Visualizations

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Read in dataset

```
library(readr)
tx_houston <- read_csv("/Users/virginiabaskin/Downloads/tx_houston_2023_01_26.csv")
```

```
## Rows: 2045972 Columns: 21
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr  (13): raw_row_number, location, geocode_source, beat, subject_race, sub...
## dbl   (5): lat, lng, district, speed, posted_speed
## lgl   (1): citation_issued
## date  (1): date
## time  (1): time
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
head(tx_houston)
```

```
## # A tibble: 6 x 21
##   raw_row_number      date       time  location   lat   lng geocode_source beat
##   <chr>               <date>     <tim> <chr>    <dbl> <dbl> <chr>          <chr>
## 1 1666931             2017-10-11    NA 200 PAR~  29.9 -95.4 GM             6B10
## 2 2600478             2020-05-06 16:05 10200 C~  29.7 -95.6 GM             19G10
## 3 1678019|1679214     2017-10-25    NA I 69 AN~  29.9 -95.4 GM             6B10
## 4 2225754             2019-02-28 18:45 WHITE O~  29.8 -95.4 GM             2A30
## 5 1343418|1343980|13~ 2016-11-22    NA US 59 A~  29.7 -95.5 GM             20G20
## 6 213563              2014-05-12    NA IH 45     30.0 -95.4 GM             <NA>
## # ... with 13 more variables: district <dbl>, subject_race <chr>,
## #   subject_sex <chr>, type <chr>, violation <chr>, citation_issued <lgl>,
## #   outcome <chr>, speed <dbl>, posted_speed <dbl>, vehicle_color <chr>,
## #   vehicle_make <chr>, vehicle_model <chr>, raw_race <chr>
```

Created smaller dataset to work with initially.

Our computers were struggling to work with the entire dataset, so we created a mini dataset by randomly sampling 1,000 rows. We will use this dataset for creating the graphs/brainstorming, then we will run the code on the large dataset as a final step.

```
mini_htx <- read_csv("Datasets/mini_htx.csv")
```

```
## Rows: 1000 Columns: 21
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr  (13): raw_row_number, location, geocode_source, beat, subject_race, sub...
## dbl   (5): lat, lng, district, speed, posted_speed
## lgl   (1): citation_issued
## date  (1): date
## time  (1): time
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
mini_htx
```

```
## # A tibble: 1,000 x 21
##    raw_row_number     date       time  location   lat   lng geocode_source beat
##    <chr>              <date>     <tim> <chr>    <dbl> <dbl> <chr>          <chr>
##  1 663776             2015-04-20    NA WESTPAR~  29.7 -95.6 GM             20G30
##  2 1192067|1192068|1~ 2016-06-29    NA 7900 BE~  29.7 -95.3 GM             13D20
##  3 2310495            2019-05-19 14:54 3500 I ~  29.8 -95.3 SU             7C20
##  4 1853763            2018-04-04 15:03 6700 MA~  29.7 -95.3 GM             14D30
##  5 929890             2015-12-03    NA 1700 SH~  29.8 -95.6 GM             20G80
##  6 1711161            2017-11-28    NA WERNER ~  29.8 -95.4 GM             3B40
##  7 227242|228252      2014-05-20    NA 8100 HA~  29.8 -95.5 GM             5F20
##  8 1680418            2017-10-26    NA 6450 LA~  29.7 -95.3 GM             11H10
##  9 1378910|1379749    2016-12-28    NA 15100 L~  29.9 -95.3 GM             22B40
## 10 1758279|1758280    2018-01-17 11:05 7800 AI~  29.7 -95.3 GM             23J50
## # ... with 990 more rows, and 13 more variables: district <dbl>,
## #   subject_race <chr>, subject_sex <chr>, type <chr>, violation <chr>,
## #   citation_issued <lgl>, outcome <chr>, speed <dbl>, posted_speed <dbl>,
## #   vehicle_color <chr>, vehicle_make <chr>, vehicle_model <chr>,
## #   raw_race <chr>
```

```
colSums(is.na(mini_htx))
```

```
##  raw_row_number            date            time        location             lat
##               0               0             630              61              63
##             lng  geocode_source            beat        district    subject_race
##              63              63             120             120             208
##     subject_sex            type       violation citation_issued         outcome
##               4               0               0               0               0
##           speed    posted_speed   vehicle_color    vehicle_make   vehicle_model
##             686             677              27               9              22
##        raw_race
##             208
```

```
mini_htx <- read_csv("/Users/virginiabaskin/Downloads/tx_houston_2023_01_26.csv")
```

```
## Rows: 2045972 Columns: 21
```

```
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr  (13): raw_row_number, location, geocode_source, beat, subject_race, sub...
## dbl   (5): lat, lng, district, speed, posted_speed
## lgl   (1): citation_issued
## date  (1): date
## time  (1): time
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

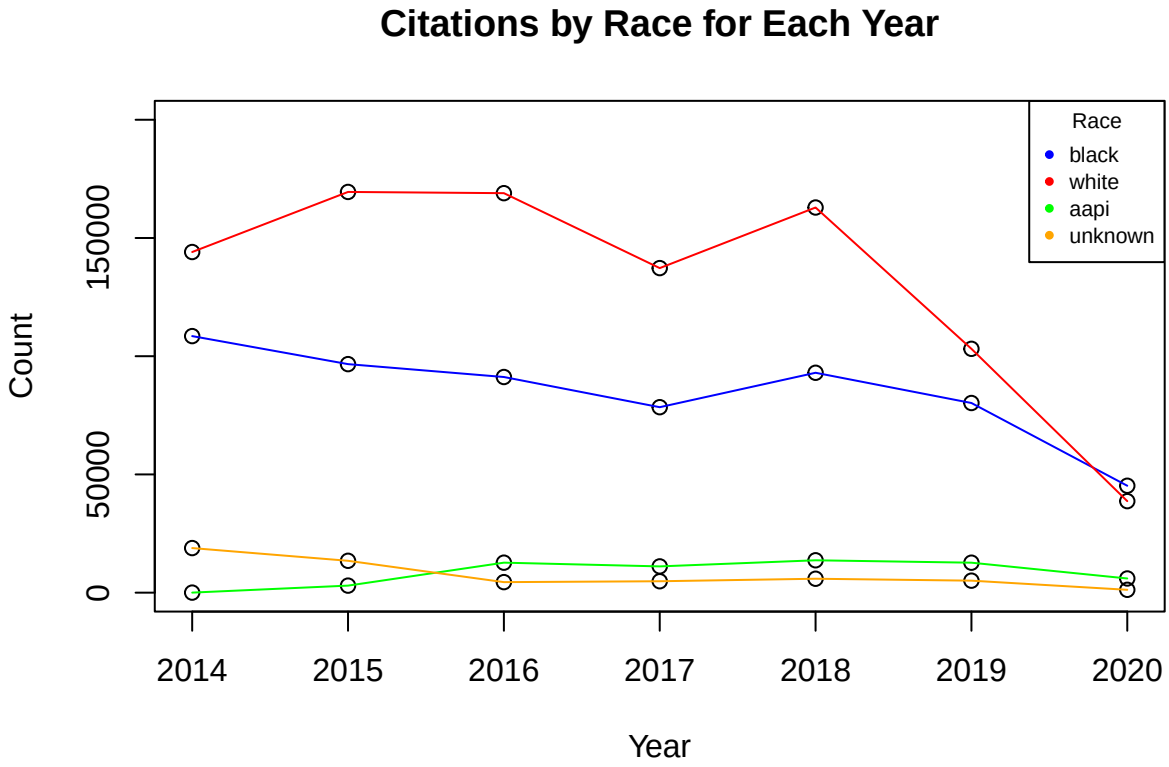
Visualizations

Before we go into visualizations, we would like to introduce our data. Our dataset is on police stops that result in citations in Houston, TX from 2015-2018. The data is from the Stanford Open Policing project and contains a little over 2 million rows. The fields of the dataset include (non-exhaustively): the date, time, location, latitude, longitude of the stop, the police beat of the officer, district, the subject's race, sex, the type of violation they receive, and the vehicle make, model, and color.

Plot 1

```
# visualize totals for each race
# Grace
# visualize totals for each race by year
# Grace

race_date <- mini_htx[,c("date", "subject_race")] # race and date
race_date <- na.omit(race_date) # omit na Values

year_only <- function(fulldate){
  year <- substring(fulldate, 1, 4) # only keep year
}

black <- race_date[race_date$subject_race=="black",]
black$year <- unlist(lapply(black$date, year_only))
plot(sort(unique(black$year)), as.vector(table((as.factor(black$year)))), ylim = c(0, 200000), main = "
lines(sort(unique(black$year)), as.vector(table((as.factor(black$year)))), type = "l", col = "blue")

white <- race_date[race_date$subject_race=="white",]
white$year <- unlist(lapply(white$date, year_only))
points(sort(unique(white$year)), as.vector(table(as.factor(white$year))))
lines(sort(unique(white$year)), as.vector(table((as.factor(white$year)))), type = "l", col = "red")

aapi <- race_date[race_date$subject_race=="asian/pacific islander",]
aapi$year <- unlist(lapply(aapi$date, year_only))
points(sort(unique(aapi$year)), as.vector(table(as.factor(aapi$year))))
lines(sort(unique(aapi$year)), as.vector(table((as.factor(aapi$year)))), type = "l", col = "green")


unknown <- race_date[race_date$subject_race=="unknown",]
unknown$year <- unlist(lapply(unknown$date, year_only))
```

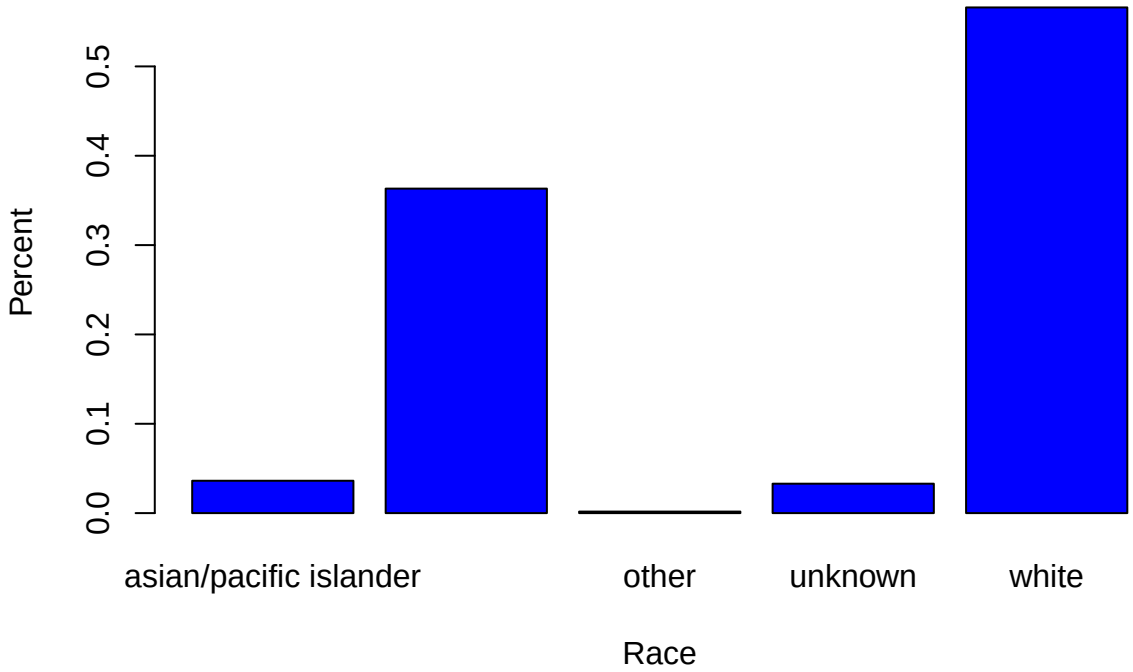
```
points(sort(unique(unknown$year)), as.vector(table(as.factor(unknown$year))))
lines(sort(unique(unknown$year)), as.vector(table((as.factor(unknown$year)))), type = "l", col = "orang

legend("topright", legend=c("black", "white", "aapi", "unknown"), col=c("blue", "red", "green", "orange
```



First, we turn our attention to the total individuals of each race issued citations in each year 2014-2020. From 2014-2018, the greatest number of individuals issued citations were white, but in 2019 and 2020, black individuals were issued the most citations of any racial group. Overall, individuals of unknown race and asian/pacific islanders received significantly fewer citations than white and black individuals. In 2019 and 2020, a decrease in citations issued to white individuals can be observed. This data is not sufficient for drawing conclusions of racial bias in the citation process; more investigation is necessary into confounding factors.

Plot 2

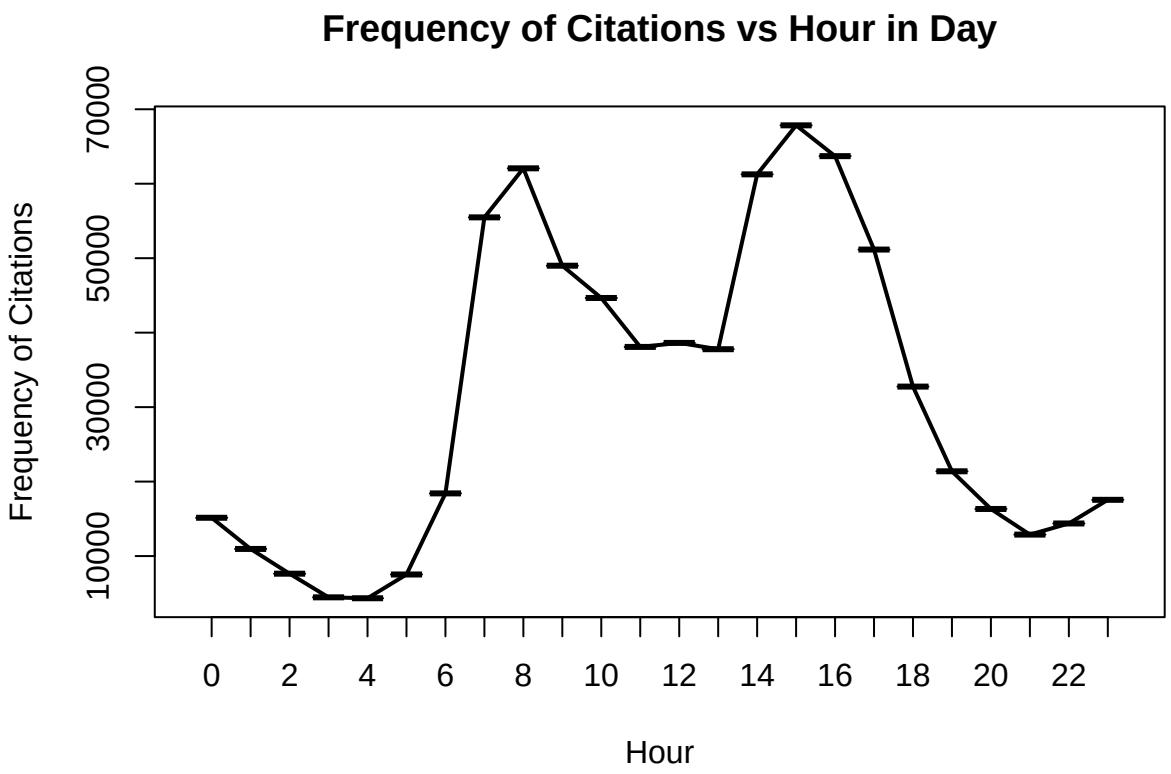
```
# x axis: race
# y axis: Count
# two bars per race for citation issued true and citation issued false
# visualize to investigate for evidence of racial bias
# Siddhi
counts <- table(mini_htx$citation_issued, mini_htx$subject_race)
counts <- na.omit(counts)
barplot(counts/sum(counts), main = "% Citation by Race", xlab = "Race", ylab = "Percent", col = "blue",
```



Now we will look at the Citation Count by Race. As we can see, white individuals have the highest percentage of citations, followed by black individuals, unknown races, and finally, Asian/pacific individuals. This is somewhat proportional to the actual demographics of Houston (according to the U.S. census) – the White and Black percentages of citations are slightly higher than their population in Houston, while the proportion of citations gotten by Asian individuals is slightly lower than the proportion of Asian people in Houston.

Plot 3

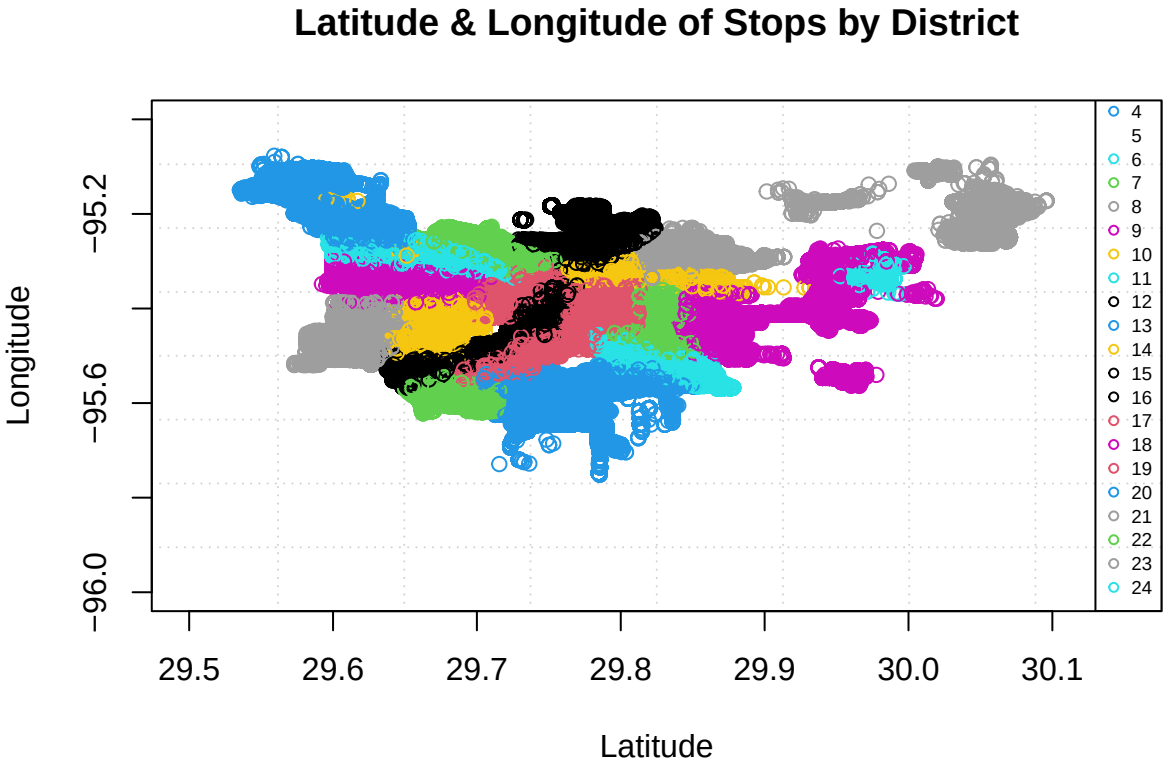
```
# Observe citations over time and any time-associate patterns
# Siddhi
time <- as.POSIXct(mini_htx$time, format = "%H:%M:%S")
hour <- as.numeric(format(time, "%H"))
count <- data.frame(table(na.omit(hour)))
plot(count$Var1, count$Freq, type = "n", xlab = "Hour", ylab = "Frequency of Citations", main = "Freque
lines(count$Var1, count$Freq, type = "l", lwd = 2)
```



Now we will look at the Frequency of citations over the Hours of the Day.Citations are most common around 8 am, and around 3 pm. There may be a higher proportion of citations around 8 am because of high travel due to work. We are not quite sure why another peak is found at 3 pm, it may be people returning from school and/or work. We also see less citations during the super late/super early hours – likely due to less travel as a whole.

Plot 4

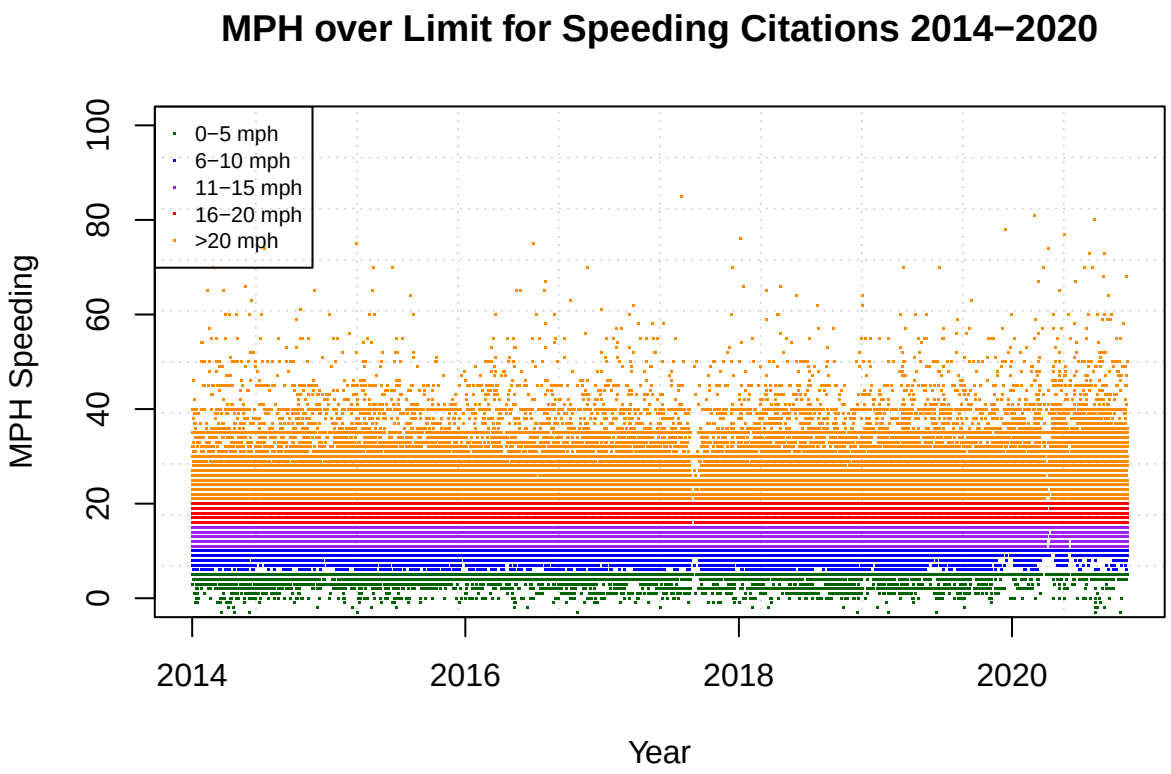
```
# Verifying the hubs for citation and locations of districts
# Virginia
mini_htx2 <- mini_htx
mini_htx2$district <- factor(mini_htx2$district)

plot(mini_htx2$lat, mini_htx2$lng, col = mini_htx2$district, panel.first = grid(8,8),  xlim = c(29.5, 3
legend("bottomright", legend=levels(mini_htx2$district), cex = 0.62, pch=1, col=unique(mini_htx2$distri
```



Next, we want to explore the spatial features of our data. We have both the latitude and the longitude of each stop, along with the district and beat. We knew that beat meant a motorized police unit that patrols a specific territory, but "district" in this context is not as clear, as it could mean multiple things. We investigated this by creating a scatterplot of the latitude versus the longitude of stops and colored it by district. We see very clear spatial grouping for each district, which means districts are not a police-defined feature but a location feature. From this plot, we can ascertain that district refers to Houston's subdistricts.

Plot 5

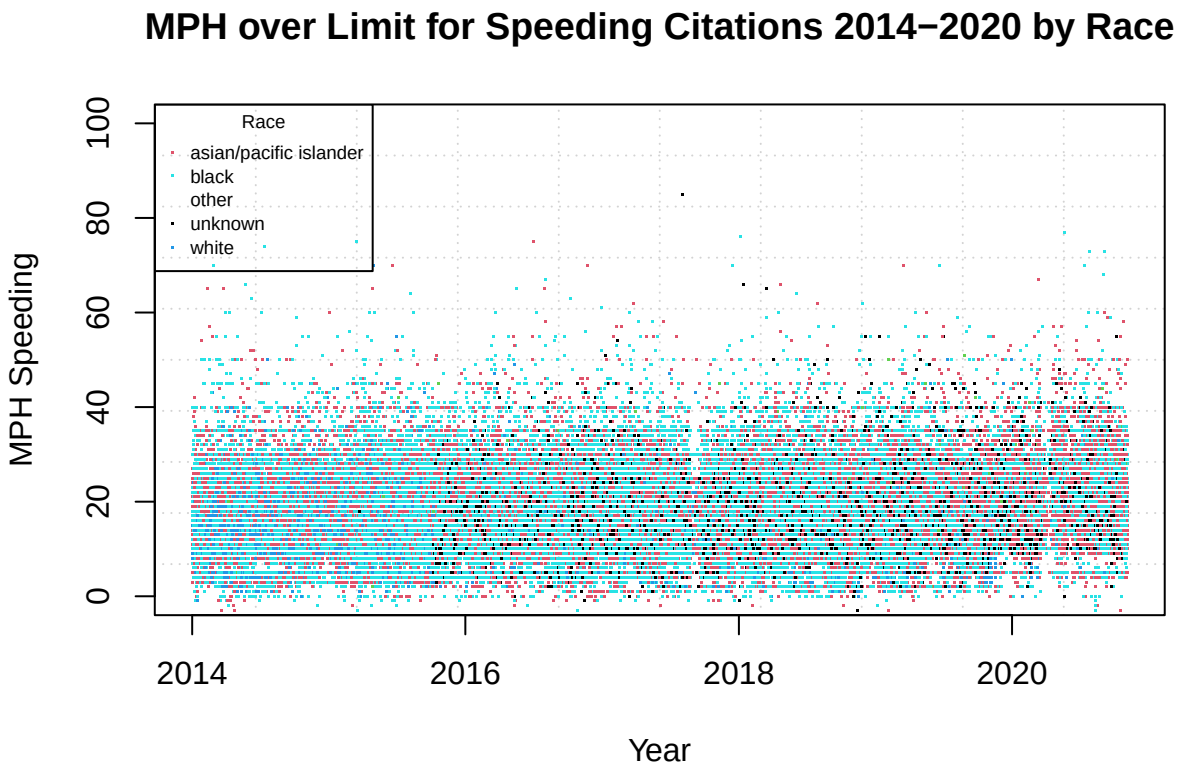
```
# if we want to do a line plot
# Virginia
mini_htx2$diff <- (mini_htx2$speed - mini_htx2$posted_speed)
diff <- mini_htx2$diff


plot(mini_htx2$date, mini_htx2$diff, main = "MPH over Limit for Speeding Citations 2014-2020",
     xlab = "Year", ylab = "MPH Speeding", pch = ".", panel.first = grid(10,10),ylim = c(0,100),
     col = ifelse((diff <= 5), "dark green",
                  ifelse((diff <= 10), "blue",
                         ifelse((diff <= 15), "purple",
                                ifelse((diff <= 20), "red", "dark orange")))))

legend("topleft", legend = c("0-5 mph", "6-10 mph", "11-15 mph", "16-20 mph", ">20 mph"),
       col = c("dark green", "blue", "purple", "red", "dark orange"), pch = ".", cex = 0.7)
```



This plot investigates citations that are given for speeding. Namely, by how much were people speeding to have been issued a citation. We colored different instances of citation by levels of severity. The x axis is the year/general time from the citation occurred in, and there does not seem to be any evidence of temporal trends (i.e. no one year ticketed people more / for slower speeds than other years).

Plot 5.5

```
plot(mini_htx2$date, mini_htx2$diff, main = "MPH over Limit for Speeding Citations 2014-2020 by Race",
     xlab = "Year", ylab = "MPH Speeding", pch = ".", panel.first = grid(10,10), col = factor(mini_htx2$

legend("topleft", legend=levels(factor(mini_htx2$subject_race)), cex = 0.62, pch=".", col=unique(factor
```



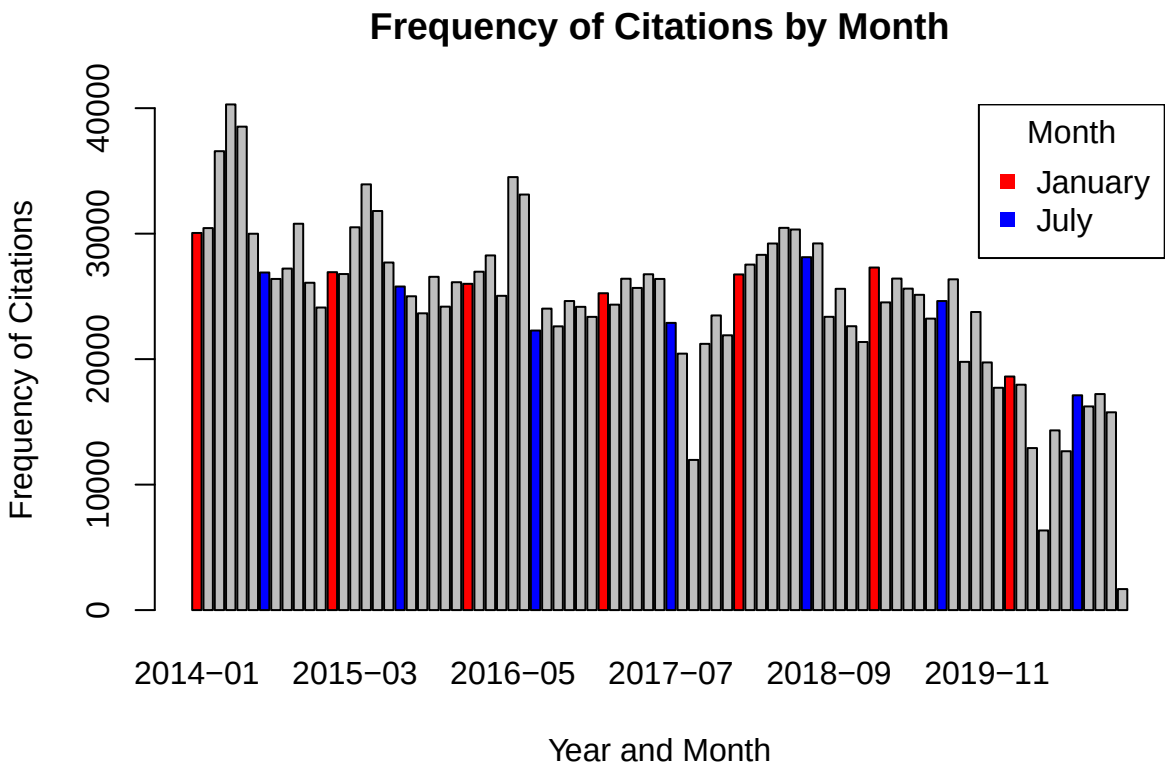
Just for fun, I colored the amount people were speeding by using the person's race to investigate if there were any observable affects there.

Some of the observations disappear (clearly seen in citation where the subject is 35+ mph over the speed limit in 2019) for the second plot of this type. This is due to the speed citation not recording the subject's race. Therefore, they are omitted from this plot.

Some of the points are not colored (the black Xs), which are observations that

Plot 6

```
# x axis is the time of day
# y is frequency
# Grace

dates <- mini_htx$date # get the dates column

yearmonth <- function(fulldate){ # function to extract year and month
  fulldate <- substring(fulldate, 1, 7) # delete day
}

ym_dates <- unlist(lapply(dates, yearmonth)) # apply function
ym_dates <- as.factor(ym_dates)              # save unique dates

barplot(table(ym_dates), xlab = "Year and Month", ylab = "Frequency of Citations", col = rep(c("red", "
     main = "Frequency of Citations by Month")

legend("topright", legend=c("January", "July"), col=c("red", "blue"), title="Month", pch=15)
```



Finally, we evaluated the frequency of citations for each month in the dataset in order to observe any monthly citation patterns over the years. From 2014-2016, citations experienced a mid-year dip in July, but this pattern did not consistently persist. No singular month stood out as consistently yielding the most or least citations between years. We also observed that 2019 and 2020 had the least number of total citations overall and began with the least number of citations in January for all years.