Project Draft

2020 Vision

Mihir Patel, Tina Xia, Leah Okamura, Kyra Cooperman

Introduction

The subject matter we're investigating is information about crime in San Francisco. In recent years, San Francisco hasn't been the safest place to live; the overall crime rate in San Francisco is 151% higher than the national average. According to SFChronicle, "homicides increased by 21.4% in San Francisco from March to June of this year," compared to 2019 (https://www.sfchronicle.com/bayarea/article/Which-crimes-are-up-down-in-SF-during-15408485.php). There is a 1 in 15 chance of becoming a victim of any crime. We wanted to use this dataset to obtain conclusions about specific factors that correlate to higher levels of crime, which will hopefully inform us of some key insights we can keep during future travels.

https://www.sfchronicle.com/bayarea/philmatier/article/SF-ranks-high-in-property-crime-while-it-ranks-14439369.php

Research Question: What factors can the general population associate with local crime in order to be the safest while in San Francisco (or in other cities with similar characteristics)?

Hypotheses: A later time (e.g. nighttime hours) correlates to a higher level or rate of crime. Location is correlated to levels of crime.

We are interested in these two hypotheses because we believe they can then lead to other interesting relationships between variables within this dataset. For example, if there is a strong correlation between night and rate of crime, then is there a correlation between which night of the week (ex. Sunday night) and rate of crime? With location, are there certain districts that have a specific crime that is common there? By delving further and examining these relationships, we will be able to understand if crime has any specific pattern in San Francisco.

Data

```r
set.seed(1)
sanfrancrime <- sanfrancrimeBIG %>%
  sample_n(15000)
  glimpse(sanfrancrime)
```

```
## Rows: 15,000
## Columns: 13
## $ IncidntNum <chr> "160074818", "166163532", "160697272", "160666750", "160...
## $ Category   <chr> "ASSAULT", "LARCENY/THEFT", "NON-CRIMINAL", "NON-CRIMINA...
## $ Descript   <chr> "THREATS AGAINST LIFE", "GRAND THEFT FROM LOCKED AUTO", ...
## $ DayOfWeek  <chr> "Tuesday", "Wednesday", "Sunday", "Tuesday", "Wednesday"...
## $ Date       <chr> "01/26/2016 12:00:00 AM", "06/15/2016 12:00:00 AM", "08/...
## $ Time       <time> 13:45:00, 08:06:00, 12:55:00, 16:00:00, 06:30:00, 15:55...
## $ PdDistrict <chr> "NORTHERN", "BAYVIEW", "SOUTHERN", "CENTRAL", "NORTHERN"...
## $ Resolution <chr> "NONE", "NONE", "NONE", "NONE", "NONE", "NONE", "NONE", ...
## $ Address    <chr> "FRANKLIN ST / PACIFIC AV", "CESAR CHAVEZ ST / ILLINOIS ...
## $ X          <dbl> -122.4249, -122.3866, -122.4136, -122.4065, -122.4197, -...
## $ Y          <dbl> 37.79461, 37.75033, 37.77951, 37.79515, 37.78967, 37.719...
## $ Location   <chr> "(37.7946072650051, -122.424873688619)", "(37.7503255046...
## $ PdId       <dbl> 1.600748e+13, 1.661635e+13, 1.606973e+13, 1.606668e+13, ...
```

The observations in the dataset are of crime data in San Francisco from 2016. We found our dataset at https://www.kaggle.com/roshansharma/sanfranciso-crime-dataset. Each observation in this datase is a crime whose various aspects have been recorded. There were originally 150,500 individual crimes/observations in this dataset. However, because of the nature of R Studio through OIT, we will be taking a random and reproducible sample from the larger dataset. We created this sample by using the function sample_n() on sanfrancrimeBIG to randomly select 15,000 observations. We chose 15,000 because it is still large enough to get an accurate portrayal of the total data set, yet is much more manageable to process.

There are 13 variables in the dataset: IncidntNum (double): gives the Incident Number of the crime Category (character): gives category of crime Description (character): gives description of crime DayofWeek (character): gives day of week the crime occurred on Date (character): gives date (day, month, and year) of crime Time (double): gives time of crime (in military time) PdDistrict (character): gives police district crime occurred in Resolution (character): gives kind of punishment given to the criminal to resolve the case Address (character): gives address where the crime happened X (double): gives latitude of crime location Y (double): gives longitude of crime location Location (character): exact location using latitude and longitude PdId (double): ID of police officer

The curator of the dataset got it from the final assignment for Coursera and IBM's Data Visualization Course. The information in this dataset is most likely directly from the San Francisco Police Department for their reported crimes during 2016. This dataset was originally used to practice analyzing and visualizing data through geo spatial mapping by using folium maps for geographical understanding.

Methodology

The statistical methods we believe will be useful in answering our research question include the CLT, simulated null distributions, bootstrapping, etc. We're using these because certain variables are categorical, so they ETC ETC

Note: we plan on grouping violence based on violent vs nonviolent.

Variables we're considering: Category Day of Week Date Time PdDistrict Resolution

Results

Showcase how you arrived at answers to your question using any techniques we have learned in this class (and some beyond, if you're feeling adventurous). Provide the main results from your analysis. The goal is not to do an exhaustive data analysis, but rather let me know that you are proficient at asking meaningful questions and answering them with results of data analysis, that you are proficient in using R, and that you are proficient at interpreting and presenting the results. Focus on methods that help you begin to answer your research questions.

Relationship between category and time? Mihir

To determine the relationship between category and time, I have created 4 time intervals (morning, day, evening, and night) and categorized the crimes based on the type of crime. I will then be performing a Chi-Squared test between these categorical variables to determine if there is any relationship between them? (is that the right explanation).

```
important <- sanfrancrime %>%
  mutate(str = as.character(Time)) %>%
  mutate(hourstr = substr(str, 1, 2)) %>%
  mutate (hour = as.numeric(hourstr)) %>%
  select(Category, DayOfWeek, Date, PdDistrict, Resolution, hour)
```

```
important <- important %>%
  mutate(timerange = case_when( hour >= 0 & hour < 6 ~ "night",
                                hour >= 6 & hour < 12 ~ "morning",
                                hour >= 12 & hour < 18 ~ "day",
                                hour >= 18 & hour < 24 ~ "evening"))
glimpse(important)
```

```
## Rows: 15,000
## Columns: 7
## $ Category   <chr> "ASSAULT", "LARCENY/THEFT", "NON-CRIMINAL", "NON-CRIMINA...
## $ DayOfWeek  <chr> "Tuesday", "Wednesday", "Sunday", "Tuesday", "Wednesday"...
## $ Date       <chr> "01/26/2016 12:00:00 AM", "06/15/2016 12:00:00 AM", "08/...
## $ PdDistrict <chr> "NORTHERN", "BAYVIEW", "SOUTHERN", "CENTRAL", "NORTHERN"...
## $ Resolution <chr> "NONE", "NONE", "NONE", "NONE", "NONE", "NONE", "NONE", ...
## $ hour       <dbl> 13, 8, 12, 16, 6, 15, 8, 11, 22, 22, 23, 14, 0, 0, 2, 6,...
## $ timerange  <chr> "day", "morning", "day", "day", "morning", "day", "morni...
```

```
important <- important %>%
  mutate(crimetype = case_when(

    Category == "BURGLARY" | Category == "LARCENY/THEFT" |
    Category == "STOLEN PROPERTY" | Category == "RECOVERED VEHICLE" |
    Category == "VEHICLE THEFT" | Category == "ARSON" |
    Category == "VANDALISM"  ~ "Property",

    Category == "ROBBERY" | Category == "ASSAULT" |
    Category == "KIDNAPPING" |
      Category == "SEX OFFENSES, FORCIBLE" ~ "Violent",

    Category == "BRIBERY" | Category == "BAD CHECKS" |
    Category == "EMBEZZLEMENT"| Category == "FORGERY/COUNTERFEITING" |
    Category == "FRAUD" | Category == "GAMBLING"|
    Category == "EXTORTION" ~ "White Collar",

    Category == "DRIVING UNDER THE INFLUENCE" | Category == "DRUG/NARCOTIC" |
    Category == "DRUNKENNESS"| Category == "LIQUOR LAWS" ~ "Drug/Alcohol",

    Category == "PORNOGRAPHY/OBSCENE MAT" | Category == "PROSTITUTION" |
    Category == "SEX OFFENSES, NON FORCIBLE" ~ "Sex",

    Category == "LOITERING" | Category == "TREA" |
    Category == "TRESPASS"| Category == "SUSPICIOUS OCC" |
    Category == "DISORDERLY CONDUCT" ~ "Suspicious",

    Category == "WARRANTS"|Category == "WEAPON LAWS" |
    Category == "SECONDARY CODES" ~ "Legal Violation",

    Category == "MISSING PERSON" |Category == "NON-CRIMINAL"|
    Category == "OTHER OFFENSES" |Category == "SUICIDE"|
    Category == "FAMILY OFFENSES" | Category == "RUNAWAY" ~ "Miscellaneous"))

glimpse(important)
```

```
## Rows: 15,000
## Columns: 8
## $ Category   <chr> "ASSAULT", "LARCENY/THEFT", "NON-CRIMINAL", "NON-CRIMINA...
## $ DayOfWeek  <chr> "Tuesday", "Wednesday", "Sunday", "Tuesday", "Wednesday"...
## $ Date       <chr> "01/26/2016 12:00:00 AM", "06/15/2016 12:00:00 AM", "08/...
## $ PdDistrict <chr> "NORTHERN", "BAYVIEW", "SOUTHERN", "CENTRAL", "NORTHERN"...
## $ Resolution <chr> "NONE", "NONE", "NONE", "NONE", "NONE", "NONE", "NONE", ...
## $ hour       <dbl> 13, 8, 12, 16, 6, 15, 8, 11, 22, 22, 23, 14, 0, 0, 2, 6,...
## $ timerange  <chr> "day", "morning", "day", "day", "morning", "day", "morni...
## $ crimetype  <chr> "Violent", "Property", "Miscellaneous", "Miscellaneous",...
```

H_0 : NO relationship between the crime types created above and categories for time of day created above.

H_a : There IS a relationship between the crime types created above and categories for time of day created above.

α of 0.05

```
#Table needs to be fixed
crimecount <- important %>%
  count(crimetype)
crimecount
```

```
## # A tibble: 8 x 2
##   crimetype           n
##   <chr>           <int>
## 1 Drug/Alcohol      512
## 2 Legal Violation   942
## 3 Miscellaneous    4230
## 4 Property         6244
## 5 Sex                71
## 6 Suspicious        810
## 7 Violent          1805
## 8 White Collar      386
```

```
test <- important %>%
  group_by(crimetype) %>%
  count(timerange)
test
```

```
## # A tibble: 32 x 3
## # Groups:   crimetype [8]
##    crimetype       timerange     n
##    <chr>           <chr>     <int>
##  1 Drug/Alcohol    day         194
##  2 Drug/Alcohol    evening     132
##  3 Drug/Alcohol    morning     106
##  4 Drug/Alcohol    night        80
##  5 Legal Violation day         354
##  6 Legal Violation evening     280
##  7 Legal Violation morning     173
##  8 Legal Violation night       135
##  9 Miscellaneous   day        1574
## 10 Miscellaneous   evening    1103
## # ... with 22 more rows
```

```
crimestuff <- c(rep(crimecount$crimetype[1], crimecount$n[1]),
               rep(crimecount$crimetype[2], crimecount$n[2]),
               rep(crimecount$crimetype[3], crimecount$n[3]),
               rep(crimecount$crimetype[4], crimecount$n[4]),
               rep(crimecount$crimetype[5], crimecount$n[5]),
               rep(crimecount$crimetype[6], crimecount$n[6]),
               rep(crimecount$crimetype[7], crimecount$n[7]))

timestuff <- c(
rep(test$timerange[1], test$n[1]), rep(test$timerange[2], test$n[2]),
rep(test$timerange[3], test$n[3]), rep(test$timerange[4], test$n[4]),

rep(test$timerange[5], test$n[5]), rep(test$timerange[6], test$n[6]),
rep(test$timerange[7], test$n[7]), rep(test$timerange[8], test$n[8]),

rep(test$timerange[9], test$n[9]), rep(test$timerange[10], test$n[10]),
rep(test$timerange[11], test$n[11]), rep(test$timerange[12], test$n[12]),

rep(test$timerange[13], test$n[13]), rep(test$timerange[14], test$n[14]),
rep(test$timerange[15], test$n[15]), rep(test$timerange[16], test$n[16]),

rep(test$timerange[17], test$n[17]), rep(test$timerange[18], test$n[18]),
rep(test$timerange[19], test$n[19]), rep(test$timerange[20], test$n[20]),

rep(test$timerange[21], test$n[21]), rep(test$timerange[22], test$n[22]),
rep(test$timerange[23], test$n[23]), rep(test$timerange[24], test$n[24]),

rep(test$timerange[25], test$n[25]), rep(test$timerange[26], test$n[26]),
rep(test$timerange[27], test$n[27]), rep(test$timerange[28], test$n[28]))


table <- table(crimestuff, timestuff)

chisq.test(table)
```

```
##
##  Pearson's Chi-squared test
##
## data:  table
## X-squared = 322.57, df = 18, p-value < 2.2e-16
```

The test statistic is 359.84, which has a chi squared distribution with 18 df under H_0. The p-value is $<$ 2.2e-16 which is less than the α of 0.05. This means there is sufficient evidence to reject the null hypothesis. As a result, I conclude that there is sufficient evidence to suggest that at the 0.05 significance level that there is a relationship between the crime types created above and categories for time of day created above.

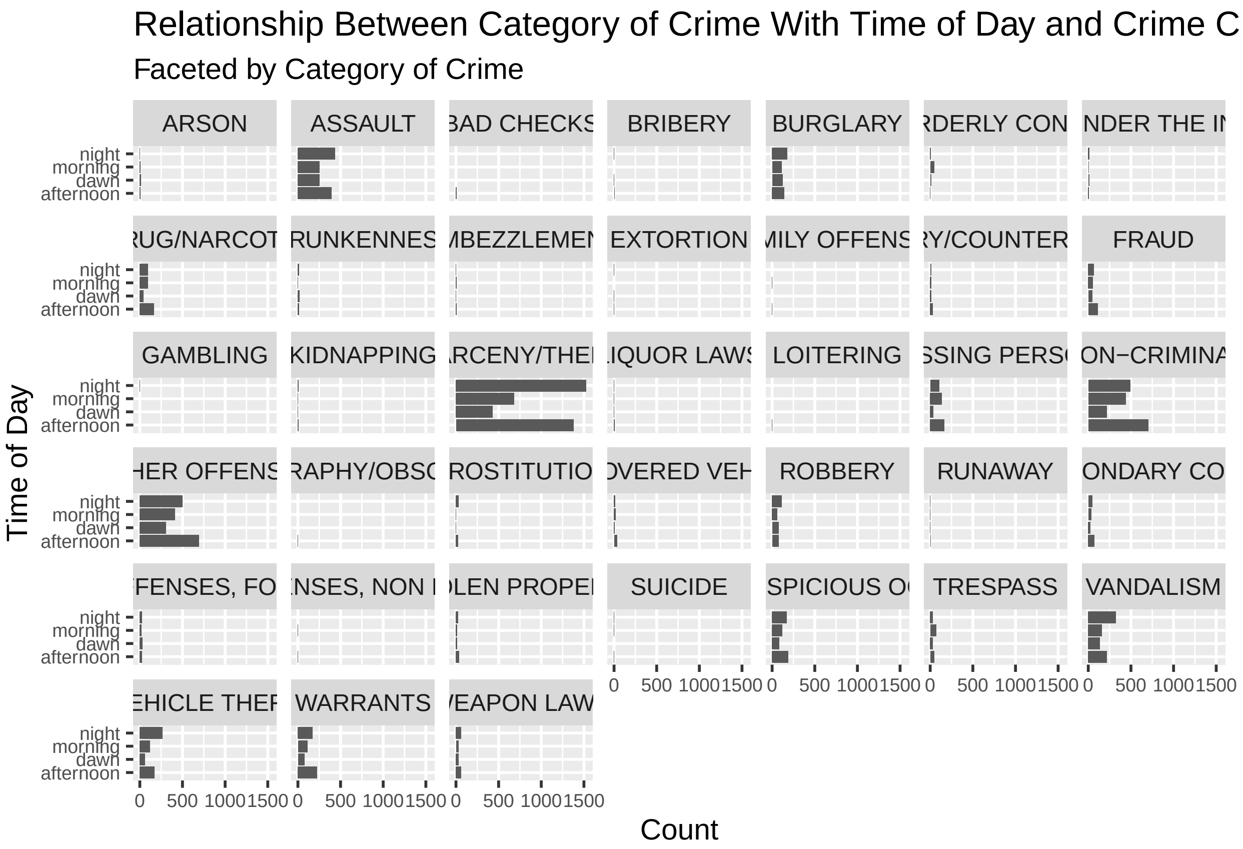
Relationship between time and crime? Tina

Question: Do more crimes generally occur at night in San Francisco? We will construct an effective, well-labeled visualization of the crime count and time.

```
sanfrancrime <- sanfrancrime %>%
  mutate(str = as.character(Time)) %>%
  mutate(hourstr = substr(str, 1, 2)) %>%
  mutate (hour = as.numeric(hourstr))

sanfrancrime <- sanfrancrime %>%
  mutate(timerange = case_when( hour >= 0 & hour < 6 ~ "dawn",
                                hour >= 6 & hour < 12 ~ "morning",
                                hour >= 12 & hour < 18 ~ "afternoon",
                                hour >= 18 & hour < 24 ~ "night"))


ggplot(sanfrancrime, mapping = aes(y = timerange)) +
  geom_bar() + facet_wrap(~ Category) + labs(
    x = "Count",
    y = "Time of Day",
    title = "Relationship Between Category of Crime With Time of Day and Crime Count", subtitle = "Face
```



```
# sanfrancrime <- sanfrancrime %>%
#   group_by(Category) %>%
#   summarise(count = n())
# sanfrancrime
```

After constructing our visualization of crime count and time, a few things are clear: first, we can see that certain categories of crime are far more prominent than others. For example, larceny/theft is more common, along with non-criminal crimes, assault, and other crimes. Most crimes seem to happen during the afternoon and night, with the least happening in the hours from 0 to 6 (or in the early morning). Out of all the categories of crime listed, larceny/theft is mostly conducted during the evening, or between hours 18 & 24, ie between 6pm and 12am. This makes sense, as this is usually when night begins to set in, and it's a bit darker out, thus lending to increased obscurity and decreased acuity and vision-related impairments. Overall, this visualization was quite interesting to dissect, as there does seem to be a correlation between crimes and their time of occurrence, as more crimes occur during afternoons and evenings.

```
# library(sf)
# data1 <- st_read("data/Police_Department_Incidents_-_Previous_Year__2016_.csv", quiet = TRUE)
# data1

# ggplot(data1) +
#   geom_sf(aes(fill = voted)) +
#   labs(title = "Higher population counties have more votes cast",
#        fill = "Total number of votes cast") +
#   theme_bw()
#
# ggplot(data1) +
#   geom_sf(color = "green", size = 1.5, fill = "orange", alpha = 0.50) +
#   labs(title = "SF data with theme and aesthetics") +
#   theme_bw()
```

Office hrs

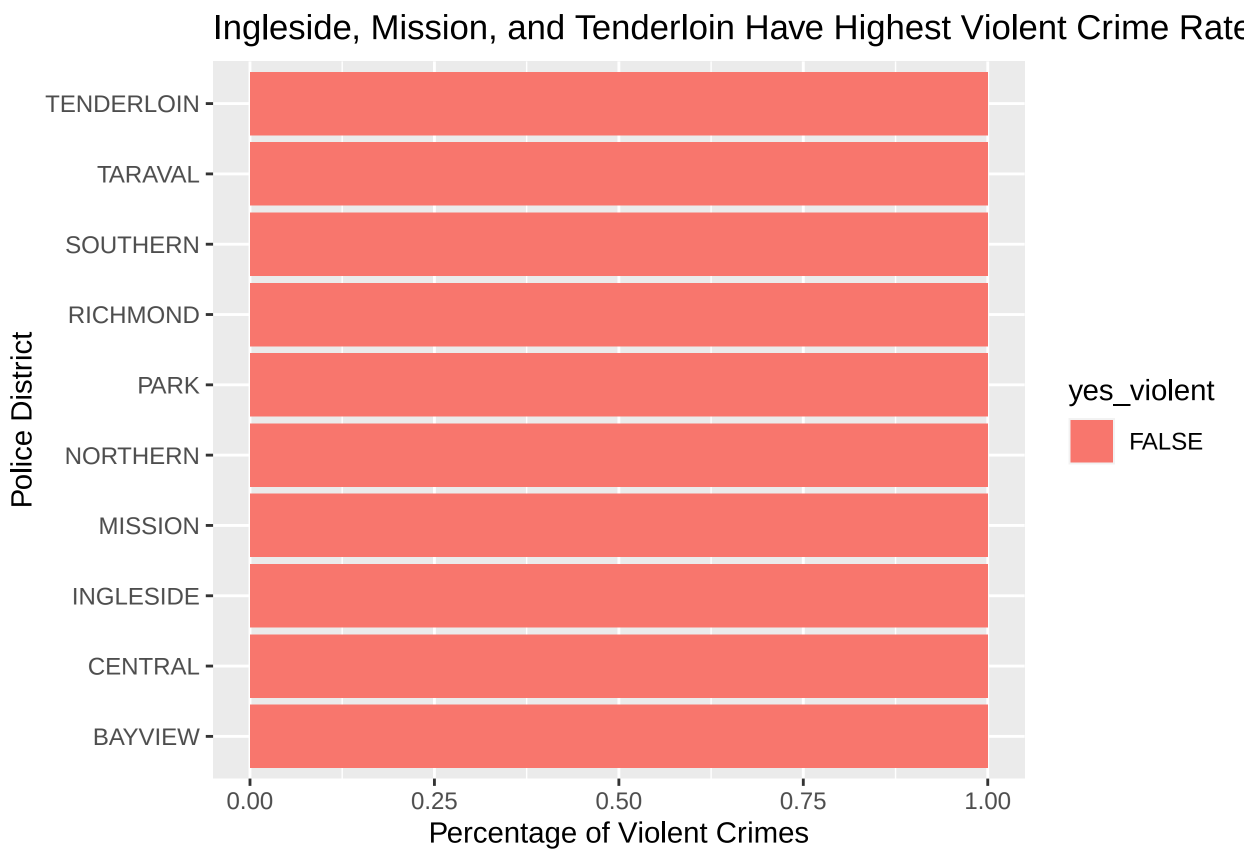
Which PD has the highest proportion of violent crime? Kyra

```
pd_violent <- sanfrancrime%>%
  group_by(Category)%>%
  count()
pd_violent<- sanfrancrime%>%
  mutate(violent_crime = case_when(
    Category == "ASSAULT" | Category == "SEX OFFENSES FORCIBLE" |
      Category == "ROBBERY" | Category == "KIDNAPPING" ~ "YES",
    Category != "ASSAULT" | Category != "SEX OFFENSES, FORCIBLE" |
      Category != "ROBBERY" | Category !="KIDNAPPING" ~ "NO"))
important <- important%>%
  filter(PdDistrict!="NA")%>%
  group_by(PdDistrict)%>%
  mutate(yes_violent = crimetype == "violence related")%>%
  arrange(desc(yes_violent))


important%>%
  group_by(PdDistrict)%>%
  count(yes_violent)%>%
  mutate(perc = (n/sum(n)*100))%>%
  arrange(desc(perc))%>%
  filter(yes_violent=="TRUE")
```

```
## # A tibble: 0 x 4
## # Groups:   PdDistrict [0]
## # ... with 4 variables: PdDistrict <chr>, yes_violent <lgl>, n <int>,
## #   perc <dbl>
```

```
ggplot(important, aes(x = PdDistrict, fill = yes_violent))+
  geom_bar(position = "fill") + coord_flip()+
  labs(title =
         "Ingleside, Mission, and Tenderloin Have Highest Violent Crime Rates ",
       y = "Percentage of Violent Crimes", x = "Police District")
```



Ingleside, Mission, and Tenderloin have the highest rates of violent crime. However, Mission, Southern, and Bayview have the highest number of violent crimes. Park and Richmond both have the lowest rates and total numbers of violent crimes. For all police districts, the percentage of violent crimes is lower than 16%.

How does time range affect whether crimes are violent? Kyra

```
library(broom)
mod<- lm(yes_violent~timerange,
         data = important)
tidy(mod)
```

```
## # A tibble: 4 x 5
##   term             estimate std.error statistic p.value
##   <chr>               <dbl>     <dbl>     <dbl>   <dbl>
## 1 (Intercept)             0         0       NaN     NaN
## 2 timerangeevening        0         0       NaN     NaN
## 3 timerangemorning        0         0       NaN     NaN
## 4 timerangenight          0         0       NaN     NaN
```

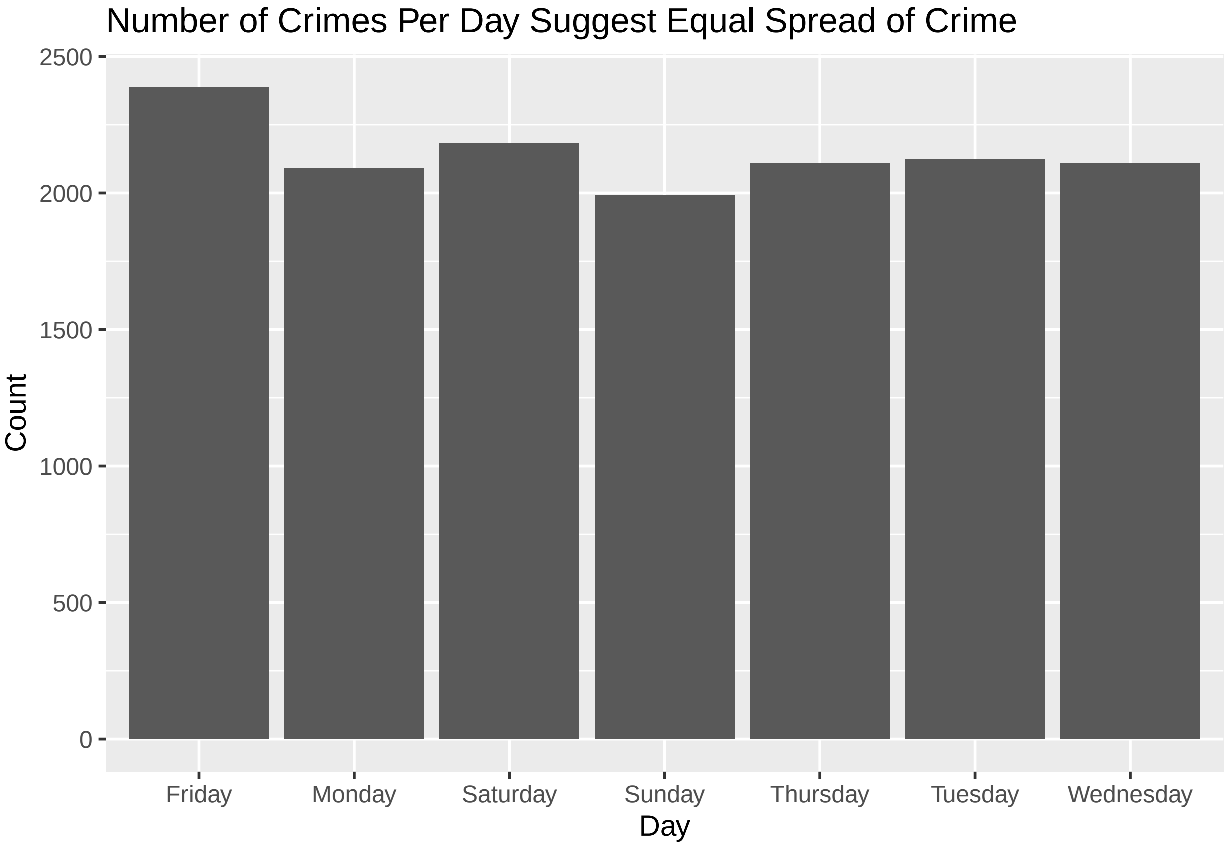
$\text{logit}(p) = 0.10383 + 0.01188(\text{evening}) + 0.00227(\text{morning}) + 0.06939(\text{night})$

Day of the week and category? Leah

```
#library(forcats)
#sanfrancrime <- sanfrancrime%>%
  #mutate(DayOfWeek = factor(DayOfWeek, labels = c("Monday", "Tuesday", "Wednesday", "Thursday", "Frida
day <- sanfrancrime%>%
  group_by(DayOfWeek)%>%
  mutate(cpday = n())%>%
  select(DayOfWeek, cpday)
day
```

```
## # A tibble: 15,000 x 2
## # Groups:   DayOfWeek [7]
##    DayOfWeek cpday
##    <chr>     <int>
##  1 Tuesday    2124
##  2 Wednesday  2110
##  3 Sunday     1993
##  4 Tuesday    2124
##  5 Wednesday  2110
##  6 Monday     2093
##  7 Monday     2093
##  8 Thursday   2108
##  9 Wednesday  2110
## 10 Friday     2388
## # ... with 14,990 more rows
```

```
ggplot(data = day, mapping = aes(x = DayOfWeek)) +
    geom_bar()  + labs(x = "Day", y = "Count",
      title = "Number of Crimes Per Day Suggest Equal Spread of Crime")
```



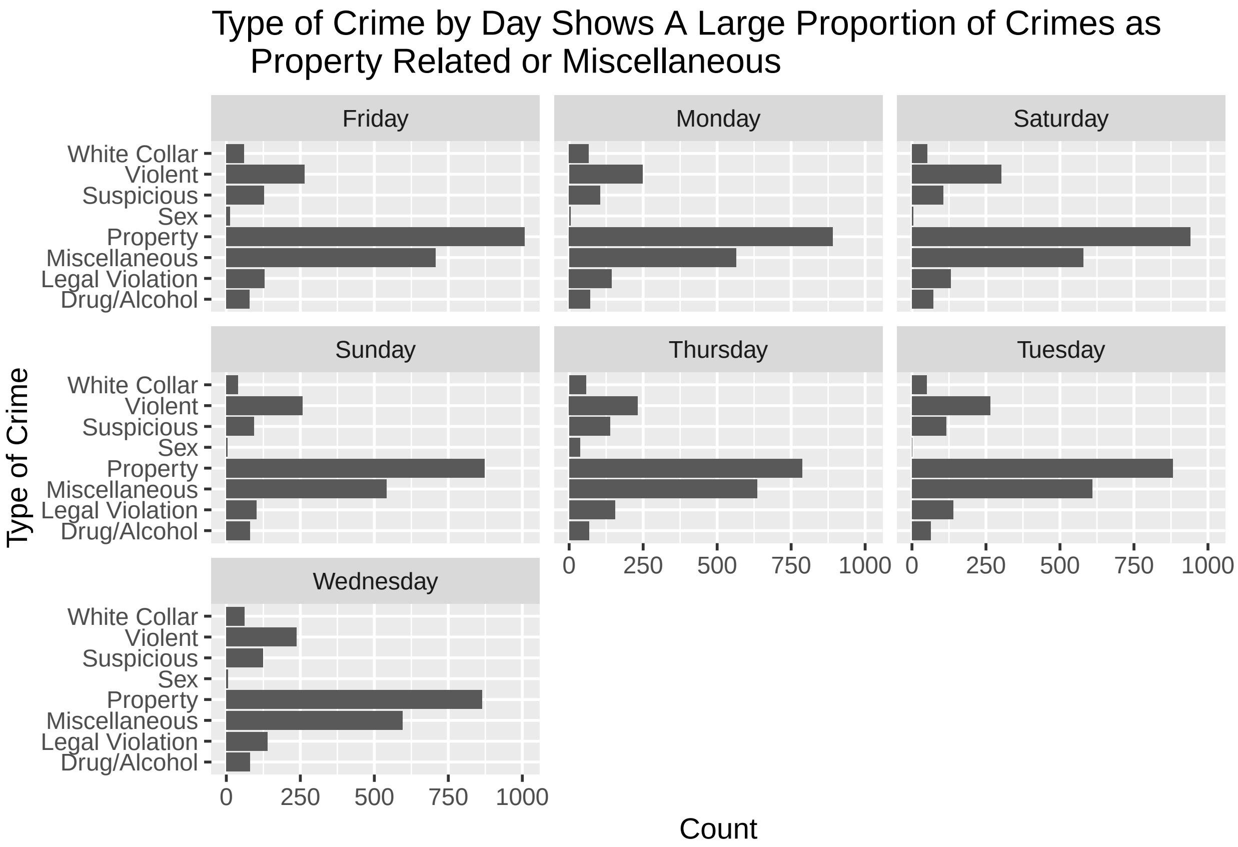
```
#need to change order of days of the week
```

One relationship we were interested in was if certain days had a higher rates of crime. We visualized this relationship by creating a bar graph that compares the day of the week and number of crimes each day during this time period. By looking at the visual, we are able to see that each has a relatively similar crime count compared to the other. In addition to this, there is no significant pattern that sticks out as well.

```
crimetypeday <-important%>%
  group_by(crimetype)%>%
  mutate(ctcount = n())
crimetypeday
```

```
## # A tibble: 15,000 x 10
## # Groups:   crimetype [8]
##    Category DayOfWeek Date  PdDistrict Resolution  hour timerange crimetype
##    <chr>    <chr>     <chr> <chr>      <chr>      <dbl> <chr>     <chr>
##  1 ASSAULT  Tuesday   01/2~ NORTHERN   NONE          13 day       Violent
##  2 LARCENY~ Wednesday 06/1~ BAYVIEW    NONE           8 morning   Property
##  3 NON-CRI~ Sunday    08/2~ SOUTHERN   NONE          12 day       Miscella~
##  4 NON-CRI~ Tuesday   08/1~ CENTRAL    NONE          16 day       Miscella~
##  5 NON-CRI~ Wednesday 02/0~ NORTHERN   NONE           6 morning   Miscella~
##  6 ROBBERY  Monday    03/2~ INGLESIDE  NONE          15 day       Violent
##  7 NON-CRI~ Monday    10/1~ SOUTHERN   NONE           8 morning   Miscella~
##  8 NON-CRI~ Thursday  02/0~ SOUTHERN   NONE          11 morning   Miscella~
##  9 WARRANTS Wednesday 05/0~ NORTHERN   ARREST, B~    22 evening   Legal Vi~
## 10 VEHICLE~ Friday    04/0~ INGLESIDE  NONE          22 evening   Property
## # ... with 14,990 more rows, and 2 more variables: yes_violent <lgl>,
## #   ctcount <int>
```

```
ggplot(data = crimetypeday, mapping = aes(y = crimetype)) +
  geom_bar() + facet_wrap(~ DayOfWeek) +
  labs(
    x = "Count",
    y = "Type of Crime",
    title = "Type of Crime by Day Shows A Large Proportion of Crimes as
    Property Related or Miscellaneous")
```



```
#need to fix crimetype names
# make miscellaneous crimes more specific?
```

The faceted bar graph shows the frequency of each crime rate on a given day of the week. When looking at the visualization, it is easy to see the large difference between types of crime that exist. On each day, the number of property related crimes and miscellaneous crimes are significantly greater than the 5 other crime types. When looking at the frequency of crime types from day to day, every day has a similar pattern of frequency. This further supports the observation from the previous visualization where crime and day of the week do not necessarily have a relationship.

Discussion

This section is a conclusion and discussion. This will require a summary of what you have learned about your research question along with statistical arguments supporting your conclusions. Also, critique your own methods and provide suggestions for improving your analysis. Issues pertaining to the reliability and validity of your data and appropriateness of the statistical analysis should also be discussed here. A paragraph on what you would do differently if you were able to start over with the project or what you would do next if you were going to continue work on the project should also be included.