nypd_analysis

April 30, 2023

0.0.1 Overview

1) Introduction
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   - Load csv data into R data frame
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1 1 Introduction

This is a comprhensive analysis of the NYPD Shooting Incident Data (Historic) - Catalog. This dataset records every shooting incident that occured in 2006 - 2022. Each record includes information related to the shooting such as suspect and victim demographics, location, and date.

We will study and visulaize the data using ggplot2 and tidyverse. Later, we will generate some questions based on our findings about the data. Finally, we will model our processed data and make an analysis about the questions we have formed.

The purpose of this report is to examine the following questions: 1) Is the number of shooting incidents going up or down? 2) What is distribution of the Victim's demographic information

1.1 1.1 Install and Load Libraries

[1]:
```
#install packages
```

[2]:
```
#common packages

#data wrangling packages
library(tidyverse)

#data visualization packages
library(forcats)

#utility packages
```

```r
library(assert)
```

```
  Attaching core tidyverse packages               tidyverse
2.0.0
 dplyr     1.1.0      readr     2.1.4
 forcats   1.0.0      stringr   1.5.0
 ggplot2   3.4.1      tibble    3.2.0
 lubridate 1.9.2      tidyr     1.3.0
 purrr     1.0.1
  Conflicts
tidyverse_conflicts()
 dplyr::filter() masks stats::filter()
 dplyr::lag()    masks stats::lag()
 Use the conflicted package
(<http://conflicted.r-lib.org/>) to force all conflicts to
become errors
```

1.2 1.2 Load Data

[21]:
```r
#check data size, columns and data types
file_path = 'NYPD_Shooting_Incident_Data__Historic_.csv'
original_df = read_csv(file_path)
spec(original_df)
```

```
Rows: 25596 Columns: 19
  Column specification

Delimiter: ","
chr  (10): OCCUR_DATE, BORO, LOCATION_DESC, PERP_AGE_GROUP, PERP_SEX,
PERP_R…
dbl   (7): INCIDENT_KEY, PRECINCT, JURISDICTION_CODE, X_COORD_CD,
Y_COORD_CD…
lgl   (1): STATISTICAL_MURDER_FLAG
time  (1): OCCUR_TIME

 Use `spec()` to retrieve the full column specification for this
data.
 Specify the column types or set `show_col_types = FALSE` to quiet
this message.

cols(
  INCIDENT_KEY = col_double(),
  OCCUR_DATE = col_character(),
  OCCUR_TIME = col_time(format = ""),
  BORO = col_character(),
  PRECINCT = col_double(),
  JURISDICTION_CODE = col_double(),
  LOCATION_DESC = col_character(),
```

```
  STATISTICAL_MURDER_FLAG = col_logical(),
  PERP_AGE_GROUP = col_character(),
  PERP_SEX = col_character(),
  PERP_RACE = col_character(),
  VIC_AGE_GROUP = col_character(),
  VIC_SEX = col_character(),
  VIC_RACE = col_character(),
  X_COORD_CD = col_double(),
  Y_COORD_CD = col_double(),
  Latitude = col_double(),
  Longitude = col_double(),
  Lon_Lat = col_character()
)
```

2 2 EDA

2.1 2.1 Quick Overview of the Entire Data

[22]:
```
summary(original_df)
```

```
  INCIDENT_KEY        OCCUR_DATE          OCCUR_TIME            BORO
 Min.   :  9953245   Length:25596       Length:25596       Length:25596
 1st Qu.: 61593633   Class :character   Class1:hms         Class :character
 Median : 86437258   Mode  :character   Class2:difftime    Mode  :character
 Mean   :112382648                      Mode  :numeric
 3rd Qu.:166660833
 Max.   :238490103

    PRECINCT      JURISDICTION_CODE LOCATION_DESC      STATISTICAL_MURDER_FLAG
 Min.   :  1.00   Min.   :0.0000    Length:25596       Mode :logical
 1st Qu.: 44.00   1st Qu.:0.0000    Class :character   FALSE:20668
 Median : 69.00   Median :0.0000    Mode  :character   TRUE :4928
 Mean   : 65.87   Mean   :0.3316
 3rd Qu.: 81.00   3rd Qu.:0.0000
 Max.   :123.00   Max.   :2.0000
                  NA's   :2
 PERP_AGE_GROUP       PERP_SEX          PERP_RACE         VIC_AGE_GROUP
 Length:25596       Length:25596       Length:25596       Length:25596
 Class :character   Class :character   Class :character   Class :character
 Mode  :character   Mode  :character   Mode  :character   Mode  :character



   VIC_SEX            VIC_RACE           X_COORD_CD        Y_COORD_CD
 Length:25596       Length:25596       Min.   : 914928   Min.   :125757
 Class :character   Class :character   1st Qu.:1000011   1st Qu.:182782
```

```
 Mode  :character   Mode  :character   Median :1007715   Median :194038
                                       Mean   :1009455   Mean   :207894
                                       3rd Qu.:1016838   3rd Qu.:239429
                                       Max.   :1066815   Max.   :271128

    Latitude       Longitude       Lon_Lat
 Min.   :40.51   Min.   :-74.25   Length:25596
 1st Qu.:40.67   1st Qu.:-73.94   Class :character
 Median :40.70   Median :-73.92   Mode  :character
 Mean   :40.74   Mean   :-73.91
 3rd Qu.:40.82   3rd Qu.:-73.88
 Max.   :40.91   Max.   :-73.70
```

[23]:
```
glimpse(original_df)
```

```
Rows: 25,596
Columns: 19
$ INCIDENT_KEY            <dbl> 236168668, 231008085,
230717903, 237712309, 22…
$ OCCUR_DATE              <chr> "11/11/2021", "07/16/2021",
"07/11/2021", "12/…
$ OCCUR_TIME              <time> 15:04:00, 22:05:00,
01:09:00, 13:42:00, 20:00…
$ BORO                    <chr> "BROOKLYN", "BROOKLYN",
"BROOKLYN", "BROOKLYN"…
$ PRECINCT                <dbl> 79, 72, 79, 81, 113, 113, 42,
52, 34, 75, 32, …
$ JURISDICTION_CODE       <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 2, 2, 0, 0, 0…
$ LOCATION_DESC           <chr> NA, NA, NA, NA, NA, NA,
"COMMERCIAL BLDG", NA,…
$ STATISTICAL_MURDER_FLAG <lgl> FALSE, FALSE, FALSE, FALSE,
FALSE, TRUE, TRUE,…
$ PERP_AGE_GROUP          <chr> NA, "45-64", "<18", NA, NA,
NA, NA, NA, NA, "2…
$ PERP_SEX                <chr> NA, "M", "M", NA, NA, NA, NA,
NA, NA, "M", "M"…
$ PERP_RACE               <chr> NA, "ASIAN / PACIFIC
ISLANDER", "BLACK", NA, N…
$ VIC_AGE_GROUP           <chr> "18-24", "25-44", "25-44",
"25-44", "25-44", "…
$ VIC_SEX                 <chr> "M", "M", "M", "M", "M", "M",
"M", "M", "M", "…
$ VIC_RACE                <chr> "BLACK", "ASIAN / PACIFIC
ISLANDER", "BLACK", …
$ X_COORD_CD              <dbl> 996313, 981845, 996546,
1001139, 1050710, 1051…
```

```
$ Y_COORD_CD              <dbl> 187499, 171118, 187436,
192775, 184826, 196646…
$ Latitude                <dbl> 40.68132, 40.63636, 40.68114,
40.69579, 40.673…
$ Longitude               <dbl> -73.95651, -74.00867,
-73.95567, -73.93910, -7…
$ Lon_Lat                 <chr> "POINT (-73.95650899099996
40.68131820000008)"…
```

2.2 2.2 Cleaning and Extracting Data

Before we start exploring our data, we can drop some columns of the data where information overlaps.

We can drop: - *X_COORD_CD* & *Y_COORD_CD* because *Latitude* & *Longitude* exists - *Latitude* and *Longitude* because *Lon_Lat* is a column that combines both - *ind* & *INCIDENT_KEY* - *BORO* because *PRECINCT* contains boro information

[25]:
```
df = original_df %>%
    select(-c(X_COORD_CD, Y_COORD_CD, Latitude, Longitude, INCIDENT_KEY,␣
 ↪OCCUR_TIME, PRECINCT, JURISDICTION_CODE, STATISTICAL_MURDER_FLAG, Lon_Lat))
```

[26]:
```
glimpse(df)
```

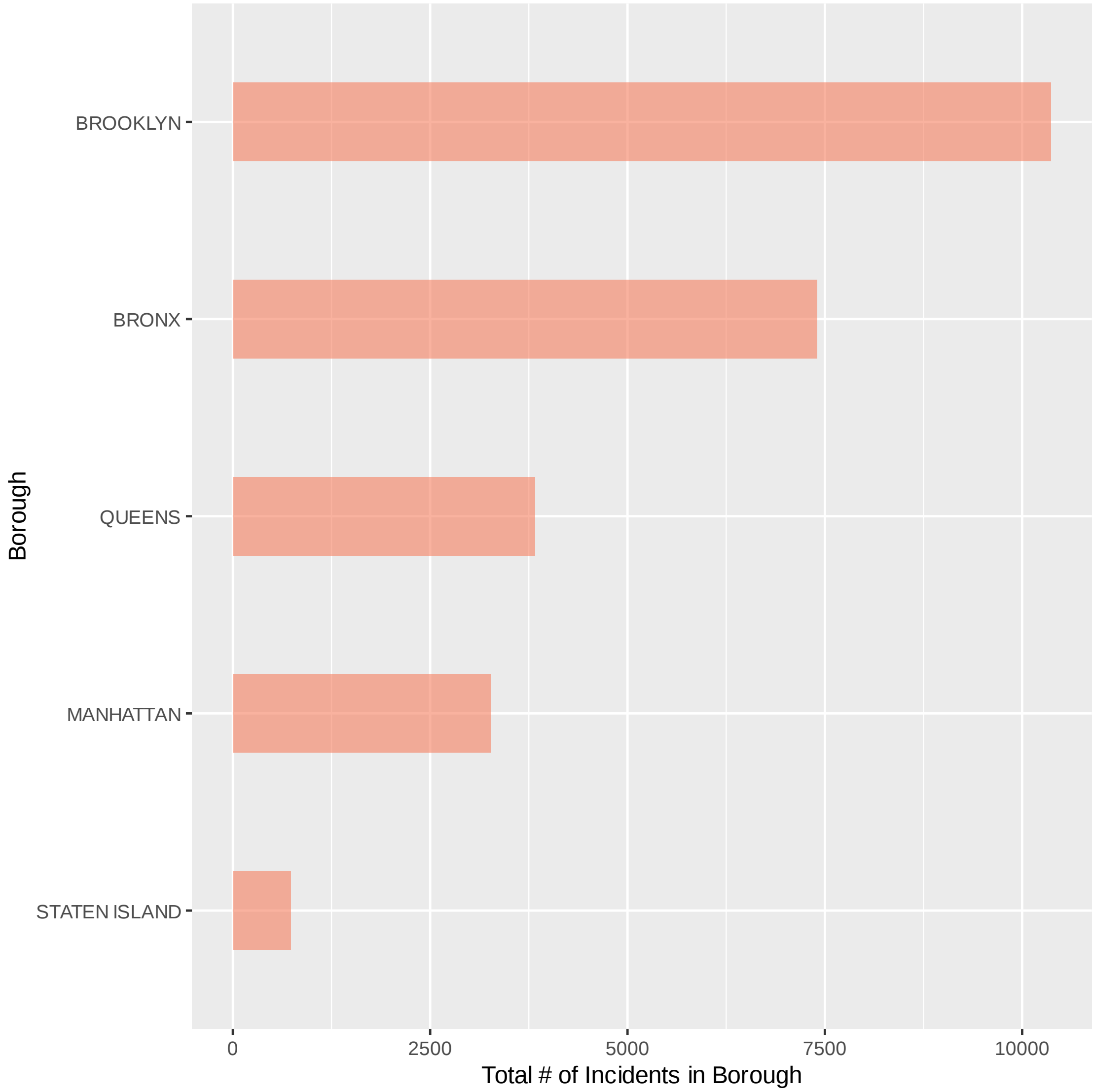
```
Rows: 25,596
Columns: 9
$ OCCUR_DATE     <chr> "11/11/2021", "07/16/2021",
"07/11/2021", "12/11/2021",…
$ BORO           <chr> "BROOKLYN", "BROOKLYN", "BROOKLYN",
"BROOKLYN", "QUEENS…
$ LOCATION_DESC  <chr> NA, NA, NA, NA, NA, NA, "COMMERCIAL
BLDG", NA, NA, NA, …
$ PERP_AGE_GROUP <chr> NA, "45-64", "<18", NA, NA, NA, NA,
NA, NA, "25-44", "2…
$ PERP_SEX       <chr> NA, "M", "M", NA, NA, NA, NA, NA, NA,
"M", "M", NA, "M"…
$ PERP_RACE      <chr> NA, "ASIAN / PACIFIC ISLANDER",
"BLACK", NA, NA, NA, NA…
$ VIC_AGE_GROUP  <chr> "18-24", "25-44", "25-44", "25-44",
"25-44", "25-44", "…
$ VIC_SEX        <chr> "M", "M", "M", "M", "M", "M", "M",
"M", "M", "M", "M", …
$ VIC_RACE       <chr> "BLACK", "ASIAN / PACIFIC ISLANDER",
"BLACK", "BLACK", …
```

2.3 2.3 Individual Feature Visualization

2.3.1 Distribution of Borough Where Incident Took Place

This is the frequency distribution of where the shooting incident took place:

[27]:
```
boro_distribution = df %>%
  group_by(BORO) %>%
  summarise(ct = n())


boro_distribution %>%
  mutate(BORO = fct_reorder(BORO, ct)) %>%
  ggplot( aes(x=BORO, y=ct)) +
    geom_bar(stat="identity", fill="#f68060", alpha=.6, width=.4) +
    coord_flip() +
    xlab("Borough") +
    ylab("Total # of Incidents in Borough")
```



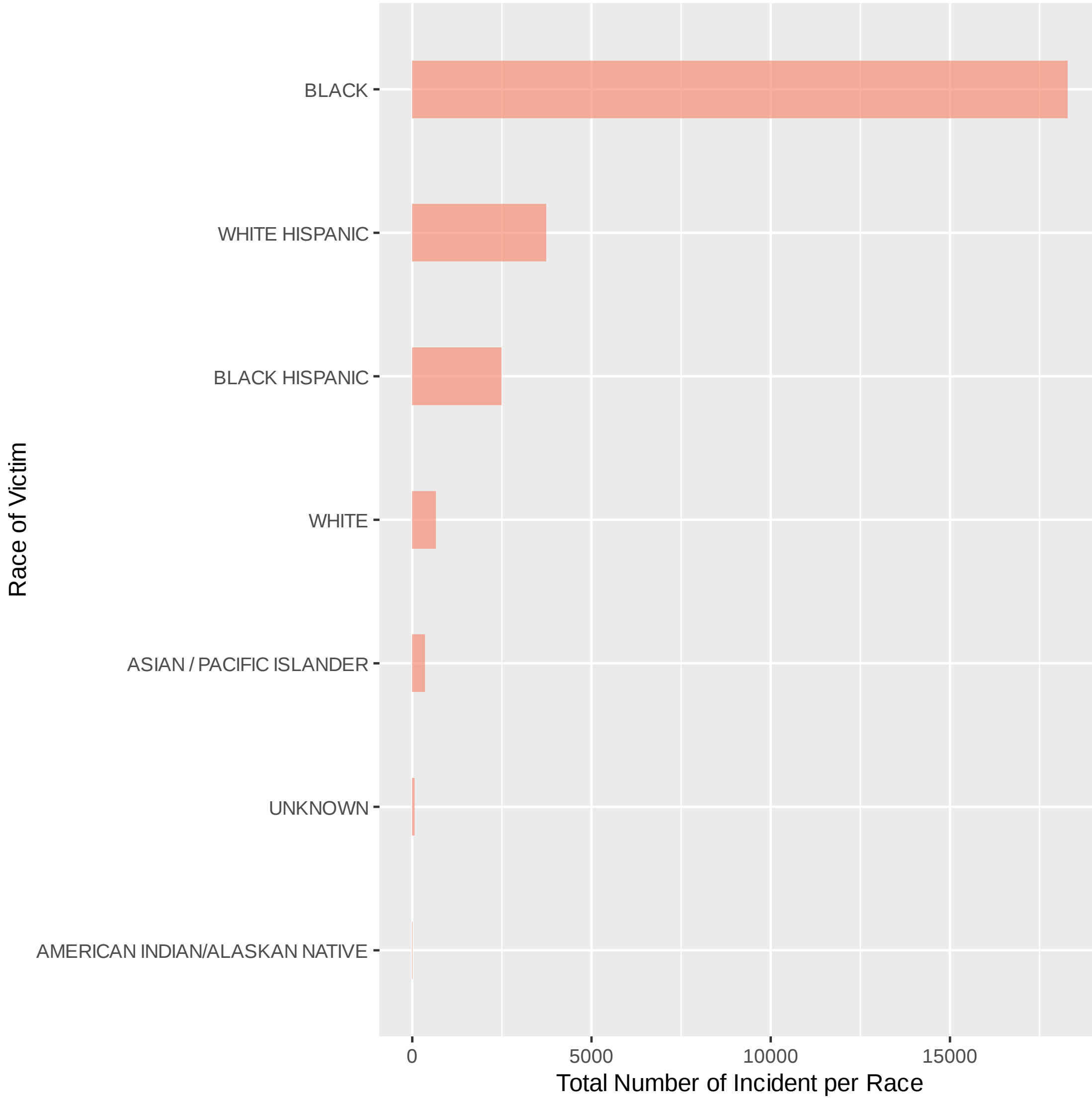
Based on our inital visualization, we can that Brooklyn has highest shooting rate with over 10000 cases. Furthermore, if we take a look at the population of each borough, we notice that as the population increases, the number of shooting incident increases. ### Conisdering Population Population in Millions as of April 1st, 2020

- **Brooklyn**: 2.64 million
- **Bronx**: 1.47 million
- **Queens**: 2.41 million
- **Manhattan**: 1.69 million
- **Staten Island**: 0.49 million

However, Queens does not fit the trend. Despite the population similar to Brooklyn, the number of shooting incidents is less than half. Deep dive into Queens demographics may help us undercover methods to decrease shooting rates in other Boroughs.

2.3.2 Distribution of Victim Demographics: Race

[32]:
```
victim_race_distribution = df %>%
  group_by(VIC_RACE) %>%
  summarise(ct = n()) %>%
  arrange(desc(ct))

victim_race_distribution %>%
  mutate(VIC_RACE = fct_reorder(VIC_RACE, ct)) %>%
  ggplot( aes(x=VIC_RACE, y=ct)) +
    geom_bar(stat="identity", fill="#f68060", alpha=.6, width=.4) +
    coord_flip() +
    xlab("Race of Victim") +
    ylab("Total Number of Incident per Race")
```



Here, we find that a heavy majority of the victim's in the shooting incident were black.

2.3.3 Distribution of Perpatrator Demographics: Race

[70]:
```
df %>%
  group_by(PERP_RACE) %>%
  summarise(ct = n()) %>%
  arrange(desc(ct))
```

A tibble: 7 × 2

PERP_RACE	ct
<chr>	<int>
UNKNOWN	11146
BLACK	10668
WHITE HISPANIC	2164
BLACK HISPANIC	1203
WHITE	272
ASIAN / PACIFIC ISLANDER	141
AMERICAN INDIAN/ALASKAN NATIVE	2

2.3.4 Handling Missing Data

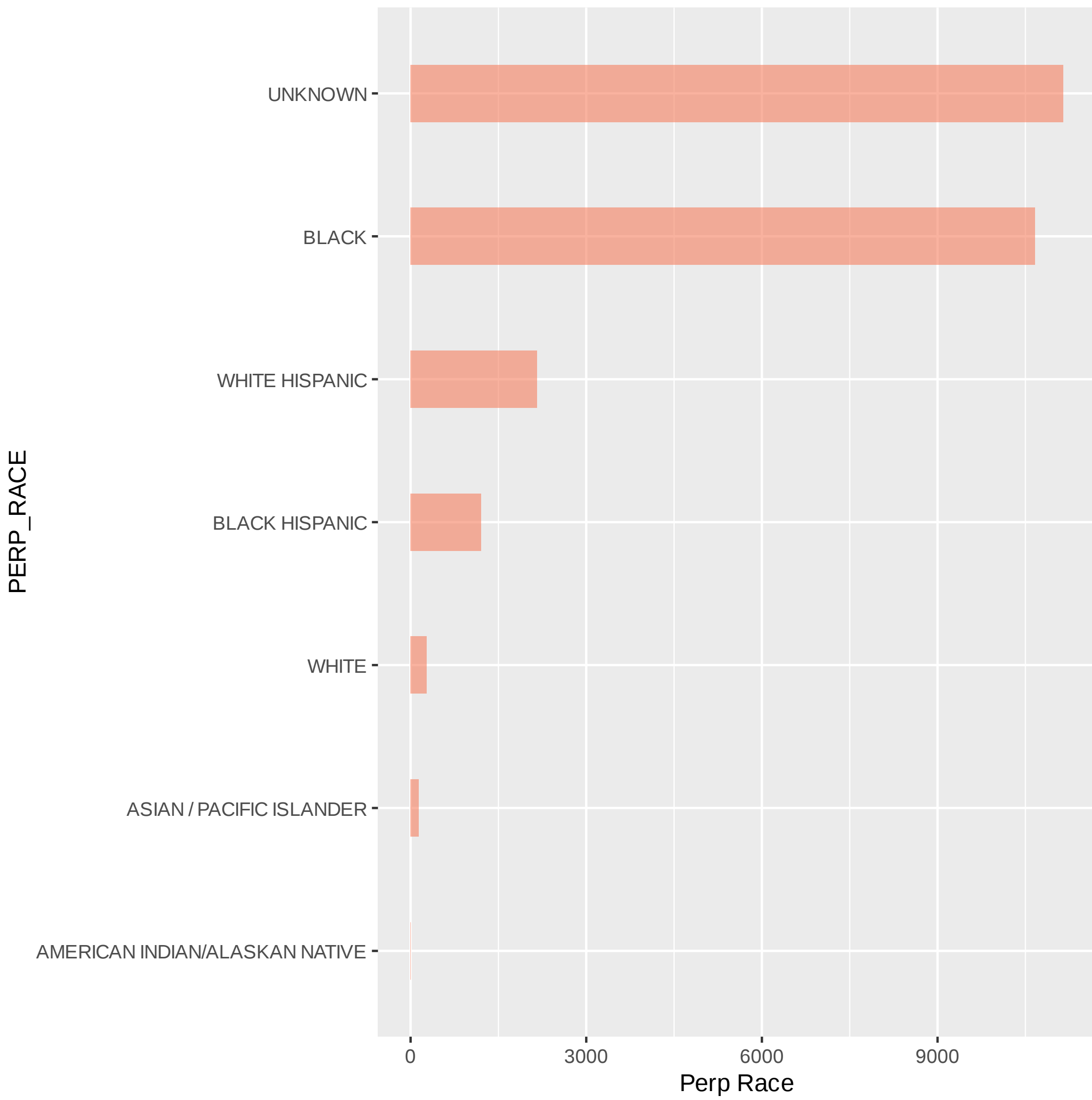
There are two ways missing data is handled in the PERP_RACE col.

1) NA
2) UNKNOWN

There were no further information regarding the difference from the source NYPD Shooting Incident Data (Historic) | NYC Open Data.Therefore we will make the assumption that NA refers to shooting incidents where the perpatrator has not been found. Unkown refers to cases where they have found the perpatrator but was unable to correctly identify their race. However, for our purposes, we will treat NA as UNKNOWN.

[53]:
```
df = df %>% dplyr::mutate(PERP_RACE = replace_na(PERP_RACE, "UNKNOWN"))

perpetrator_race_distribution = df %>%
  group_by(PERP_RACE) %>%
  summarise(ct = n()) %>%
  arrange(desc(ct))
```

[54]:
```
perpetrator_race_distribution %>%
  mutate(PERP_RACE = fct_reorder(PERP_RACE, ct)) %>%
  ggplot( aes(x=PERP_RACE, y=ct)) +
    geom_bar(stat="identity", fill="#f68060", alpha=.6, width=.4) +
    coord_flip() +
    xlab("PERP_RACE") +
    ylab("Perp Race")
```



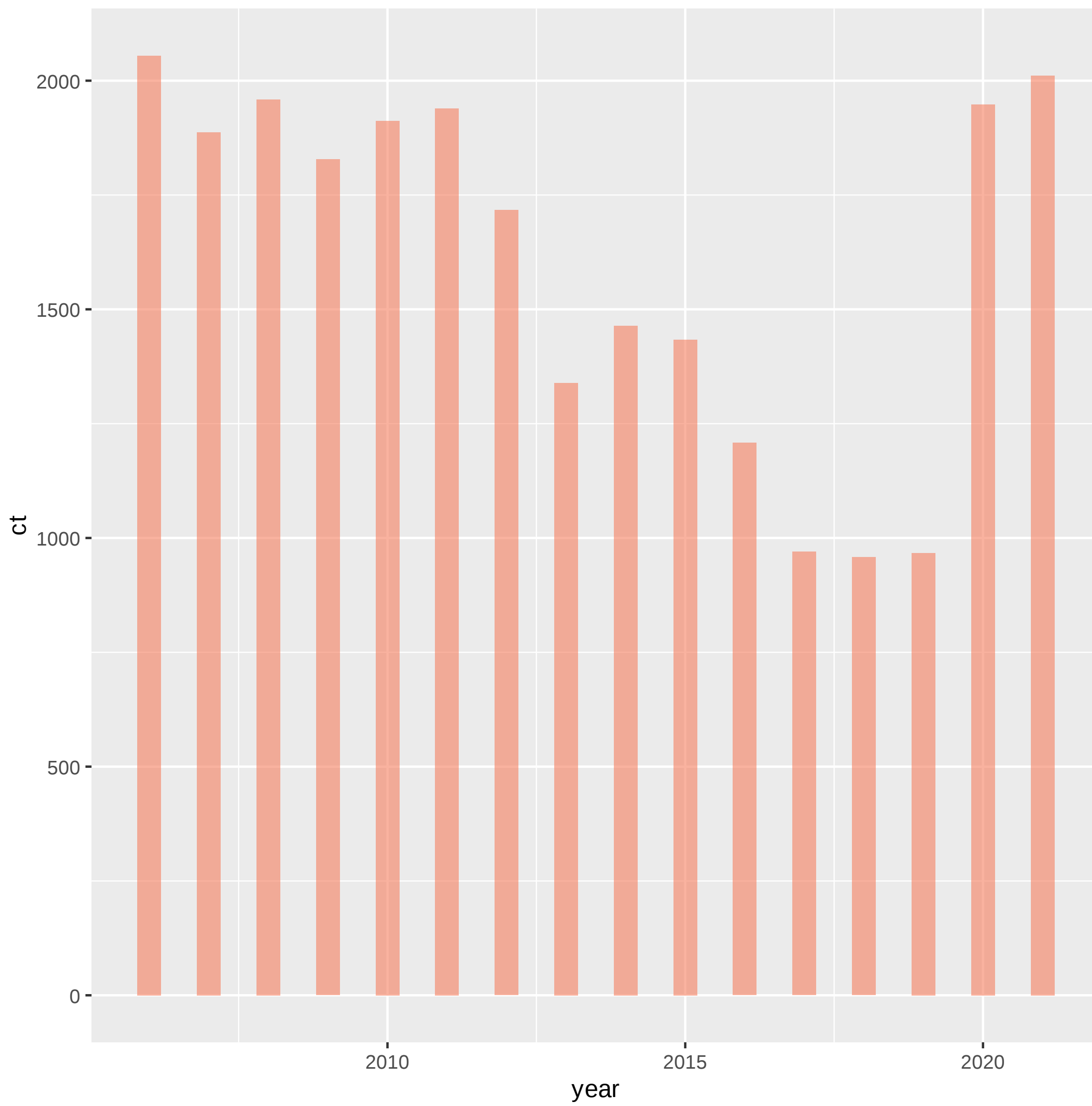
Here, we find that a heavy majority of the Perpatrator's in the shooting incident were black. However, there are many UNKOWN's which may impact the distribution if they are correctly indentified.

3 3 Linear Regression Model to Determine Trend in Number of Shooting Incident Per Year

3.1 Feature Engineering

[88]:
```
#split the occur_date string into 3 cols:
# year, day, and month
```

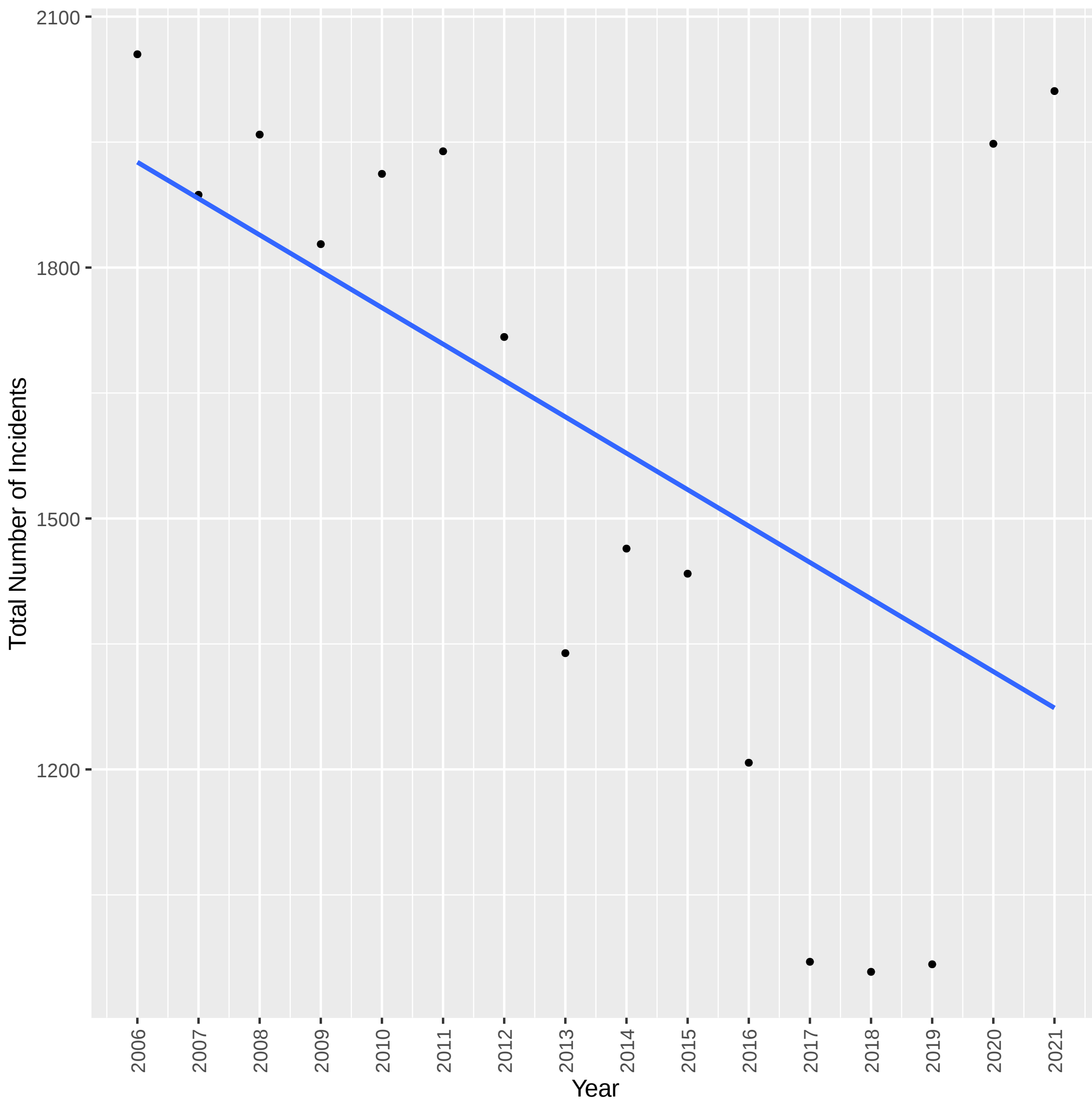
```r
date_df = str_split_fixed(df$OCCUR_DATE, "/", 3)

df$year = as.integer(date_df[,3])
df$day =  as.integer(date_df[,2])
df$month =  as.integer(date_df[,1])
df$year_month = as.character(df$year + df$month/100)

incident_count_by_year = df %>%
  group_by(year) %>%
  summarise(ct = n()) %>%
  arrange()

incident_count_by_year %>%
  ggplot( aes(x=year, y=ct)) +
    geom_bar(stat="identity", fill="#f68060", alpha=.6, width=.4)
```



Based on the above visualization, from 2006 to 2019, there is a clear down trend. However, there is a big spike up in 2020.

[79]:
```r
ggplot(incident_count_by_year, aes(x=year, y=ct)) +
    geom_point(size=1) +
    geom_smooth(method = "lm", se = FALSE) +
    scale_x_continuous(breaks = seq(min(df$year), max(df$year), by = 1)) +
    xlab("Year") +
    ylab("Total Number of Incidents") +
    theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))
```

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



[80]:
```
incidentcountbyyear.lm <- lm(ct ~ year, data = incident_count_by_year)
summary(incidentcountbyyear.lm)
```

```
Call:
lm(formula = ct ~ year, data = incident_count_by_year)

Residuals:
    Min      1Q  Median      3Q     Max
-477.49 -282.62   18.48  136.73  737.52

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 89192.92   39375.83   2.265   0.0399 *
year          -43.50      19.56  -2.225   0.0431 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 360.6 on 14 degrees of freedom
Multiple R-squared:  0.2612,	Adjusted R-squared:  0.2084
F-statistic: 4.949 on 1 and 14 DF,  p-value: 0.04307
```

3.1.1 Predicting Future Shooting Incident Numbers

[76]:
```
89192.92 - (2030*43.50)
```

887.919999999998

4 4 Conclusions

In short, we have determined using a linear regression model that there is a down trend in the number of shootings per year in NY. While there is an anomly in the data, it can be explained with its correlation with the COVID-19 outbreak. By 2030, the number of shooting incidents in NY should approximately be lower than 900.

Because we have a large amount of data, we would like to randomly parition the data into train and validation set. We will perform EDA and modeling on train set. Later, we will use the validation set to test our model.

[4]:
```
# set seed
set.seed(42)

#randomly partition oringal dataset into two: train & validation set
df$ind = seq.int(nrow(df))
```

```r
smp_size = floor(0.75 * nrow(df))
train_ind = sample(seq_len(nrow(df)), size=smp_size)
original_train_df = df[train_ind, ]
original_valid_df = df[-train_ind, ]

#make sure train_df row count + valid_df row count equals original cf
nrow(original_train_df) + nrow(original_valid_df) == nrow(df)

valid_df = original_valid_df %>%
    select(-c(X_COORD_CD, Y_COORD_CD, Latitude, Longitude, INCIDENT_KEY, ind,
 ↪OCCUR_TIME, PRECINCT, JURISDICTION_CODE, STATISTICAL_MURDER_FLAG, Lon_Lat))
```

TRUE