Toronto’s Parking Ticket Data Analysis

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Introduction

The City of Toronto publishes their parking tickets data every year. Below is one year parking tickets data to show you when and where most tickets are issued.

I will be using R and some of its extended libraries for this project to find the trends and patterns into the data set.

About the Data Set

The data set can be accessed through City of Toronto Open Data Portal. It contains 2256761 parking tickets, from January 1 2016 to December 31 2016, the amount from 0 to $450. I will omit missing values in the data, that means 1331 rows are omitted. Also I will need to do some cleaning such as change the date and time format to the appropriate format. I also added a new column - day of week.

Read & Merge Data

```
data1 <- read.csv("C:/Users/ADMIN/Desktop/Parking Tickets/Parking_Tags_Data_2016_1.csv", stringsAsFactors = F)
data2 <- read.csv("C:/Users/ADMIN/Desktop/Parking Tickets/Parking_Tags_Data_2016_2.csv", stringsAsFactors = F)
data3 <- read.csv("C:/Users/ADMIN/Desktop/Parking Tickets/Parking_Tags_Data_2016_3.csv", stringsAsFactors = F)
data4 <- read.csv("C:/Users/ADMIN/Desktop/Parking Tickets/Parking_Tags_Data_2016_4.csv", stringsAsFactors = F)

parking_df <- rbind(data1, data2, data3, data4)

options("scipen"=100, "digits"=4)
```

Dimentions of the data set

```
dim(parking_df)
```

```
## [1] 2254761      11
```

```
parking_df$date_of_infraction <- as.Date(as.character(parking_df$date_of_infraction), "%Y%m%d")
```

Summary of the data set

```
summary(parking_df$date_of_infraction)
```

```
##         Min.      1st Qu.       Median         Mean      3rd Qu.         Max. 
## "2016-01-01" "2016-04-02" "2016-06-25" "2016-06-28" "2016-09-26" "2016-12-31"
```

```
summary(parking_df$set_fine_amount)
```

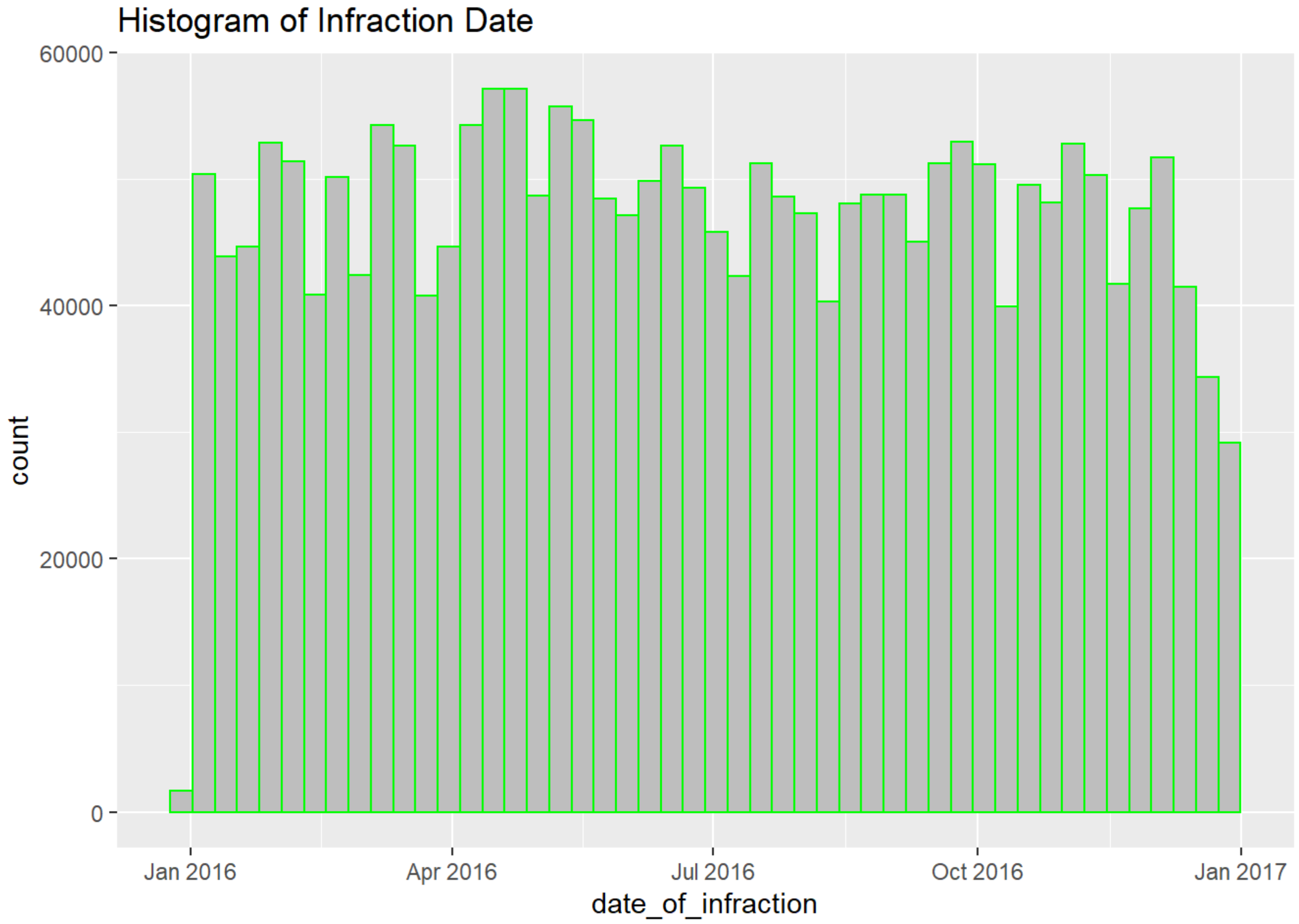
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##     0.0    30.0    30.0    48.6    50.0   450.0
```

```
parking_df$time_of_infraction <- sprintf("%04d", parking_df$time_of_infraction)
parking_df$time_of_infraction <- format(strptime(parking_df$time_of_infraction, format="%H%M"
), format = "%H:%M")
```

```
parking_df <- parking_df[complete.cases(parking_df[,-1]),]
```

Histogram of Infraction Date

```
library(ggplot2)
ggplot(aes(x = date_of_infraction), data = parking_df) + geom_histogram(bins = 48, color = 'g
reen', fill = 'grey') +
  ggtitle('Histogram of Infraction Date')
```

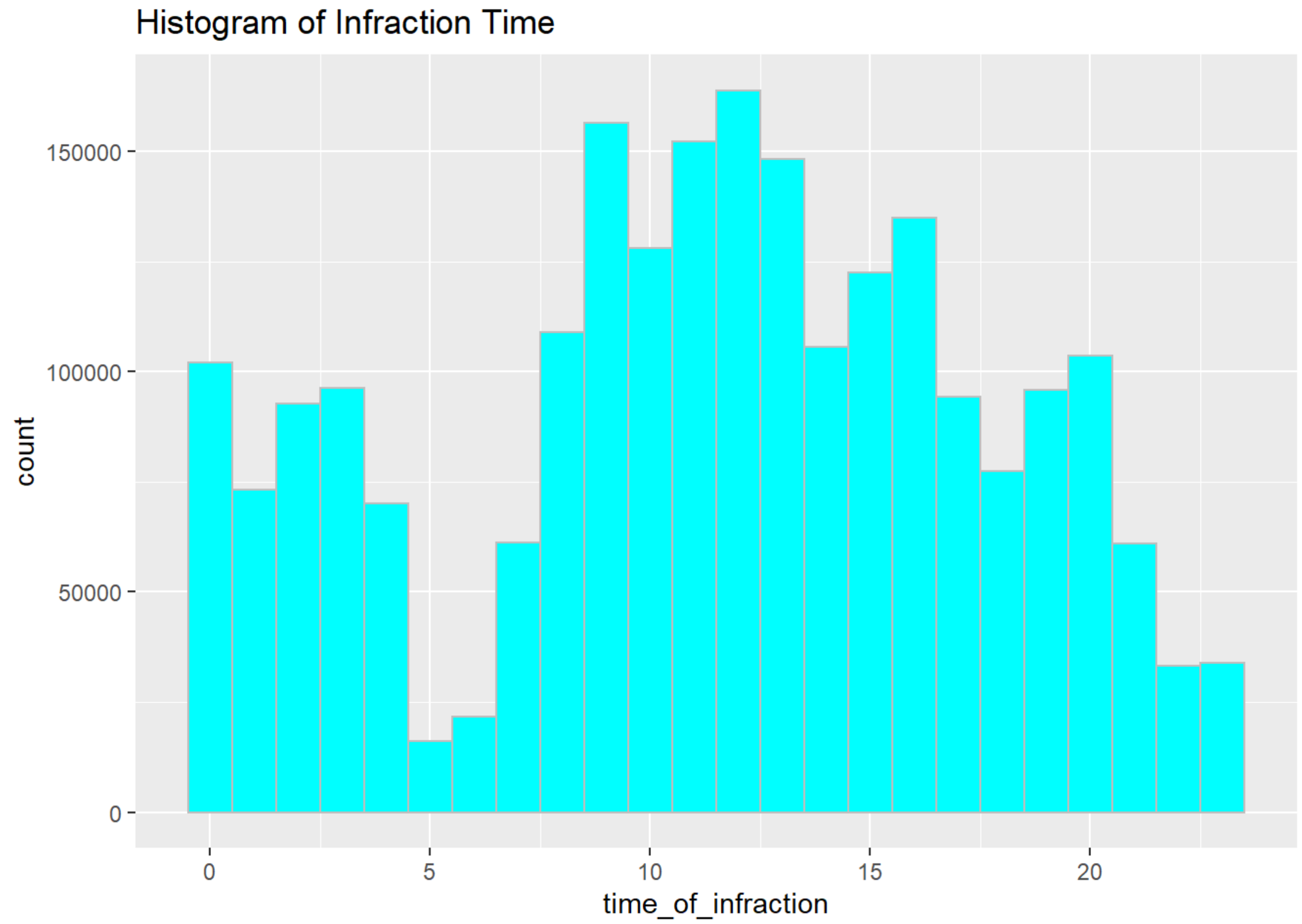


#### The number of parking tickets distributed almost evenly throughout the year. It seems slowing down towards the end of the year.

```
parking_df$time_of_infraction <- as.POSIXlt(parking_df$time_of_infraction, format="%H:%M")$ho
ur
```

Histogram of Infraction Time

```
ggplot(aes(x = time_of_infraction), data = parking_df) + geom_histogram(bins = 24, color = 'g
rey', fill = 'cyan') +
  ggtitle('Histogram of Infraction Time')
```



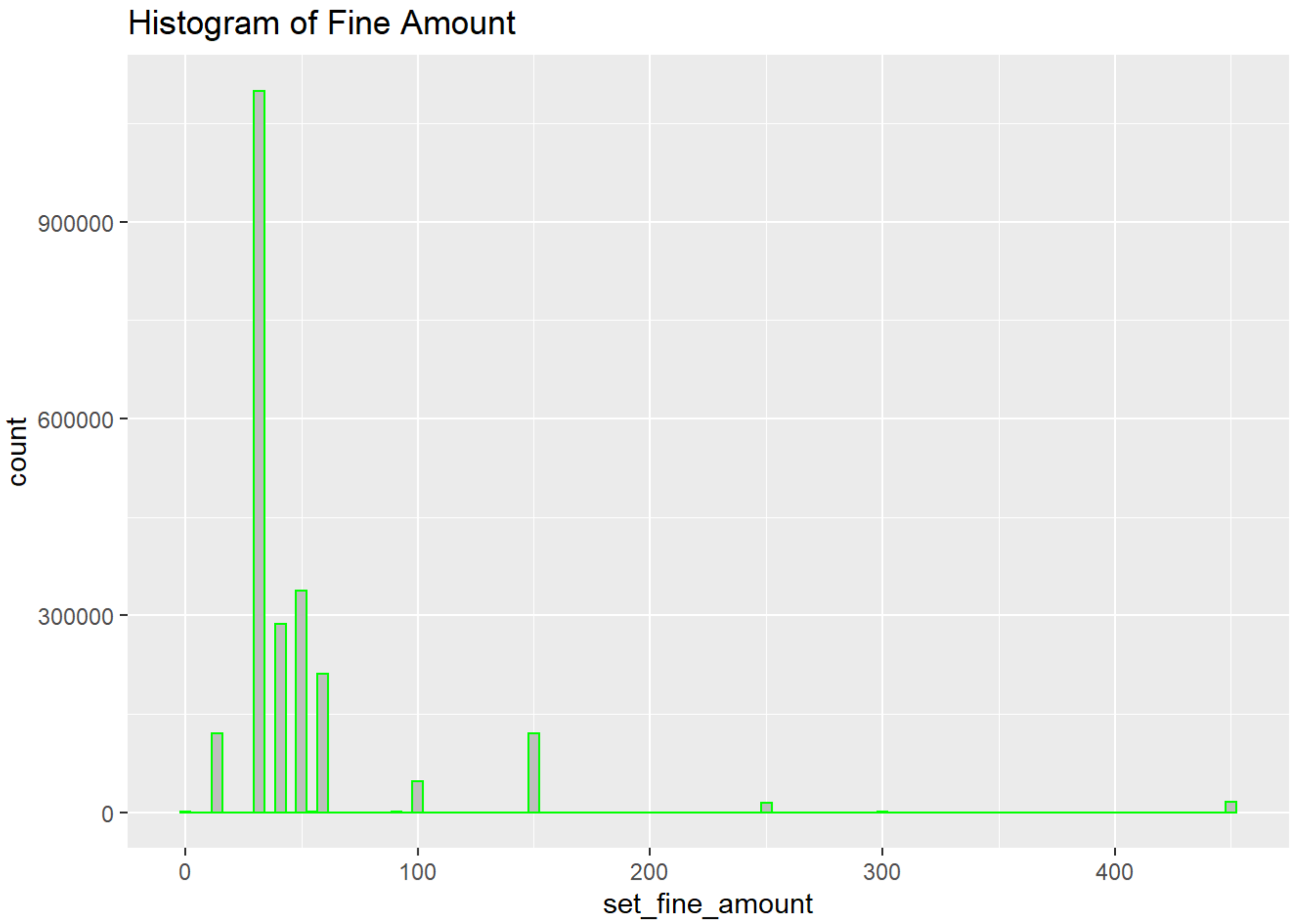
#### The time distribution appears bimodal with period peaking around 9am to 1pm and again after midnight. The safest time to park your car without being nailed is around 5 and 6am.

Histogram of Fine Amount

```
sort(table(parking_df$set_fine_amount))
```

```
## 
##     200      55       0     300      90     250     450     100      15     150 
##       3     177     210     881     920   14655   16029   46356  119410  119615 
##      60      40      50      30 
##  211209  286409  337904 1099652
```

```
ggplot(aes(x = set_fine_amount), data = parking_df) + geom_histogram(bins = 100, color = 'gre
en', fill = 'grey') +
  ggtitle('Histogram of Fine Amount')
```



#### The most common amount is $30, then $50, then $40. I believe the “0” value means the parking tickets were cancelled.

```
parking_df$day_of_week <- weekdays(as.Date(parking_df$date_of_infraction))
```

Infractions Day of Week

```
library(dplyr)
```

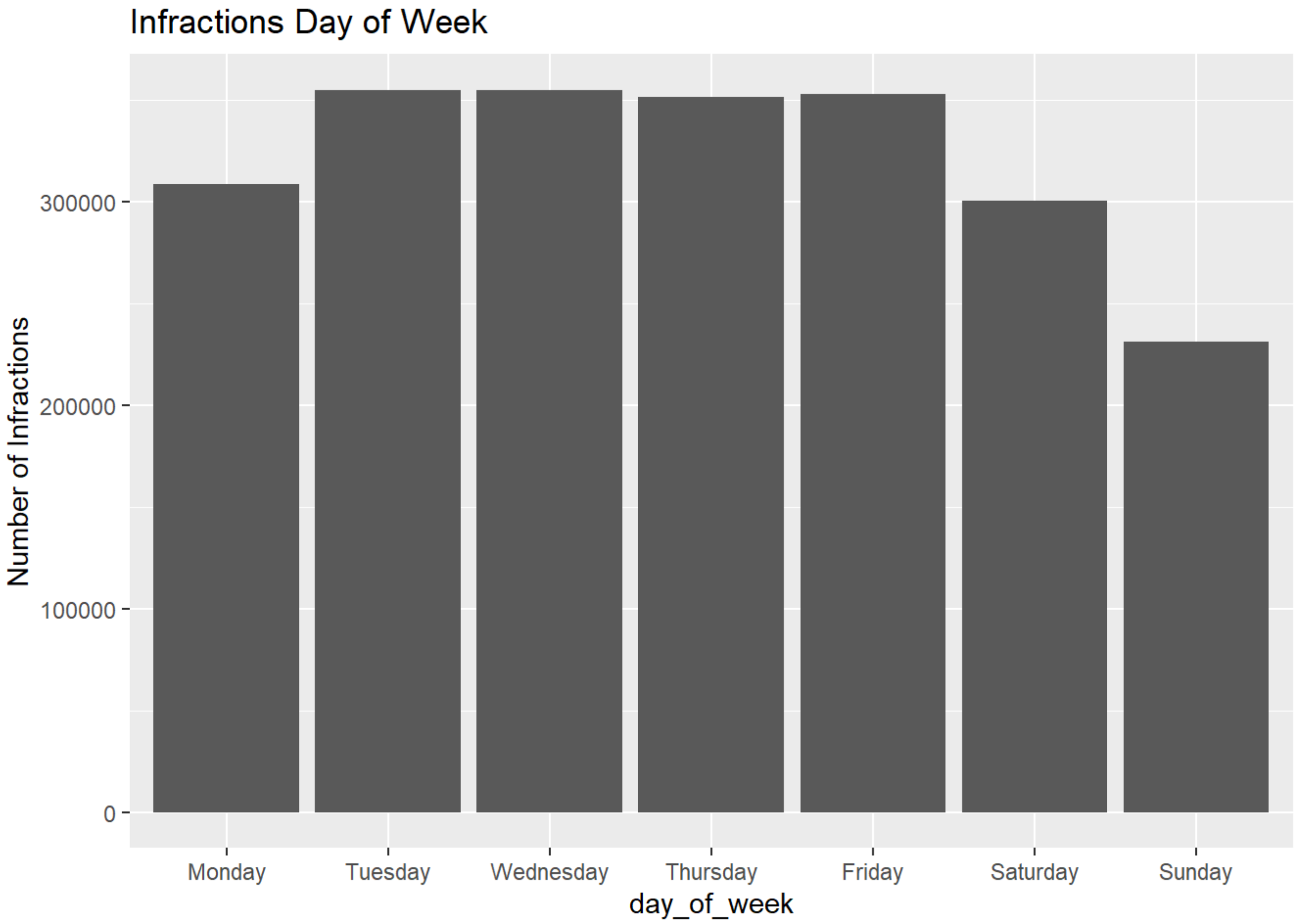
```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
weekday_group <- group_by(parking_df, day_of_week)
parking_df_weekday <- dplyr::summarise(weekday_group, count = n(),
                                       total_day = sum(set_fine_amount))

parking_df_weekday$day_of_week <- ordered(parking_df_weekday$day_of_week, levels = c('Monday'
, 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday'))
ggplot(aes(x = day_of_week, y = count), data = parking_df_weekday) +
  geom_bar(stat = 'identity') +
  ylab('Number of Infractions') +
  ggtitle('Infractions Day of Week')
```



#### Apparently, less infractions happened in the weekend than during the weekdays.

Now let’s look at what the infractions are. Because there are more than 200 different infractions, it makes sense to only look at the top 10.

```
library(dplyr)
infraction_group <- group_by(parking_df, infraction_description, infraction_code)
parking_df_infr <- dplyr::summarise(infraction_group, count = n())
```

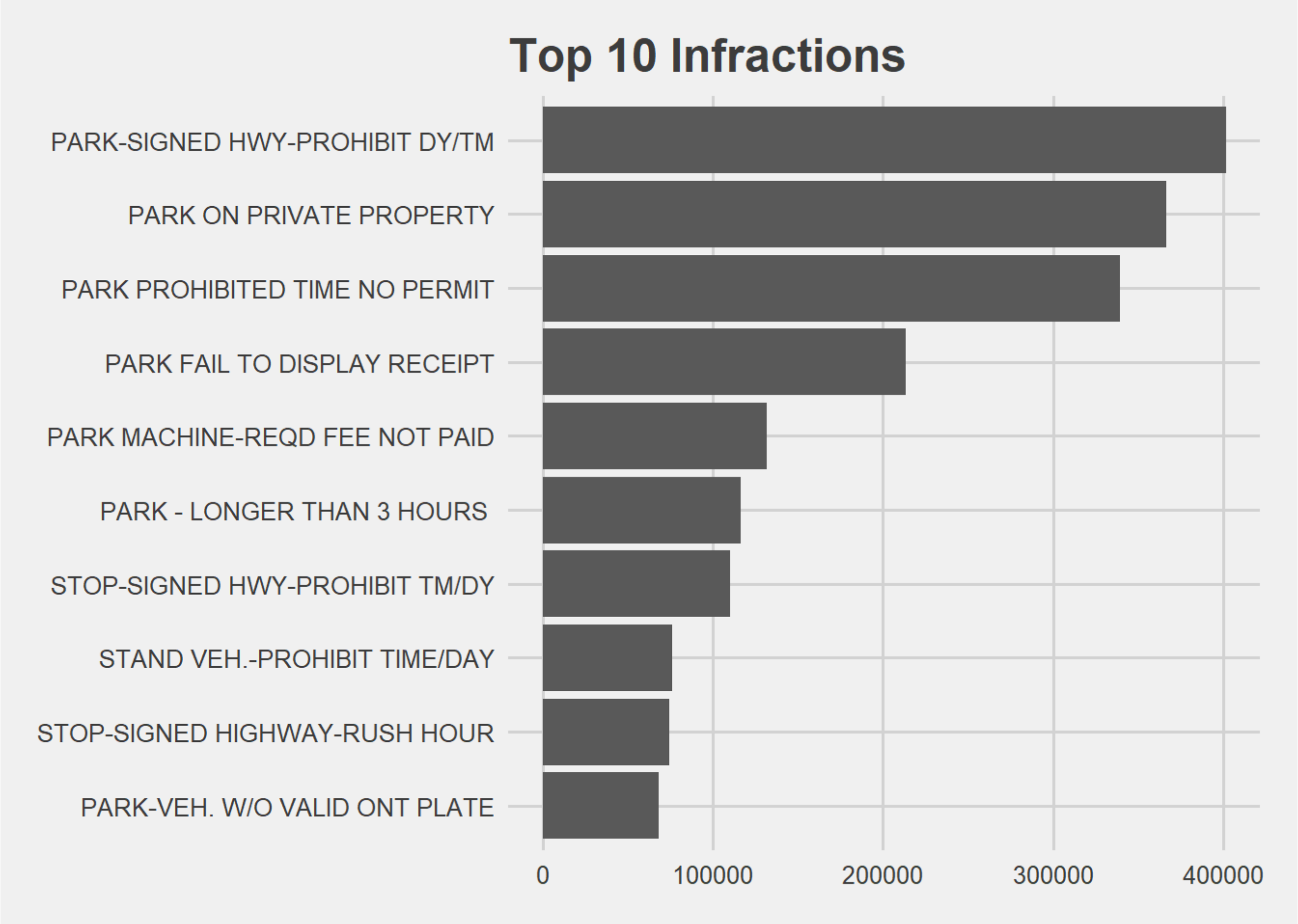
```
## `summarise()` has grouped output by 'infraction_description'. You can override using the
`.groups` argument.
```

```
parking_df_infr <- head(parking_df_infr[order(parking_df_infr$count, decreasing = TRUE),], n
 = 10)
parking_df_infr
```

```
## # A tibble: 10 x 3
## # Groups:   infraction_description [10]
##    infraction_description           infraction_code  count
##    <chr>                                      <int>  <int>
##  1 "PARK-SIGNED HWY-PROHIBIT DY/TM"               5 401542
##  2 "PARK ON PRIVATE PROPERTY"                     3 366662
##  3 "PARK PROHIBITED TIME NO PERMIT"              29 339124
##  4 "PARK FAIL TO DISPLAY RECEIPT"               210 213323
##  5 "PARK MACHINE-REQD FEE NOT PAID"             207 131504
##  6 "PARK - LONGER THAN 3 HOURS "                  2 116494
##  7 "STOP-SIGNED HWY-PROHIBIT TM/DY"               9 110424
##  8 "STAND VEH.-PROHIBIT TIME/DAY"                 8  76393
##  9 "STOP-SIGNED HIGHWAY-RUSH HOUR"              403  74242
## 10 "PARK-VEH. W/O VALID ONT PLATE"              406  68262
```

Top 10 Infractions

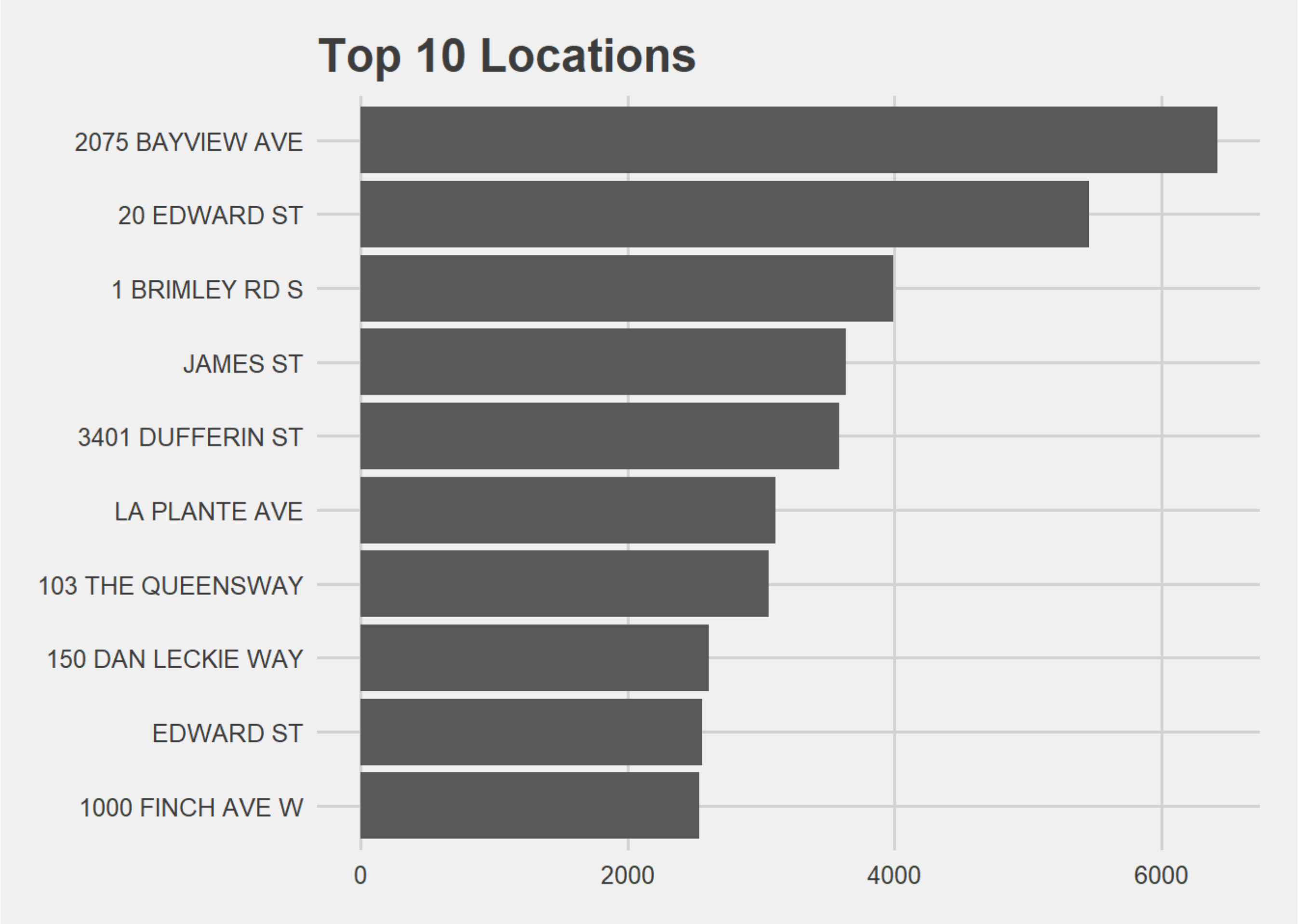
```
library(ggthemes)
ggplot(aes(x = reorder(infraction_description, count), y = count), data = parking_df_infr) +
  geom_bar(stat = 'identity') +
  theme_tufte() +
  theme(axis.text = element_text(size = 10, face = 'bold')) +
  coord_flip() +
  xlab('') +
  ylab('Total Number of Infractions') +
  ggtitle("Top 10 Infractions") +
  theme_fivethirtyeight()
```



#### Now, what are the top 10 locations that have the most infractions?

Top 10 Locations

```
library(dplyr)
location_group <- group_by(parking_df, location2)
parking_df_lo <- dplyr::summarise(location_group, total = sum(set_fine_amount),
                                  count = n())
parking_df_lo <- head(parking_df_lo[order(parking_df_lo$count, decreasing = TRUE), ], n=10)
ggplot(aes(x = reorder(location2, count), y = count), data = parking_df_lo) +
  geom_bar(stat = 'identity') +
  theme_tufte() +
  theme(axis.text = element_text(size = 10, face = 'bold')) +
  coord_flip() +
  xlab('') +
  ylab('Total Number of Infractions') +
  ggtitle("Top 10 Locations") +
  theme_fivethirtyeight()
```



#### Here it is! Be aware when you are around those areas.

How about the trend? Is there any infraction type increase or decrease over time?

```
parking_df_infr_1 <- parking_df %>%
  filter(infraction_description %in% parking_df_infr$infraction_description)
```

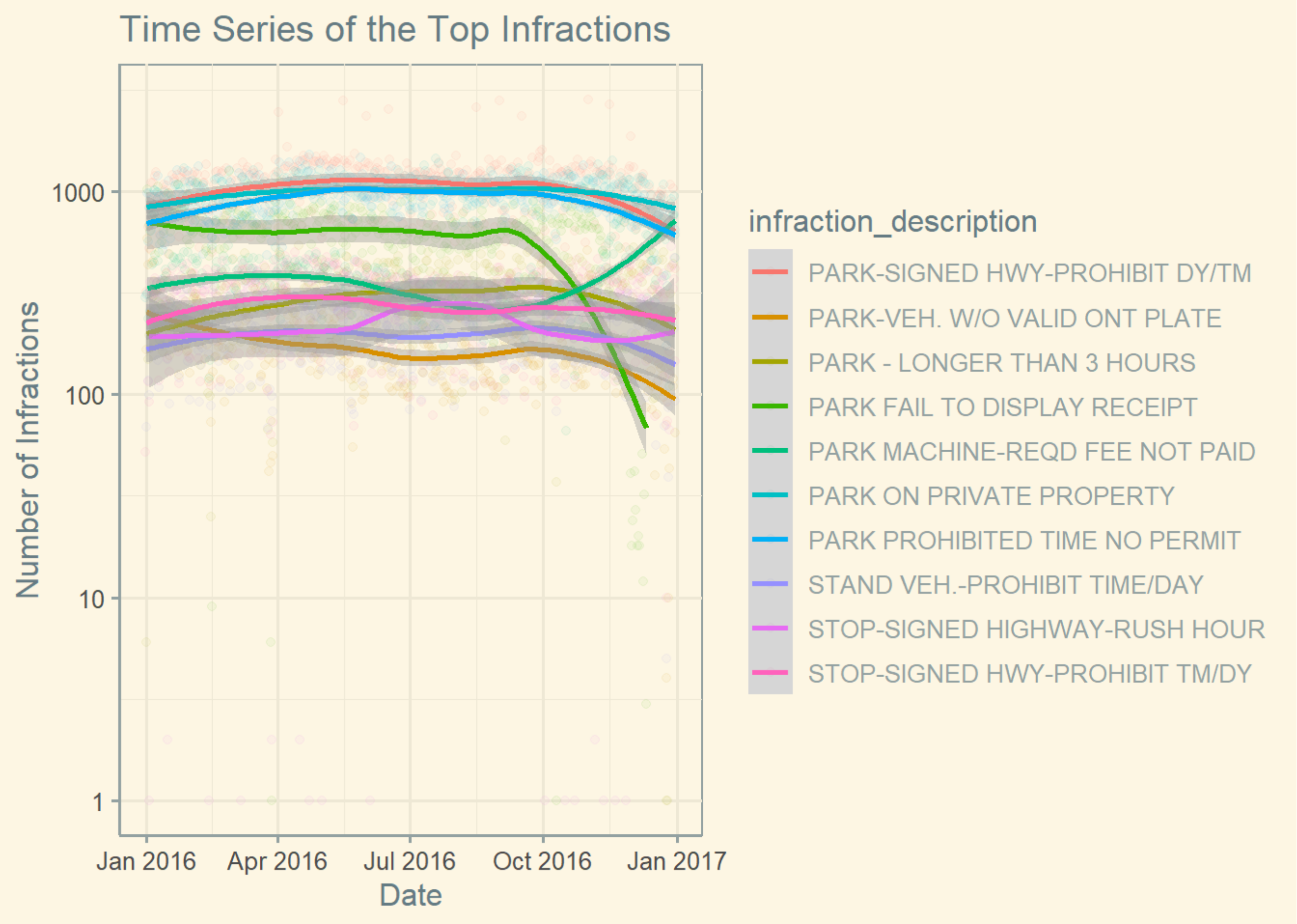
```
library(dplyr)
date_in_group <- group_by(parking_df_infr_1, infraction_description, date_of_infraction)
parking_df_infr_1 <- dplyr::summarise(date_in_group, total =
                                      sum(set_fine_amount),
                                      count = n())
```

```
## `summarise()` has grouped output by 'infraction_description'. You can override using the
`.groups` argument.
```

Time Series of Top Infractions

```
ggplot(aes(x = date_of_infraction, y = count, color = infraction_description), data = parking
_df_infr_1) +
  geom_jitter(alpha = 0.05) +
  geom_smooth(method = 'loess') +
  xlab('Date') +
  ylab('Number of Infractions') +
  ggtitle('Time Series of the Top Infractions') +
  scale_y_log10() +
  theme_solarized()
```

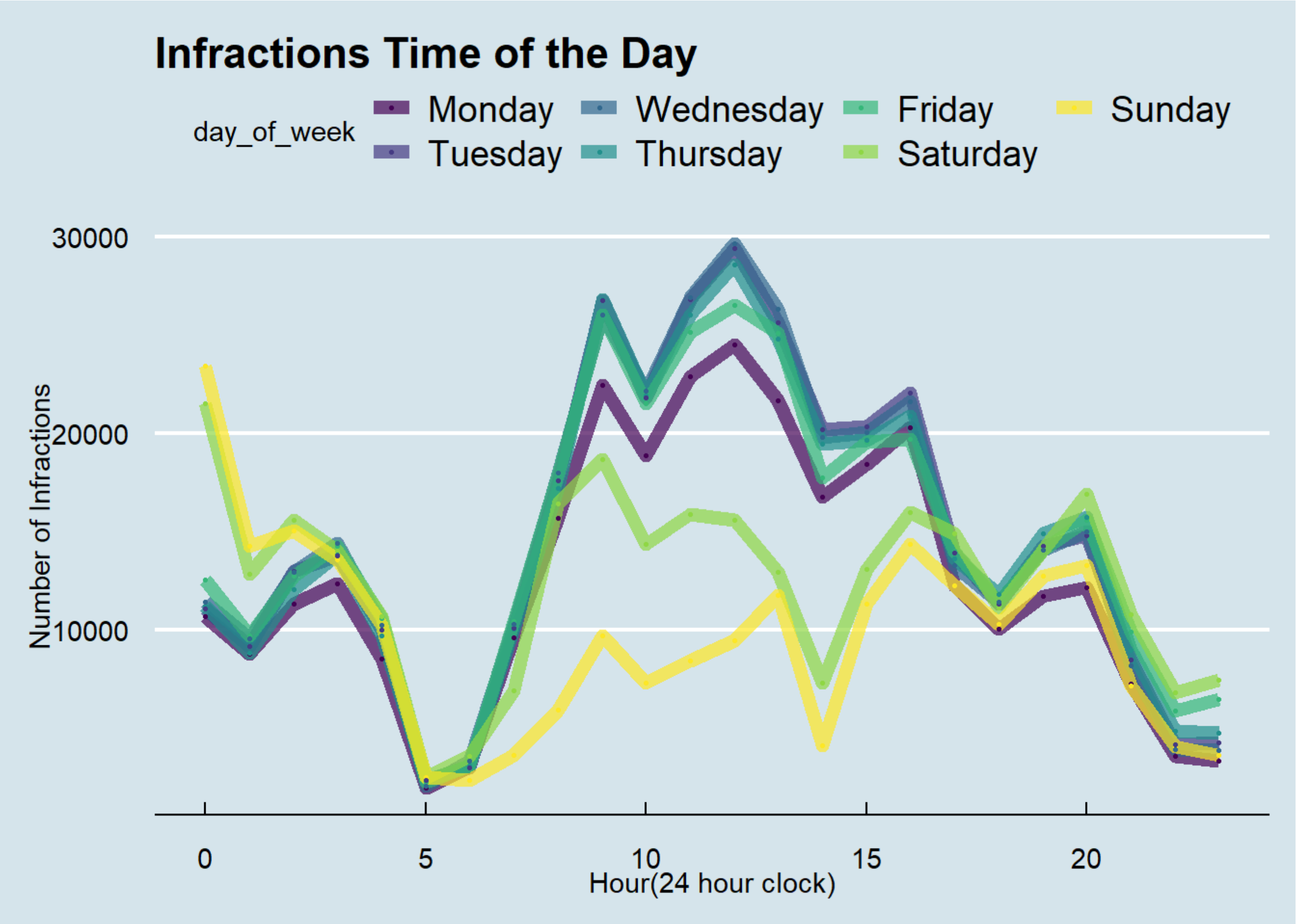
```
## `geom_smooth()` using formula 'y ~ x'
```



#### This is not a good looking graph. Most of the top infractions have been steady over time. only “PARK FAIL TO DISPLAY RECEIPT” had dropped since fall, and “PARK MACHINE-REQD FEE NOT PAID” had an increase since October. Does it have anything to do with the season? or weather? Or simply more park machines broken toward the end of the year?

Infractions time of the day

```
parking_df_week_time$day_of_week <- ordered(parking_df_week_time$day_of_week, levels = c('Mon
day', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday'))
ggplot(aes(x = time_of_infraction, y = count, color = day_of_week), data = parking_df_week_ti
me) +
  geom_line(size = 2.5, alpha = 0.7) +
  geom_point(size = 0.5) +
  xlab('Hour(24 hour clock)') +
  ylab('Number of Infractions') +
  ggtitle('Infractions Time of the Day') +
  theme_economist()
```



#### This is a much better looking graph. the highest counts are around noon time during the weekday, this trend changed during the weekend.

Now let me drill down to the top 10 infractions.

```
top_10 <- c('PARK-SIGNED HWY-PROHIBIT DY/TM', 'PARK ON PRIVATE PROPERTY', 'PARK PROHIBITED TI
ME NO PERMIT', 'PARK FAIL TO DISPLAY RECEIPT', 'PARK MACHINE-REQD FEE NOT PAID', 'PARK - LONG
ER THAN 3 HOURS ', 'STOP-SIGNED HWY-PROHIBIT TM/DY', 'STAND VEH.-PROHIBIT TIME/DAY', 'STOP-SI
GNED HIGHWAY-RUSH HOUR', 'PARK-VEH. W/O VALID ONT PLATE')
top_10
```

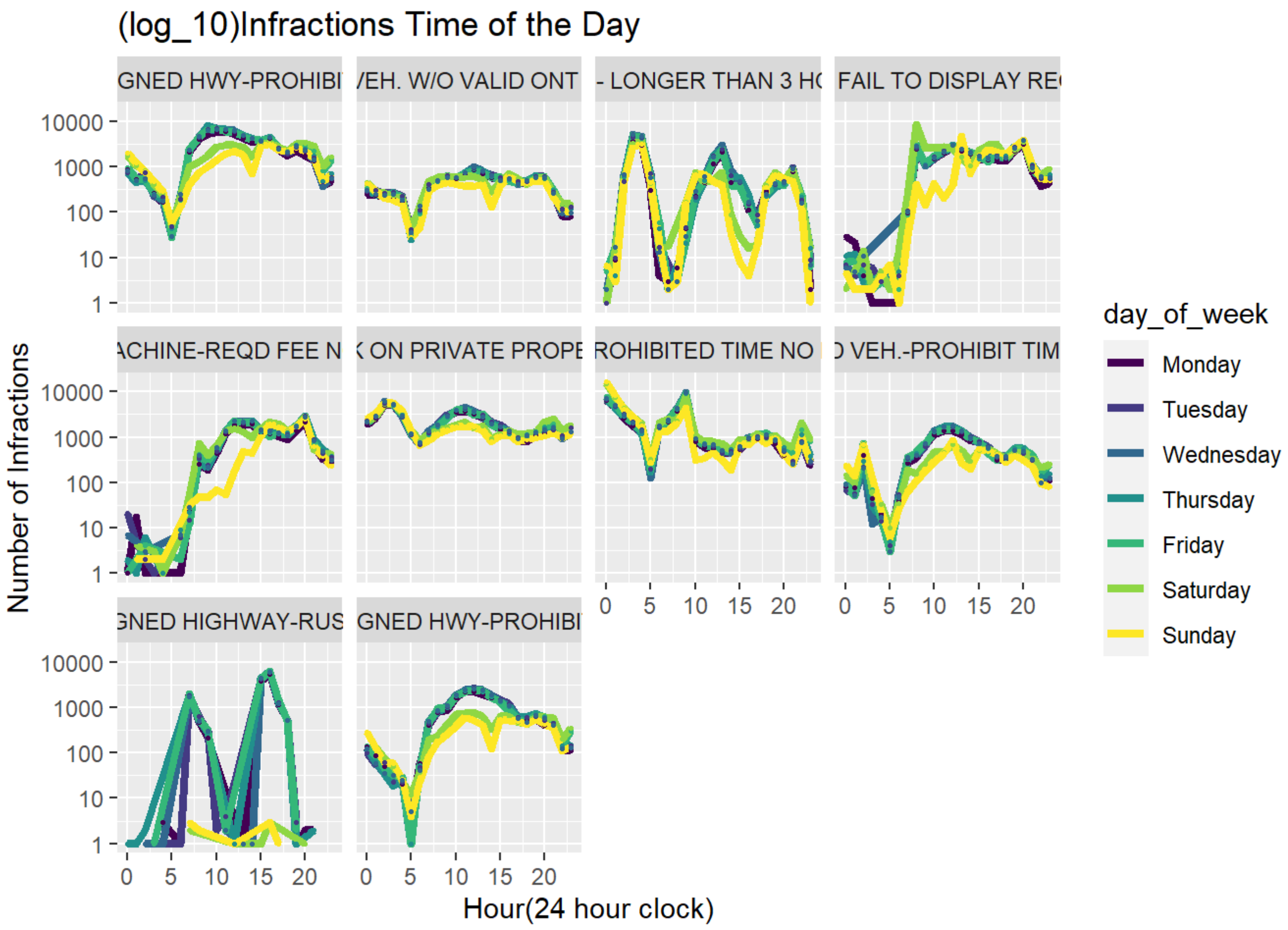
```
##  [1] "PARK-SIGNED HWY-PROHIBIT DY/TM" "PARK ON PRIVATE PROPERTY"
##  [3] "PARK PROHIBITED TIME NO PERMIT" "PARK FAIL TO DISPLAY RECEIPT"
##  [5] "PARK MACHINE-REQD FEE NOT PAID" "PARK - LONGER THAN 3 HOURS "
##  [7] "STOP-SIGNED HWY-PROHIBIT TM/DY" "STAND VEH.-PROHIBIT TIME/DAY"
##  [9] "STOP-SIGNED HIGHWAY-RUSH HOUR"  "PARK-VEH. W/O VALID ONT PLATE"
```

```
parking_df_top_10 <- parking_df %>%
  filter(infraction_description %in% top_10)
top_10_groups <- group_by(parking_df_top_10, infraction_description, day_of_week, time_of_inf
raction)
parking_df_top_10 <- dplyr::summarise(top_10_groups, total =
                                      sum(set_fine_amount),
                                      count = n())
```

```
## `summarise()` has grouped output by 'infraction_description', 'day_of_week'. You can overr
ide using the `.groups` argument.
```

Infractions time of the day

```
parking_df_top_10$day_of_week <- ordered(parking_df_top_10$day_of_week, levels = c('Monday',
'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday'))
ggplot(aes(x = time_of_infraction, y = count, color = day_of_week), data = parking_df_top_10)
+
  geom_line(size = 1.5) +
  geom_point(size = 0.5) +
  xlab('Hour(24 hour clock)') +
  ylab('Number of Infractions') +
  ggtitle('(log_10)Infractions Time of the Day') +
  scale_y_log10() +
  facet_wrap(~infraction_description)
```



Observations

I found two sharp curved infractions interesting, one is “STOP-SIGNED HIGHWAY RUSH-HOUR”, there are two peak infraction hours around 8am and 4pm during the weekdays, the weekend is very quiet. It makes sense as it labels as “RUSH-HOUR”. Another is ‘PARK-LONGER THAN 3 HOURS’, this is the only infractions happened more during the early hours around 4am, this applies to weekends as well as weekdays.

It seems to me that residents live in an appartment building without a garage will be ticketed for overnight parking on their street if their street has no on-street permits. That’s why most of the infractions happened in the early hours of the day.

The above analysis doesn’t represent all the problems and areas since not every illegally parked car will be reported. It does give a general idea and might start a conversation on how and where the City of Toronto should intervene.