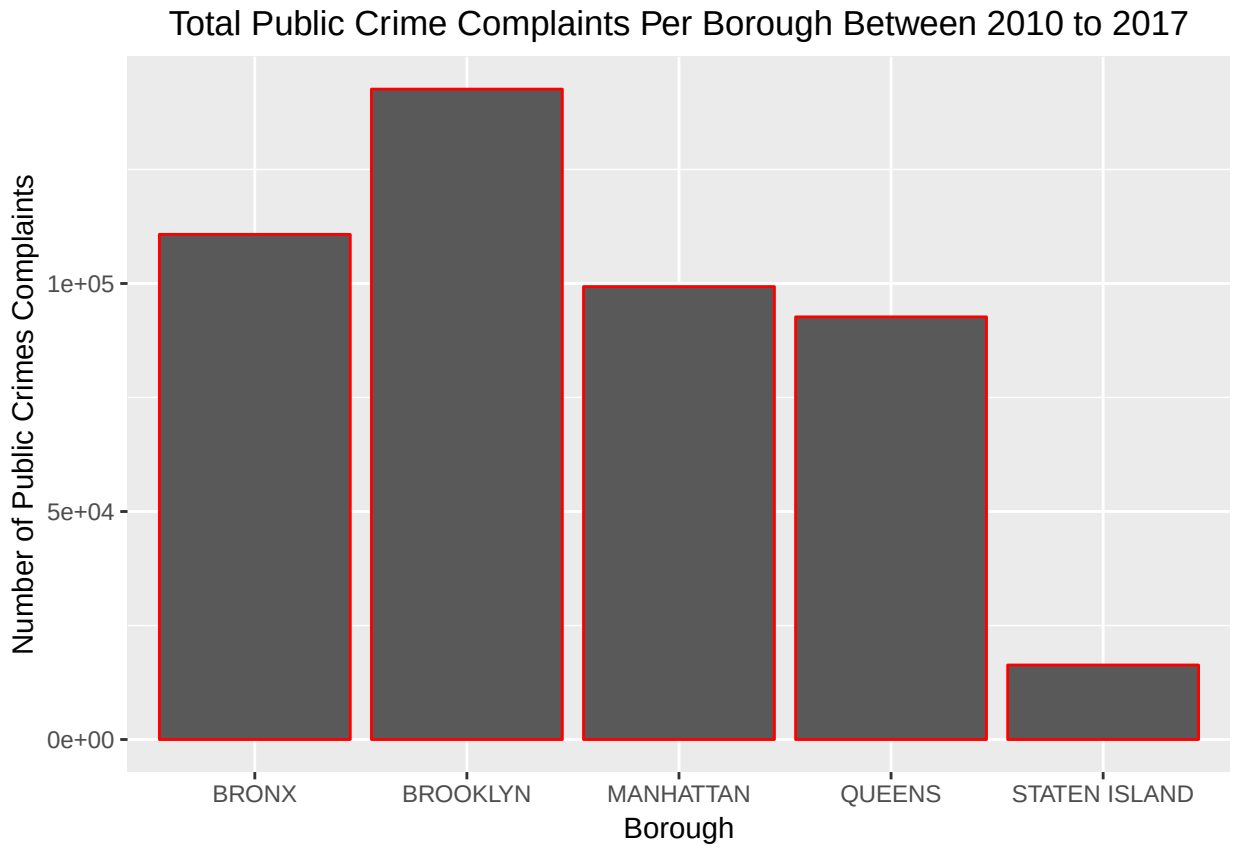
There is a decrease in crime complaints by looking at the first bar graph. But the line graph shows the changes more clearly that there is a decrease in public crimes between 2010 to 2017. By using the length, which function, the number of public crime complaints in 2010 and 2017 were found to be 62713 and 52440 respectively. The percentage change between 2010 and 2017 in public crime complaints is calculated to be 16.38%.

Looking at the total public crime complaints monthly between 2010 to 2017



There is a trend of decrease in public crime complaints every year between the month of November, December, and January. The crime complaints start to increase after January and reaches the peak around the month of June and July of each year and drop again after.

Looking at the total public crime complaints per borough between the year 2010 to 2017



According to the bar graph above. It clearly shown that Staten Island have significantly less public crime complaints than the other four boroughs. This isbecause of the size of population in the boroughs. According to the website (city population), Staten Island only hold 5.6% of the New York City population. But Brookyln (population size of 2648771) shows to have significantly more public crime complaints than other boroughs even when Queens (population size of 2358582) have similar population size. Population size are determined by City Population

USA: New York City Boroughs

Boroughs

The population of the boroughs of New York City according to census results and latest official estimates.

Name	Status	Population Census 1990-04-01	Population Census 2000-04-01	Population Census 2010-04-01	Population Estimate 2017-07-01
Bronx	Borough	1,203,789	1,332,244	1,384,794	1,471,160
Brooklyn (Kings County)	Borough	2,300,664	2,465,689	2,504,706	2,648,771
Manhattan (New York County)	Borough	1,487,536	1,538,096	1,586,184	1,664,727
Queens	Borough	1,951,598	2,229,394	2,230,545	2,358,582
Staten Island (Richmond County)	Borough	378,977	443,762	468,730	479,458
New York City	**City**	**7,322,564**	**8,009,185**	**8,174,959**	**8,622,698**

Source: US Census Bureau (web).

```
(length(which(AllComplaint$Borough == "BRONX")) /1471160)*100
```

```
## [1] 7.528753
```

```
(length(which(AllComplaint$Borough == "BROOKLYN")) /2648771)*100
```

```
## [1] 5.384044
```

```
(length(which(AllComplaint$Borough == "MANHATTAN")) /1664727)*100
```

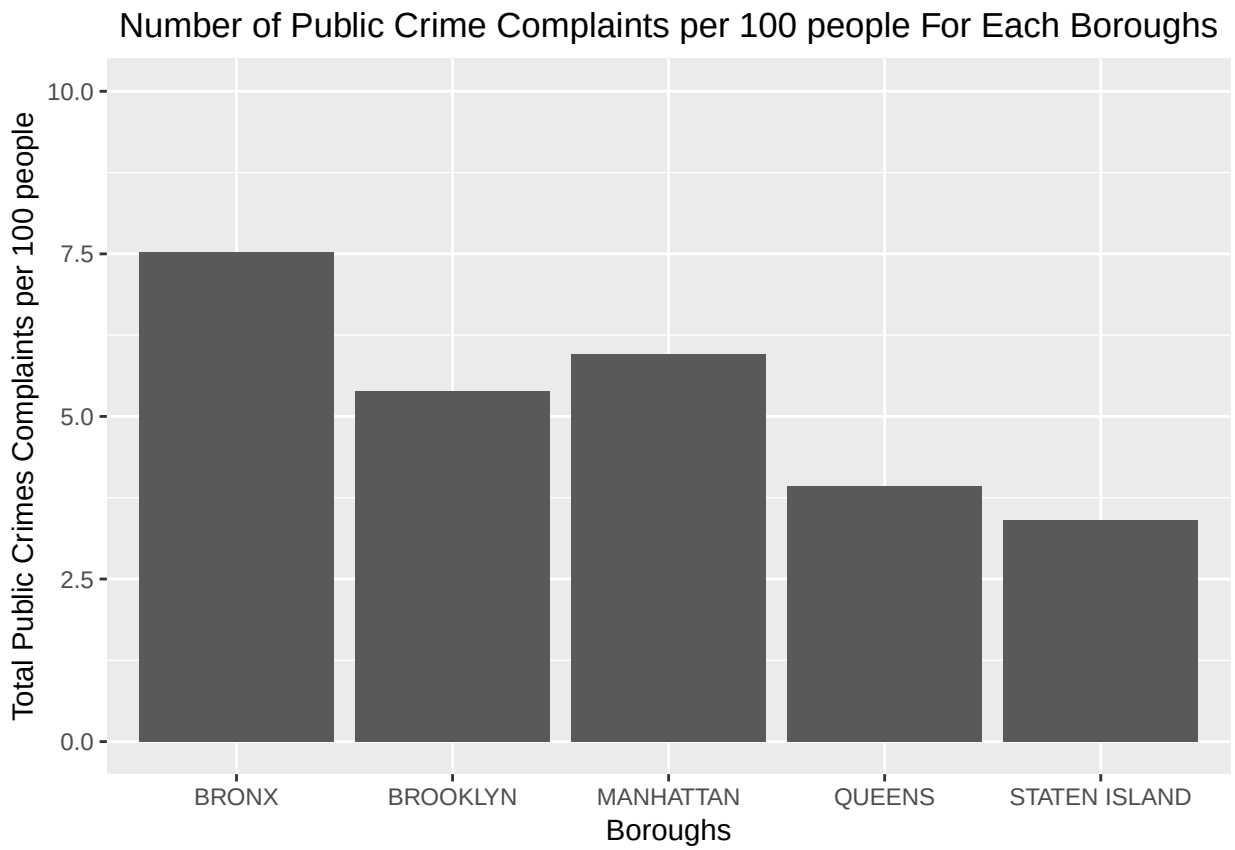
```
## [1] 5.965723
```

```
(length(which(AllComplaint$Borough == "QUEENS")) /2358582)*100
```

```
## [1] 3.928971
```

```
(length(which(AllComplaint$Borough == "STATEN ISLAND")) /479458)*100
```

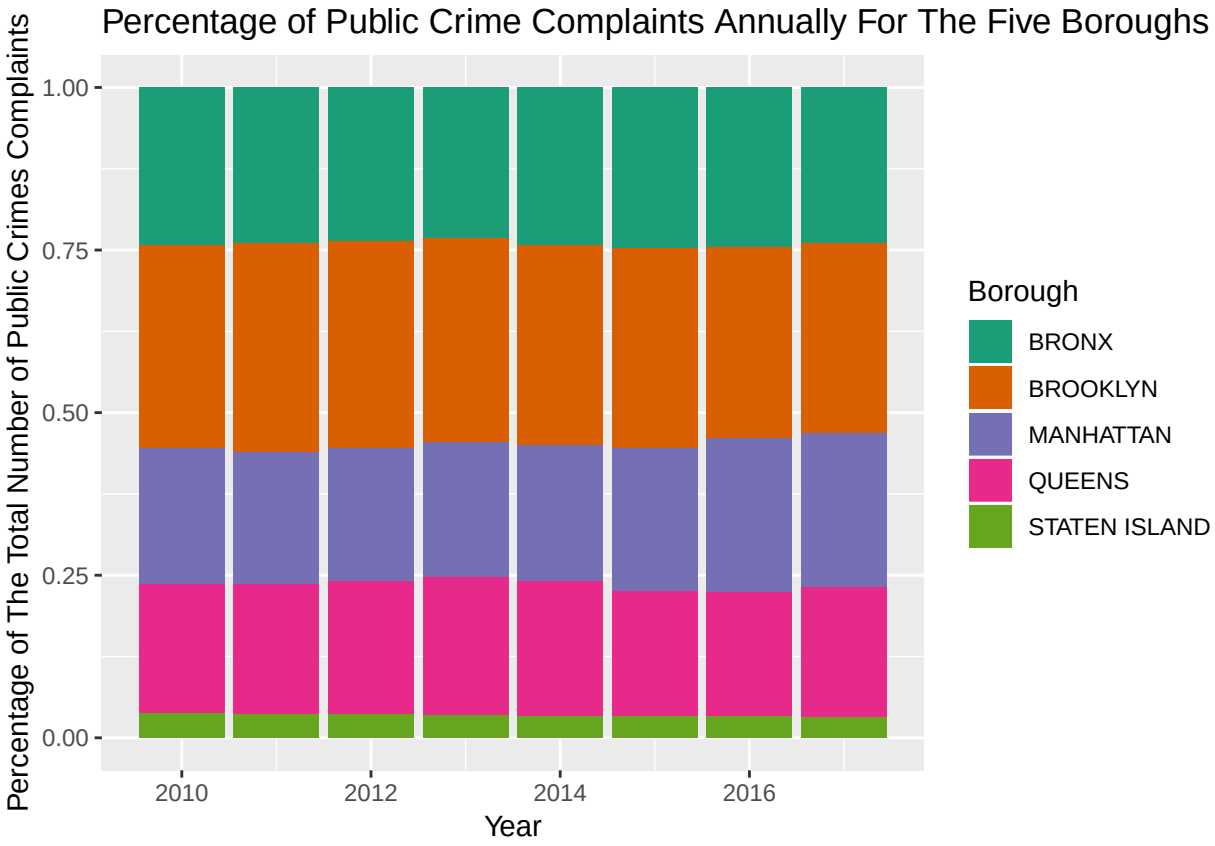
```
## [1] 3.405721
```

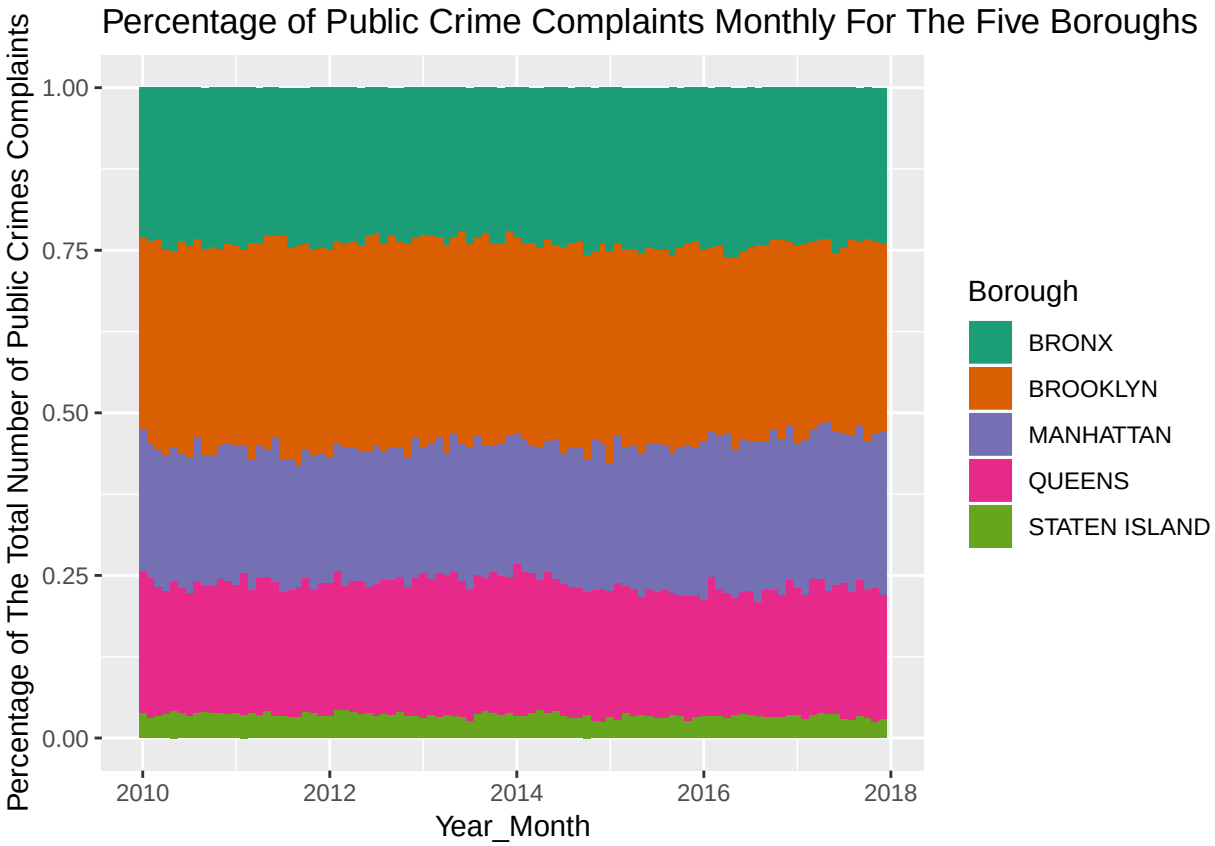


The complaint per capita is found by dividing the total public crime complaints with the population size for each boroughs. From the year of 2010 to 2017, there is a public crime complaint rate of 7.5 per 100 people

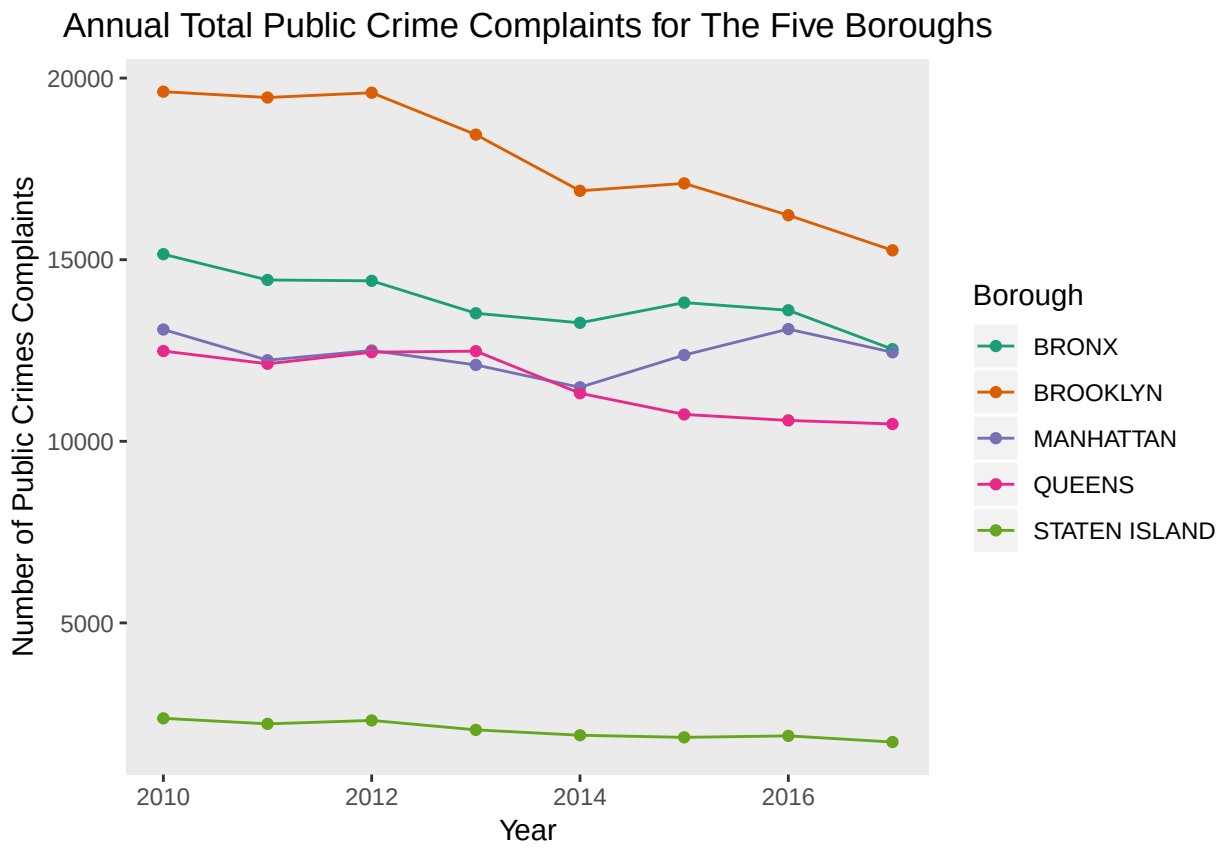
in Bronx, 5.4 per 100 people in Brookyln, 6 per 100 people in Manhattan, 3.9 per 100 people in Queens, and 3.4 per 100 people in Staten Island.

The number of public crimes complaints per 100 people for each boroughs bar graph show that Bronx have the most public crime complaints while Brooklyn have almost twice the amount of population. Staten Island have the least amount of population size and least amount of public crime complaints.





Both of the percentage of public crime complaints for each boroughs bar graph above shown that the percentage of public crime complaints did not have any significant changes monthly or yearly. Bronx's public crime complaints averaged around a little less than 25% of the total number of complaints. Brooklyn's public crime complaints averaged around 30% of the total number of complaints. Manhattan and Queens averaged around 20% of the total number of complaints. Staten Island averaged a little less than 5% of the total number of compaint.



The annual total public crime complaints line graph above shown that Brookyln's public crime complaints have a more noticeable sight of decrease over the years than the other boroughs.

```
#Number of public crime complaints in 2010 and 2017 For Bronx
length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "BRONX"))
```

```
## [1] 15151
```

```
length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "BRONX"))
```

```
## [1] 12536
```

```
#The percentage change in public crime complaints between 2010 and 2017 in Bronx
BX10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "BRONX"))
BX17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "BRONX"))
(BX10 - BX17)/BX10
```

```
## [1] 0.1725959
```

```
#Number of public crime complaints in 2010 and 2017 For Brooklyn
length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "BROOKLYN"))
```

```
## [1] 19626
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "BROOKLYN"))
```

```
## [1] 15258
```

```r
#The percentage change in public crime complaints between 2010 and 2017 in Brooklyn
BN10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "BROOKLYN"))
BN17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "BROOKLYN"))
(BN10 - BN17)/BN10
```

```
## [1] 0.2225619
```

```r
#Number of public crime complaints in 2010 and 2017 For Manhattan
length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "MANHATTAN"))
```

```
## [1] 13078
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "MANHATTAN"))
```

```
## [1] 12450
```

```r
#The percentage change in public crime complaints between 2010 and 2017 in Manhattan
MN10 <- length(which(AllComplaint$Year== 2010 | AllComplaint$Borough == "MANHATTAN"))
MN17 <- length(which(AllComplaint$Year== 2017 | AllComplaint$Borough == "MANHATTAN"))
(MN10 - MN17)/MN10
```

```
## [1] 0.06475414
```

```r
#Number of public crime complaints in 2010 and 2017 For Queens
length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "QUEENS"))
```

```
## [1] 12485
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "QUEENS"))
```

```
## [1] 10476
```

```r
#The percentage change in public crime complaints betwen 2010 and 2017 in Queens
QS10 <- length(which(AllComplaint$Year== 2010 | AllComplaint$Borough == "QUEENS"))
QS17 <- length(which(AllComplaint$Year== 2017 | AllComplaint$Borough == "QUEENS"))
(QS10 - QS17)/QS10
```

```
## [1] 0.05783227
```

```r
#Number of public crime complaints in 2010 and 2017 For Staten Island
length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "STATEN ISLAND"))
```

```
## [1] 2373
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "STATEN ISLAND"))
```

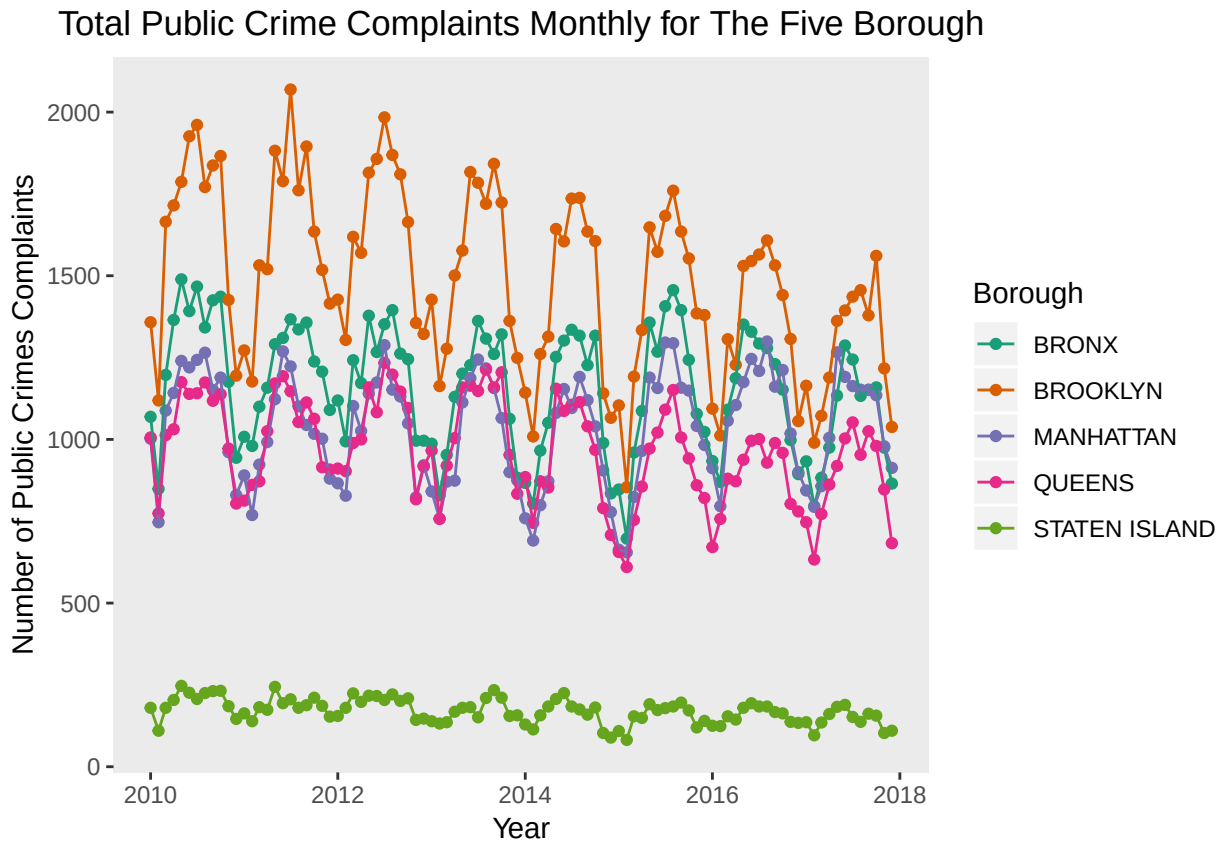
```
## [1] 1720
```

```r
#The percentage change in public crime complaints between 2010 and 2017 in Staten Island
SD10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Borough == "STATEN ISLAND"))
SD17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Borough == "STATEN ISLAND"))
(SD10 - SD17)/SD10
```

```
## [1] 0.2751791
```

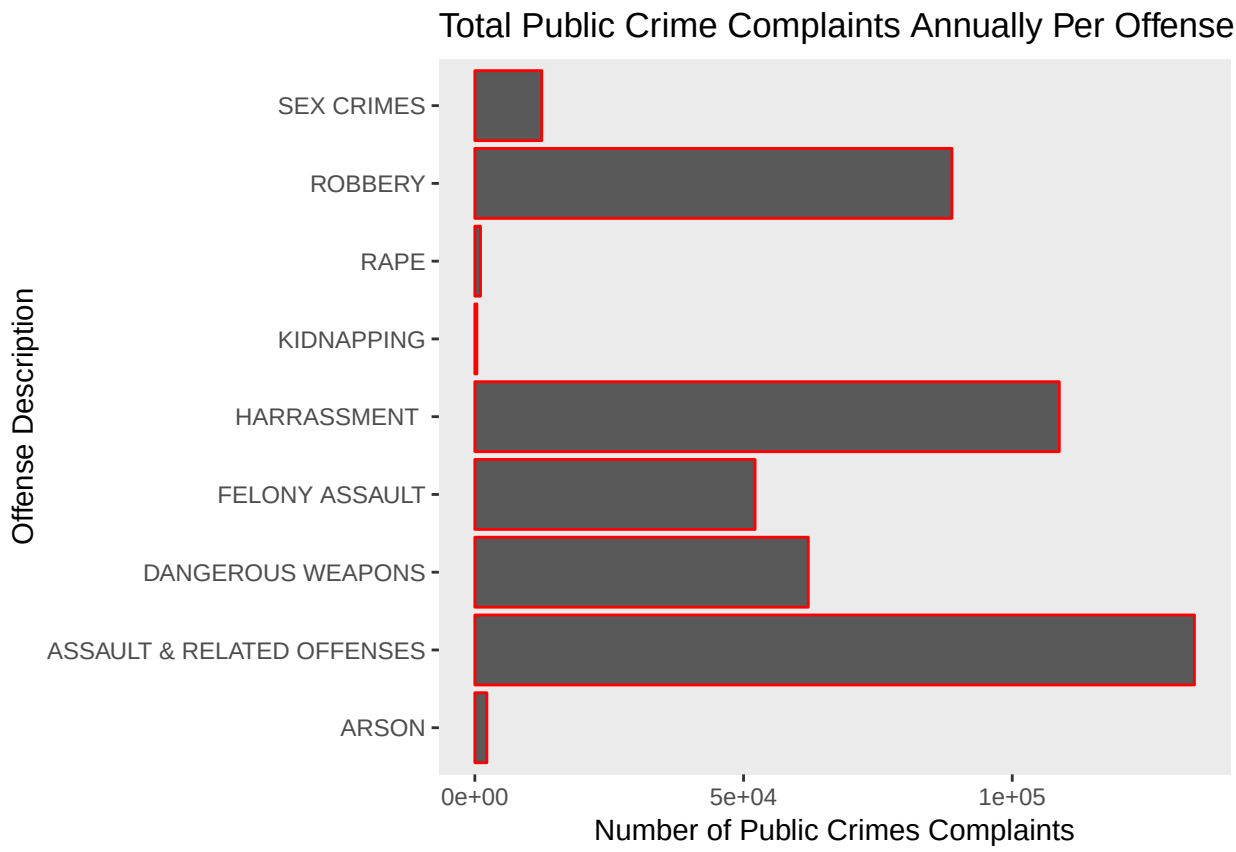
To determine if the number of public crime complaints have increased or decreased for each boroughs between 2010 and 2017, the percentage changes in public crime complaints between 2010 and 2017 is calculated.

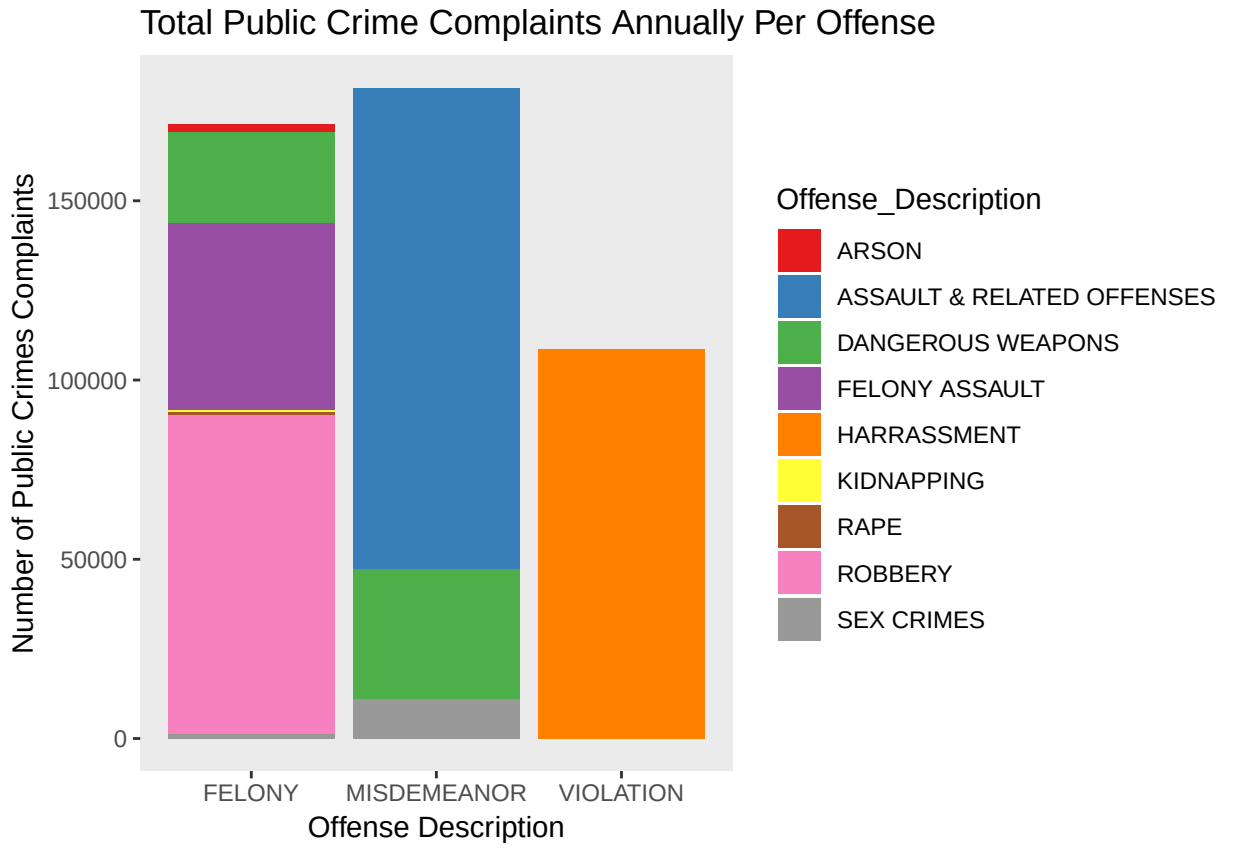
The public crime complaints have decreased for all five boroughs at the end of 2017. Bronx decreased 17.3%, Brooklyn decreased 22.2%, Manhattan decreased 6.5%, Queens decreased 5.8%, and Staten Island decreased 27.5%.



The monthly complaints for the five boroughs line graph above once again shows that there is significantly less public crime complaints during the month of November, December, and January for each boroughs. And there is significantly more public crime complaints during the month of June, July, and August for each boroughs.

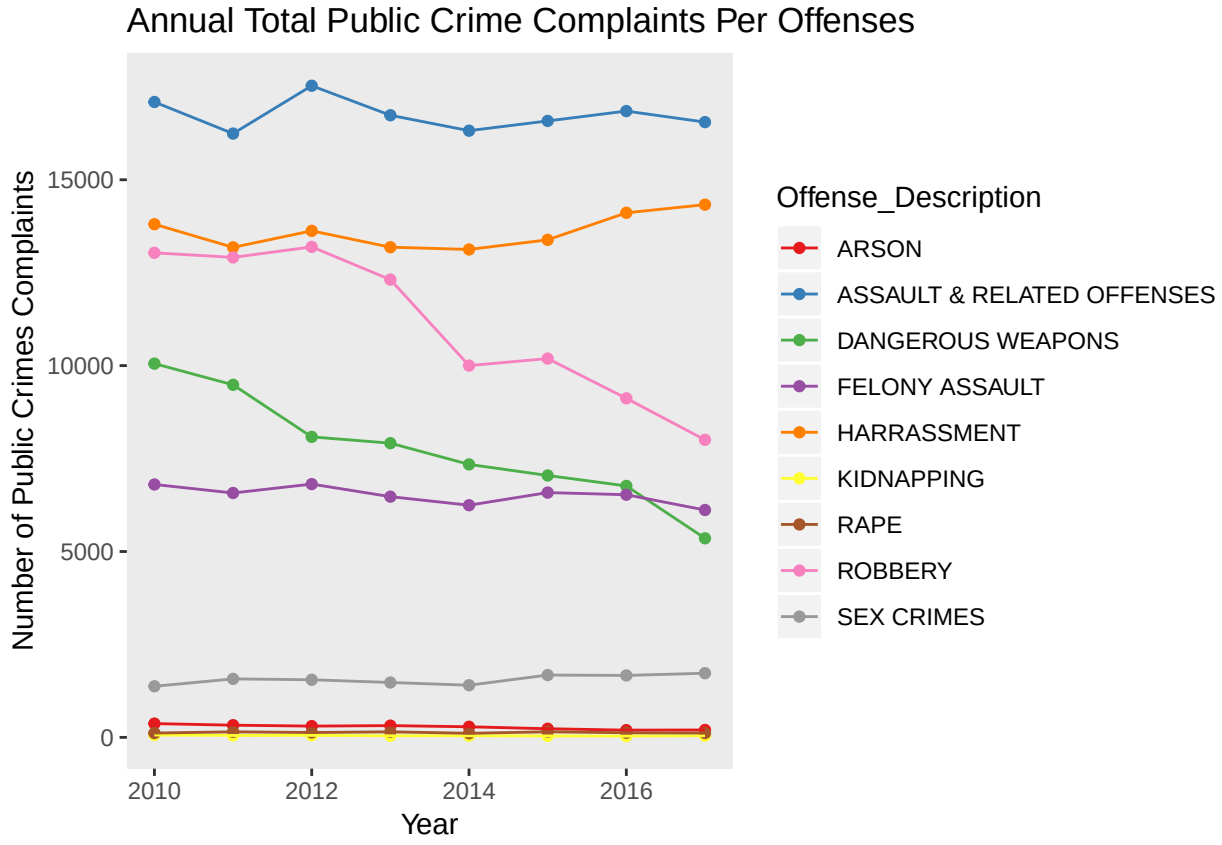
Looking at the leve of offenses





In the world of Criminal Justice, violations are considered to be the minor of offenses. Violations can be punishable by a fine and will not result in any jail or prison time. Misdemeanor offenses are a more serious than violation offenses. Misdemeanor can result up to one year in jail. Felonies are the most serious offense out of the three. Felonies are seperated by letter (Class A - Class E). Class A felonies are the most serious and class E is the least. The punishment are sorted by class (A: up to life time in prison, B:25 years+, C: 10 - 25 years, D: 5 - 10 years, and E: 1 - 5 years). Legal Dictionary

Crimes such as arson, kidnapping, and rape are considered class A felonies, hence those crimes are the minority among the total public crime complaints. Robbery and felony assault are considered class B felonies, which is the majority of the number of public crime complaints. Sex crime and in the possession of danerous weapons are mixture of felony and misdemeanor. Assault and related offenses are the majority of misdemeanor offenses. And harrassment is only considered as violation.



The annual total public crime complaints per offenses line graph above shown that harrassment and sex crimes had clearly increased. The possession of dangerous weapons and robbery had clearly decreased. But other offenses are hard to tell.

```
#Number of public crime complaints in 2010 and 2017 for arson
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "ARSON"))
```

```
## [1] 371
```

```
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "ARSON"))
```

```
## [1] 199
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for arson
AN10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "ARSON"))
AN17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "ARSON"))
(AN10 - AN17)/AN10
```

```
## [1] 0.4636119
```

```r
#Number of public crime complaints in 2010 and 2017 for assault & related offenses
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "ASSAULT & RELATED OFFENSES"
```

```
## [1] 17092
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "ASSAULT & RELATED OFFENSES"
```

```
## [1] 16550
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for assault & related offenses
AT10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "ASSAULT & RELATED O
AT17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "ASSAULT & RELATED O
(AT10 - AT17)/AT10
```

```
## [1] 0.03171074
```

```r
#Number of public crime complaints in 2010 and 2017 for possession of dangerous weapons
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "DANGEROUS WEAPONS"))
```

```
## [1] 10054
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "DANGEROUS WEAPONS"))
```

```
## [1] 5355
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for possession of dangerous weap
DW10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "DANGEROUS WEAPONS"))
DW17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "DANGEROUS WEAPONS"))
(DW10 - DW17)/DW10
```

```
## [1] 0.4673762
```

```r
#Number of public crime complaints in 2010 and 2017 for felony assault
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "FELONY ASSAULT"))
```

```
## [1] 6803
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "FELONY ASSAULT"))
```

```
## [1] 6116
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for felony assault
FA10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "FELONY ASSAULT"))
FA17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "FELONY ASSAULT"))
(FA10 - FA17)/FA10
```

```
## [1] 0.1009849
```

```r
#Number of public crime complaints in 2010 and 2017 for harrassment
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "HARRASSMENT "))
```

```
## [1] 13804
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "HARRASSMENT "))
```

```
## [1] 14330
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for harrassment
HT10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "HARRASSMENT "))
HT17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "HARRASSMENT "))
(HT10 - HT17)/HT10
```

```
## [1] -0.0381049
```

```r
#Number of public crime complaints in 2010 and 2017 for kidnapping
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "KIDNAPPING"))
```

```
## [1] 64
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "KIDNAPPING"))
```

```
## [1] 44
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for kidnapping
KG10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "KIDNAPPING"))
KG17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "KIDNAPPING"))
(KG10 - KG17)/KG10
```

```
## [1] 0.3125
```

```r
#Number of public crime complaints in 2010 and 2017 for rape
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "RAPE"))
```

```
## [1] 116
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "RAPE"))
```

```
## [1] 116
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for rape
RE10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "RAPE"))
RE17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "RAPE"))
(RE10 - RE17)/RE10
```

```
## [1] 0
```

```r
#Number of public crime complaints in 2010 and 2017 for robbery
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "ROBBERY"))
```

```
## [1] 13035
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "ROBBERY"))
```

```
## [1] 8004
```

```r
#The percentage change in public crime complaints between 2010 and 2017 for robbery
RY10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "ROBBERY"))
RY17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "ROBBERY"))
(RY10 - RY17)/RY10
```

```
## [1] 0.3859609
```

```r
#Number of public crime complaints in 2010 and 2017 for sex crimes
length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "SEX CRIMES"))
```

```
## [1] 1374
```

```r
length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "SEX CRIMES"))
```

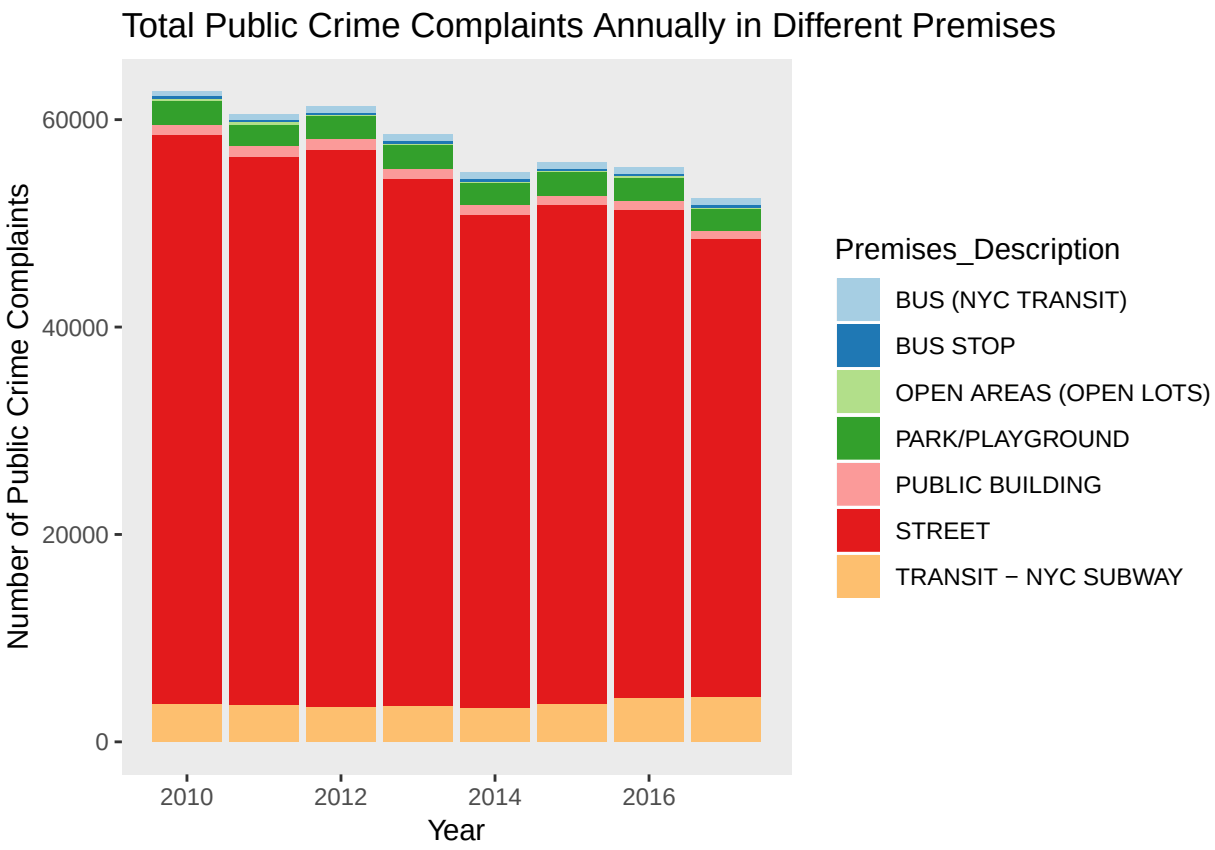
```
## [1] 1726
```

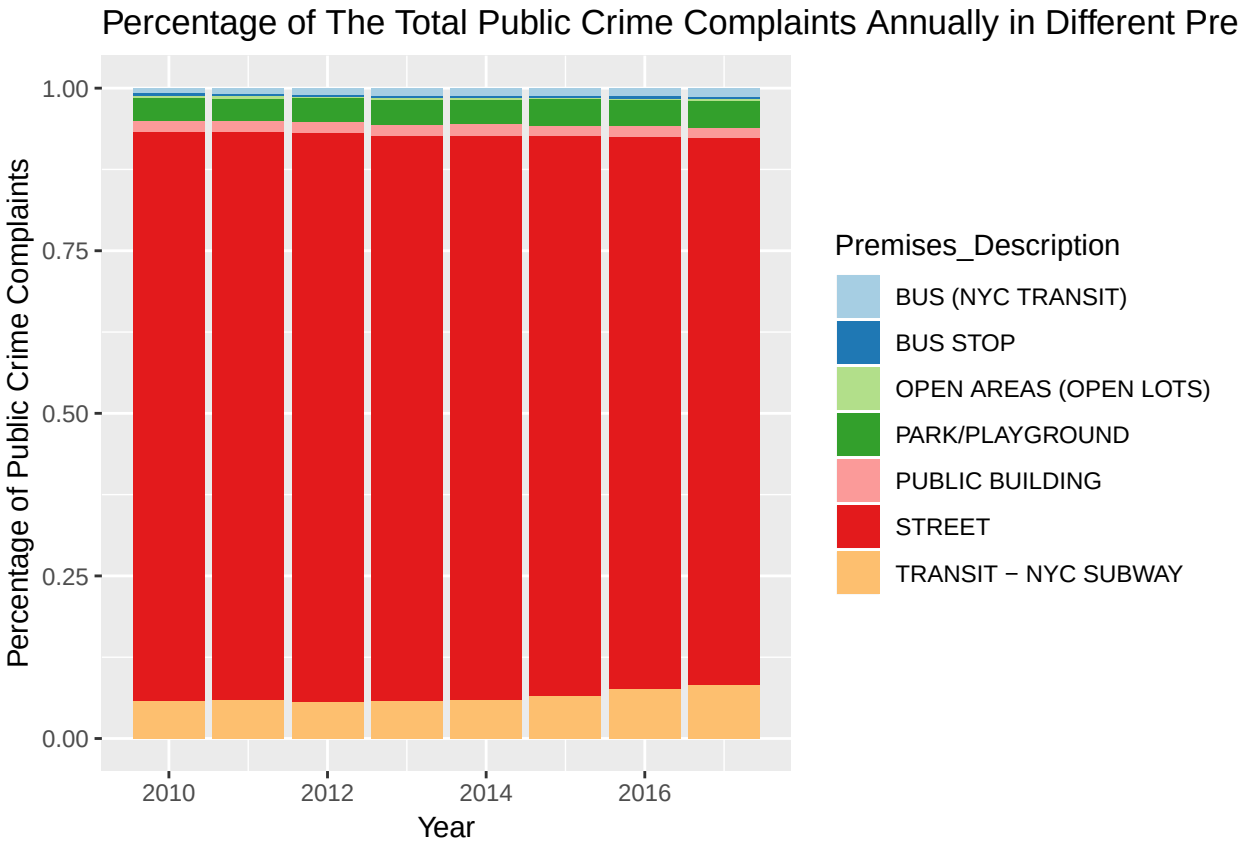
```r
#The percentage change in public crime complaints between 2010 and 2017 for sex crimes
SC10 <- length(which(AllComplaint$Year== 2010 & AllComplaint$Offense_Description == "SEX CRIMES"))
SC17 <- length(which(AllComplaint$Year== 2017 & AllComplaint$Offense_Description == "SEX CRIMES"))
(SC10 - SC17)/SC10
```

```
## [1] -0.2561863
```

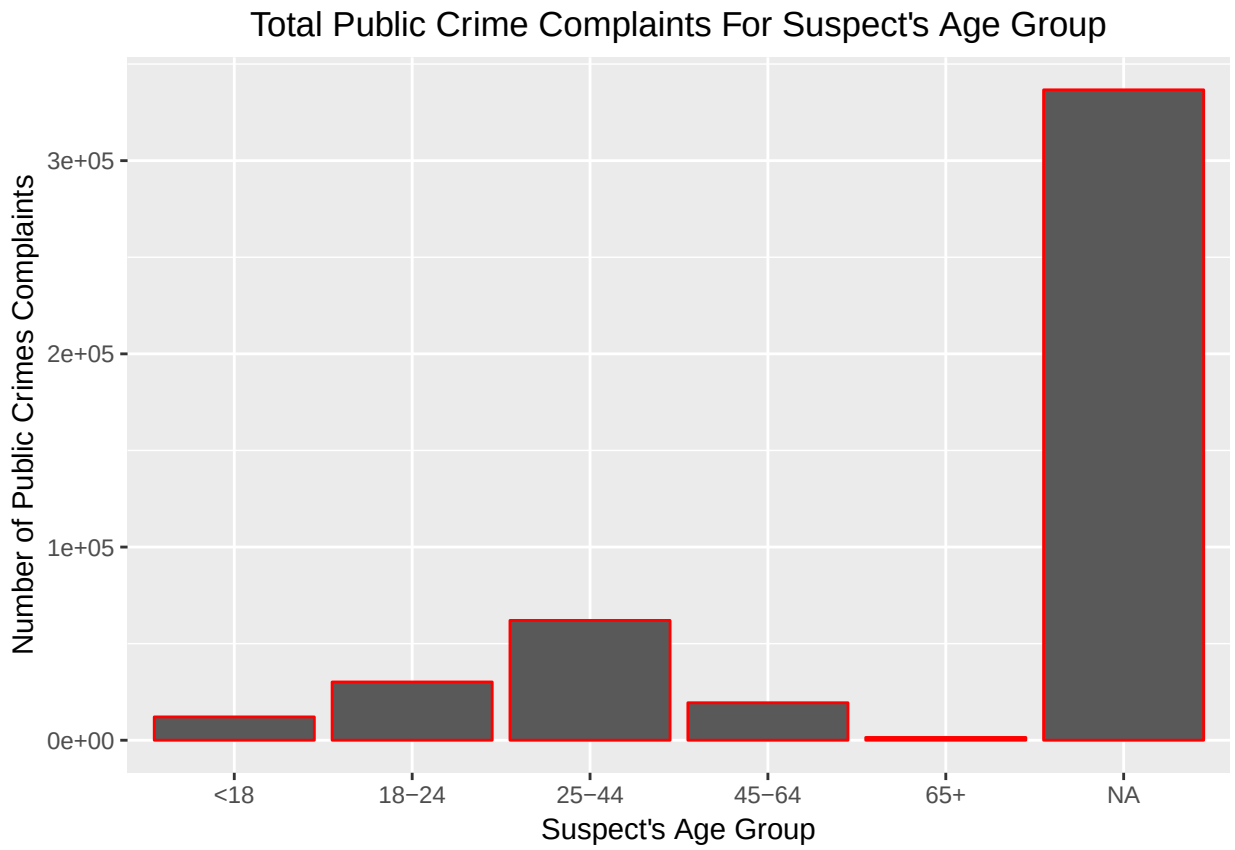
The percentage changes between 2010 and 2017 are once again calculated by using the formula above. Which helps to identify whether the offenses have decreased or increased in percentage. The percentage change in public crime complaints in 2017 from 2010: arson have decreased by 46.4%, assault & related offenses have decreased by 3.2%, possession of dangerous weapons have decreased by 46.7%, felony assault have decreased by 10.1%, harrassment have increased by 3.8%, kiddnapping have decreased by 31.3%, rape is unchanged, robbery have decreased by 38.6%, and sex crimes have increased by 25.6%.

Looking at the premises description

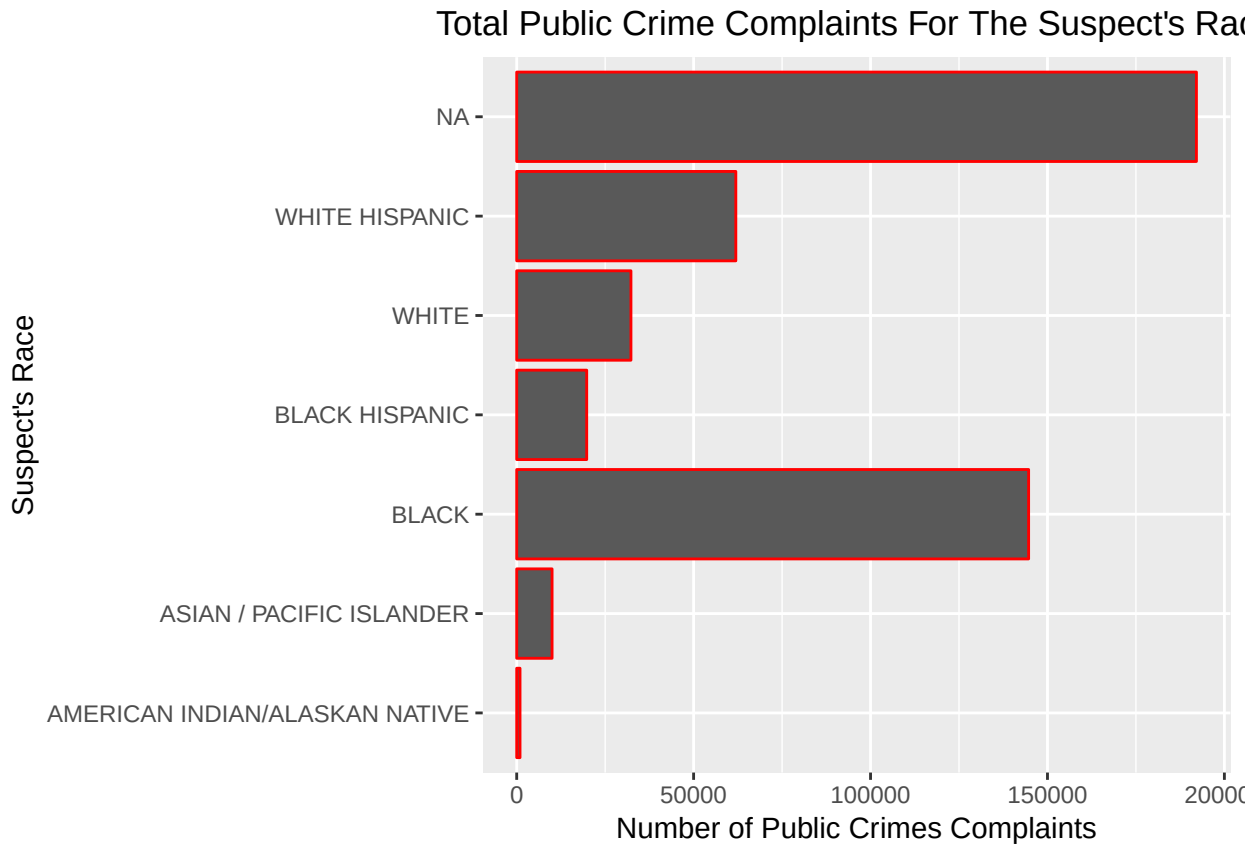


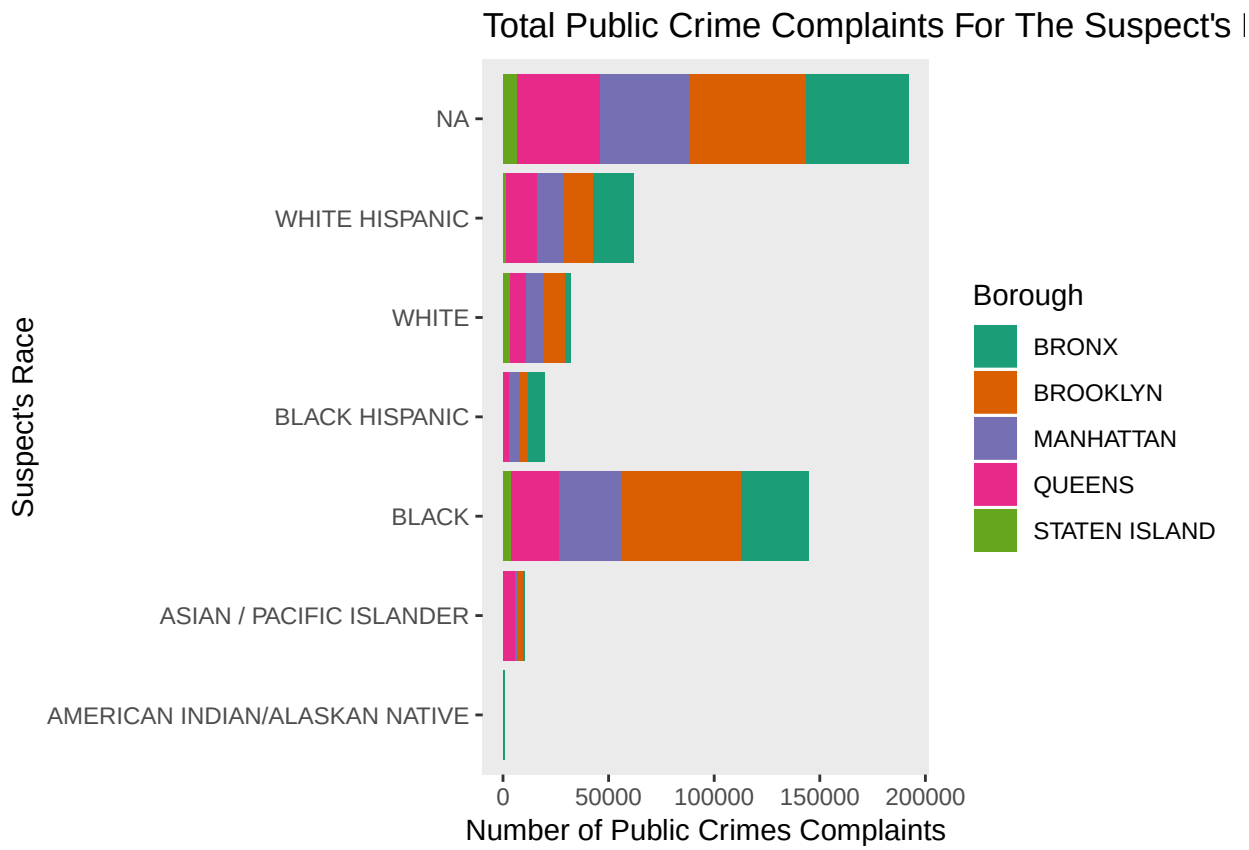


Majority of the total public crime complaints are from the street. Over the years, the percentage of street complaints have decreased while the percentage of transit - NYC subway have increased.

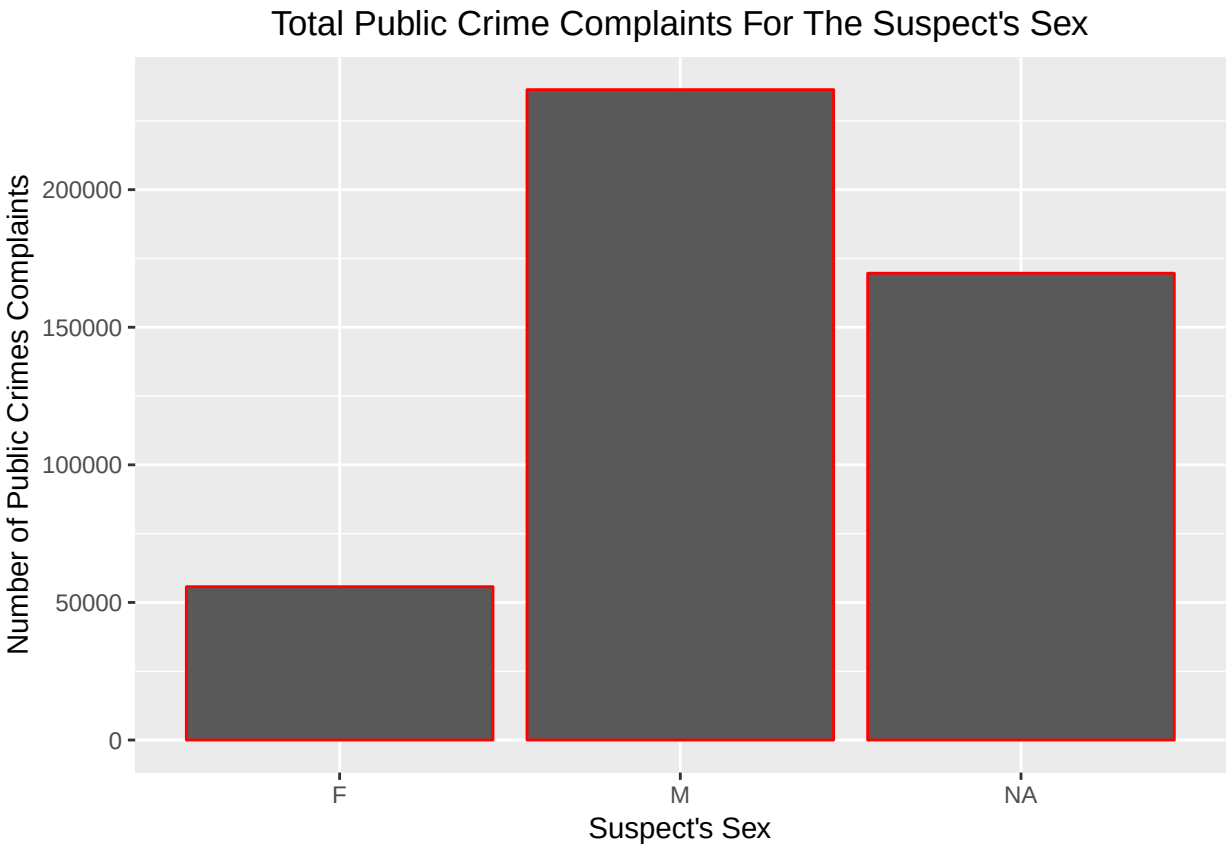


Majority of the data is NA because the suspect wasn't caught or seen. Most of the suspects that were reported were in the age group of 25-44.

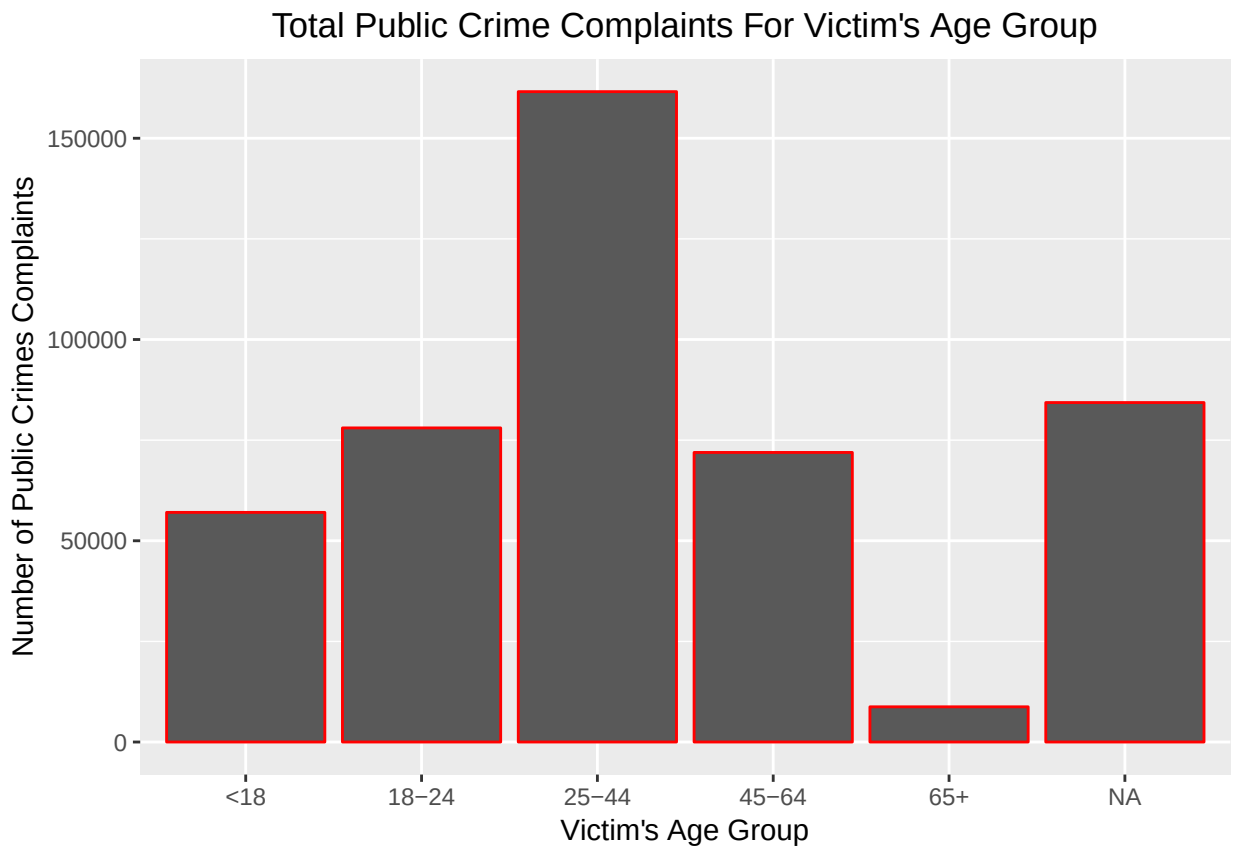

Total Public Crime Complaints For The Suspect's Rac
Suspect's Race
NA
WHITE HISPANIC
WHITE
BLACK HISPANIC
BLACK
ASIAN / PACIFIC ISLANDER
AMERICAN INDIAN/ALASKAN NATIVE
0
50000
100000
150000
20000
Number of Public Crimes Complaints



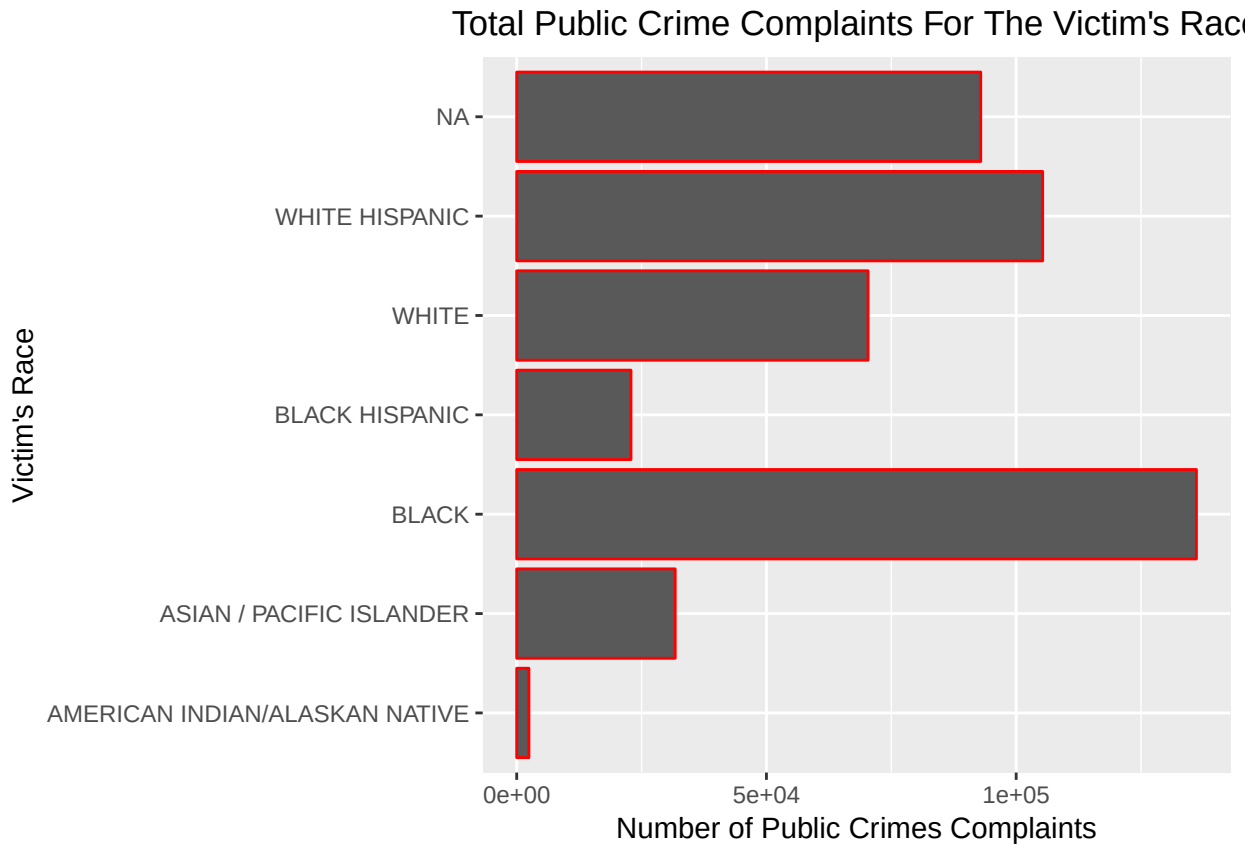
Majority of the suspects that were reported were Black. Brooklyn have significant more Black suspects than other boroughs. Most of the Asian/Pacific Islander suspects were in Queens.

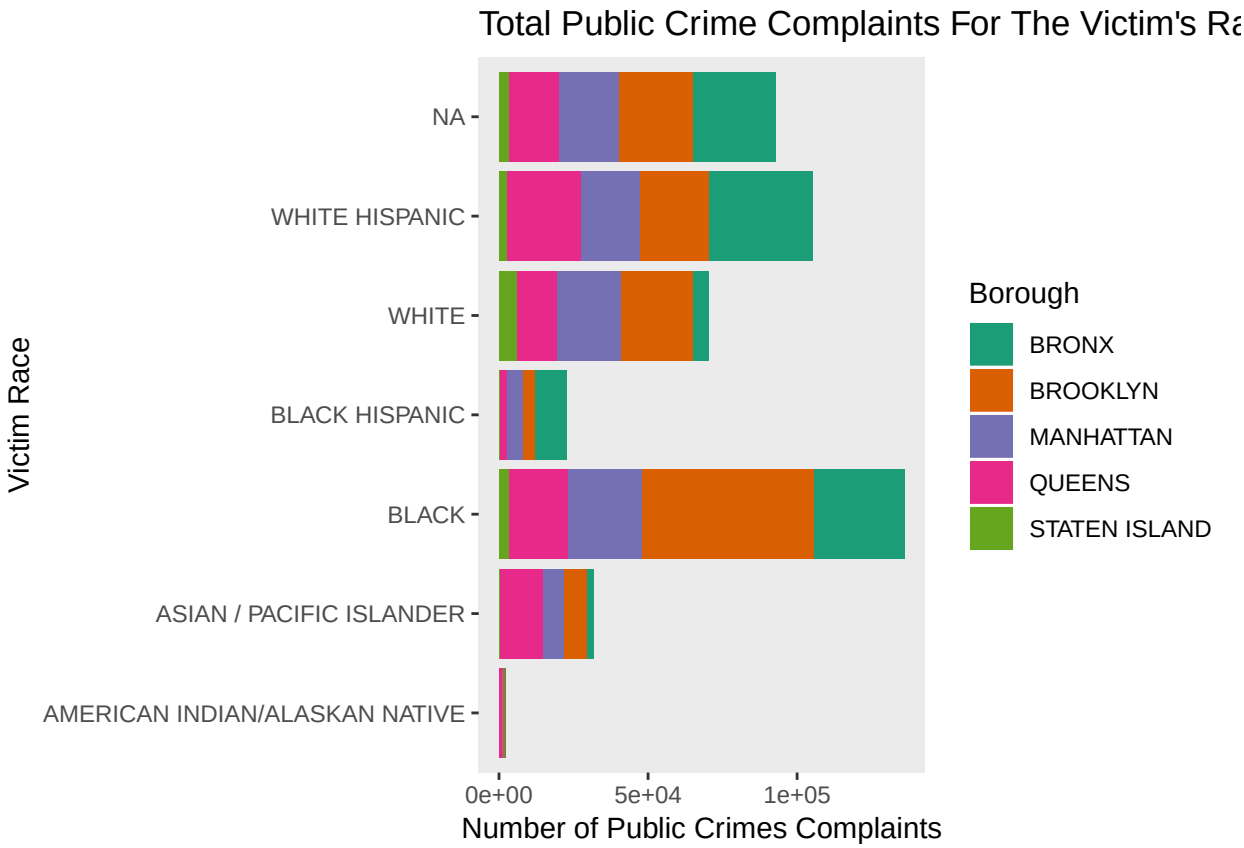


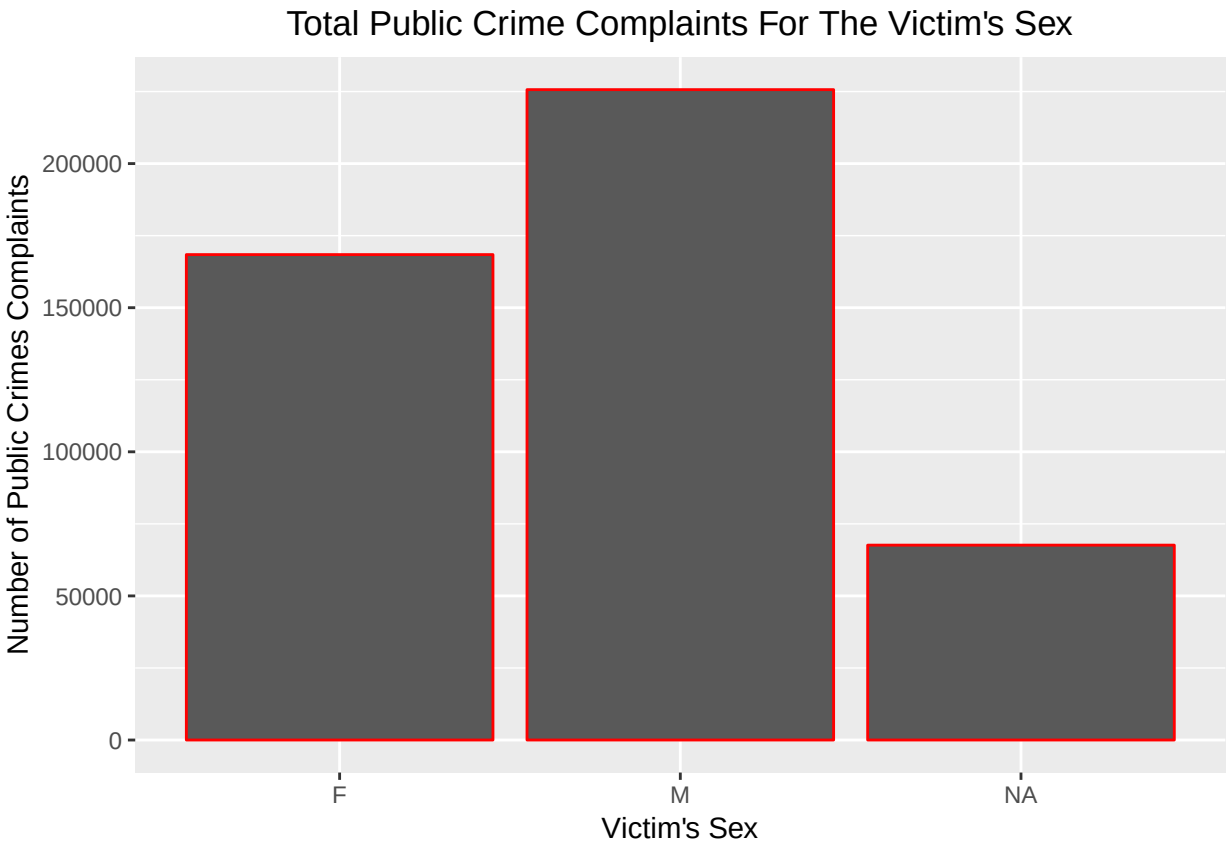
Majority of the suspects that were reported were males. Male suspects are more than quadruple times the female suspects.

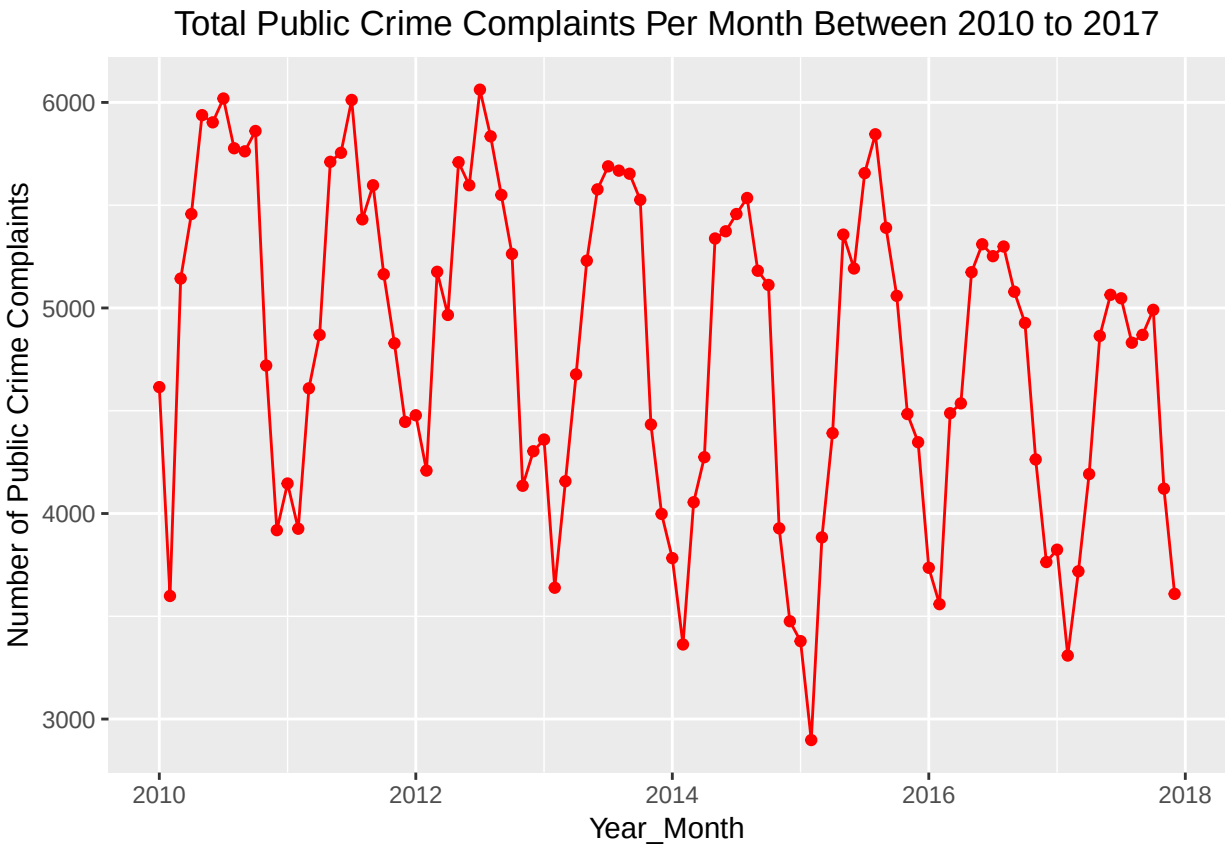


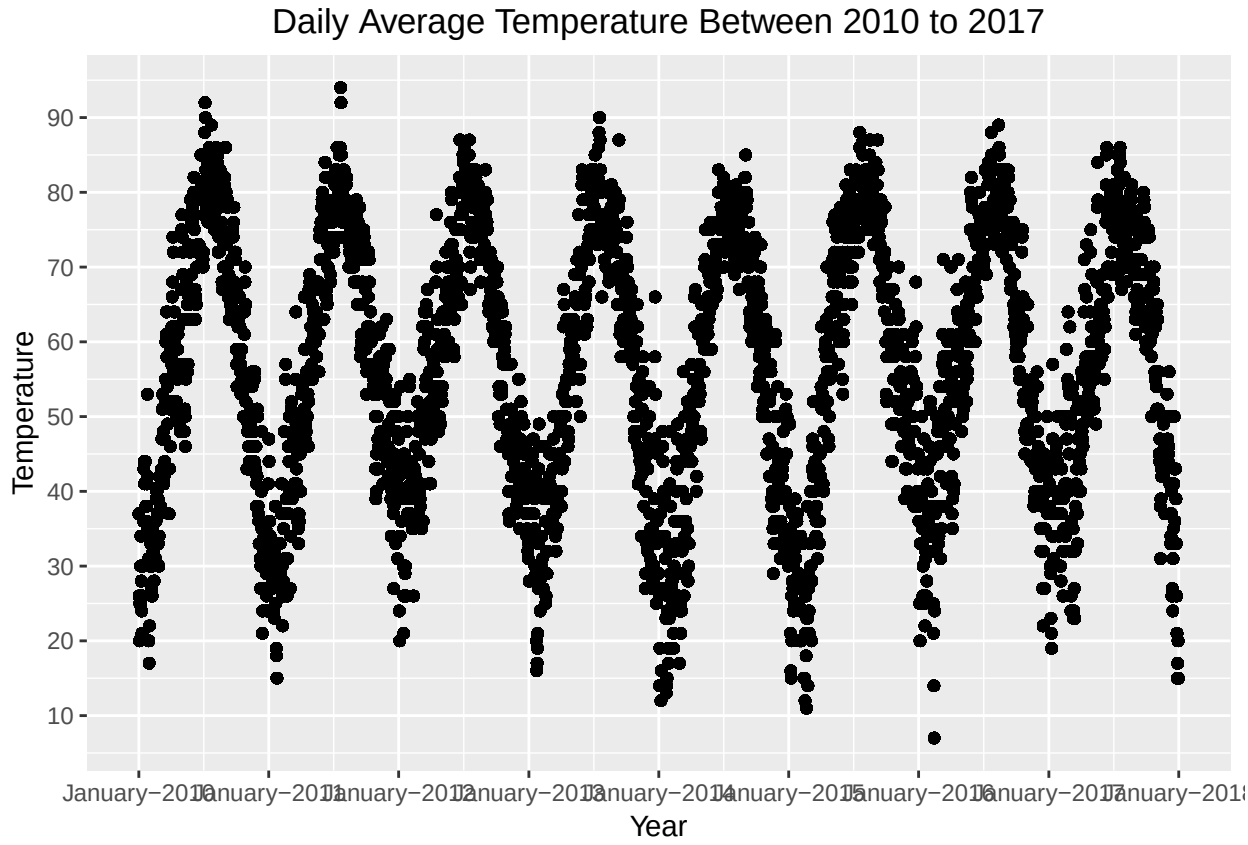
The age group of 25-44 is also the most total public crime complaint for the victim's age group.

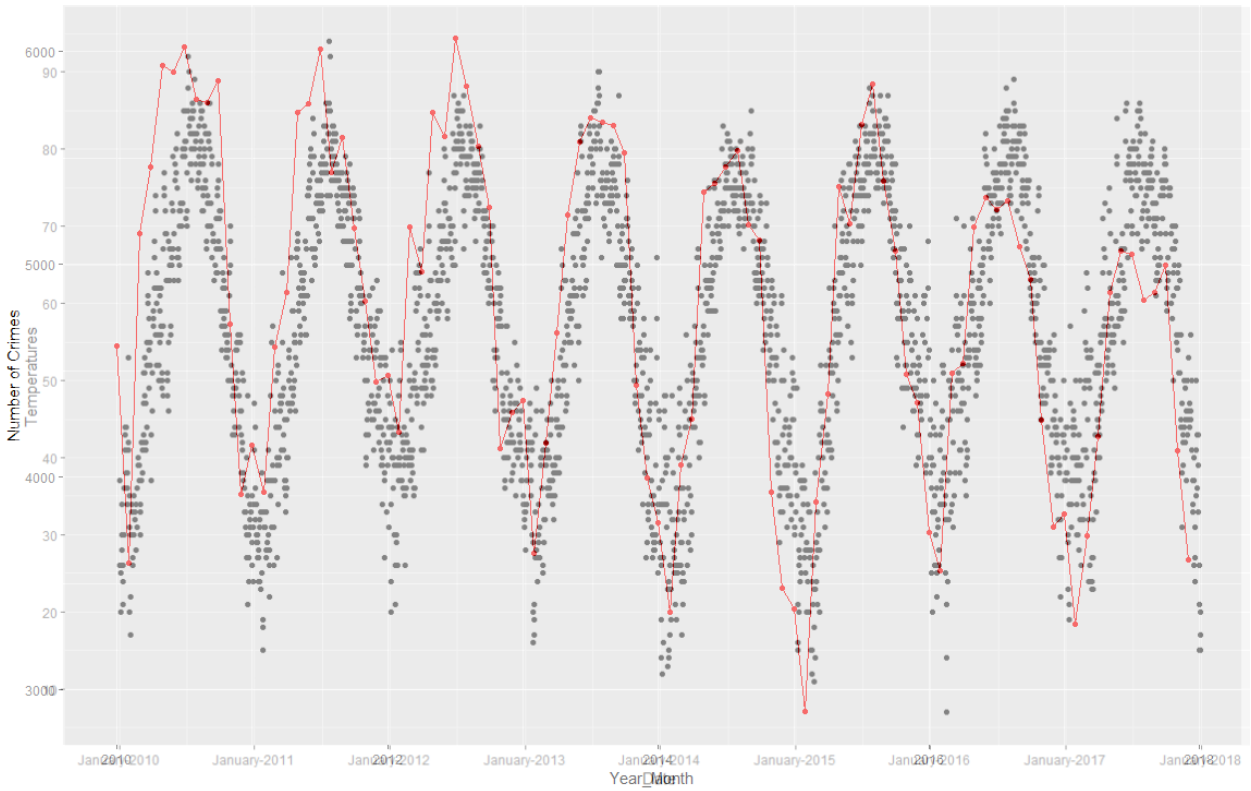

Total Public Crime Complaints For The Victim's Rac
Victim's Race
NA
WHITE HISPANIC
WHITE
BLACK HISPANIC
BLACK
ASIAN / PACIFIC ISLANDER
AMERICAN INDIAN/ALASKAN NATIVE
0e+00
5e+04
1e+05
Number of Public Crimes Complaints


Total Public Crime Complaints For The Victim's Ra
Victim Race
NA
WHITE HISPANIC
WHITE
BLACK HISPANIC
BLACK
ASIAN / PACIFIC ISLANDER
AMERICAN INDIAN/ALASKAN NATIVE
0e+00
5e+04
1e+05
Number of Public Crimes Complaints
Borough
BRONX
BROOKLYN
MANHATTAN
QUEENS
STATEN ISLAND


Total Public Crime Complaints For The Victim's Sex
Number of Public Crimes Complaints
200000
150000
100000
50000
0
F
M
NA
Victim's Sex


Total Public Crime Complaints Per Month Between 2010 to 2017
Number of Public Crime Complaints
6000
5000
4000
3000
2010
2012
2014
2016
2018
Year_Month





By compare the temperature with the total public crime The figure shows a strong correlation between the

daily average temperature and total crime complaint over the year of 2010 to 2017. As the temperature decrease, the public crime decreases as well and as the temperature increase, the public crime complaints increases as well.

```
#Total public crime complaints during shift 1
nrow(Shift1)
```

```
## [1] 118733
```

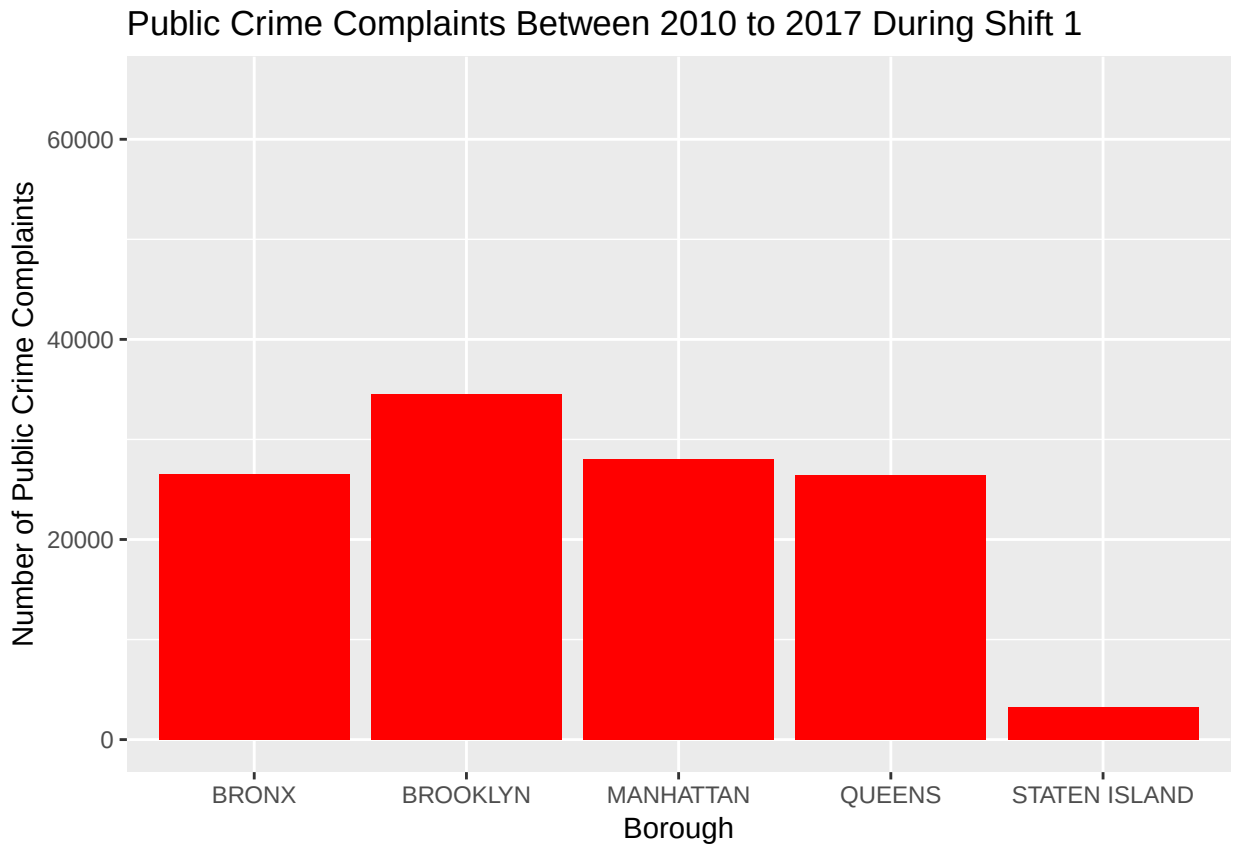
```
#Total public crime complaints during shift 2
nrow(Shift2)
```

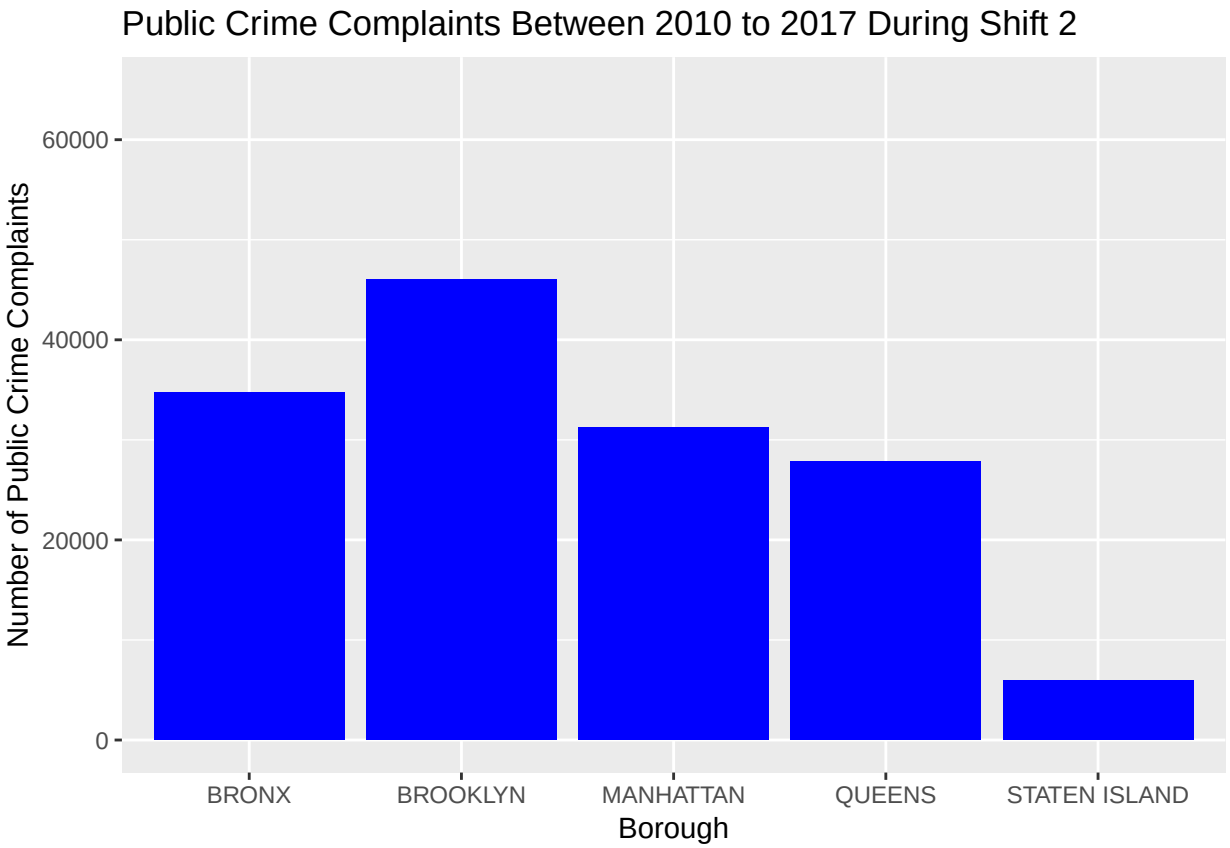
```
## [1] 145766
```

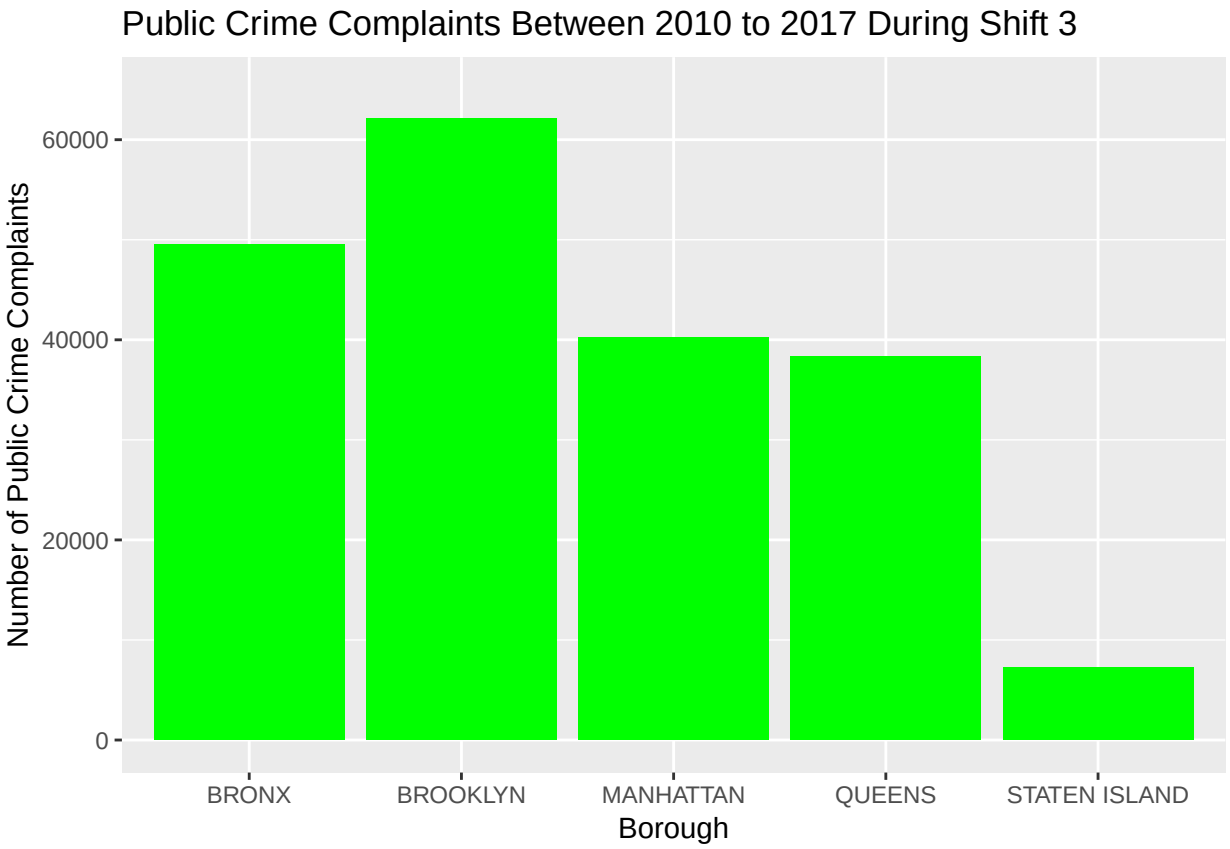
```
#Total public crime complaints during shift 3
nrow(Shift3)
```

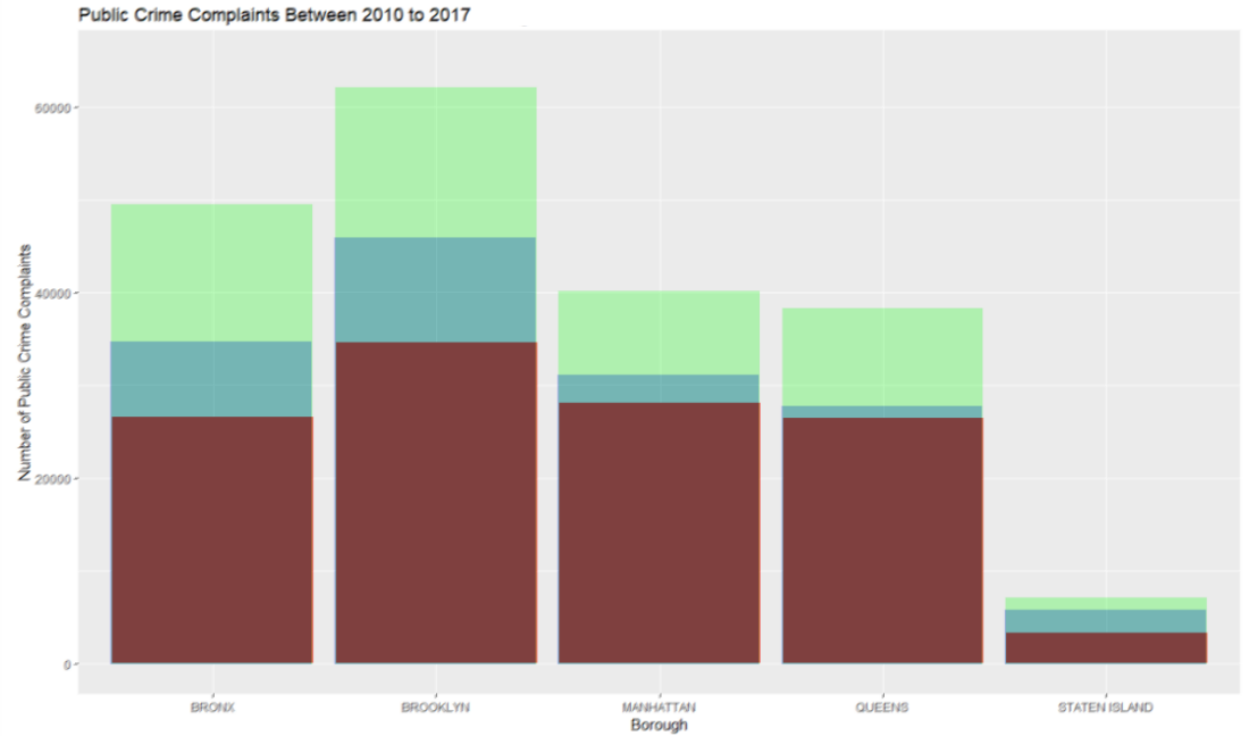
```
## [1] 197408
```

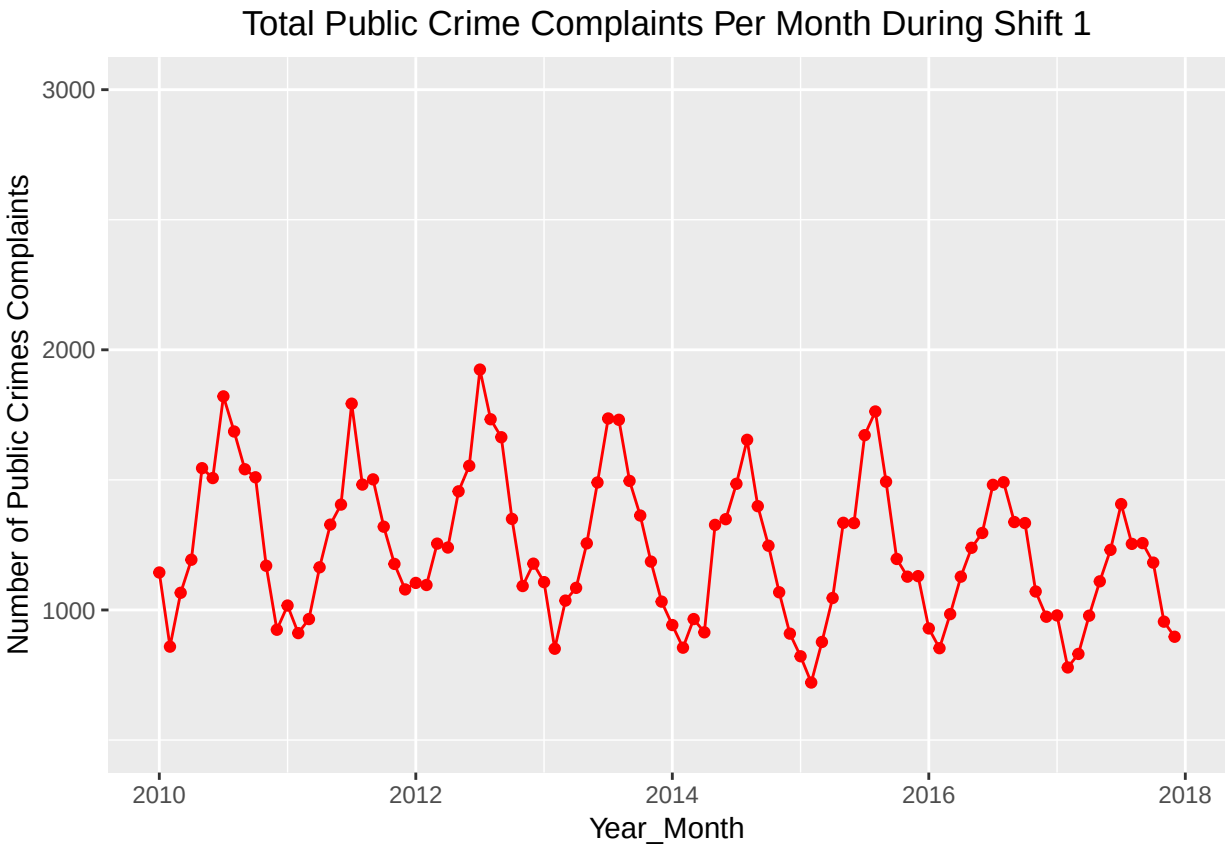
From the nrow function, Shift 3 (hour 16:00 - 24:00) was found to have the most public crime complaints. Shift 1 have 118733 complaints, shift 2 have 145766 complaints, and shift 3 have 197408 complaints.

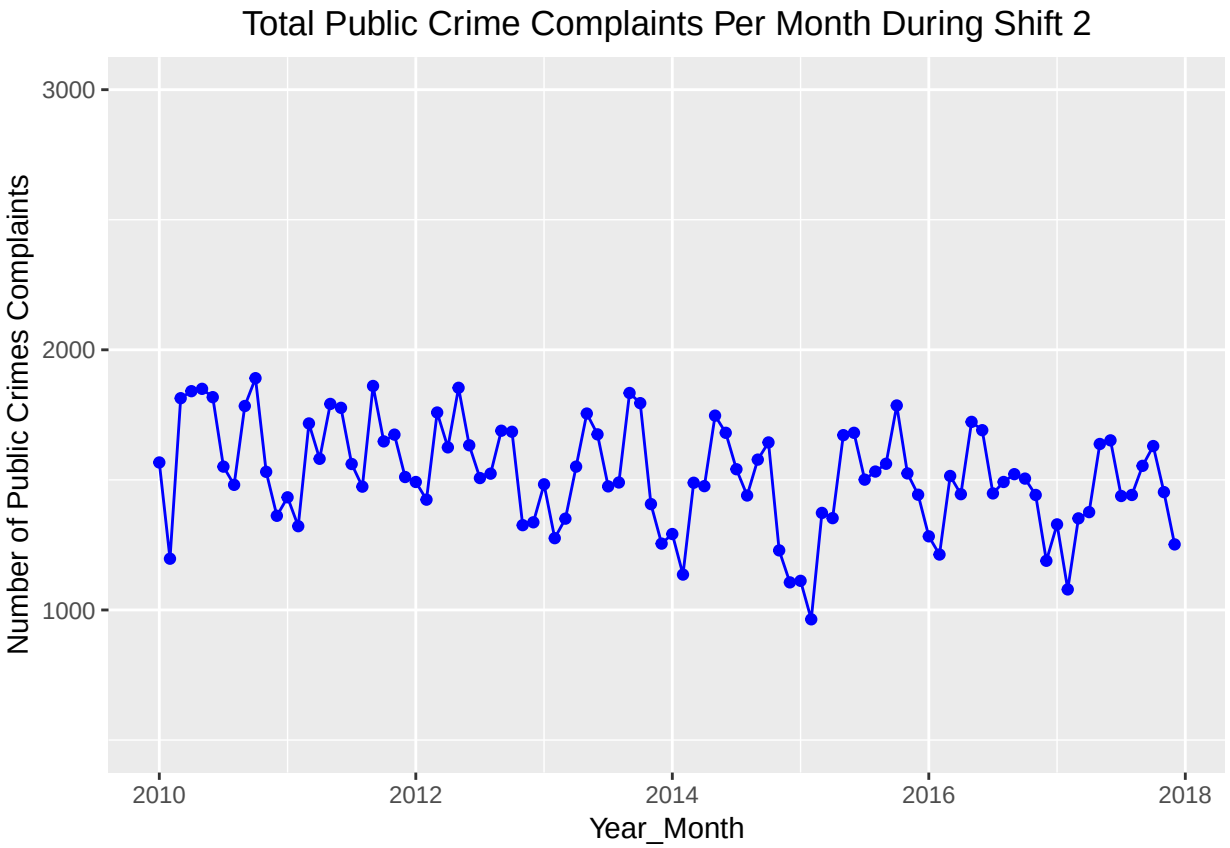


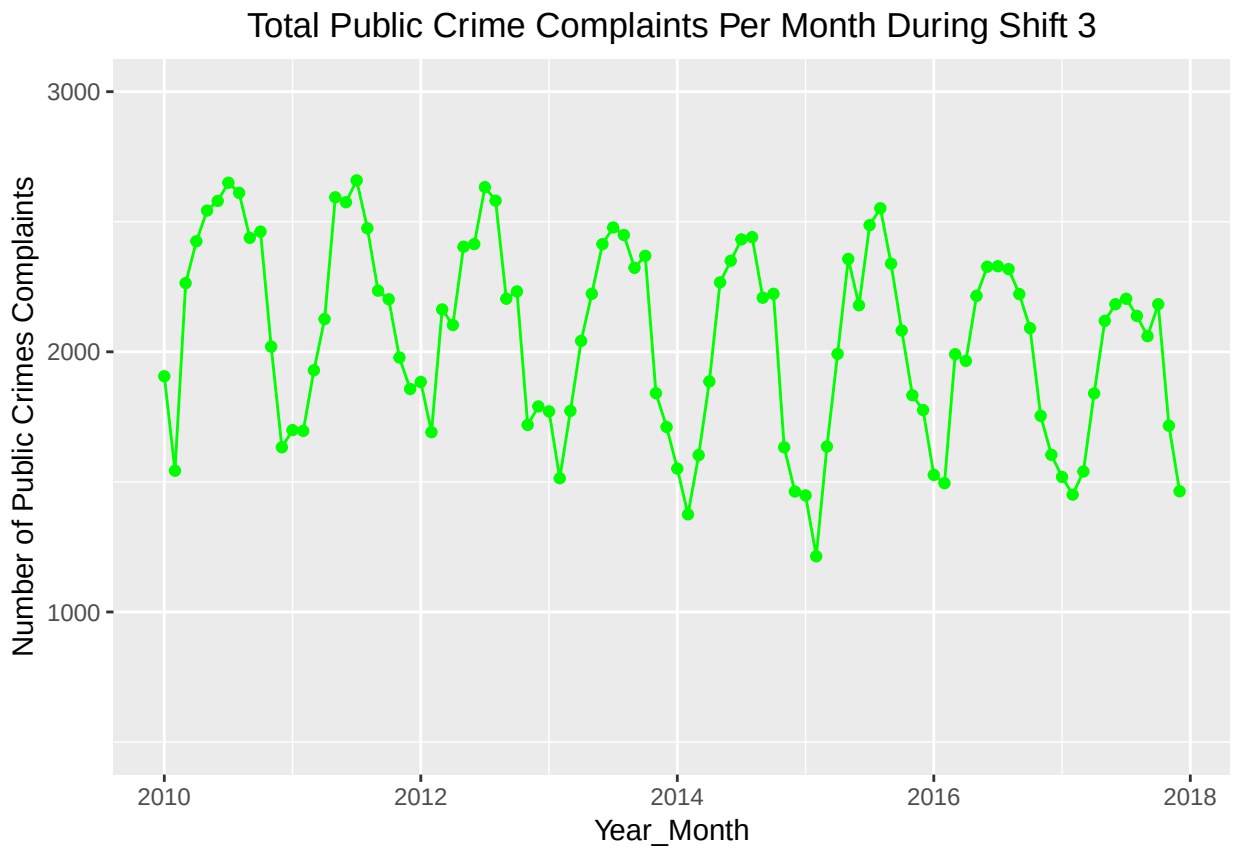

Public Crime Complaints Between 2010 to 2017 During Shift 2
Number of Public Crime Complaints
60000
40000
20000
0
BRONX
BROOKLYN
MANHATTAN
QUEENS
STATEN ISLAND
Borough

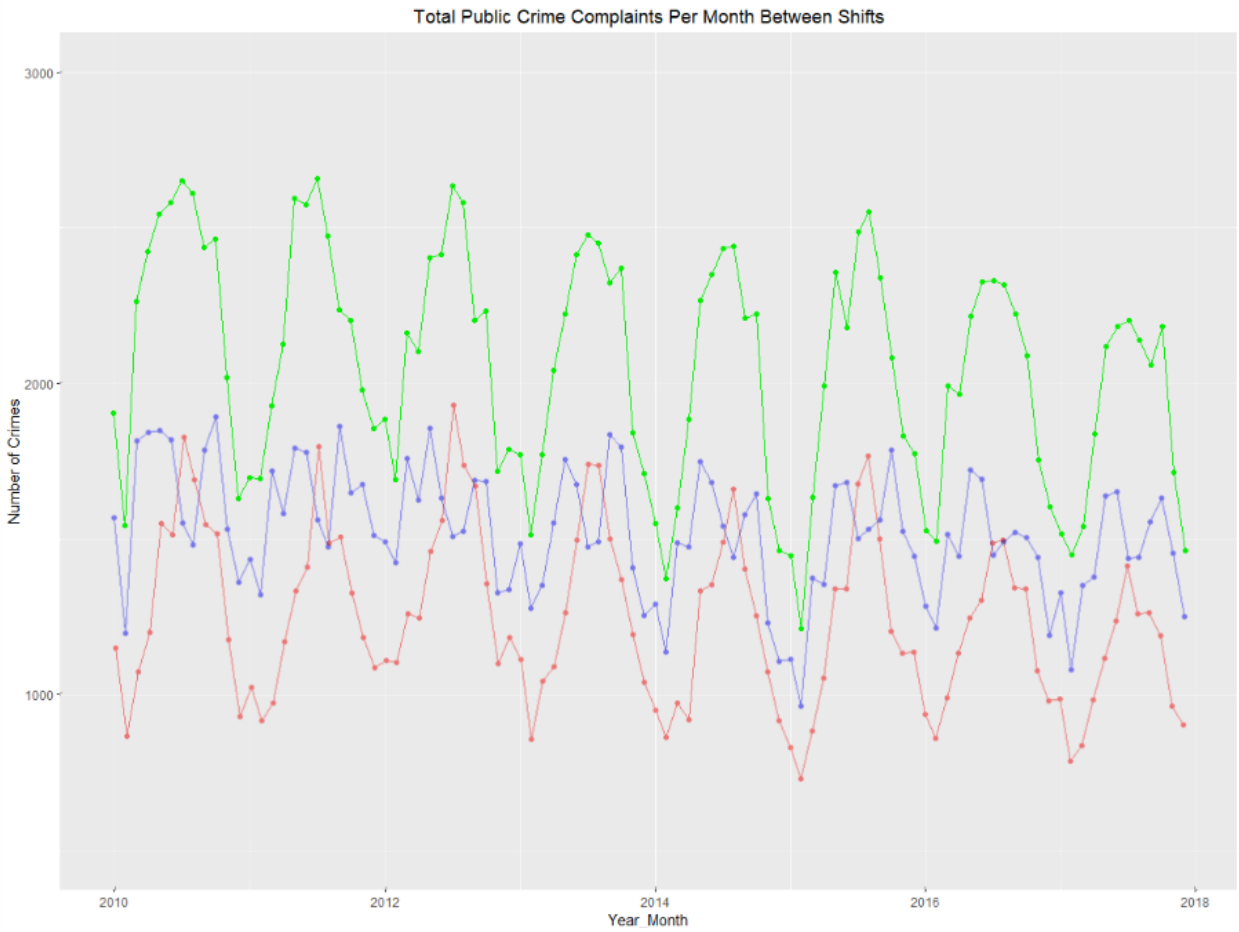

Public Crime Complaints Between 2010 to 2017 During Shift 3
Number of Public Crime Complaints
60000
40000
20000
0
BRONX
BROOKLYN
MANHATTAN
QUEENS
STATEN ISLAND
Borough


Public Crime Complaints Between 2010 to 2017
Number of Public Crime Complaints
60000
40000
20000
0
BRONX
BROOKLYN
MANHATTAN
QUEENS
STATEN ISLAND
Borough


Total Public Crime Complaints Per Month During Shift 1
Number of Public Crimes Complaints
3000
2000
1000
2010
2012
2014
2016
2018
Year_Month


Total Public Crime Complaints Per Month During Shift 2
Number of Public Crimes Complaints
3000
2000
1000
2010
2012
2014
2016
2018
Year_Month

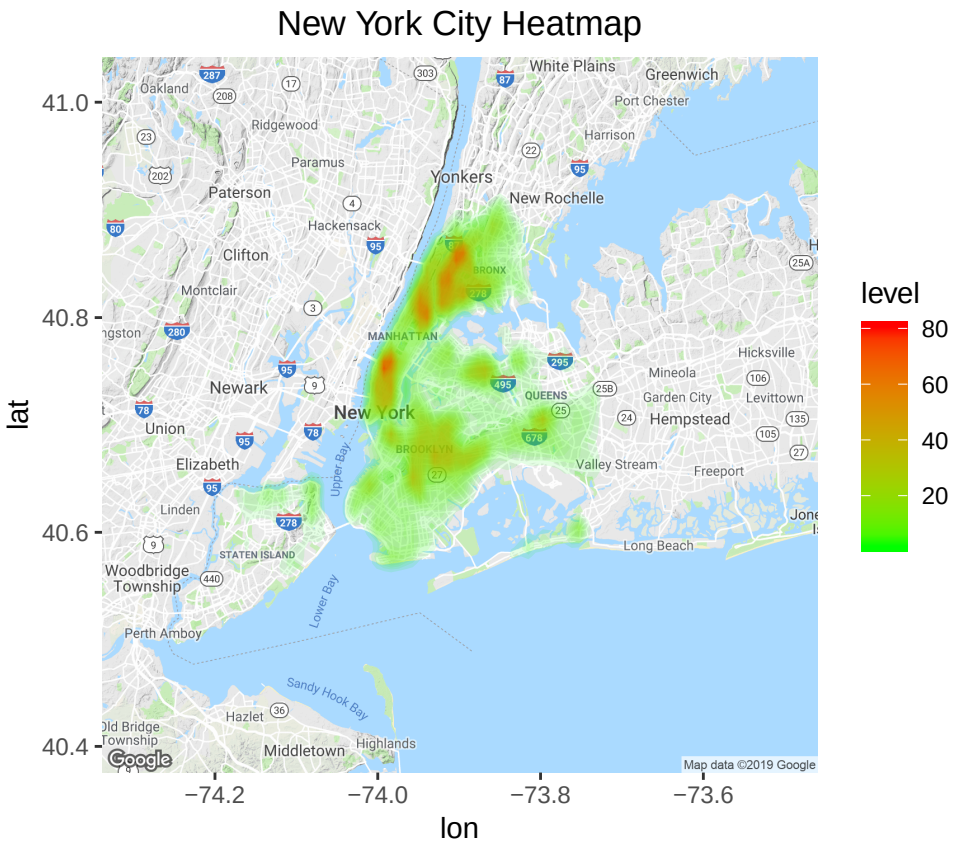

Total Public Crime Complaints Per Month During Shift 3
Number of Public Crimes Complaints
3000
2000
1000
2010
2012
2014
2016
2018
Year_Month

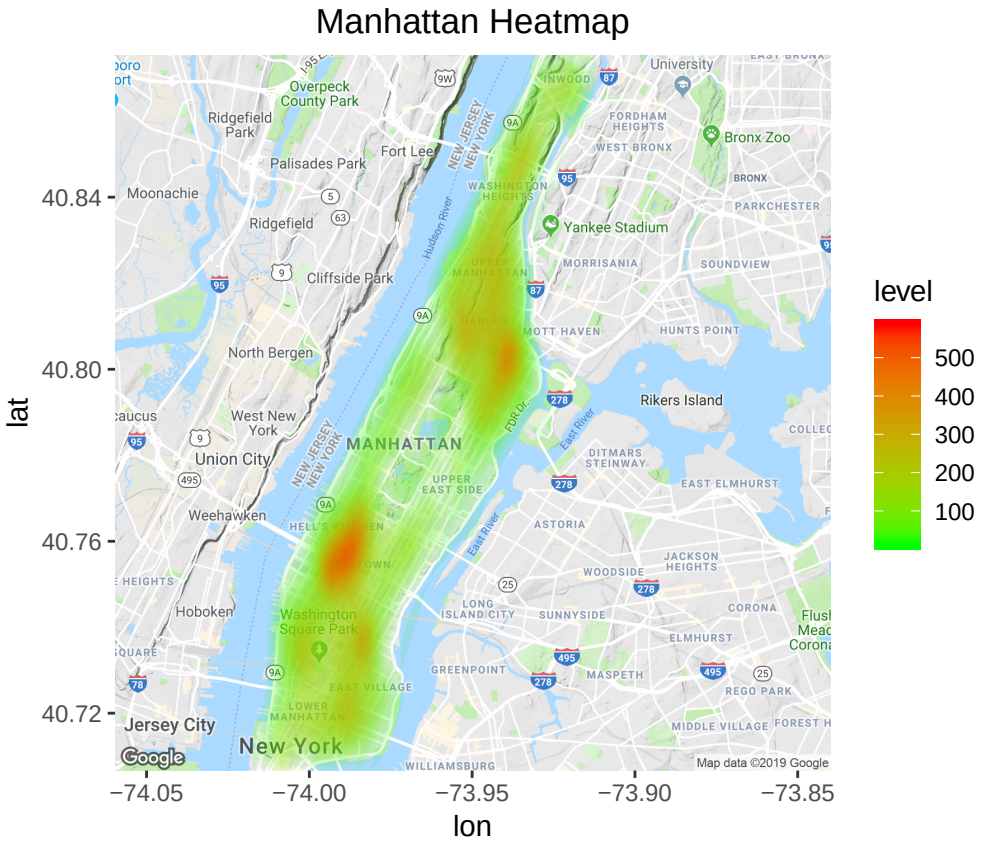


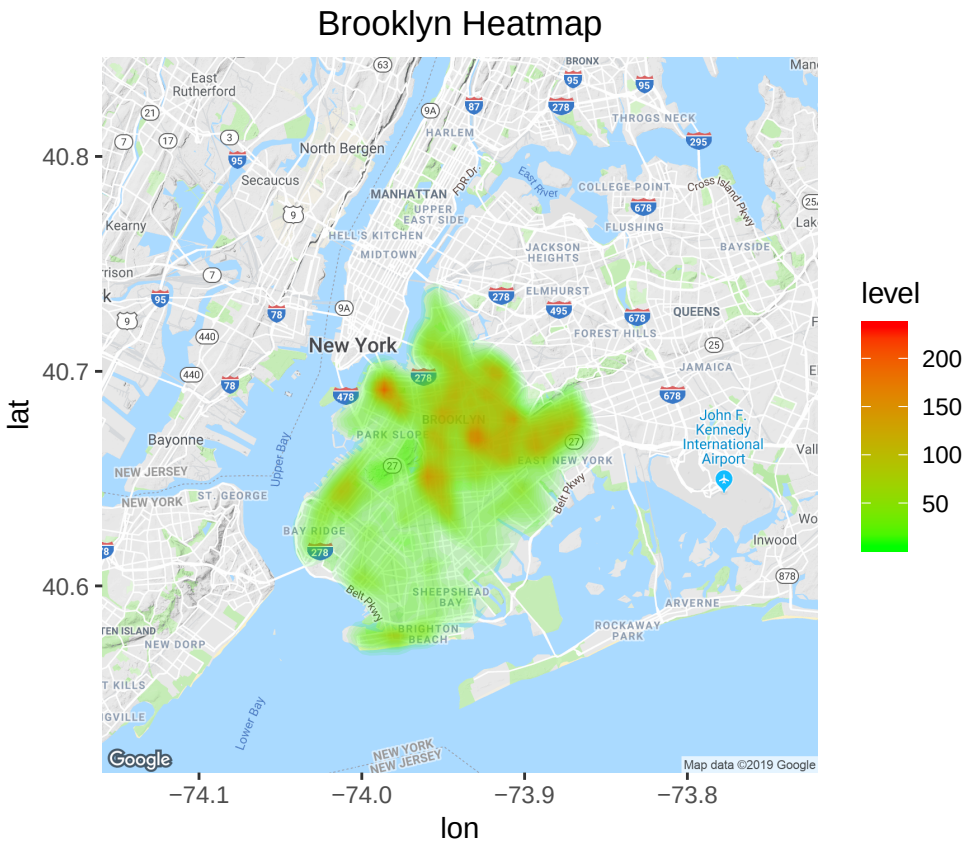
The image above shown that the number of public crime complaints in all five boroughs are in order for every shifts. Brooklyn always have the most compaints, Bronx always come second, Manhattan always third, Queens fourth, and Staten Island always last.

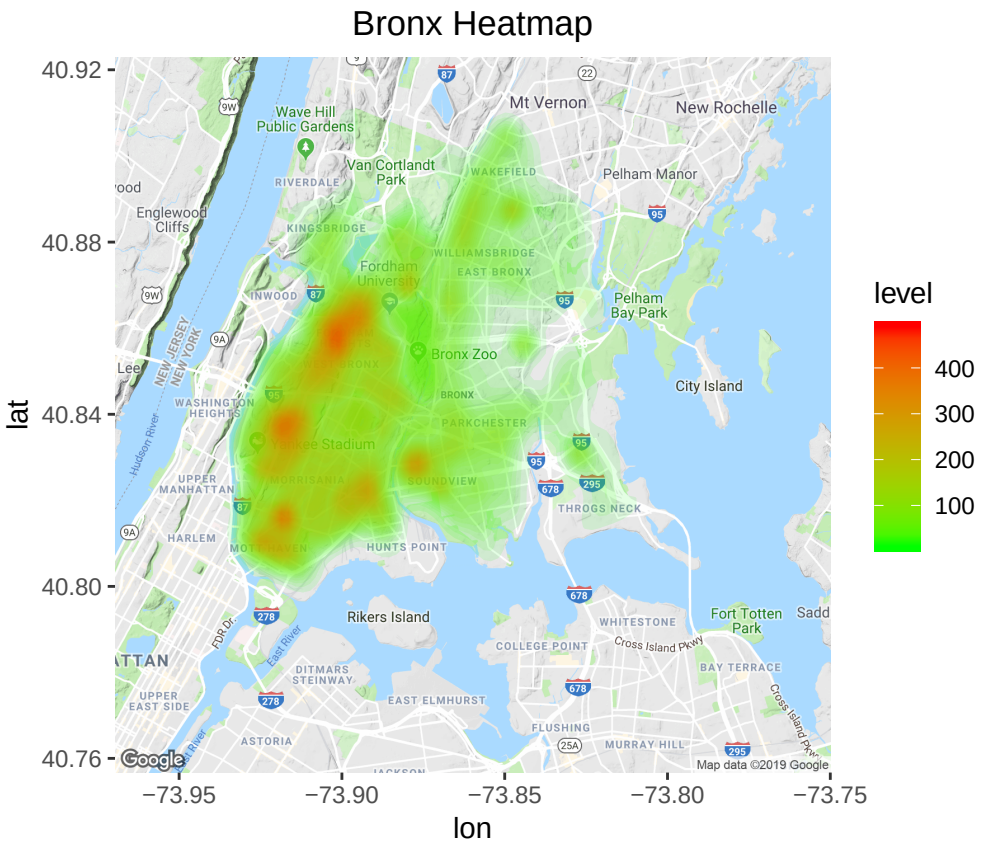
Load the library for plotting heatmap

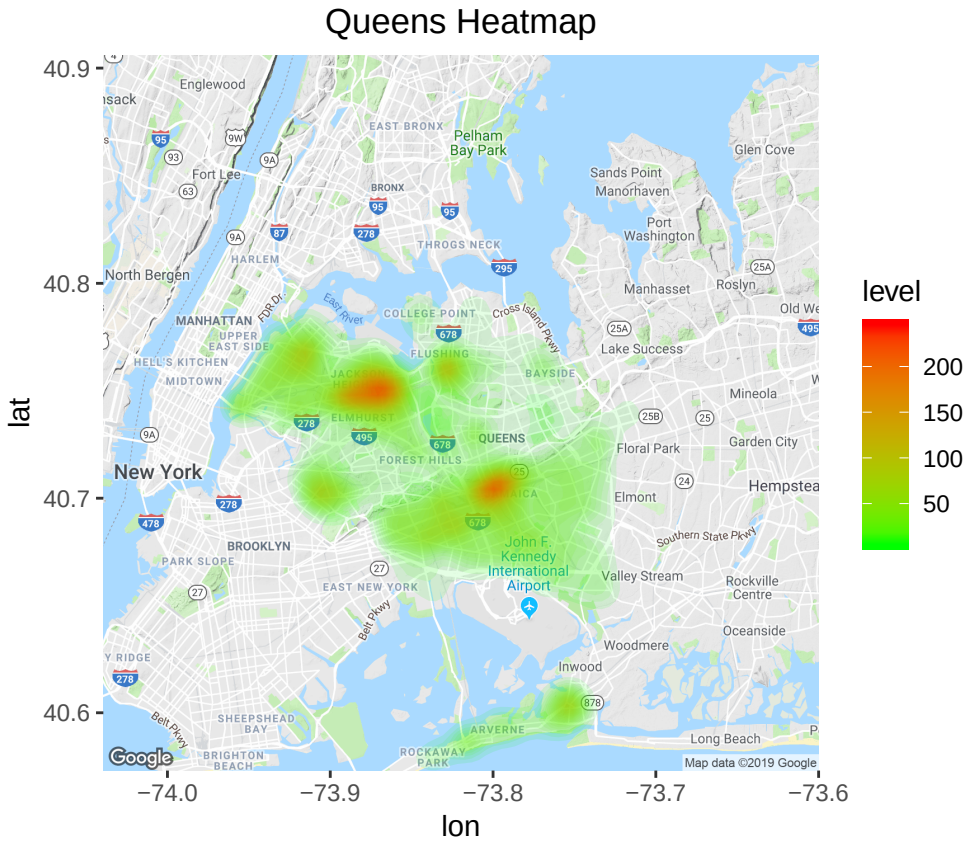
```
library(ggplot2)
library(ggthemes)
library(viridis)
library(ggmap)
library(scales)
library(grid)
library(gridExtra)
library(tigris)
library(leaflet)
library(sp)
library(maptools)
library(broom)
library(httr)
library(rgdal)
```

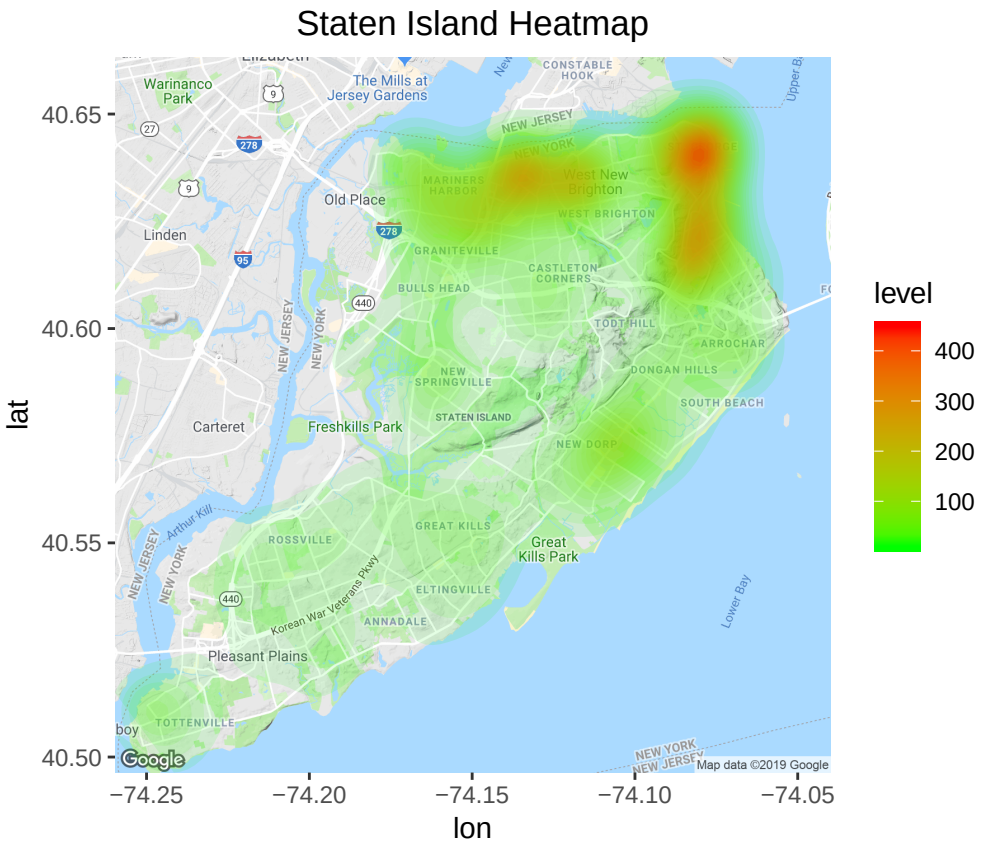

New York City Heatmap
lat
lon
41.0
40.8
40.6
40.4
−74.2
−74.0
−73.8
−73.6
level
80
60
40
20
White Plains
Greenwich
Port Chester
Harrison
Yonkers
New Rochelle
Oakland
Ridgewood
Paramus
Paterson
Hackensack
Clifton
Montclair
Newark
New York
Union
Elizabeth
Linden
Woodbridge Township
Perth Amboy
Hazlet
Middletown
Highlands
Sandy Hook Bay
Lower Bay
Upper Bay
BRONX
MANHATTAN
QUEENS
BROOKLYN
STATEN ISLAND
Hicksville
Mineola
Garden City
Levittown
Hempstead
Valley Stream
Freeport
Long Beach
Google
Map data ©2019 Google


Manhattan Heatmap
lat
40.84
40.80
40.76
40.72
lon
−74.05
−74.00
−73.95
−73.90
−73.85
level
500
400
300
200
100
MANHATTAN
New York
Jersey City
Hoboken
Union City
West New York
North Bergen
Weehawken
Ridgefield
Ridgefield Park
Palisades Park
Fort Lee
Moonachie
Overpeck County Park
Cliffside Park
Yankee Stadium
Bronx Zoo
University
Rikers Island
Washington Square Park
Hudson River
East River
Google
Map data ©2019 Google

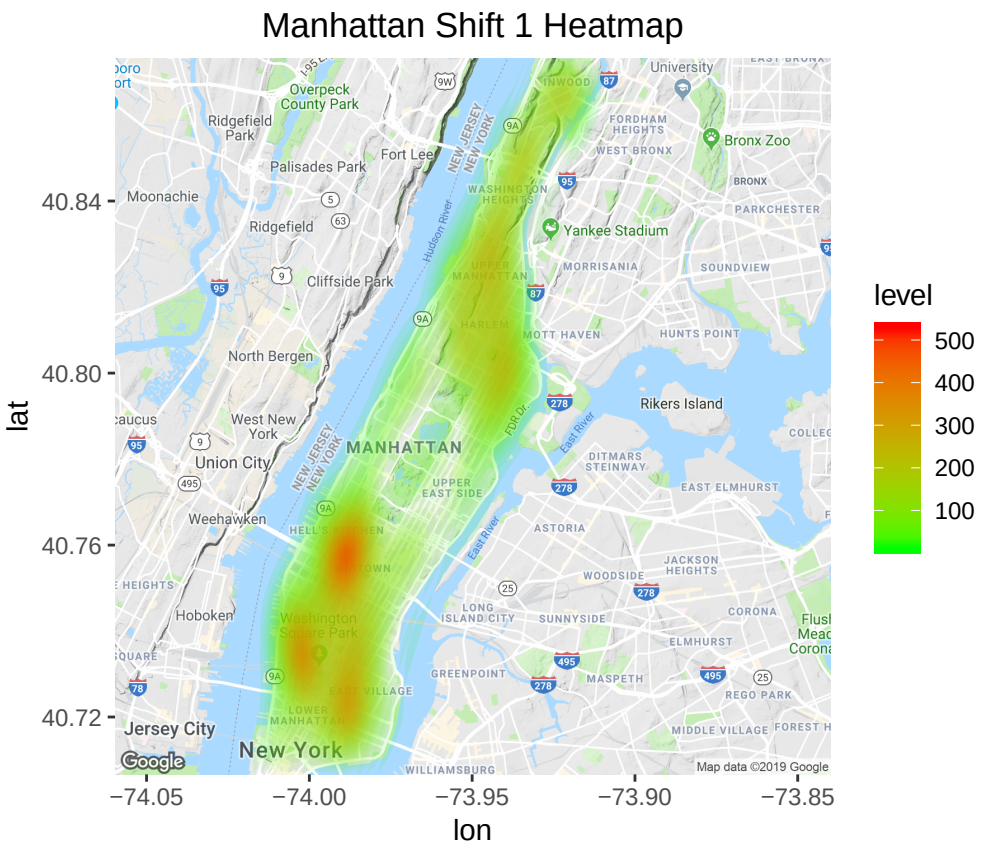

Brooklyn Heatmap
lat
40.8
40.7
40.6
lon
−74.1
−74.0
−73.9
−73.8
level
200
150
100
50
New York
Bayonne
North Bergen
Secaucus
Kearny
East Rutherford
MANHATTAN
BROOKLYN
QUEENS
BRONX
HARLEM
UPPER EAST SIDE
HELL'S KITCHEN
MIDTOWN
JACKSON HEIGHTS
ELMHURST
FOREST HILLS
COLLEGE POINT
FLUSHING
THROGS NECK
BAYSIDE
JAMAICA
PARK SLOPE
EAST NEW YORK
BAY RIDGE
SHEEPSHEAD BAY
BRIGHTON BEACH
ROCKAWAY PARK
ARVERNE
Inwood
John F. Kennedy International Airport
NEW JERSEY
NEW YORK
ST. GEORGE
NEW DORP
Upper Bay
Lower Bay
East River
FDR Dr
Belt Pkwy
Cross Island Pkwy
Google
Map data ©2019 Google

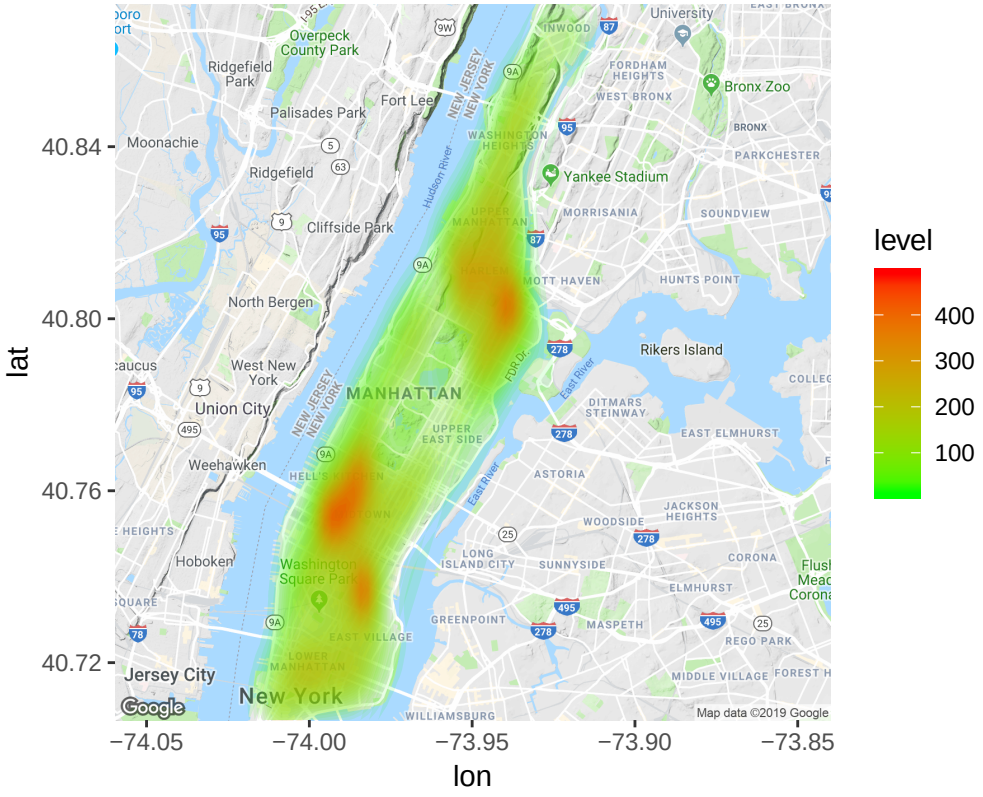

Bronx Heatmap
40.92
40.88
40.84
40.80
40.76
lat
−73.95
−73.90
−73.85
−73.80
−73.75
lon
level
400
300
200
100
Mt Vernon
New Rochelle
Wave Hill Public Gardens
Van Cortlandt Park
Pelham Manor
Englewood Cliffs
Fordham University
Pelham Bay Park
Bronx Zoo
City Island
Yankee Stadium
Rikers Island
Fort Totten Park
Google
Map data ©2019 Google

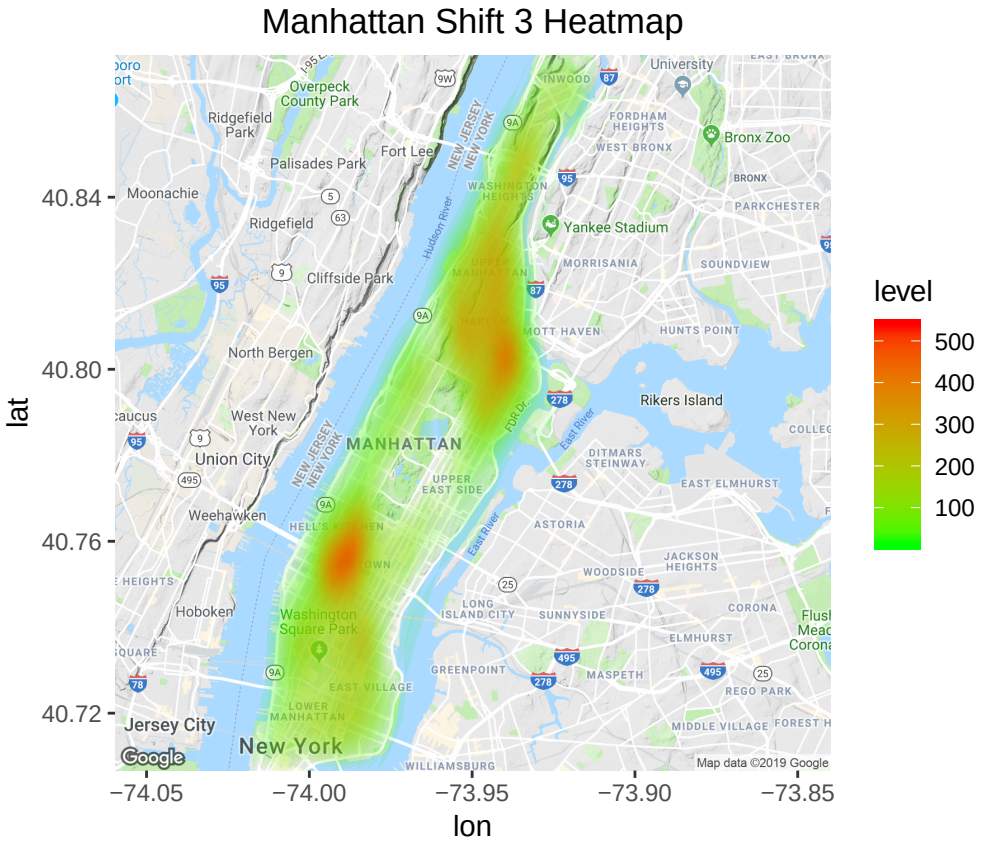

Queens Heatmap
lat
lon
level
200
150
100
50
40.9
40.8
40.7
40.6
−74.0
−73.9
−73.8
−73.7
−73.6
Englewood
Fort Lee
North Bergen
Pelham Bay Park
Glen Cove
Sands Point
Manorhaven
Port Washington
Manhasset
Roslyn
Lake Success
Mineola
Garden City
Floral Park
Hempstead
Elmont
Valley Stream
Rockville Centre
Oceanside
Woodmere
Inwood
Long Beach
New York
MANHATTAN
HARLEM
HELL'S KITCHEN
MIDTOWN
UPPER EAST SIDE
BRONX
EAST BRONX
THROGS NECK
COLLEGE POINT
FLUSHING
BAYSIDE
ELMHURST
QUEENS
FOREST HILLS
JAMAICA
BROOKLYN
PARK SLOPE
EAST NEW YORK
SHEEPSHEAD BAY
BRIGHTON BEACH
ROCKAWAY PARK
ARVERNE
John F. Kennedy International Airport
FDR Dr.
East River
Cross Island Pkwy
Belt Pkwy
Southern State Pkwy
Google
Map data ©2019 Google


Staten Island Heatmap
lat
lon
40.65
40.60
40.55
40.50
−74.25
−74.20
−74.15
−74.10
−74.05
level
400
300
200
100
Warinanco Park
The Mills at Jersey Gardens
CONSTABLE HOOK
NEW JERSEY
NEW YORK
MARINERS HARBOR
West New Brighton
WEST BRIGHTON
Old Place
Linden
GRANITEVILLE
CASTLETON CORNERS
BULLS HEAD
TODT HILL
ARROCHAR
DONGAN HILLS
SOUTH BEACH
NEW SPRINGVILLE
STATEN ISLAND
Carteret
Freshkills Park
NEW DORP
GREAT KILLS
Great Kills Park
ROSSVILLE
Arthur Kill
Korean War Veterans Pkwy
ELTINGVILLE
ANNADALE
Lower Bay
Pleasant Plains
TOTTENVILLE
Google
Map data ©2019 Google

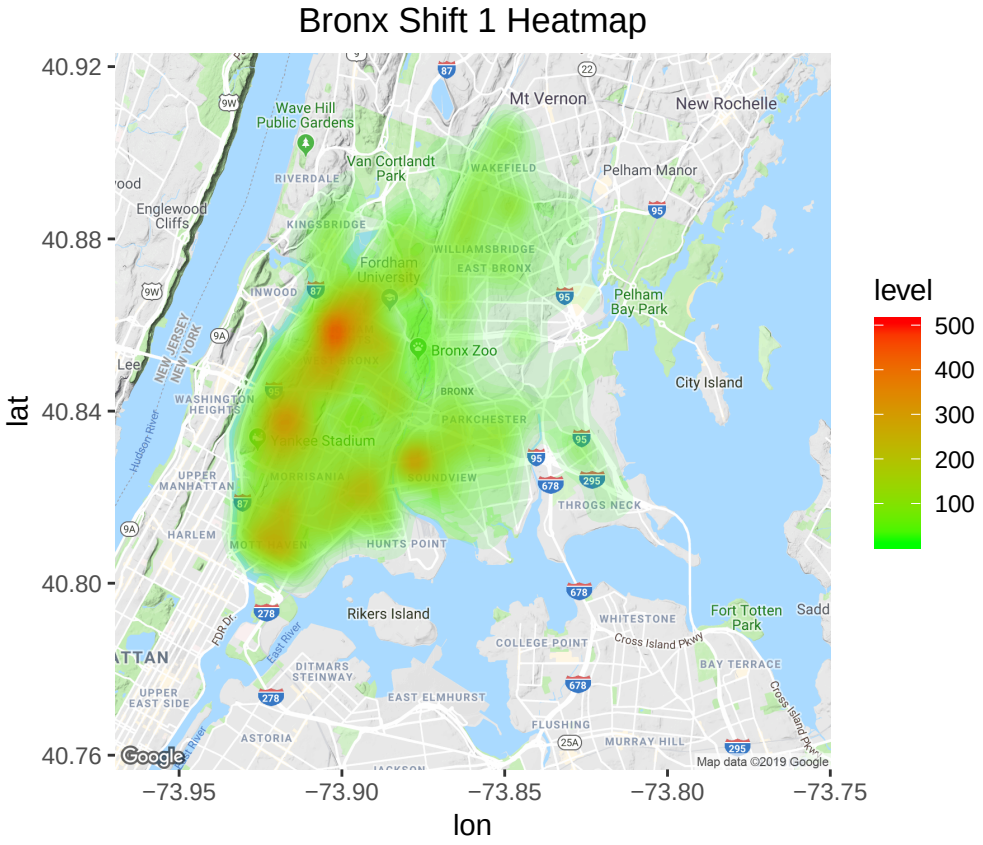
Comparing the hotspots in Manhattan by shifts

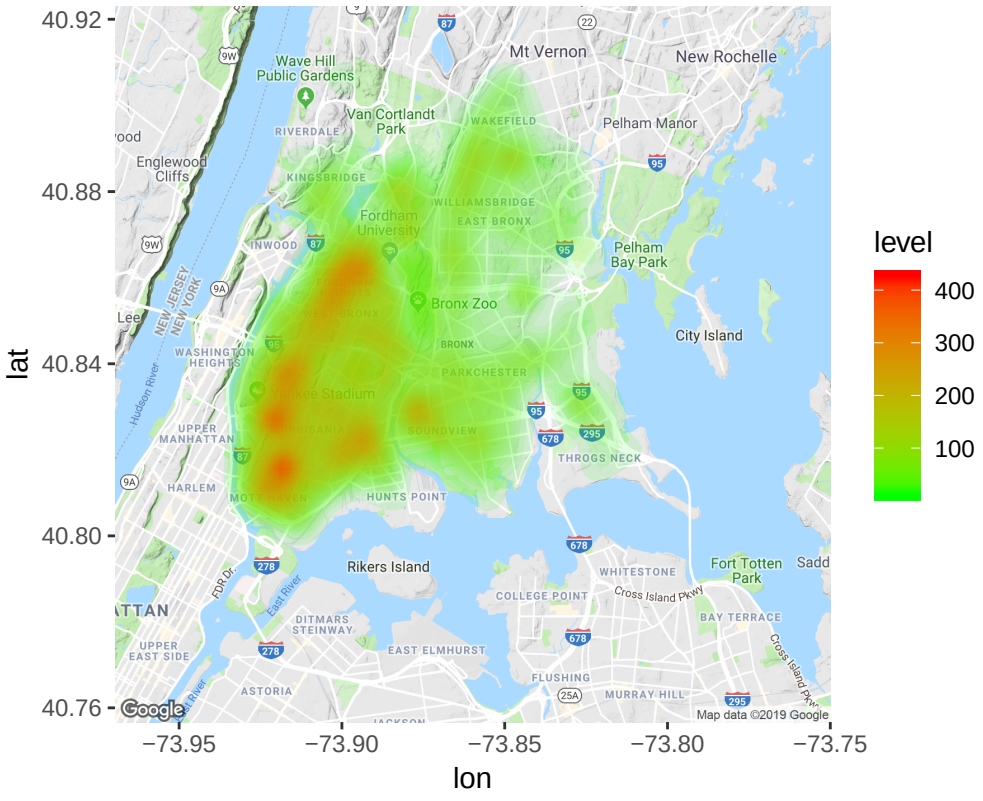


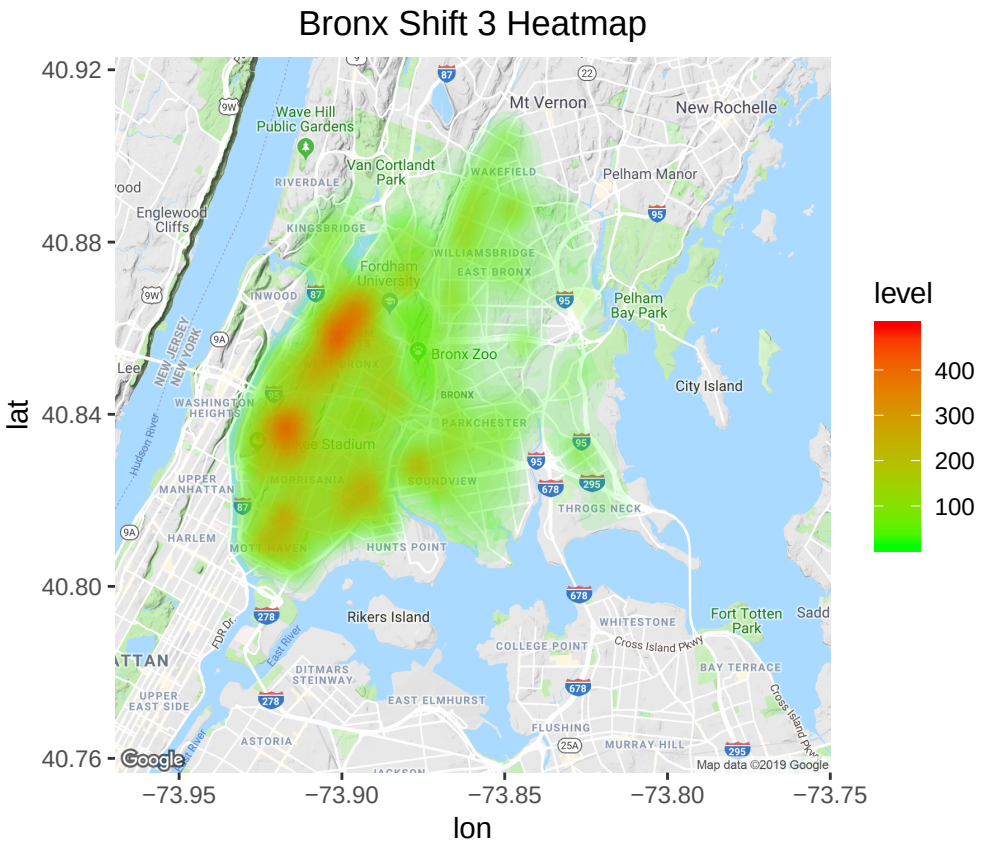



Manhattan Shift 3 Heatmap
lat
40.84
40.80
40.76
40.72
lon
−74.05
−74.00
−73.95
−73.90
−73.85
level
500
400
300
200
100
MANHATTAN
New York
Jersey City
Union City
West New York
North Bergen
Weehawken
Hoboken
Fort Lee
Palisades Park
Ridgefield
Ridgefield Park
Overpeck County Park
Moonachie
Cliffside Park
Yankee Stadium
Bronx Zoo
University
Rikers Island
Washington Square Park
Hudson River
East River
Google
Map data ©2019 Google

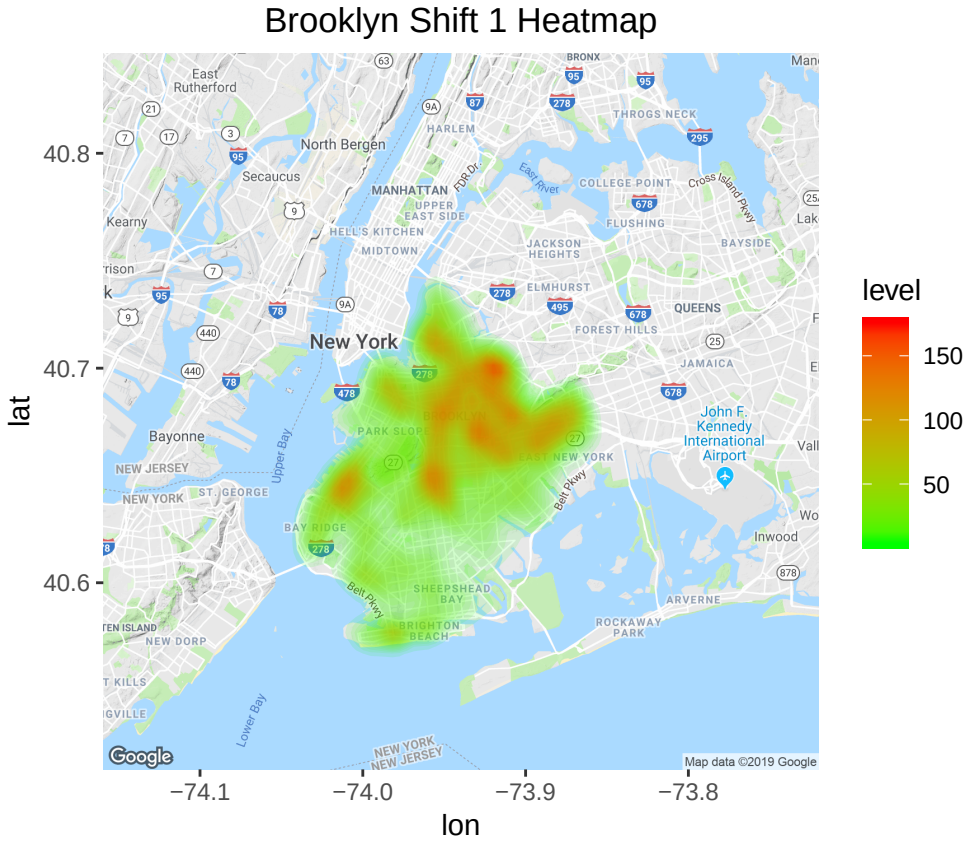
Comparing the hotspots in Bronx by shifts

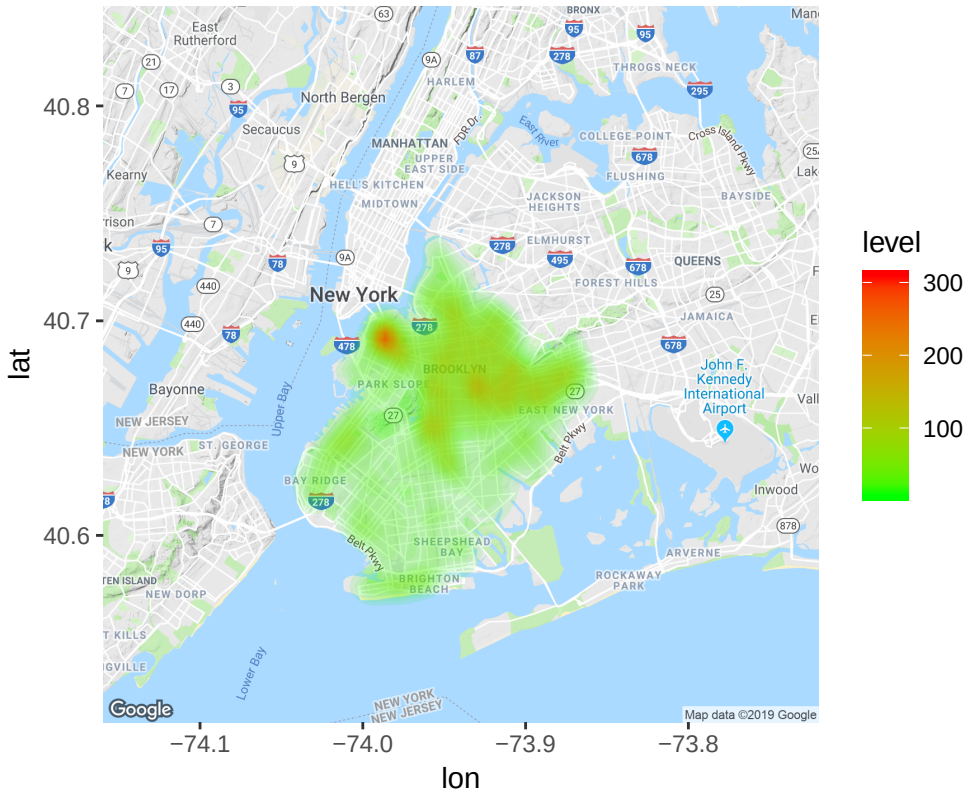


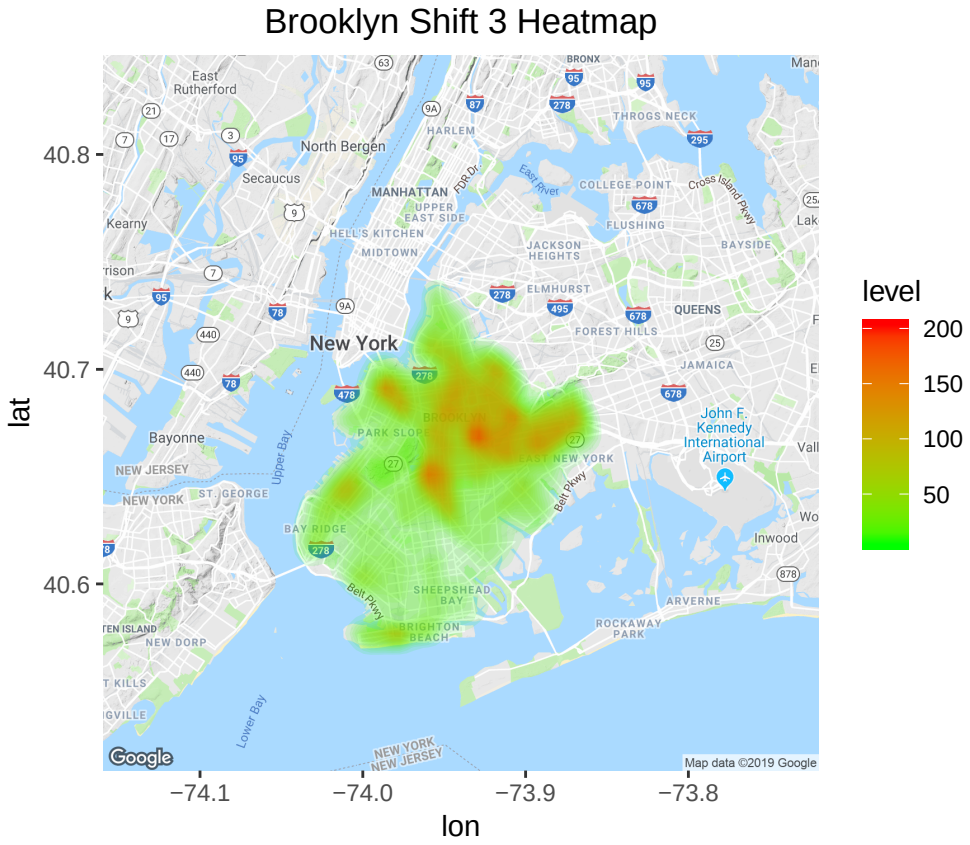



Bronx Shift 3 Heatmap
40.92
40.88
40.84
40.80
40.76
lat
−73.95
−73.90
−73.85
−73.80
−73.75
lon
level
400
300
200
100
Wave Hill Public Gardens
Van Cortlandt Park
Mt Vernon
New Rochelle
Pelham Manor
Englewood Cliffs
Fordham University
Pelham Bay Park
Bronx Zoo
City Island
Rikers Island
Fort Totten Park
Google
Map data ©2019 Google

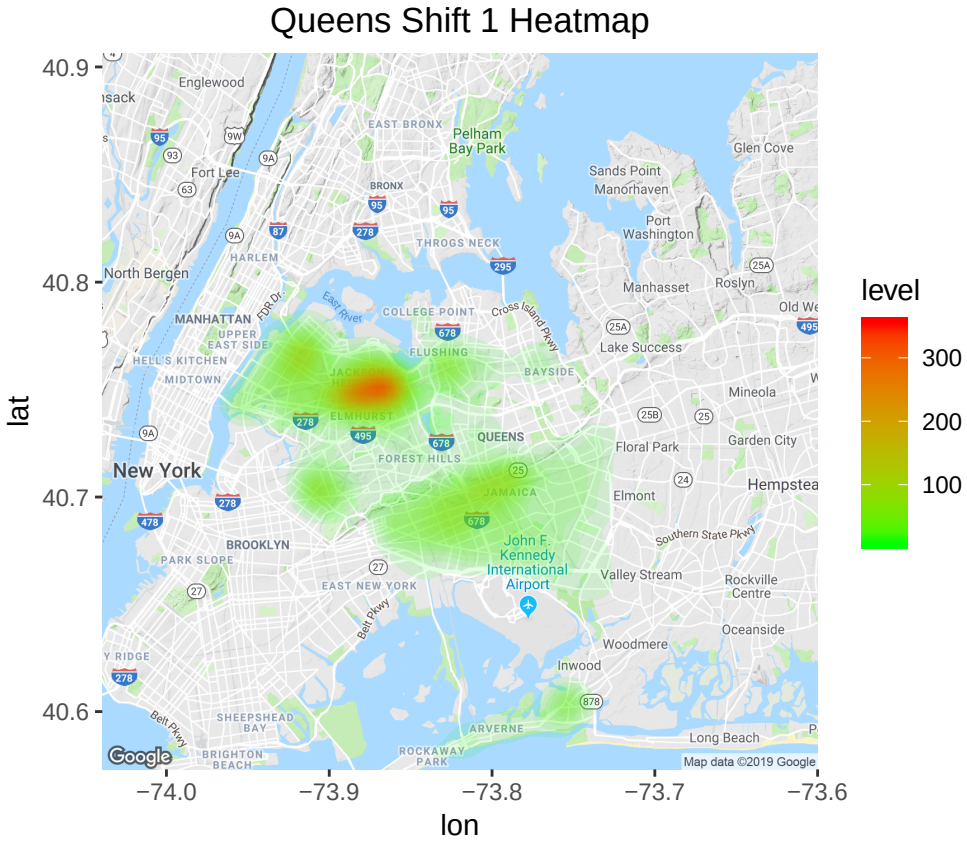
Comparing the hotspots in Brooklyn by shifts

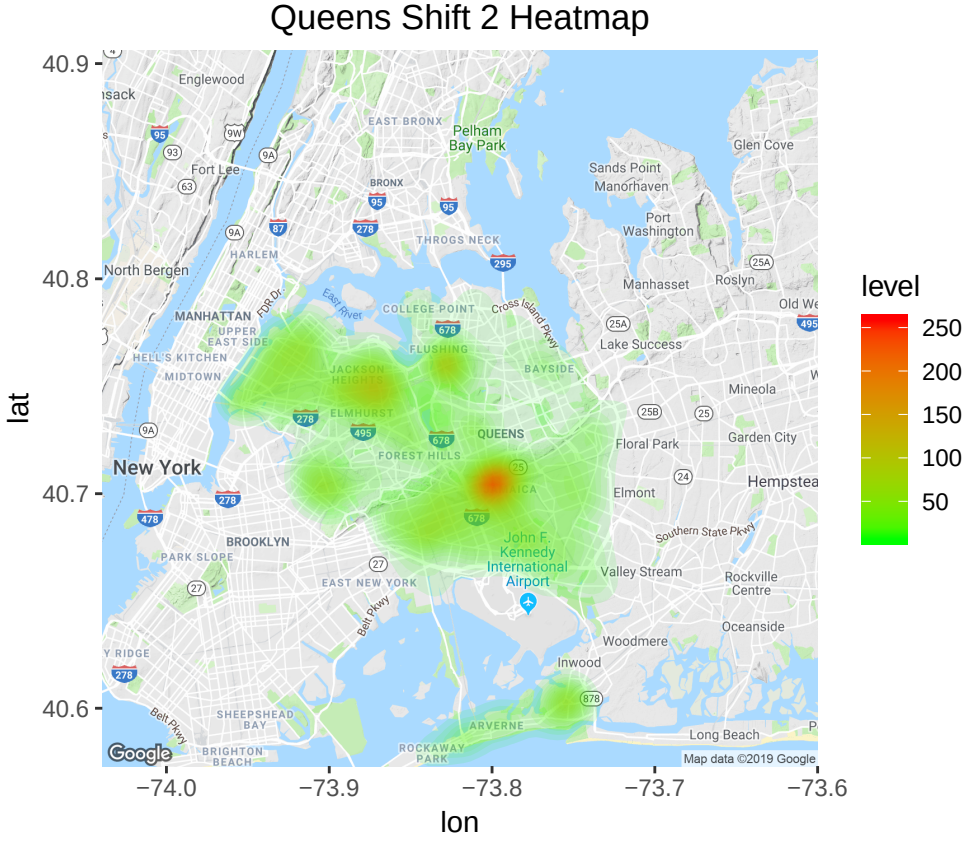


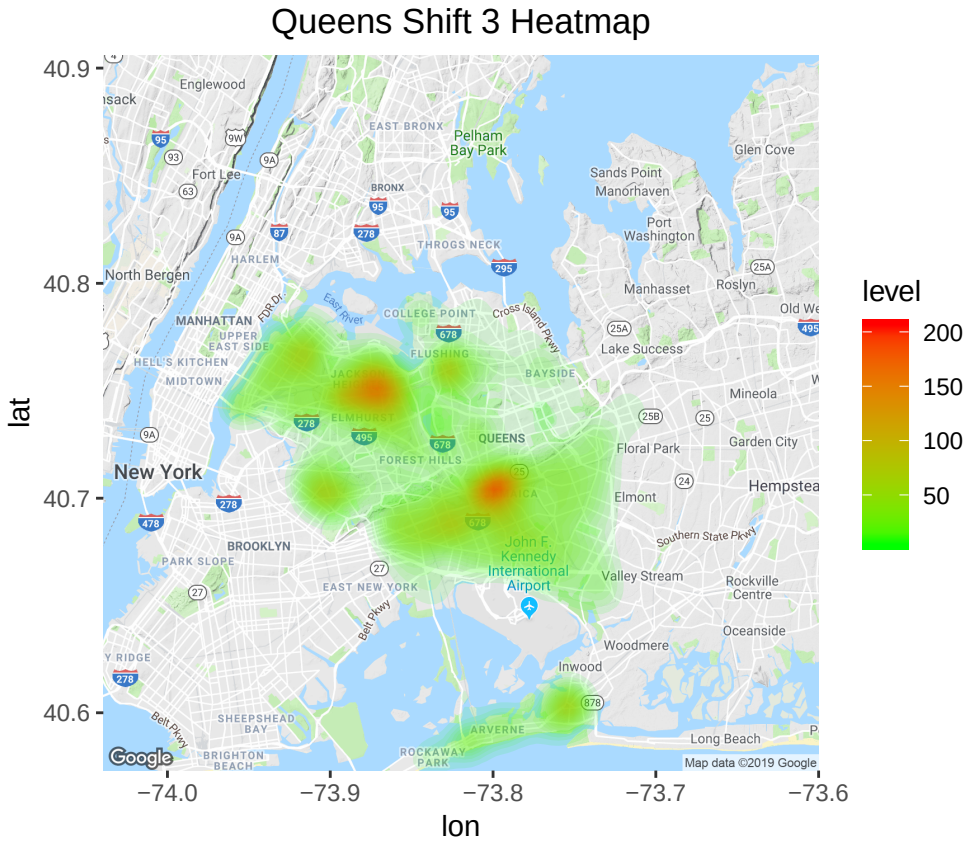



Brooklyn Shift 3 Heatmap
lat
40.8
40.7
40.6
lon
−74.1
−74.0
−73.9
−73.8
level
200
150
100
50
New York
Bayonne
North Bergen
Secaucus
Kearny
East Rutherford
MANHATTAN
BROOKLYN
QUEENS
BRONX
PARK SLOPE
BAY RIDGE
SHEEPSHEAD BAY
BRIGHTON BEACH
EAST NEW YORK
FLUSHING
JAMAICA
FOREST HILLS
ELMHURST
JACKSON HEIGHTS
COLLEGE POINT
THROGS NECK
BAYSIDE
HARLEM
UPPER EAST SIDE
HELL'S KITCHEN
MIDTOWN
ROCKAWAY PARK
ARVERNE
Inwood
John F. Kennedy International Airport
NEW JERSEY
NEW YORK
ST. GEORGE
NEW DORP
Upper Bay
Lower Bay
Belt Pkwy
FDR Dr
East River
Cross Island Pkwy
Google
Map data ©2019 Google

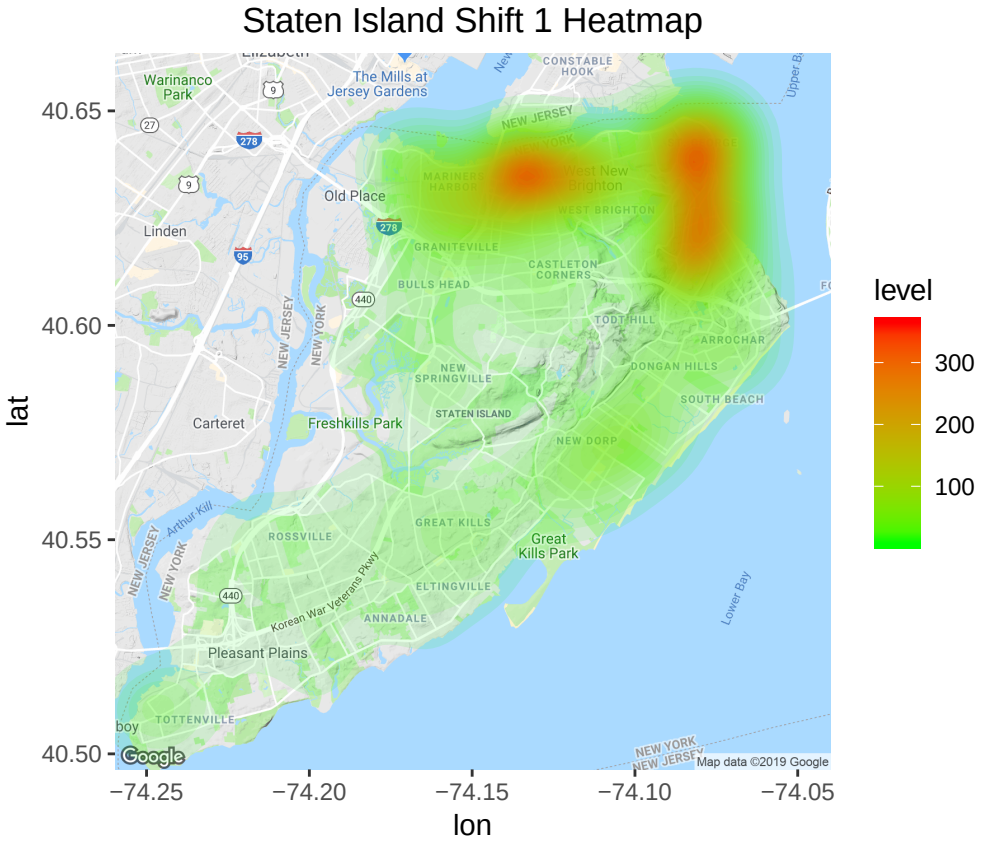
Comparing the hotspots in Queens by shifts

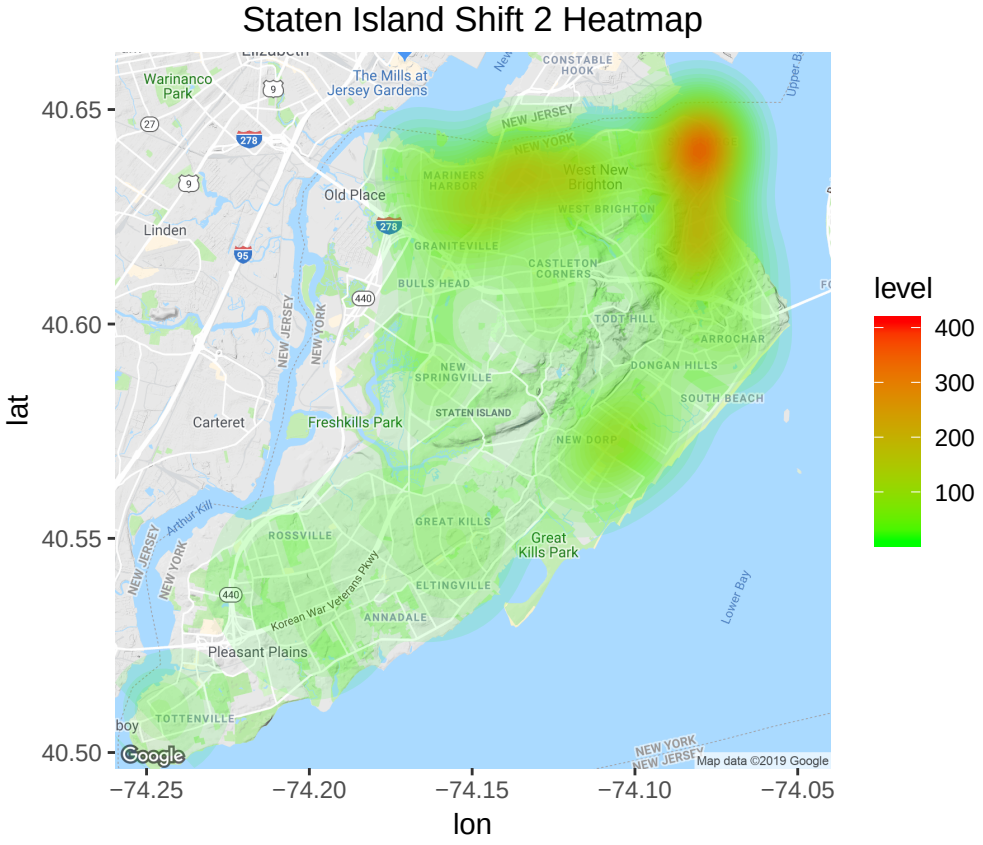


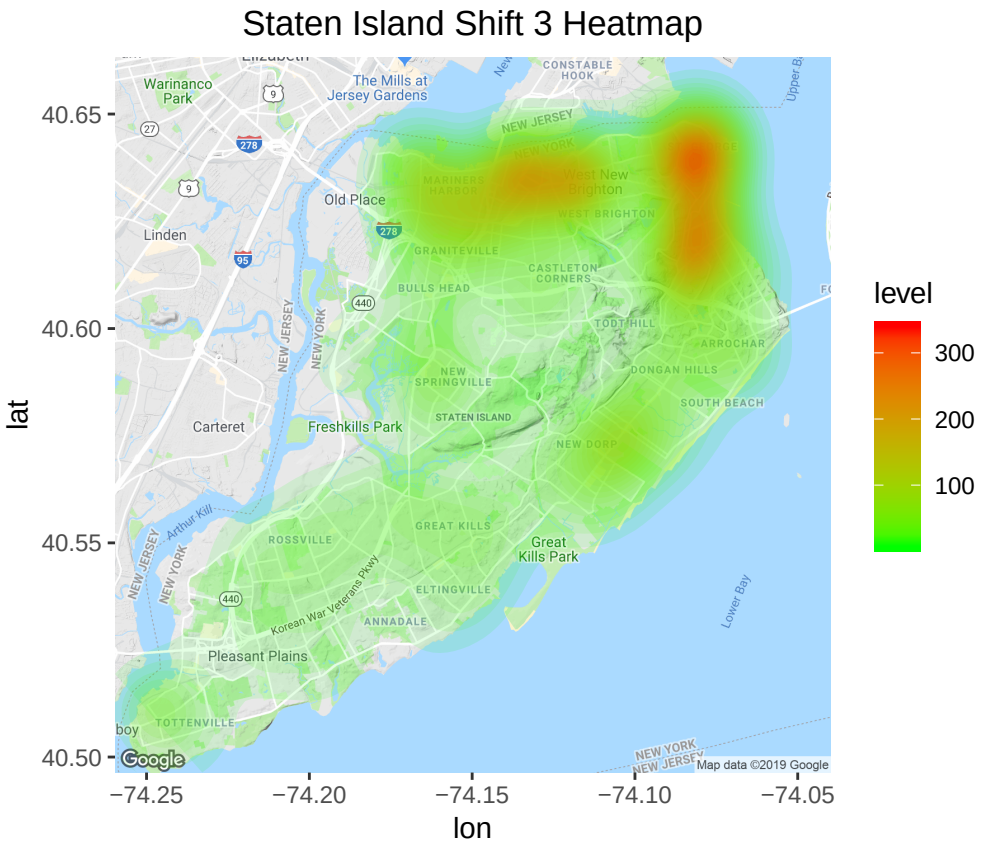



Queens Shift 3 Heatmap
lat
lon
level
200
150
100
50
40.9
40.8
40.7
40.6
−74.0
−73.9
−73.8
−73.7
−73.6
Englewood
Fort Lee
North Bergen
Pelham Bay Park
Glen Cove
Sands Point
Manorhaven
Port Washington
Manhasset
Roslyn
Lake Success
Mineola
Garden City
Floral Park
Hempstead
Elmont
Valley Stream
Rockville Centre
Oceanside
Woodmere
Inwood
Long Beach
John F. Kennedy International Airport
New York
MANHATTAN
BROOKLYN
QUEENS
BRONX
HARLEM
MIDTOWN
FLUSHING
BAYSIDE
COLLEGE POINT
ELMHURST
FOREST HILLS
EAST NEW YORK
PARK SLOPE
SHEEPSHEAD BAY
BRIGHTON BEACH
ROCKAWAY PARK
ARVERNE
THROGS NECK
EAST BRONX
Map data ©2019 Google

Comparing the hotspots in Staten Island by shifts







Machine Learning Linear Regression

Load the library

```
library(caTools)
```

Load the dataframe

```
str(holiday)
```

```
## 'data.frame':    2922 obs. of  8 variables:
##  $ Complaint_Date                  : Date, format: "2010-01-01" "2010-01-02" ...
##  $ Number_of_Complaints            : int  193 105 101 118 133 135 189 175 137 120 ...
##  $ Average_Temperature             : int  37 26 20 25 25 30 34 28 24 21 ...
##  $ Precipitation_Greater_3inches   : Factor w/ 2 levels "0 No","1 Yes": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Federal_Holidays_Description    : Factor w/ 18 levels "","Christmas Day",..: 13 1 1 1 1 1 1 1 1
##  $ Federal_Holidays                : Factor w/ 2 levels "0 No","1 Yes": 2 1 1 1 1 1 1 1 1 ...
##  $ Public_Schools_Closed_Description: Factor w/ 21 levels "Chancellor's Conference Day",..: 20 19 19
##  $ Public_Schools_Closed           : Factor w/ 2 levels "0 No","1 Yes": 2 2 2 1 1 1 1 1 2 2 ...
```

The dataframe have 8 columns. The columns are: The complaint date, number of complaints of that day, average temperature of that day, if that day have precipitation greater than 3 inches, federeal holidays descriptions, federal holidays, public schools closed decriptions, and public schools closed. Precipitation

greater than 3 inches have two factor levels, if the day have a precipitation greater than 3 inches then it will be "1 Yes" and if not then it will be "0 No". Federal holidays have two factors levels, if the day is a federal holiday then it will be "1 Yes" and if not then it will be "0 No". Public Schools Closed have two factors levels, if public school is closed for the day then it will be "1 Yes" and if not then it will be "0 No".

```
#18 factor levels of holiday description
levels(holiday$Federal_Holidays_Description)
```

```
##  [1] ""                        "Christmas Day"
##  [3] "Christmas Day (lieu)"    "Columbus Day"
##  [5] "Day after Thanksgiving"  "Election Day"
##  [7] "Independence Day"        "Independence Day (lieu)"
##  [9] "Labor Day"               "Lincoln's Birthday"
## [11] "Memorial Day"            "MLK Day"
## [13] "New Year's Day"          "New Year's Day (lieu)"
## [15] "Presidents' Day"         "Thanksgiving Day"
## [17] "Veterans Day"            "Veterans Day (lieu)"
```

```
#21 factor levels of public school closed description
levels(holiday$Public_Schools_Closed_Description)
```

```
##  [1] "Chancellor's Conference Day" "Clerical Day "
##  [3] "Columbus Day"                "Eid al-Adha"
##  [5] "Eid al-Fitr"                 "Election Day"
##  [7] "Good Friday"                 "Labor Day"
##  [9] "Memorial Day"                "Midwinter Recess"
## [11] "MLK Day"                     "Presidents' Day"
## [13] "Rosh Hashanah"               "School Day"
## [15] "Spring Recess"               "Summer Vacation"
## [17] "Thanksgiving Recess"         "Veterans Day"
## [19] "Weekend"                     "Winter Recess"
## [21] "Yom Kippur"
```

Linear Regression Model with Number of complaints as dependent variable and average temperature of the day as independent variable and looking at the summary

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Average_Temperature, data = holiday)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -109.345  -16.968   -0.167   16.461  119.467
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)         80.21428    1.56140   51.37   <2e-16 ***
## Average_Temperature  1.37330    0.02634   52.13   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 24.84 on 2920 degrees of freedom
```

```
## Multiple R-squared:  0.482,  Adjusted R-squared:  0.4819
## F-statistic:  2718 on 1 and 2920 DF,  p-value: < 2.2e-16
```

By looking at the summary, the average temperature as the independent variable is very significant to number of complaints as the dependent variable ('***') according to the the significant codes. The summary shows a positive estimate, which means as the average temperature increase, the number of complaints increases as well.

Linear Regreassion Model with Number of complaints as dependent variable and precipitation greater than 3 inches as independent variables and looking at the summary

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Precipitation_Greater_3inches,
##     data = holiday)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -102.601  -22.601    0.399   24.399  103.399
##
## Coefficients:
##                                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)                         160.6005     0.6621  242.57   <2e-16
## Precipitation_Greater_3inches1 Yes -23.2693     1.9822  -11.74   <2e-16
##
## (Intercept)                         ***
## Precipitation_Greater_3inches1 Yes ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 33.73 on 2920 degrees of freedom
## Multiple R-squared:  0.04507,    Adjusted R-squared:  0.04474
## F-statistic: 137.8 on 1 and 2920 DF,  p-value: < 2.2e-16
```

By looking at the summary, the precipitation greater than 3 inches as the independent variable is very significant to number of complaints as the dependent variable ('***') according to the the significant codes. The summary shows a negative estimate, which means when there is a day that have precipitation greater than 3 inches, the number of complaints decreases.

Linear Regreassion Model with Number of complaints as dependent variable and Federal holiday description as independent variable and looking at the summary

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Federal_Holidays_Description,
##     data = holiday)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -113.675  -22.675    1.325   24.325  105.325
##
## Coefficients:
```

```
##                                                Estimate Std. Error
## (Intercept)                                    158.6748     0.6317
## Federal_Holidays_DescriptionChristmas Day      -64.2998    11.8832
## Federal_Holidays_DescriptionChristmas Day (lieu)  -57.6748    19.3880
## Federal_Holidays_DescriptionColumbus Day       -15.9248    11.8832
## Federal_Holidays_DescriptionDay after Thanksgiving  -41.1748    13.7167
## Federal_Holidays_DescriptionElection Day       -21.6748    33.5692
## Federal_Holidays_DescriptionIndependence Day    36.7002    11.8832
## Federal_Holidays_DescriptionIndependence Day (lieu)  35.3252    23.7412
## Federal_Holidays_DescriptionLabor Day           32.0752    11.8832
## Federal_Holidays_DescriptionLincoln's Birthday  -37.9248    16.7935
## Federal_Holidays_DescriptionMemorial Day         3.4502    11.8832
## Federal_Holidays_DescriptionMLK Day            -55.7998    11.8832
## Federal_Holidays_DescriptionNew Year's Day      50.3252    11.8832
## Federal_Holidays_DescriptionNew Year's Day (lieu)  -42.6748    23.7412
## Federal_Holidays_DescriptionPresidents' Day    -67.5498    11.8832
## Federal_Holidays_DescriptionThanksgiving Day   -69.6748    11.8832
## Federal_Holidays_DescriptionVeterans Day       -15.1748    11.8832
## Federal_Holidays_DescriptionVeterans Day (lieu)  -23.6748    33.5692
##                                                t value Pr(>|t|)
## (Intercept)                                    251.188  < 2e-16 ***
## Federal_Holidays_DescriptionChristmas Day       -5.411 6.78e-08 ***
## Federal_Holidays_DescriptionChristmas Day (lieu)  -2.975  0.00296 **
## Federal_Holidays_DescriptionColumbus Day        -1.340  0.18031
## Federal_Holidays_DescriptionDay after Thanksgiving  -3.002  0.00271 **
## Federal_Holidays_DescriptionElection Day        -0.646  0.51854
## Federal_Holidays_DescriptionIndependence Day     3.088  0.00203 **
## Federal_Holidays_DescriptionIndependence Day (lieu)  1.488  0.13688
## Federal_Holidays_DescriptionLabor Day           2.699  0.00699 **
## Federal_Holidays_DescriptionLincoln's Birthday  -2.258  0.02400 *
## Federal_Holidays_DescriptionMemorial Day        0.290  0.77158
## Federal_Holidays_DescriptionMLK Day            -4.696 2.78e-06 ***
## Federal_Holidays_DescriptionNew Year's Day      4.235 2.36e-05 ***
## Federal_Holidays_DescriptionNew Year's Day (lieu)  -1.798  0.07236 .
## Federal_Holidays_DescriptionPresidents' Day     -5.684 1.44e-08 ***
## Federal_Holidays_DescriptionThanksgiving Day    -5.863 5.05e-09 ***
## Federal_Holidays_DescriptionVeterans Day        -1.277  0.20171
## Federal_Holidays_DescriptionVeterans Day (lieu)  -0.705  0.48071
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 33.56 on 2904 degrees of freedom
## Multiple R-squared:  0.05987,    Adjusted R-squared:  0.05436
## F-statistic: 10.88 on 17 and 2904 DF,  p-value: < 2.2e-16
```

By looking at the summary, the federal holidays descripitions as the independent variables have different significant factor level to number of complaints as the dependent variable. Factor levels of "Christmas Day", "Martin Luther King Jr. Day", "New Year", "Thankgiving Day", and "Presidents' Day" are very significant with ('3stars'). Factor levels of "Christmas Day (lieu)", "Day after Thanksgiving", "Independence Day", and "Labor Day" are significant with ('2stars'). Factor level of "Lincoln's Birthday" are significant with ('1star'). Factor level of "New Year's Day (lieu)" are significant with ('.'). Factor levels of "Columbus Day", "Election Day", "Independence Day (lieu)", "Memorial Day", "Veterans Day", and "Veterans Day (lieu)" are not significant at all. The summary shows a postive estimate on "New Year's Day", "Independence Day", and "Labor Day" for the significant independent variables. The summary shows a negative estimate on

"Christmas Day", "Chrismas Day (lieu)", "Day after Thanksgiving", "Lincolin's Birthday", "Martin Luther King Jr. Day", "New Year's Day (lieu)", "Presidents' Day", and "Thanksgiving Day".

Linear Regreassion Model with Number of complaints as dependent variable and Federal holiday as independent variable and looking at the summary

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Federal_Holidays, data = holiday)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -113.675  -23.675    1.325   24.325  106.111
##
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)            158.6748     0.6462 245.548  < 2e-16 ***
## Federal_Holidays1 Yes -19.7859     3.5107  -5.636 1.91e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 34.33 on 2920 degrees of freedom
## Multiple R-squared:  0.01076,    Adjusted R-squared:  0.01042
## F-statistic: 31.76 on 1 and 2920 DF,  p-value: 1.908e-08
```

By looking at the summary, federal holiday as the independent variable is very significant to number of complaints as the dependent variable ('***') according to the the significant codes. The summary shows a negative estimate, which means when there is a federal holiday, the number of complaints decreases overall.

Linear Regreassion Model with Number of complaints as dependent variable and Public school closed descriptions as independent variable and looking at the summary

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Public_Schools_Closed_Description,
##     data = holiday)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -116.372  -20.843    0.157   22.157  133.552
##
## Coefficients:
##                                                    Estimate Std. Error
## (Intercept)                                         154.200      8.387
## Public_Schools_Closed_DescriptionClerical Day        -6.200     33.550
## Public_Schools_Closed_DescriptionColumbus Day       -11.450     14.222
## Public_Schools_Closed_DescriptionEid al-Adha        -13.700     24.453
## Public_Schools_Closed_DescriptionEid al-Fitr         24.800     33.550
## Public_Schools_Closed_DescriptionElection Day       -25.200     14.222
## Public_Schools_Closed_DescriptionGood Friday          -7.200     33.550
## Public_Schools_Closed_DescriptionLabor Day            37.657     14.869
## Public_Schools_Closed_DescriptionMemorial Day          7.925     14.222
```

```
## Public_Schools_Closed_DescriptionMidwinter Recess     -37.129     10.394
## Public_Schools_Closed_DescriptionMLK Day              -51.325     14.222
## Public_Schools_Closed_DescriptionPresidents' Day      -63.075     14.222
## Public_Schools_Closed_DescriptionRosh Hashanah         10.362     11.675
## Public_Schools_Closed_DescriptionSchool Day             2.643      8.431
## Public_Schools_Closed_DescriptionSpring Recess        -17.315      9.521
## Public_Schools_Closed_DescriptionSummer Vacation       18.592      8.547
## Public_Schools_Closed_DescriptionThanksgiving Recess  -49.013     11.675
## Public_Schools_Closed_DescriptionVeterans Day         -12.629     14.869
## Public_Schools_Closed_DescriptionWeekend                7.172      8.462
## Public_Schools_Closed_DescriptionWinter Recess        -42.752      9.410
## Public_Schools_Closed_DescriptionYom Kippur            14.300     24.453
##                                                    t value Pr(>|t|)
## (Intercept)                                         18.385  < 2e-16 ***
## Public_Schools_Closed_DescriptionClerical Day        -0.185 0.853399
## Public_Schools_Closed_DescriptionColumbus Day        -0.805 0.420821
## Public_Schools_Closed_DescriptionEid al-Adha         -0.560 0.575353
## Public_Schools_Closed_DescriptionEid al-Fitr          0.739 0.459846
## Public_Schools_Closed_DescriptionElection Day        -1.772 0.076508 .
## Public_Schools_Closed_DescriptionGood Friday         -0.215 0.830090
## Public_Schools_Closed_DescriptionLabor Day            2.533 0.011377 *
## Public_Schools_Closed_DescriptionMemorial Day         0.557 0.577400
## Public_Schools_Closed_DescriptionMidwinter Recess    -3.572 0.000360 ***
## Public_Schools_Closed_DescriptionMLK Day             -3.609 0.000313 ***
## Public_Schools_Closed_DescriptionPresidents' Day     -4.435 9.54e-06 ***
## Public_Schools_Closed_DescriptionRosh Hashanah        0.888 0.374834
## Public_Schools_Closed_DescriptionSchool Day           0.314 0.753898
## Public_Schools_Closed_DescriptionSpring Recess       -1.819 0.069057 .
## Public_Schools_Closed_DescriptionSummer Vacation      2.175 0.029693 *
## Public_Schools_Closed_DescriptionThanksgiving Recess -4.198 2.77e-05 ***
## Public_Schools_Closed_DescriptionVeterans Day        -0.849 0.395784
## Public_Schools_Closed_DescriptionWeekend              0.848 0.396711
## Public_Schools_Closed_DescriptionWinter Recess       -4.543 5.76e-06 ***
## Public_Schools_Closed_DescriptionYom Kippur           0.585 0.558738
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 32.48 on 2901 degrees of freedom
## Multiple R-squared:  0.1202, Adjusted R-squared:  0.1142
## F-statistic: 19.82 on 20 and 2901 DF,  p-value: < 2.2e-16
```

By looking at the summary, the public school closed descripitions as the independent variables have different significant factor level to number of complaints as the dependent variable. Factor levels of “Midwinter Recess”, “Martin Luther King Jr. Day”, “Thanksgiving Recess”, “Winter Recess”, and “Presidents’ Day” are very significant with (‘3stars’). Factor levels of “Summer Vacation” and " Labor Day" are significant with (‘1star’). Factor levels of “Election Day” and “Spring Recess” are significant with (‘.’). Factor levels of “Clerical Day”, “Columbus Day”, “al-Adha”, “al-Fitr”, “Good Friday”, “Memorial Day”, “Rosh Hashanah”, “Veterans Day”, “Weekend”, and “Yom Kippur” are not significant at all. The summary shows a postive estimate on “Labor Day” and “Summer Vacation” for the significant independent variables. The summary shows a negative estimate on “Election Day”, “Midwinter Recess”, “Martin Luther King Jr. Day”, “Presidents’ Day”, “Spring Recess”, “Thankgiving Recess”, and “Winter Recess” for the significant independent variables.

Linear Regreassion Model with Number of complaints as dependent variable and Public school closed as independent variable and looking at the summary

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Public_Schools_Closed, data = holiday)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -114.137  -23.843    1.157   24.863  104.863
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 156.8434     0.9082 172.688   <2e-16 ***
## Public_Schools_Closed1 Yes   2.2939     1.2766   1.797   0.0725 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 34.5 on 2920 degrees of freedom
## Multiple R-squared:  0.001104,   Adjusted R-squared:  0.0007624
## F-statistic: 3.229 on 1 and 2920 DF,  p-value: 0.07246
```

By looking at the summary, public school closed as the independent variable is significant to number of complaints as the dependent variable (‘.’) according to the the significant codes. The summary shows a postive estimate, which means when public school close, the number of complaints increases overall.

Linear Regression Model with Number of complaints as dependent variable and average temperature of the day with precipitation greater than 3 inches as independent variables and looking at the summary (Holiday.Model1)

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Average_Temperature + Precipitation_Greater_3inches,
##     data = holiday)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -88.862 -15.696  -0.608  15.376 116.867
##
## Coefficients:
##                                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)                         82.8565     1.5022   55.16   <2e-16
## Average_Temperature                  1.3720     0.0252   54.45   <2e-16
## Precipitation_Greater_3inches1 Yes -23.0362     1.3964  -16.50   <2e-16
##
## (Intercept)                        ***
## Average_Temperature                ***
## Precipitation_Greater_3inches1 Yes ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23.77 on 2919 degrees of freedom
## Multiple R-squared:  0.5262, Adjusted R-squared:  0.5259
```

```
## F-statistic:  1621 on 2 and 2919 DF,  p-value: < 2.2e-16
```

Both average temperature of the day and precipitation greater than 3 inches are very significant to the number of complaints ('***'). The multiple R-square increased from 0.482 to 0.5262.

Linear Regression Model with Number of complaints as dependent variable and average temperature of the day with precipitation greater than 3 inches and federal holidays as independent variables and looking at the summary (Holiday.Model2)

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Average_Temperature + Precipitation_Greater_3inches +
##     Federal_Holidays, data = holiday)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -89.059 -15.945  -0.766  15.151 128.641
##
## Coefficients:
##                                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)                        83.74157    1.50572  55.616  < 2e-16
## Average_Temperature                 1.36407    0.02514  54.259  < 2e-16
## Precipitation_Greater_3inches1 Yes -23.16791    1.39070 -16.659  < 2e-16
## Federal_Holidays1 Yes              -12.39676    2.42466  -5.113 3.38e-07
##
## (Intercept)                        ***
## Average_Temperature                ***
## Precipitation_Greater_3inches1 Yes ***
## Federal_Holidays1 Yes              ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23.66 on 2918 degrees of freedom
## Multiple R-squared:  0.5304, Adjusted R-squared:  0.5299
## F-statistic:  1099 on 3 and 2918 DF,  p-value: < 2.2e-16
```

The independent variable of average temperature of the day, precipitation greater than 3 inches, and federal holiday are very significant to the number of complaints ('***'). The multiple R-square increased from 0.5262 to 0.5304.

Linear Regression Model with Number of complaints as dependent variable and average temperature of the day with precipitation greater than 3 inches, federal holidays, public school closed as independent variables and looking at the summary (Holiday.Model3)

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Average_Temperature + Precipitation_Greater_3inches +
##     Federal_Holidays + Public_Schools_Closed, data = holiday)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -92.881 -15.414  -1.455  14.954 130.202
```

```
##
## Coefficients:
##                                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)                        84.49844    1.47789  57.175  < 2e-16
## Average_Temperature                 1.43611    0.02552  56.274  < 2e-16
## Precipitation_Greater_3inches1 Yes -23.47537    1.36378 -17.213  < 2e-16
## Federal_Holidays1 Yes               -7.25984    2.42355  -2.996  0.00276
## Public_Schools_Closed1 Yes          -9.83251    0.90273 -10.892  < 2e-16
##
## (Intercept)                       ***
## Average_Temperature               ***
## Precipitation_Greater_3inches1 Yes ***
## Federal_Holidays1 Yes             **
## Public_Schools_Closed1 Yes        ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23.2 on 2917 degrees of freedom
## Multiple R-squared:  0.5488, Adjusted R-squared:  0.5482
## F-statistic: 886.9 on 4 and 2917 DF,  p-value: < 2.2e-16
```

When the public school closed independent variable is added to the linear regression model, the federal holidays significance decrease to ('**'). All other independent variables have the significant code ('3stars'). The multiple R-square increased from 0.5304 to 0.5488.

Looking at the RMSE(root mean square error)

```
##RMSE for Holiday.Model1
SSE.model1 <- sum(holiday.model1$residuals^2)
SSE.model1
```

```
## [1] 1648606
```

```
RMSE.model1 <- sqrt(SSE.model1/nrow(holiday))
RMSE.model1
```

```
## [1] 23.75299
```

```
##RMSE for Holiday.Model2
SSE.model2 <- sum(holiday.model2$residuals^2)
SSE.model2
```

```
## [1] 1633968
```

```
RMSE.model2 <- sqrt(SSE.model2/nrow(holiday))
RMSE.model2
```

```
## [1] 23.64731
```

```
##RMSE for Holiday.Model2
SSE.model3 <- sum(holiday.model3$residuals^2)
SSE.model3
```

```
## [1] 1570111
```

```
RMSE.model3 <- sqrt(SSE.model3/nrow(holiday))
RMSE.model3
```

```
## [1] 23.18062
```

The root mean square error is the least on model3 and the multiple r-squared is the largest in model3. I will be using model3 for prediction.

Splitting the data into training and test data

```
set.seed(314)
holiday.split <- sample.split(holiday$Number_of_Complaints, SplitRatio =  0.65)
holiday.train <- holiday[ holiday.split == TRUE, ]
nrow(holiday.train)
```

```
## [1] 1908
```

```
holiday.test <- holiday[ holiday.split == FALSE, ]
nrow(holiday.test)
```

```
## [1] 1014
```

The dataset is splitted into training set and testing set. 65% is in the training set and 35% is in the testing set.

Creating the model

```
holiday.model3.train <- lm(Number_of_Complaints~ Average_Temperature+Precipitation_Greater_3inches+Fede
summary(holiday.model3.train)
```

```
##
## Call:
## lm(formula = Number_of_Complaints ~ Average_Temperature + Precipitation_Greater_3inches +
##     Federal_Holidays + Public_Schools_Closed, data = holiday.train)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -92.267 -15.442  -0.783  15.001 132.311
##
## Coefficients:
##                                   Estimate Std. Error t value Pr(>|t|)
```

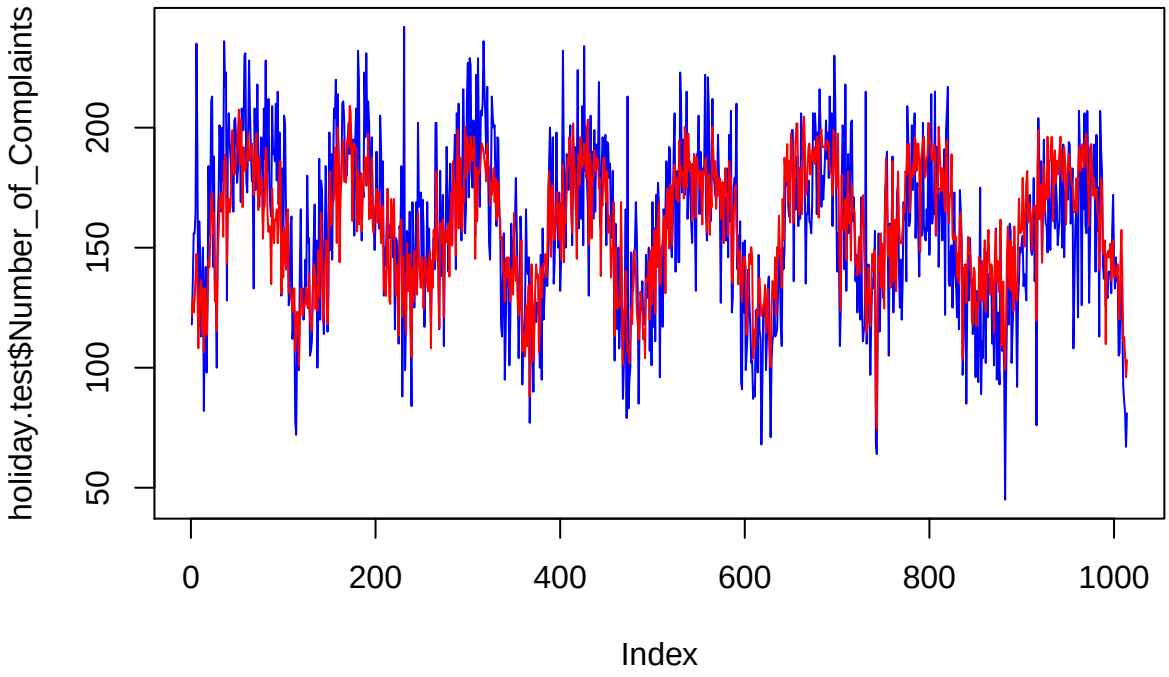
```
## (Intercept)                          85.81361    1.84543  46.501  < 2e-16
## Average_Temperature                   1.43177    0.03181  45.010  < 2e-16
## Precipitation_Greater_3inches1 Yes -25.15789    1.65178 -15.231  < 2e-16
## Federal_Holidays1 Yes               -9.10653    3.07726  -2.959  0.00312
## Public_Schools_Closed1 Yes         -11.26692    1.12332 -10.030  < 2e-16
##
## (Intercept)                         ***
## Average_Temperature                 ***
## Precipitation_Greater_3inches1 Yes ***
## Federal_Holidays1 Yes               **
## Public_Schools_Closed1 Yes          ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23.34 on 1903 degrees of freedom
## Multiple R-squared:  0.5505, Adjusted R-squared:  0.5495
## F-statistic: 582.6 on 4 and 1903 DF,  p-value: < 2.2e-16
```

The independent variable of federal holidays decreased to ('*') on the significant level for the train set but the multiple r-squared have increased from 0.5488 to 0.557.

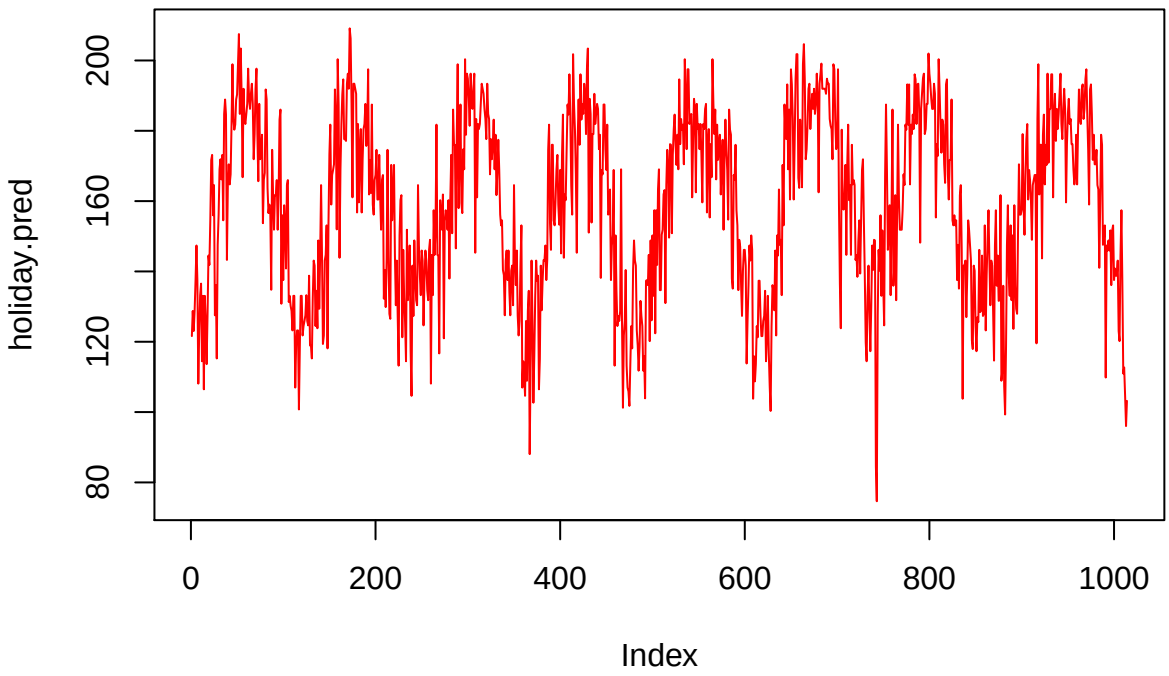
Prediction

```
holiday.pred <- predict(holiday.model3.train, holiday.test)
```

Comparing predicted vs actual values



The test set number of complaints is in blue and the prediction is in red.



Showing only the prediction

Conclusion

The public crime complaints in New York City have decreased 16.38% at the end of 2017. Brooklyn is the borough in New York City that have the most public crime activity that violate pedestrians. There is a strong correlation between public crime activity and weather temperature. As the temperature decreased, the number of crime activities decreased as well. Same as the temperature increased, the number of crime activities increased. The most crime activity happens at the hour 16:01 - 24:00 (shift 3). The hotspots for each borough are shown on the heatmaps above.