Crime rate prediction in Chicago

1.Data Collection and Cleaning:

```
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.3.2
```

```
##
## 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
```

```
library(tidyr)
```

```
## Warning: package 'tidyr' was built under R version 4.3.2
```

```
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.3.2
```

```
## Loading required package: ggplot2
```

```
## Warning: package 'ggplot2' was built under R version 4.3.2
```

```
## Loading required package: lattice
```

```
crime_data <- read.csv("C:/Users/18388/OneDrive/GitHub Projects/crime
project/Chicago_crime_dataset.csv")
weather_data<-read.csv("C:/Users/18388/OneDrive/GitHub Projects/crime
project/Temperature_dataset.csv")

crime_data$Date <- as.POSIXct(crime_data$Date, format = "%m/%d/%Y %H:%M")
crime_data$Date <- as.Date(crime_data$Date)
crime_data$Time <- format(crime_data$Date, "%H:%M:%S")
crime_data$Date <- format(crime_data$Date, "%m-%d-%Y")




#summary(crime_data,n=10)
head(weather_data,n=10)
```

```
##                      name       Date temp  dew humidity precip snow
## 1  Chicago,United States 01-01-2021 -0.7 -3.2     82.8  7.045  0.0
## 2  Chicago,United States 02-01-2021  0.5 -1.7     85.2  0.000  1.1
## 3  Chicago,United States 03-01-2021 -0.2 -2.4     85.4  1.054  0.2
## 4  Chicago,United States 04-01-2021 -2.6 -4.3     88.3  0.000  0.0
## 5  Chicago,United States 05-01-2021  0.2 -2.4     82.4  0.000  0.0
## 6  Chicago,United States 06-01-2021  1.3 -2.3     77.3  0.000  0.0
## 7  Chicago,United States 07-01-2021  2.6 -3.8     63.0  0.000  0.0
## 8  Chicago,United States 08-01-2021  1.0 -3.8     70.3  0.267  0.0
## 9  Chicago,United States 09-01-2021  0.0 -5.4     67.4  0.000  0.0
## 10 Chicago,United States 10-01-2021 -2.0 -6.4     72.1  0.000  0.0
```

```
crime_data <- left_join(crime_data, weather_data, by ="Date")
head(crime_data,n=10)
```

```
##          ID Case.Number       Date                Block IUCR
Primary.Type
## 1  12259050    JE100626 01-01-2021    057XX S DAMEN AVE 1310   CRIMINAL
DAMAGE
## 2  12259424    JE100501 01-01-2021 062XX S MICHIGAN AVE 1320   CRIMINAL
DAMAGE
## 3  12311821    JE164805 01-01-2021   031XX N RACINE AVE 0820
THEFT
## 4  12260063    JE101649 01-01-2021      031XX W POLK ST 1320   CRIMINAL
DAMAGE
## 5  12259020    JE100698 01-01-2021 075XX S JEFFERY BLVD 141B WEAPONS
VIOLATION
## 6  12313377    JE166660 01-01-2021      058XX W 55TH ST 0820
THEFT
## 7  12268897    JE111949 01-01-2021  109XX S EMERALD AVE 1310   CRIMINAL
DAMAGE
## 8  12259086    JE100744 01-01-2021  032XX W FILLMORE ST 0820
THEFT
## 9  12378360    JE245959 01-01-2021   002XX E ONTARIO ST 0810
THEFT
## 10 12261931    JE100377 01-01-2021    068XX S PERRY AVE 1310   CRIMINAL
DAMAGE
##                    Description Location.Description Arrest Domestic Beat
## 1                   TO PROPERTY            APARTMENT  false    false  715
## 2                    TO VEHICLE               STREET  false    false  311
## 3                 $500 AND UNDER            APARTMENT  false    false 1933
## 4                    TO VEHICLE               STREET  false    false 1134
## 5  UNLAWFUL USE - OTHER FIREARM               STREET  false    false  414
## 6                 $500 AND UNDER               STREET  false    false  811
## 7                   TO PROPERTY            RESIDENCE  false    false 2233
## 8                 $500 AND UNDER               STREET  false    false 1134
## 9                     OVER $500        HOTEL / MOTEL  false    false 1834
## 10                  TO PROPERTY            RESIDENCE  false    false  722
##    District Ward Community.Area FBI.Code X.Coordinate Y.Coordinate Year
## 1         7   15             67       14      1164009      1866506 2021
```

```
## 2         3   20             40       14      1178263      1863570 2021
## 3        19   32              6       06      1167730      1921189 2021
## 4        11   24             27       14      1155633      1896202 2021
## 5         4    8             43       15      1190847      1855361 2021
## 6         8   23             56       06      1138174      1867521 2021
## 7        22   34             49       14      1173263      1832236 2021
## 8        11   24             29       06      1155027      1895192 2021
## 9        18   42              8       06      1177947      1904538 2021
## 10        7    6             69       14      1176578      1859630 2021
##                Updated.On Latitude Longitude                     Location
## 1  01/16/2021 03:39:23 PM 41.78931 -87.67417 (41.789314851, -87.674170888)
## 2  01/16/2021 03:39:23 PM 41.78095 -87.62200 (41.780946398, -87.621995369)
## 3  03/12/2021 03:39:32 PM 41.93929 -87.65895 (41.939290467, -87.658952119)
## 4  01/16/2021 03:39:23 PM 41.87098 -87.70409  (41.870976478, -87.70408564)
## 5  01/16/2021 03:39:23 PM 41.75813 -87.57613 (41.758125331, -87.576125553)
## 6  03/16/2021 03:39:35 PM 41.79260 -87.76888 (41.792604677, -87.768876609)
## 7  01/16/2021 03:39:23 PM 41.69507 -87.64125 (41.695073774, -87.641250096)
## 8  01/16/2021 03:39:23 PM 41.86822 -87.70634   (41.8682171, -87.706337578)
## 9  06/01/2021 03:39:54 PM 41.89337 -87.62191 (41.893372823, -87.621909875)
## 10 01/16/2021 03:39:23 PM 41.77017 -87.62829 (41.770172698, -87.628291299)
##        Time                  name temp  dew humidity precip snow
## 1  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 2  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 3  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 4  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 5  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 6  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 7  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 8  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 9  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
## 10 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0
```

```r
final <- crime_data %>%
  group_by(Date) %>%
  summarise(

    Temp = first(temp),
    Snow=first(snow),
    Humidity = first(humidity),  # Assuming humidity is constant for a given
date
    Precip = first(precip),
    Crime_Count = n()
  )
crime_data <- left_join(crime_data, final, by ="Date")
head(crime_data,n=10)
```

```
##          ID Case.Number       Date                Block IUCR
Primary.Type
## 1  12259050    JE100626 01-01-2021    057XX S DAMEN AVE 1310   CRIMINAL
DAMAGE
```

```
## 2  12259424    JE100501 01-01-2021 062XX S MICHIGAN AVE 1320   CRIMINAL
DAMAGE
## 3  12311821    JE164805 01-01-2021   031XX N RACINE AVE 0820
THEFT
## 4  12260063    JE101649 01-01-2021      031XX W POLK ST 1320   CRIMINAL
DAMAGE
## 5  12259020    JE100698 01-01-2021 075XX S JEFFERY BLVD 141B WEAPONS
VIOLATION
## 6  12313377    JE166660 01-01-2021      058XX W 55TH ST 0820
THEFT
## 7  12268897    JE111949 01-01-2021  109XX S EMERALD AVE 1310   CRIMINAL
DAMAGE
## 8  12259086    JE100744 01-01-2021  032XX W FILLMORE ST 0820
THEFT
## 9  12378360    JE245959 01-01-2021   002XX E ONTARIO ST 0810
THEFT
## 10 12261931    JE100377 01-01-2021    068XX S PERRY AVE 1310   CRIMINAL
DAMAGE
##                    Description Location.Description Arrest Domestic Beat
## 1                   TO PROPERTY            APARTMENT  false    false  715
## 2                    TO VEHICLE               STREET  false    false  311
## 3                 $500 AND UNDER            APARTMENT  false    false 1933
## 4                    TO VEHICLE               STREET  false    false 1134
## 5  UNLAWFUL USE - OTHER FIREARM               STREET  false    false  414
## 6                 $500 AND UNDER               STREET  false    false  811
## 7                   TO PROPERTY            RESIDENCE  false    false 2233
## 8                 $500 AND UNDER               STREET  false    false 1134
## 9                      OVER $500        HOTEL / MOTEL  false    false 1834
## 10                  TO PROPERTY            RESIDENCE  false    false  722
##    District Ward Community.Area FBI.Code X.Coordinate Y.Coordinate Year
## 1         7   15             67       14      1164009      1866506 2021
## 2         3   20             40       14      1178263      1863570 2021
## 3        19   32              6       06      1167730      1921189 2021
## 4        11   24             27       14      1155633      1896202 2021
## 5         4    8             43       15      1190847      1855361 2021
## 6         8   23             56       06      1138174      1867521 2021
## 7        22   34             49       14      1173263      1832236 2021
## 8        11   24             29       06      1155027      1895192 2021
## 9        18   42              8       06      1177947      1904538 2021
## 10        7    6             69       14      1176578      1859630 2021
##                Updated.On Latitude Longitude                     Location
## 1  01/16/2021 03:39:23 PM 41.78931 -87.67417 (41.789314851, -87.674170888)
## 2  01/16/2021 03:39:23 PM 41.78095 -87.62200 (41.780946398, -87.621995369)
## 3  03/12/2021 03:39:32 PM 41.93929 -87.65895 (41.939290467, -87.658952119)
## 4  01/16/2021 03:39:23 PM 41.87098 -87.70409  (41.870976478, -87.70408564)
## 5  01/16/2021 03:39:23 PM 41.75813 -87.57613 (41.758125331, -87.576125553)
## 6  03/16/2021 03:39:35 PM 41.79260 -87.76888 (41.792604677, -87.768876609)
## 7  01/16/2021 03:39:23 PM 41.69507 -87.64125 (41.695073774, -87.641250096)
## 8  01/16/2021 03:39:23 PM 41.86822 -87.70634   (41.8682171, -87.706337578)
## 9  06/01/2021 03:39:54 PM 41.89337 -87.62191 (41.893372823, -87.621909875)
```

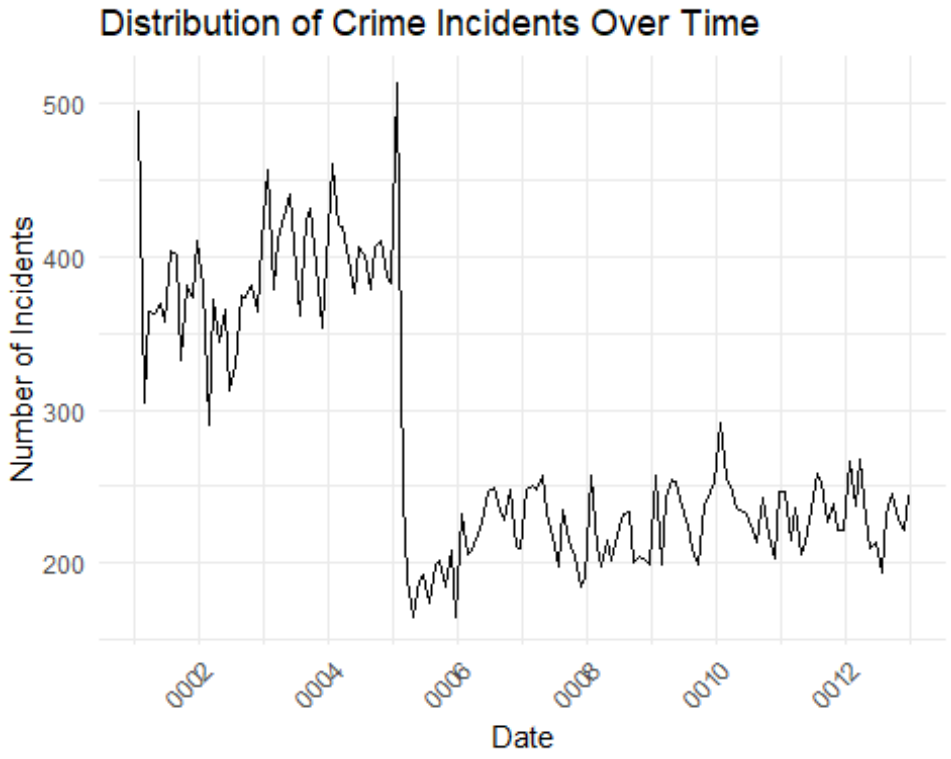
```
## 10 01/16/2021 03:39:23 PM 41.77017 -87.62829 (41.770172698, -87.628291299)
##        Time                   name temp  dew humidity precip snow Temp Snow
## 1  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 2  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 3  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 4  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 5  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 6  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 7  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 8  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 9  00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 10 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
##    Humidity Precip Crime_Count
## 1      82.8  7.045         228
## 2      82.8  7.045         228
## 3      82.8  7.045         228
## 4      82.8  7.045         228
## 5      82.8  7.045         228
## 6      82.8  7.045         228
## 7      82.8  7.045         228
## 8      82.8  7.045         228
## 9      82.8  7.045         228
## 10     82.8  7.045         228

# Handle missing values
# For numerical columns, fill NA with the mean or median
crime_data <- crime_data %>% mutate(across(where(is.numeric), ~
ifelse(is.na(.), mean(., na.rm = TRUE), .)))
missing_values <- is.na(crime_data)
```

2.Exploratory Data Analysis (EDA):

```
# Load the required libraries
library(tidyverse)

## ── Attaching core tidyverse packages ──────────────────────── tidyverse
2.0.0 ──
## ✓ forcats   1.0.0     ✓ readr     2.1.4
## ✓ lubridate 1.9.3     ✓ stringr   1.5.0
## ✓ purrr     1.0.2     ✓ tibble    3.2.1
## ── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
## ✖ purrr::lift()   masks caret::lift()
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all
conflicts to become errors

library(ggplot2)
```

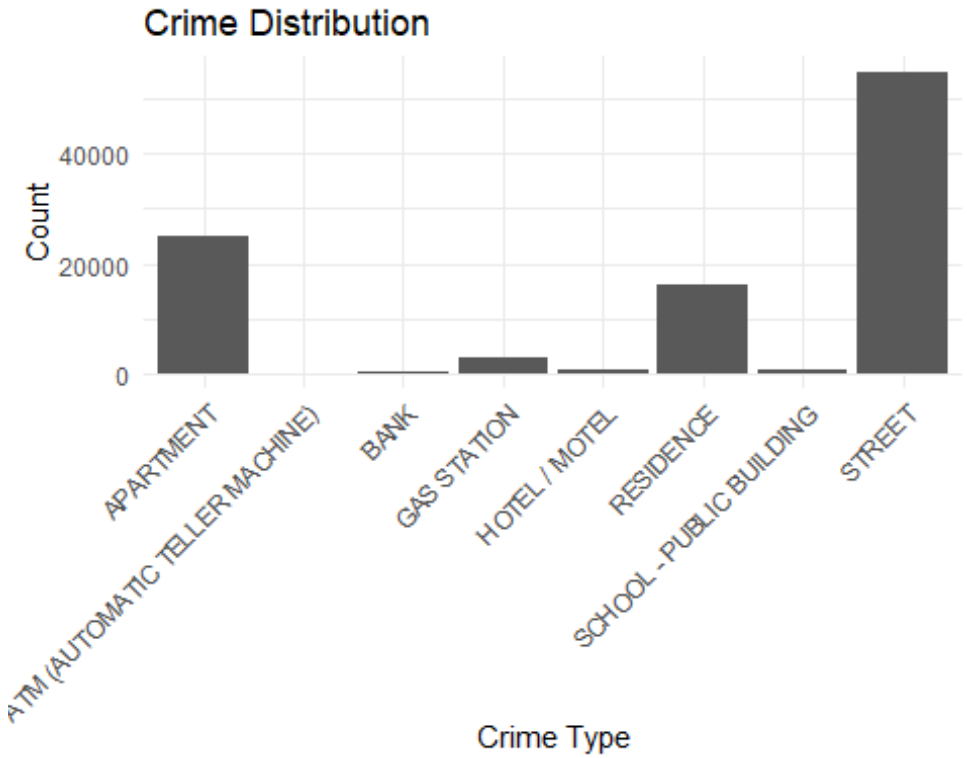
```r
# Convert the 'Date' column to datetime
crime_data$Date <- as.Date(crime_data$Date)

# Set the plot style
theme_set(theme_minimal())

# Plotting the distribution of incidents over time
ggplot(crime_data, aes(x = Date)) +
  geom_line(stat = 'count') +
  labs(title = 'Distribution of Crime Incidents Over Time',
       x = 'Date',
       y = 'Number of Incidents') +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

```
## Warning: Removed 60176 rows containing non-finite values (`stat_count()`).
```

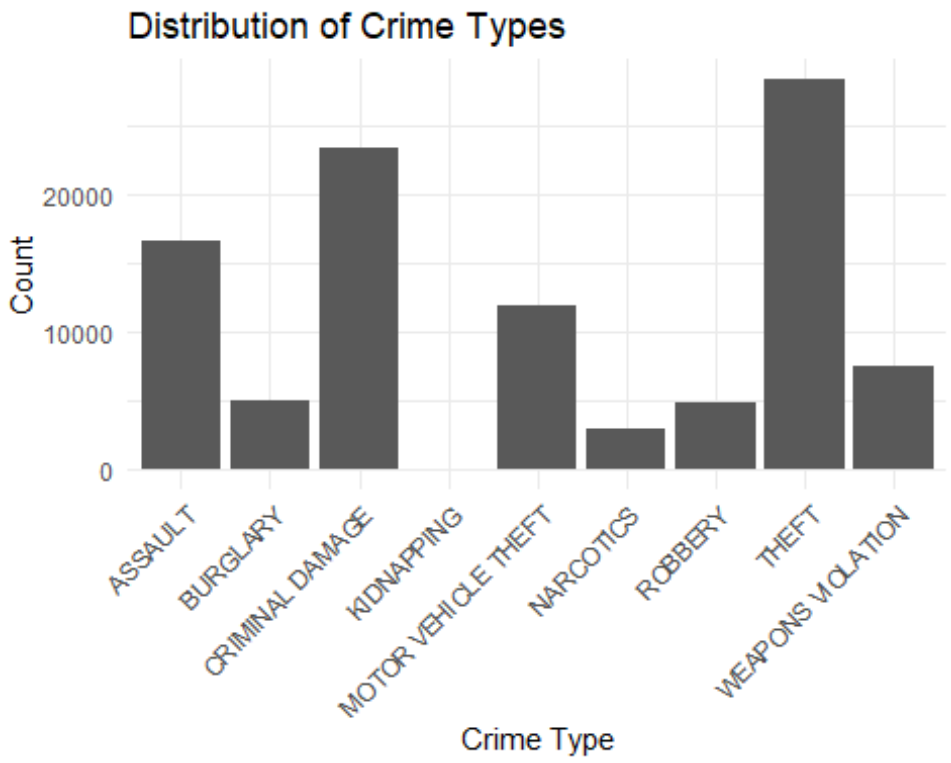



```r
# Install and load necessary libraries if not already installed
if (!requireNamespace("ggplot2", quietly = TRUE)) {
  install.packages("ggplot2")
}
library(ggplot2)

# Assuming your dataset is named crime_data
# Create a bar plot of crime distribution
ggplot(crime_data, aes(x = Location.Description)) +
  geom_bar() +
  labs(title = "Crime Distribution",
```

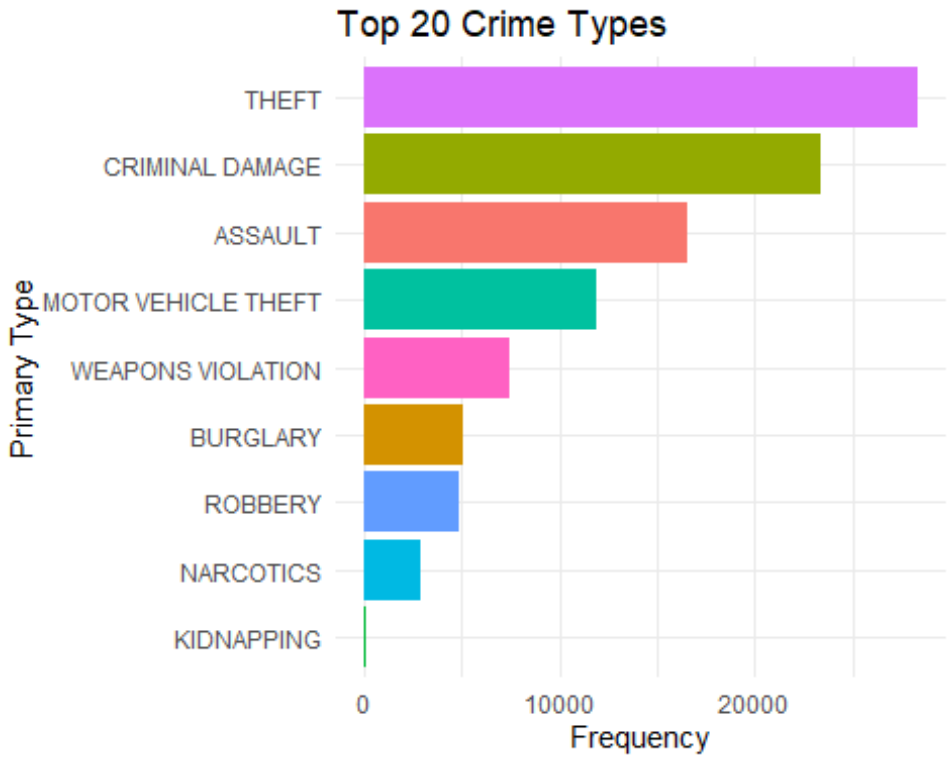
```
       x = "Crime Type",
       y = "Count") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))  # Rotate x-axis
labels for better readability
```



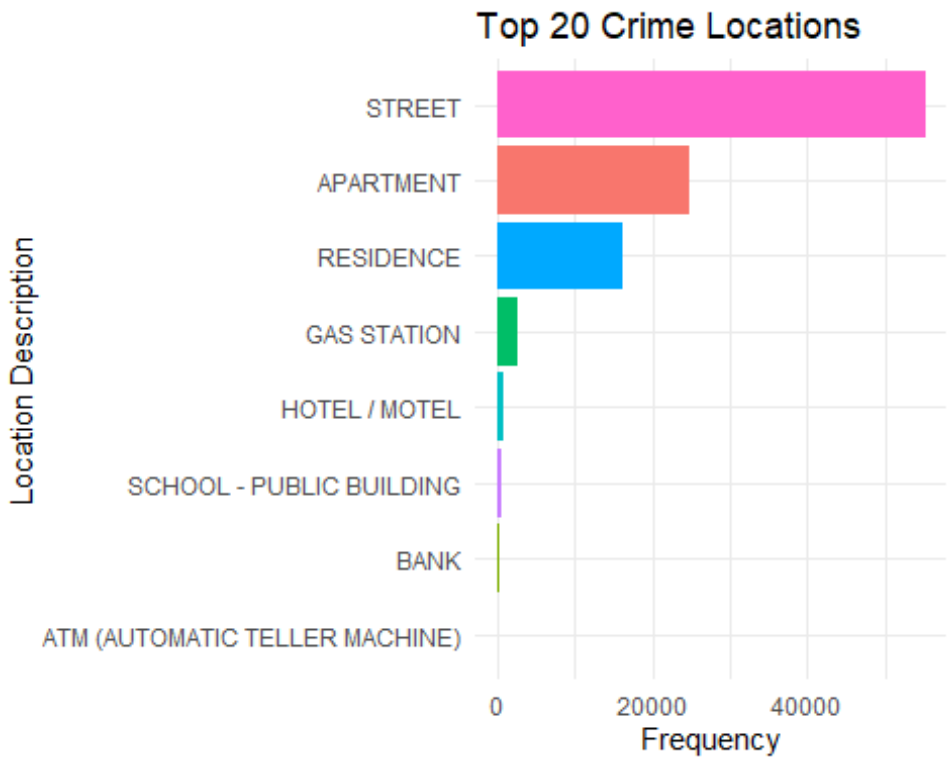

```
# Distribution of crime types
ggplot(crime_data, aes(x = Primary.Type)) +
  geom_bar() +
  labs(title = "Distribution of Crime Types",
       x = "Crime Type",
       y = "Count") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```




```r
# Load the required libraries
library(tidyverse)

# Plotting the distribution of Primary Type and Location Description
par(mfrow=c(2,1), mar=c(4,5,4,2))

# Plot for Primary Type
crime_data %>%
  count(Primary.Type) %>%
  arrange(desc(n)) %>%
  slice_head(n = 20) %>%
  ggplot(aes(y = n, x = reorder(Primary.Type, n), fill = Primary.Type)) +
  geom_bar(stat = 'identity') +
  labs(title = 'Top 20 Crime Types',
       y = 'Frequency',
       x = 'Primary Type') +
  theme_minimal() +
  theme(legend.position = 'none') +
  coord_flip()
```

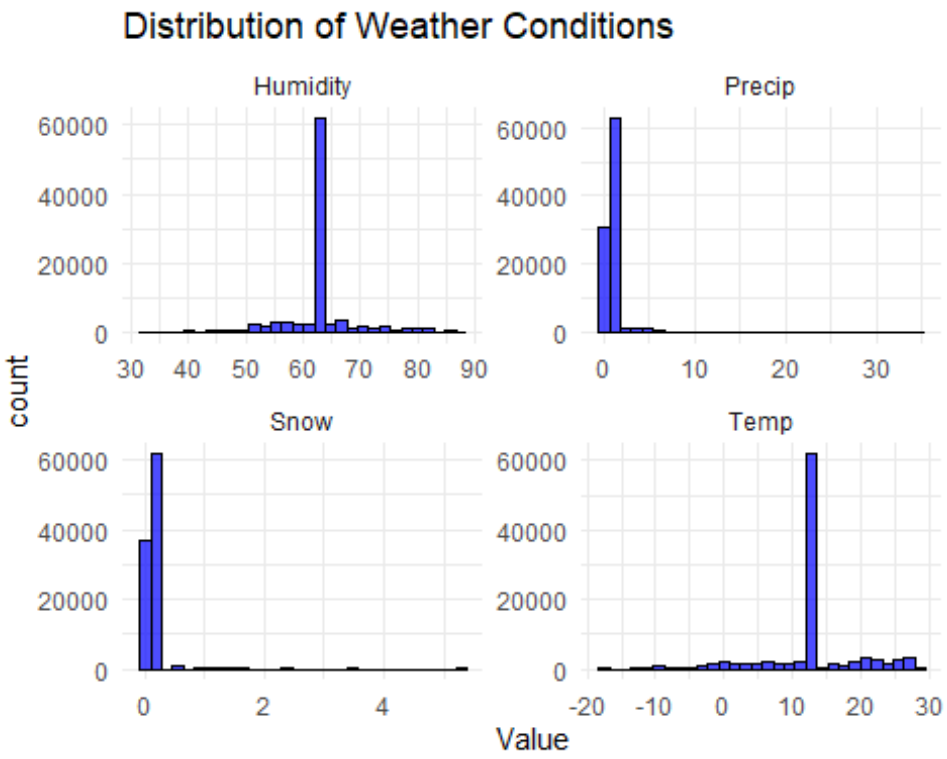



```r
# Plot for Location Description
crime_data %>%
  count(Location.Description) %>%
  arrange(desc(n)) %>%
  slice_head(n = 20) %>%
  ggplot(aes(y = n, x = reorder(Location.Description, n), fill =
Location.Description)) +
  geom_bar(stat = 'identity') +
  labs(title = 'Top 20 Crime Locations',
       y = 'Frequency',
       x = 'Location Description') +
  theme_minimal() +
  theme(legend.position = 'none') +
  coord_flip()
```




```r
# Weather conditions
weather_cols <- c('Temp', 'Snow', 'Humidity', 'Precip')

crime_data %>%
  gather(key = 'Weather', value = 'Value', weather_cols) %>%
  ggplot(aes(x = Value)) +
  geom_histogram(bins = 30, fill = 'blue', color = 'black', alpha = 0.7) +
  facet_wrap(~Weather, scales = 'free') +
  labs(title = 'Distribution of Weather Conditions')
```

```
## Warning: Using an external vector in selections was deprecated in
tidyselect 1.1.0.
## ℹ Please use `all_of()` or `any_of()` instead.
##   # Was:
##   data %>% select(weather_cols)
##
##   # Now:
##   data %>% select(all_of(weather_cols))
##
## See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```




```r
# Install and load necessary libraries if not already installed
if (!requireNamespace("tidyverse", quietly = TRUE)) {
  install.packages("tidyverse")
}
library(tidyverse)



# Check the structure of the dataset
str(crime_data)
```

```
## 'data.frame':    100562 obs. of  34 variables:
##  $ ID                  : int  12259050 12259424 12311821 12260063 12259020
12313377 12268897 12259086 12378360 12261931 ...
##  $ Case.Number         : chr  "JE100626" "JE100501" "JE164805" "JE101649"
...
##  $ Date                : Date, format: "0001-01-20" "0001-01-20" ...
##  $ Block               : chr  "057XX S DAMEN AVE" "062XX S MICHIGAN AVE"
"031XX N RACINE AVE" "031XX W POLK ST" ...
##  $ IUCR                : chr  "1310" "1320" "0820" "1320" ...
##  $ Primary.Type        : chr  "CRIMINAL DAMAGE" "CRIMINAL DAMAGE" "THEFT"
"CRIMINAL DAMAGE" ...
##  $ Description         : chr  "TO PROPERTY" "TO VEHICLE" "$500 AND UNDER"
"TO VEHICLE" ...
##  $ Location.Description: chr  "APARTMENT" "STREET" "APARTMENT" "STREET"
...
```

```
##  $ Arrest              : chr  "false" "false" "false" "false" ...
##  $ Domestic            : chr  "false" "false" "false" "false" ...
##  $ Beat                : int  715 311 1933 1134 414 811 2233 1134 1834 722
...
##  $ District            : int  7 3 19 11 4 8 22 11 18 7 ...
##  $ Ward                : num  15 20 32 24 8 23 34 24 42 6 ...
##  $ Community.Area      : int  67 40 6 27 43 56 49 29 8 69 ...
##  $ FBI.Code            : chr  "14" "14" "06" "14" ...
##  $ X.Coordinate        : num  1164009 1178263 1167730 1155633 1190847 ...
##  $ Y.Coordinate        : num  1866506 1863570 1921189 1896202 1855361 ...
##  $ Year                : int  2021 2021 2021 2021 2021 2021 2021 2021 2021
2021 ...
##  $ Updated.On          : chr  "01/16/2021 03:39:23 PM" "01/16/2021
03:39:23 PM" "03/12/2021 03:39:32 PM" "01/16/2021 03:39:23 PM" ...
##  $ Latitude            : num  41.8 41.8 41.9 41.9 41.8 ...
##  $ Longitude           : num  -87.7 -87.6 -87.7 -87.7 -87.6 ...
##  $ Location            : chr  "(41.789314851, -87.674170888)"
"(41.780946398, -87.621995369)" "(41.939290467, -87.658952119)"
"(41.870976478, -87.70408564)" ...
##  $ Time                : chr  "00:00:00" "00:00:00" "00:00:00" "00:00:00"
...
##  $ name                : chr  "Chicago,United States" "Chicago,United
States" "Chicago,United States" "Chicago,United States" ...
##  $ temp                : num  -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7
-0.7 ...
##  $ dew                 : num  -3.2 -3.2 -3.2 -3.2 -3.2 -3.2 -3.2 -3.2 -3.2
-3.2 ...
##  $ humidity            : num  82.8 82.8 82.8 82.8 82.8 82.8 82.8 82.8 82.8
82.8 ...
##  $ precip              : num  7.04 7.04 7.04 7.04 7.04 ...
##  $ snow                : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Temp                : num  -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7
-0.7 ...
##  $ Snow                : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Humidity            : num  82.8 82.8 82.8 82.8 82.8 82.8 82.8 82.8 82.8
82.8 ...
##  $ Precip              : num  7.04 7.04 7.04 7.04 7.04 ...
##  $ Crime_Count         : int  228 228 228 228 228 228 228 228 228 228 ...
```

```r
# Summary statistics
summary(crime_data)
```

```
##        ID           Case.Number            Date               Block
##  Min.   :12258517   Length:100562      Min.   :0001-01-20   Length:100562
##  1st Qu.:12370192   Class :character   1st Qu.:0003-03-27   Class
:character
##  Median :12479306   Mode  :character   Median :0005-07-20   Mode
:character
##  Mean   :12477579                      Mean   :0006-04-14
##  3rd Qu.:12582888                      3rd Qu.:0009-05-20
```

```
##  Max.   :13275887                       Max.   :0012-12-20
##                                         NA's   :60176
##      IUCR           Primary.Type       Description
Location.Description
##  Length:100562      Length:100562      Length:100562      Length:100562
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##
##     Arrest            Domestic             Beat         District
##  Length:100562      Length:100562      Min.   : 111   Min.   : 1.00
##  Class :character   Class :character   1st Qu.: 532   1st Qu.: 5.00
##  Mode  :character   Mode  :character   Median :1011   Median :10.00
##                                        Mean   :1112   Mean   :10.89
##                                        3rd Qu.:1622   3rd Qu.:16.00
##                                        Max.   :2535   Max.   :31.00
##
##       Ward       Community.Area   FBI.Code          X.Coordinate
##  Min.   : 1.00   Min.   : 1.0   Length:100562      Min.   :1095509
##  1st Qu.: 9.00   1st Qu.:24.0   Class :character   1st Qu.:1153969
##  Median :21.00   Median :37.0   Mode  :character   Median :1166956
##  Mean   :21.94   Mean   :38.6                      Mean   :1165896
##  3rd Qu.:32.00   3rd Qu.:58.0                      3rd Qu.:1177433
##  Max.   :50.00   Max.   :77.0                      Max.   :1205119
##
##   Y.Coordinate          Year       Updated.On           Latitude
##  Min.   :1813909   Min.   :2021   Length:100562      Min.   :41.64
##  1st Qu.:1856623   1st Qu.:2021   Class :character   1st Qu.:41.76
##  Median :1882922   Median :2021   Mode  :character   Median :41.83
##  Mean   :1882922   Mean   :2021                      Mean   :41.83
##  3rd Qu.:1906649   3rd Qu.:2021                      3rd Qu.:41.90
##  Max.   :1951493   Max.   :2022                      Max.   :42.02
##
##    Longitude        Location            Time               name
##  Min.   :-87.92   Length:100562      Length:100562      Length:100562
##  1st Qu.:-87.71   Class :character   Class :character   Class :character
##  Median :-87.66   Mode  :character   Mode  :character   Mode  :character
##  Mean   :-87.67
##  3rd Qu.:-87.62
##  Max.   :-87.52
##
##       temp             dew            humidity         precip
##  Min.   :-17.60   Min.   :-24.40   Min.   :33.00   Min.   : 0.000
##  1st Qu.: 12.06   1st Qu.:  4.63   1st Qu.:62.87   1st Qu.: 0.000
##  Median : 12.06   Median :  4.63   Median :62.87   Median : 1.566
##  Mean   : 12.06   Mean   :  4.63   Mean   :62.87   Mean   : 1.566
##  3rd Qu.: 12.06   3rd Qu.:  4.63   3rd Qu.:62.87   3rd Qu.: 1.566
##  Max.   : 28.70   Max.   : 22.50   Max.   :88.30   Max.   :34.776
```

```
##
##       snow              Temp              Snow          Humidity
##  Min.   :0.0000   Min.   :-17.60   Min.   :0.0000   Min.   :33.00
##  1st Qu.:0.0000   1st Qu.: 12.06   1st Qu.:0.0000   1st Qu.:62.87
##  Median :0.1068   Median : 12.06   Median :0.1068   Median :62.87
##  Mean   :0.1068   Mean   : 12.06   Mean   :0.1068   Mean   :62.87
##  3rd Qu.:0.1068   3rd Qu.: 12.06   3rd Qu.:0.1068   3rd Qu.:62.87
##  Max.   :5.3000   Max.   : 28.70   Max.   :5.3000   Max.   :88.30
##
##      Precip        Crime_Count
##  Min.   : 0.000   Min.   : 12.0
##  1st Qu.: 0.000   1st Qu.:192.0
##  Median : 1.566   Median :212.0
##  Mean   : 1.566   Mean   :210.9
##  3rd Qu.: 1.566   3rd Qu.:232.0
##  Max.   :34.776   Max.   :291.0
##
```

```r
# Missing values
missing_values <- colSums(is.na(crime_data))
print("Missing Values:")
```

```
## [1] "Missing Values:"
```

```r
print(missing_values[missing_values > 0])
```

```
##  Date  Time  name
## 60176    12 60176
```

```r
# Unique values in categorical columns
print("Unique Values in Categorical Columns:")
```

```
## [1] "Unique Values in Categorical Columns:"
```

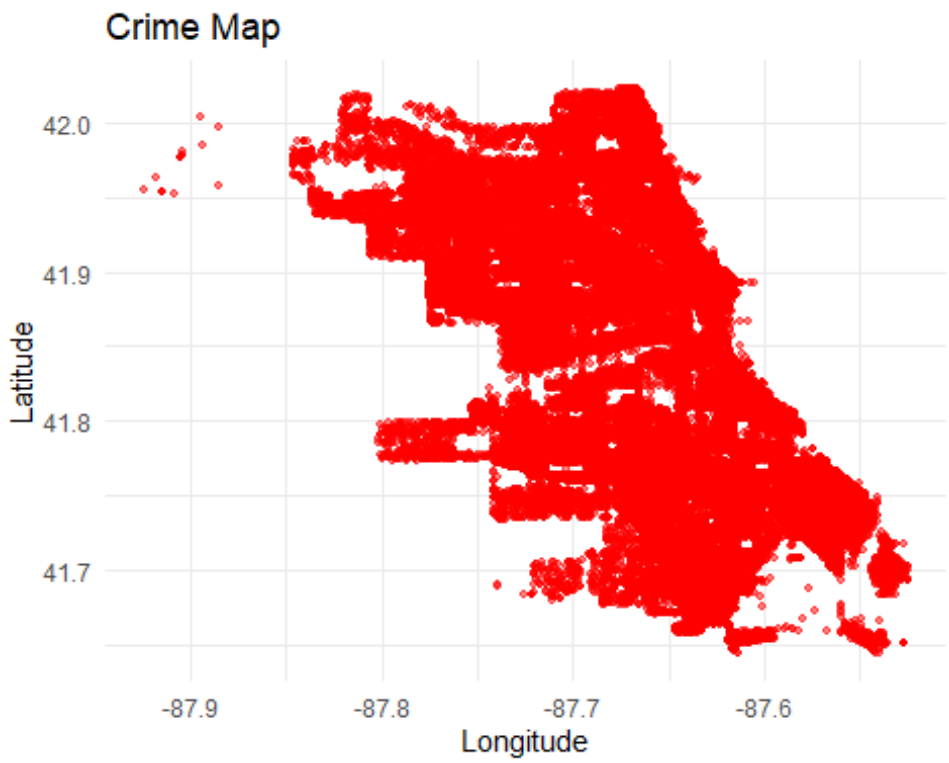
```r
sapply(crime_data[, sapply(crime_data, is.factor)], function(x)
length(unique(x)))
```

```
## named list()
```

```r
# Distribution of crime counts by month
crime_data$Date <- as.Date(crime_data$Date, format = "%m-%d-%Y")
crime_data$Month <- format(crime_data$Date, "%Y-%m")
```

```r
# Visualize geographic patterns
crime_map <- ggplot(crime_data, aes(x = Longitude, y = Latitude)) +
  geom_point(alpha = 0.5, size = 1, color = "red") +
  ggtitle("Crime Map")
```

```r
print(crime_map)
```




```r
# Correlation matrix
library(GGally)
```

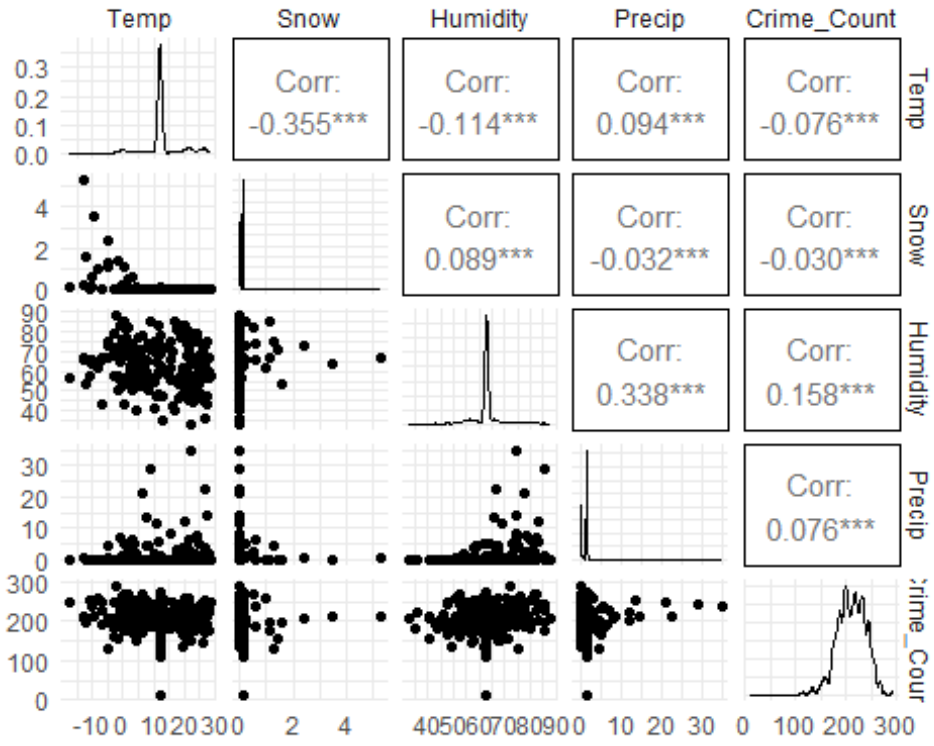
```
## Warning: package 'GGally' was built under R version 4.3.2
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```r
weather_data <- crime_data[, c("Temp", "Snow", "Humidity", "Precip",
"Crime_Count")]
cor(weather_data)
```

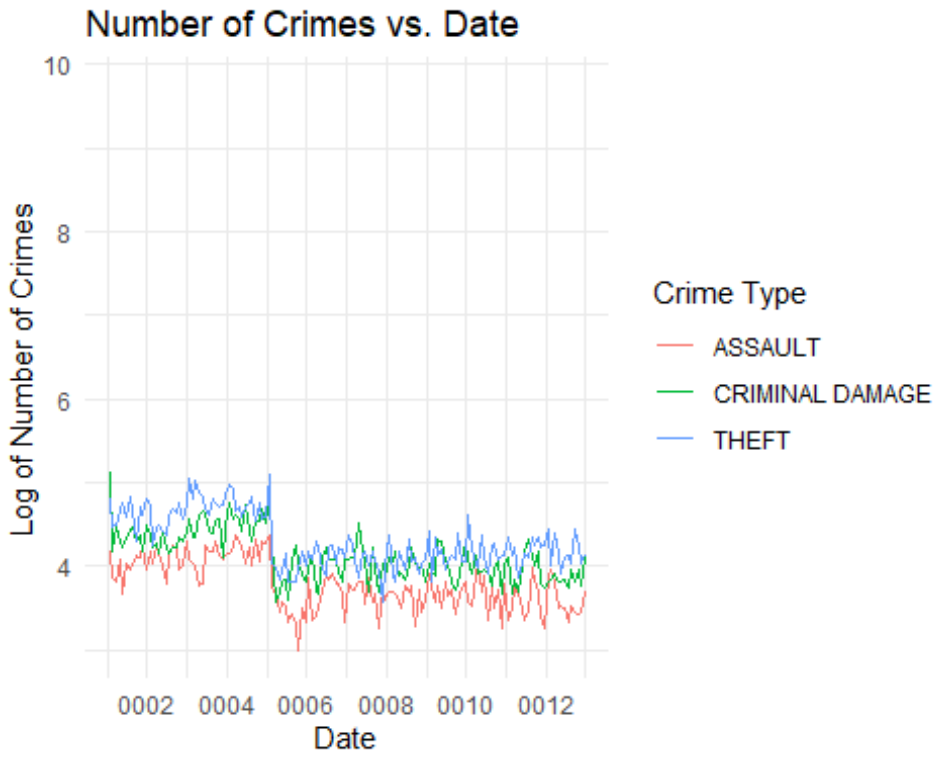
```
##                    Temp        Snow    Humidity      Precip Crime_Count
## Temp         1.00000000 -0.35520188 -0.11443576  0.09357598 -0.07634935
## Snow        -0.35520188  1.00000000  0.08861045 -0.03233319 -0.03049506
## Humidity    -0.11443576  0.08861045  1.00000000  0.33806329  0.15774452
## Precip       0.09357598 -0.03233319  0.33806329  1.00000000  0.07587110
## Crime_Count -0.07634935 -0.03049506  0.15774452  0.07587110  1.00000000
```

```r
ggpairs(crime_data,columns=c("Temp", "Snow", "Humidity", "Precip",
"Crime_Count"))
```

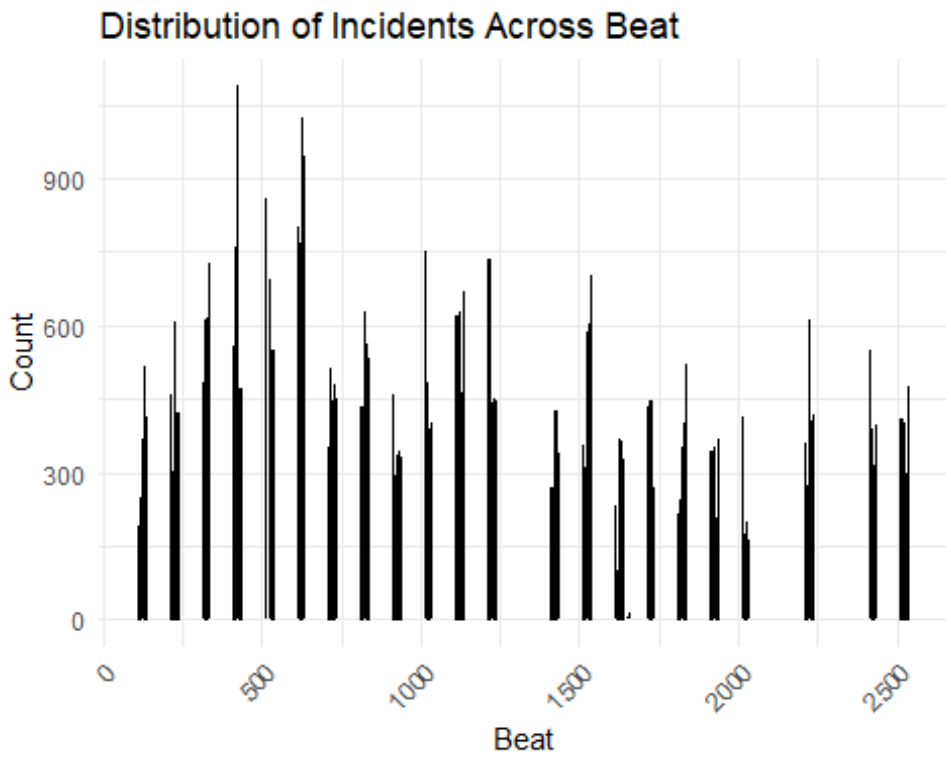



```
# Load necessary libraries
library(tidyverse)

# Convert the 'Date' column to a Date type
crime_data$Date <- as.Date(crime_data$Date, format = "%m-%d-%Y")

# Filter for specific crime types (theft, criminal damage, assault)
filtered_data <- crime_data %>%
  filter(Primary.Type %in% c("THEFT", "CRIMINAL DAMAGE", "ASSAULT"))

# Aggregate the data by date and crime type
crime_counts <- filtered_data %>%
  group_by(Date, Primary.Type) %>%
  summarise(CrimeCount = n())

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

# Plot the graph with log scale on the y-axis
ggplot(crime_counts, aes(x = Date, y = log(CrimeCount), color =
Primary.Type)) +
  geom_line() +
  labs(title = "Number of Crimes vs. Date",
       x = "Date",
       y = "Log of Number of Crimes",
       color = "Crime Type") +
  scale_y_continuous(labels = scales::comma) +  # Add comma separator for y-
```

```
axis labels
  theme_minimal()

## Warning: Removed 3 rows containing missing values (`geom_line()`).
```




```
# Plot the distribution of incidents across Beat
ggplot(crime_data, aes(x = Beat)) +
  geom_bar(fill = "skyblue", color = "black") +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  labs(title = "Distribution of Incidents Across Beat", x = "Beat", y =
"Count")
```




```r
# Load necessary libraries
library(tibble)
library(dplyr)

# Define the public holidays
public_holidays_data <- tibble(
  Date = as.Date(c(
    "2021-01-01", "2021-01-18", "2021-02-15", "2021-05-31", "2021-07-05",
    "2021-09-06", "2021-10-11", "2021-11-11", "2021-11-25", "2021-12-25",
    "2022-01-01", "2022-01-17", "2022-02-21", "2022-05-30", "2022-07-04",
    "2022-09-05", "2022-10-10", "2022-11-11", "2022-11-24", "2022-12-26"
  )),
  Holiday = c(
    "New Year's Day", "Martin Luther King Jr. Day", "Presidents' Day",
    "Memorial Day", "Independence Day", "Labor Day", "Columbus Day",
    "Veterans Day", "Thanksgiving Day", "Christmas Day",
    "New Year's Day", "Martin Luther King Jr. Day", "Presidents' Day",
    "Memorial Day", "Independence Day", "Labor Day", "Columbus Day",
    "Veterans Day", "Thanksgiving Day", "Christmas Day (Observed)"
  )
)

# Display the public holidays dataframe
print(public_holidays_data)
```

```
## # A tibble: 20 × 2
##    Date       Holiday
```

```
##    <date>     <chr>
##  1 2021-01-01 New Year's Day
##  2 2021-01-18 Martin Luther King Jr. Day
##  3 2021-02-15 Presidents' Day
##  4 2021-05-31 Memorial Day
##  5 2021-07-05 Independence Day
##  6 2021-09-06 Labor Day
##  7 2021-10-11 Columbus Day
##  8 2021-11-11 Veterans Day
##  9 2021-11-25 Thanksgiving Day
## 10 2021-12-25 Christmas Day
## 11 2022-01-01 New Year's Day
## 12 2022-01-17 Martin Luther King Jr. Day
## 13 2022-02-21 Presidents' Day
## 14 2022-05-30 Memorial Day
## 15 2022-07-04 Independence Day
## 16 2022-09-05 Labor Day
## 17 2022-10-10 Columbus Day
## 18 2022-11-11 Veterans Day
## 19 2022-11-24 Thanksgiving Day
## 20 2022-12-26 Christmas Day (Observed)
```

3.MODELING: Given the nature of your project, I assume you might be interested in predicting the Crime_Count based on other variables like Temp, Snow, Humidity, Precip, and possibly time-related variables (like the date or year).

Linear Regression: To model the relationship between Crime_Count and other independent variables using a linear approach. Random Forest Regression: To model the same relationship but using a non-linear, ensemble-based approach.

a. Linear Regression in R For linear regression, you can use the lm() function in R. Here's an example of how you might set up a linear regression model to predict Crime_Count based on certain variables:

```
library(readr)
head(crime_data)
```

```
##         ID Case.Number       Date                 Block IUCR
Primary.Type
## 1 12259050    JE100626 0001-01-20    057XX S DAMEN AVE 1310   CRIMINAL
DAMAGE
## 2 12259424    JE100501 0001-01-20 062XX S MICHIGAN AVE 1320   CRIMINAL
DAMAGE
## 3 12311821    JE164805 0001-01-20   031XX N RACINE AVE 0820
THEFT
## 4 12260063    JE101649 0001-01-20      031XX W POLK ST 1320   CRIMINAL
DAMAGE
## 5 12259020    JE100698 0001-01-20 075XX S JEFFERY BLVD 141B WEAPONS
VIOLATION
## 6 12313377    JE166660 0001-01-20      058XX W 55TH ST 0820
THEFT
```

```
##                    Description Location.Description Arrest Domestic Beat
## 1                  TO PROPERTY            APARTMENT  false    false  715
## 2                   TO VEHICLE               STREET  false    false  311
## 3                $500 AND UNDER            APARTMENT  false    false 1933
## 4                   TO VEHICLE               STREET  false    false 1134
## 5 UNLAWFUL USE - OTHER FIREARM               STREET  false    false  414
## 6                $500 AND UNDER               STREET  false    false  811
##   District Ward Community.Area FBI.Code X.Coordinate Y.Coordinate Year
## 1        7   15             67       14      1164009      1866506 2021
## 2        3   20             40       14      1178263      1863570 2021
## 3       19   32              6       06      1167730      1921189 2021
## 4       11   24             27       14      1155633      1896202 2021
## 5        4    8             43       15      1190847      1855361 2021
## 6        8   23             56       06      1138174      1867521 2021
##               Updated.On Latitude Longitude                     Location
## 1 01/16/2021 03:39:23 PM 41.78931 -87.67417 (41.789314851, -87.674170888)
## 2 01/16/2021 03:39:23 PM 41.78095 -87.62200 (41.780946398, -87.621995369)
## 3 03/12/2021 03:39:32 PM 41.93929 -87.65895 (41.939290467, -87.658952119)
## 4 01/16/2021 03:39:23 PM 41.87098 -87.70409  (41.870976478, -87.70408564)
## 5 01/16/2021 03:39:23 PM 41.75813 -87.57613 (41.758125331, -87.576125553)
## 6 03/16/2021 03:39:35 PM 41.79260 -87.76888 (41.792604677, -87.768876609)
##       Time                  name temp  dew humidity precip snow Temp Snow
## 1 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 2 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 3 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 4 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 5 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
## 6 00:00:00 Chicago,United States -0.7 -3.2     82.8  7.045    0 -0.7    0
##   Humidity Precip Crime_Count   Month
## 1     82.8  7.045         228 0001-01
## 2     82.8  7.045         228 0001-01
## 3     82.8  7.045         228 0001-01
## 4     82.8  7.045         228 0001-01
## 5     82.8  7.045         228 0001-01
## 6     82.8  7.045         228 0001-01
```

```r
set.seed(42) # For reproducibility
trainIndex <- createDataPartition(crime_data$Crime_Count, p = 0.8,
                                  list = FALSE,
                                  times = 1)
dataTrain <- crime_data[trainIndex, ]
dataTest <- crime_data[-trainIndex, ]

# Model training
model <- lm(lag(Crime_Count) ~ Temp + Snow + Humidity + Precip, data =
dataTrain)
summary(model)
```

```
##
## Call:
```

```
## lm(formula = lag(Crime_Count) ~ Temp + Snow + Humidity + Precip,
##     data = dataTrain)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -198.856  -19.299    2.144   20.185   74.649
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 179.92903    0.93613 192.206   <2e-16 ***
## Temp         -0.34989    0.01452 -24.100   <2e-16 ***
## Snow         -6.08057    0.30672 -19.825   <2e-16 ***
## Humidity      0.56160    0.01448  38.791   <2e-16 ***
## Precip        0.31075    0.03506   8.863   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 27.45 on 80445 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.03478,    Adjusted R-squared:  0.03473
## F-statistic: 724.7 on 4 and 80445 DF,  p-value: < 2.2e-16
```

```
lr_predictions <- predict(model, dataTest)
mse <- mean((lr_predictions - dataTest$Crime_Count)^2)
rsq <- summary(model)$r.squared

# Output the MSE and R-squared
print(paste("Mean Squared Error:", mse))
```

```
## [1] "Mean Squared Error: 749.621826698263"
```

```
print(paste("R-squared:", rsq))
```

```
## [1] "R-squared: 0.0347806691210506"
```

Mean Absolute Error (MAE): It measures the average absolute differences between the predicted values and the actual values. Smaller MAE values indicate better model accuracy.

Root Mean Squared Error (RMSE): It is similar to MAE but gives more weight to large errors. RMSE is the square root of the mean of the squared differences between predicted and actual values. Like MAE, lower RMSE values indicate better model accuracy.

```
# Ensure the Date column is correctly formatted and free of NAs
crime_data <- crime_data %>%
  mutate(Date = as.Date(Date)) %>%
  filter(!is.na(Date), !is.na(Crime_Count))

# Checking and printing minimum date values
min_year <- year(min(crime_data$Date))
min_month <- month(min(crime_data$Date))
print(paste("Using start year:", min_year, "and start month:", min_month))
```

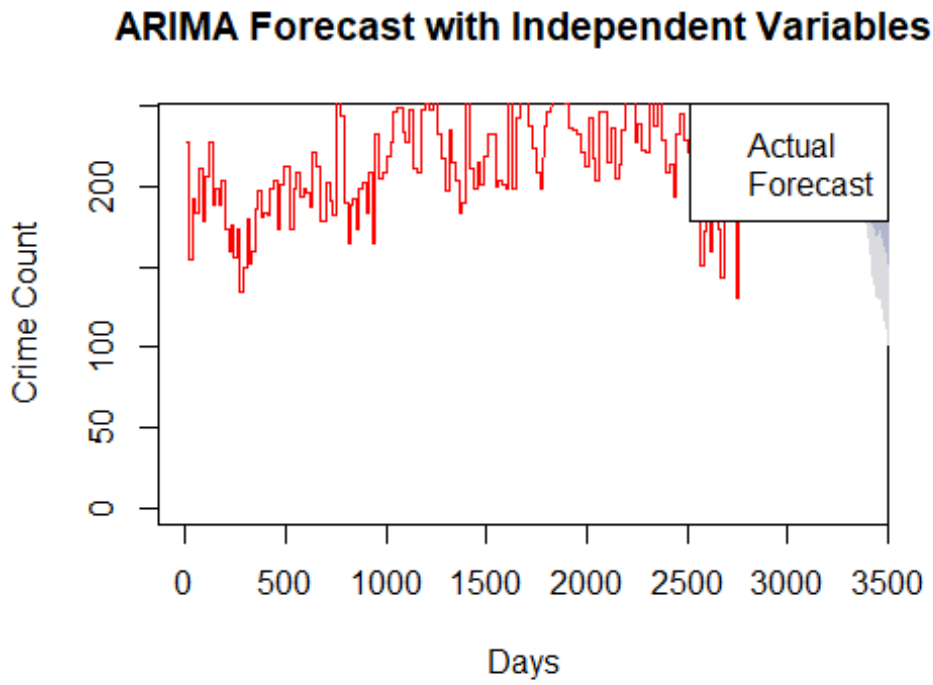
```
## [1] "Using start year: 1 and start month: 1"

# Assuming monthly data
ts_data <- ts(crime_data$Crime_Count, start = c(min_year, min_month),
frequency = 12)
```

b. ARIMA Model

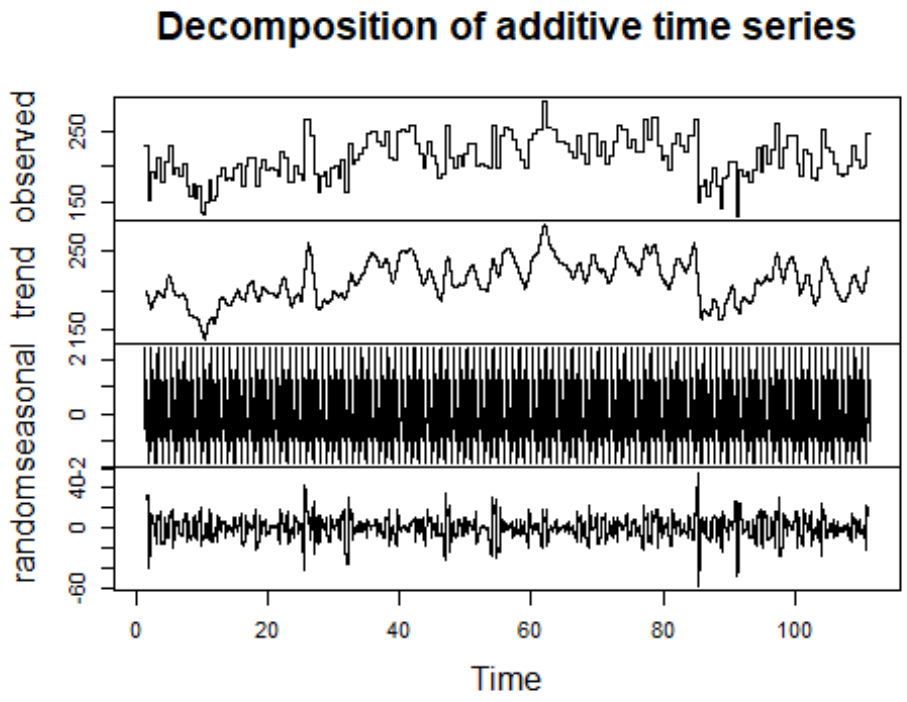
```
library(readr)
library(dplyr)
library(lubridate)
library(forecast)

## Warning: package 'forecast' was built under R version 4.3.2

## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo

library(ggplot2)

# Ensure the Date column is a Date type
crime_data$Date <- as.Date(crime_data$Date)

# Check for any NA in Date or Crime_Count
sum(is.na(crime_data$Date))

## [1] 0

sum(is.na(crime_data$Crime_Count))

## [1] 0

# Assuming monthly data, adjust frequency to 12
ts_data <- ts(crime_data$Crime_Count, start = c(year(min(crime_data$Date)),
month(min(crime_data$Date))), frequency = 12)

regressor_columns <- c("Temp","Snow","Humidity","Precip")

# Ensure no NAs in regressors
crime_data <- crime_data %>%
  filter(complete.cases(.[regressor_columns]))

model <- auto.arima(ts_data, xreg = as.matrix(crime_data[, regressor_columns,
drop = FALSE]))
summary(model)

## Series: ts_data
## Regression with ARIMA(0,1,0) errors
##
## Coefficients:
##         Temp     Snow  Humidity   Precip
```

```
##       0.1809  -6.4801    0.4327  -0.0687
## s.e.  0.0146   0.1885    0.0089   0.0231
##
## sigma^2 = 3.317:  log likelihood = -81514.77
## AIC=163039.5   AICc=163039.5   BIC=163082.6
##
## Training set error measures:
##                       ME     RMSE        MAE           MPE       MAPE
## Training set 0.0006415215 1.821191 0.09683261 -0.003957288 0.04813143
##                     MASE          ACF1
## Training set 0.07942304 -1.231625e-07
```

```r
forecast_values <- forecast(model, xreg = as.matrix(crime_data[,
regressor_columns, drop = FALSE]), h = nrow(crime_data))
plot(forecast_values, main = "ARIMA Forecast with Independent Variables",
     ylab = "Crime Count", xlab = "Days", xlim = c(min(time(ts_data)),
max(time(ts_data))),
     ylim = c(0, max(forecast_values$upper[,2], ts_data))/4)

lines(ts_data, col = "red")
legend("topright", legend = c("Actual", "Forecast"), col = c("red", "blue"))
```



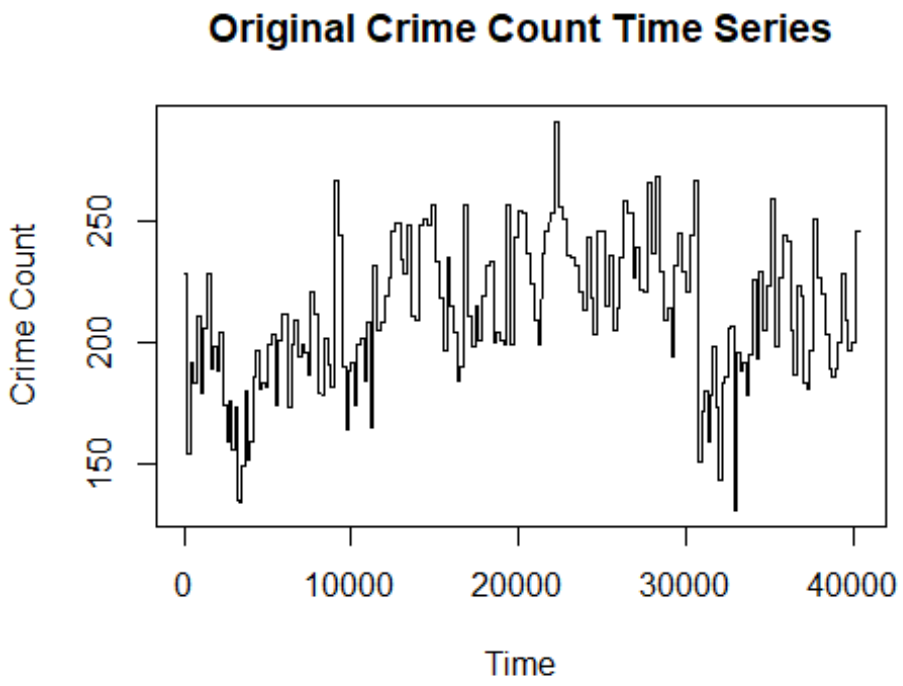

```r
crime_ts <- ts(crime_data$Crime_Count, frequency = 365) # Assuming daily data

decomposition <- decompose(crime_ts)
plot(decomposition)
```



ARIMA RELATED GRAPHS:

```
# Load necessary libraries
library(readr)
library(dplyr)
library(lubridate)
library(tseries)
library(forecast)
library(ggplot2)

crime_ts <- ts(crime_data$Crime_Count, start = c(year(min(crime_data$Date)),
month(min(crime_data$Date))), frequency = 1)

# Augmented Dickey-Fuller Test
adf_test <- adf.test(crime_ts, alternative = "stationary")

## Warning in adf.test(crime_ts, alternative = "stationary"): p-value smaller
than
## printed p-value

# Differencing the series if not stationary
if (adf_test$p.value > 0.05) {
  crime_ts_diff <- diff(crime_ts)
  adf_test_diff <- adf.test(crime_ts_diff, alternative = "stationary")
}

# Plotting the original and differenced series
```

```r
ts.plot(crime_ts, main="Original Crime Count Time Series", ylab="Crime
Count", xlab="Time")
```




```r
if (exists("crime_ts_diff")) {
  ts.plot(crime_ts_diff, main="Differenced Crime Count Time Series",
ylab="Differenced Crime Count", xlab="Time")
}

# ACF and PACF plots
#Acf(crime_ts_diff, main="ACF of Differenced Series")
#Pacf(crime_ts_diff, main="PACF of Differenced Series")
```

c. RANDOM FOREST REGRESSION MODEL:

```r
# Load necessary libraries
library(readr)
library(dplyr)
library(lubridate)
library(randomForest)

## Warning: package 'randomForest' was built under R version 4.3.2

## randomForest 4.7-1.1

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin

## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(caret)

# Set seed for reproducibility
set.seed(42)

# Calculate the size of the training set (80% of the dataset)
training_size <- floor(0.8 * nrow(crime_data))

# Randomly sample row indices for the training set
training_indices <- sample(seq_len(nrow(crime_data)), size = training_size)

# Create training and testing sets
trainingSet <- crime_data[training_indices, ]
testingSet <- crime_data[-training_indices, ]


# Ensure that Crime_Count and other predictors are numeric

trainingSet$Temp <- as.numeric(trainingSet$Temp)
trainingSet$Snow <- as.numeric(trainingSet$Snow)
trainingSet$Humidity <- as.numeric(trainingSet$Humidity)
trainingSet$Precip <- as.numeric(trainingSet$Precip)


# Random Forest model training
rf_model <- randomForest(Crime_Count ~Temp + Snow + Humidity + Precip , data
= trainingSet, ntree = 100)

# Model prediction and evaluation
rf_predictions <- predict(rf_model, testingSet)
mse <- mean((rf_predictions - testingSet$Crime_Count)^2)
rsq <- cor(rf_predictions, testingSet$Crime_Count)^2

# Output the MSE and R-squared
print(paste("Mean Squared Error:", mse))
```

```
## [1] "Mean Squared Error: 331.795424181371"
```

```
print(paste("R-squared:", rsq))
```

```
## [1] "R-squared: 0.67447459774457"
```

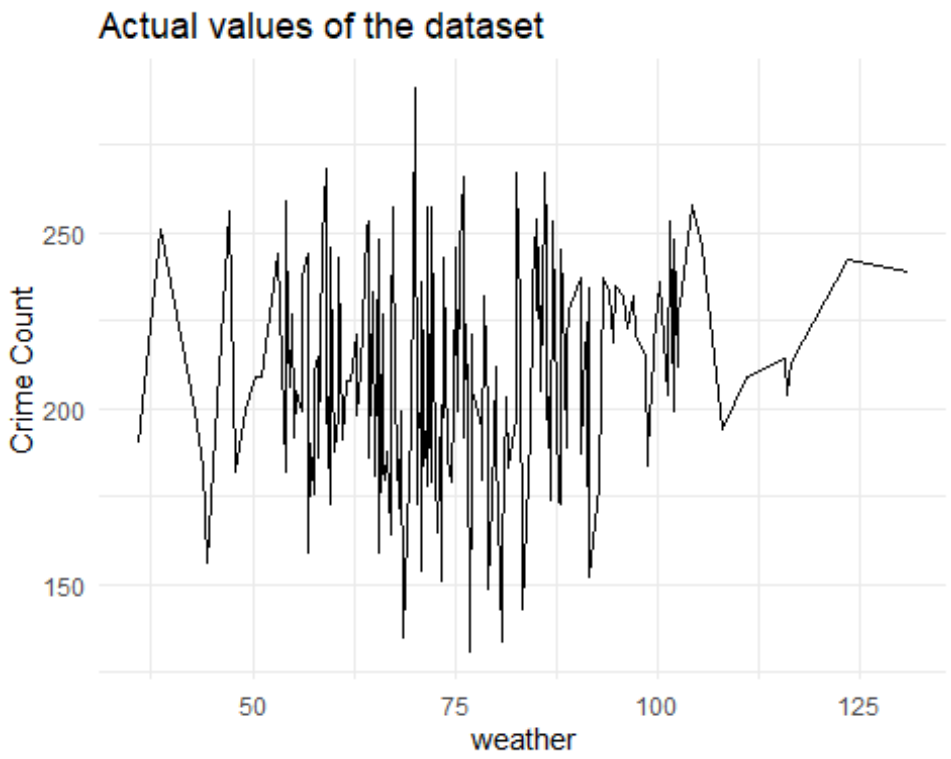
PREDICTION:

```
# Now, let's say you have a new data point for which you want to make
predictions:
new_data <- data.frame(Temp=-0.7,Snow=0
,Humidity=82.8
,Precip=7.045

)  # Replace with your actual values

# Predict the target variable for the new data point
predicted_value <- predict(rf_model, new_data)

# Print the predicted value
print(predicted_value)
```

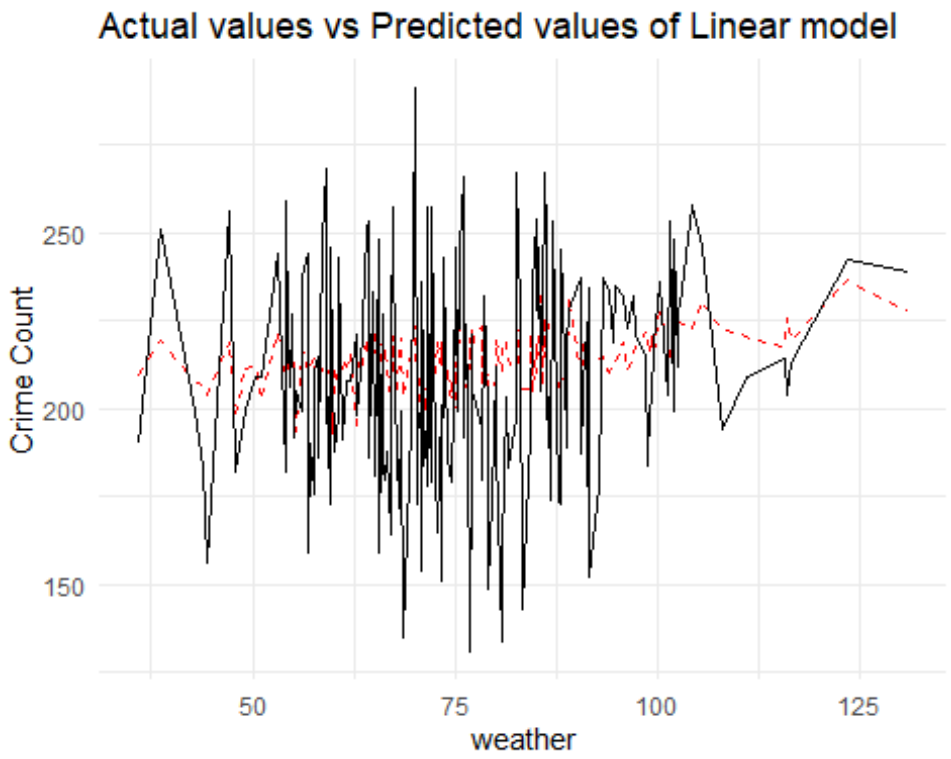
```
##      1
## 228.66
```

PREDICTION GRAPHS OF DIFFERENT MODELS:

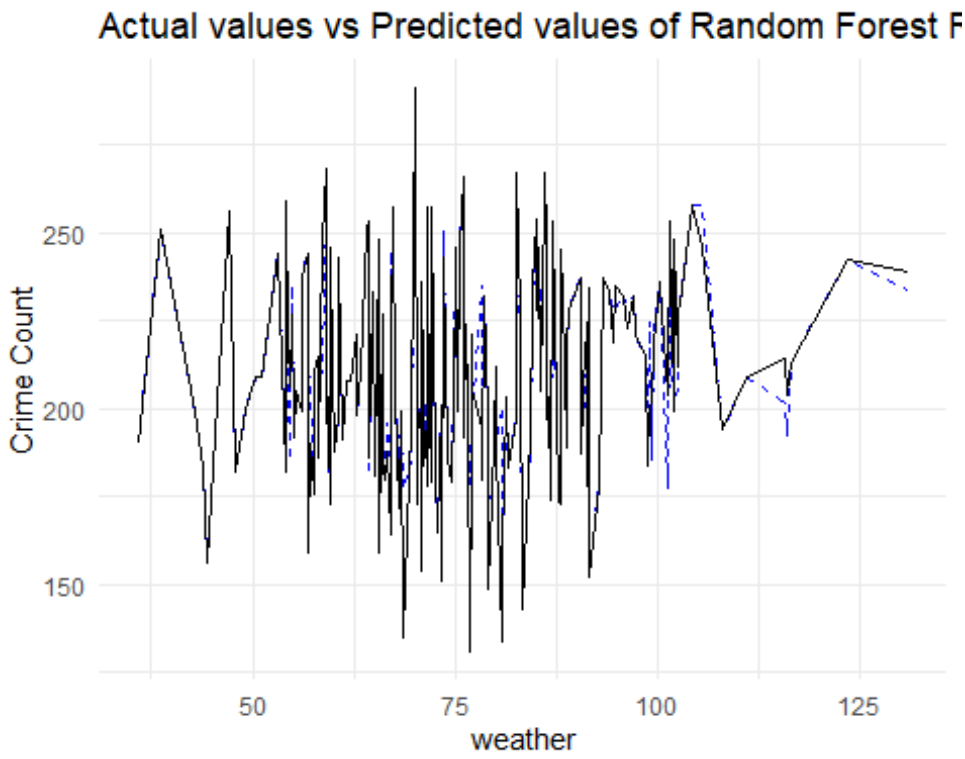
```
library(randomForest)
trainIndex <- createDataPartition(crime_data$Crime_Count, p = 0.8,
                                  list = FALSE,
                                  times = 1)
dataTrain <- crime_data[trainIndex, ]
dataTest <- crime_data[-trainIndex, ]
# Model training
model_lm <- lm(Crime_Count ~ Temp + Snow + Humidity + Precip, data =
dataTrain)
lr_predictions <- predict(model_lm, dataTest)
rf_model <- randomForest(Crime_Count ~Temp , data = dataTrain, ntree = 100)
rf_predictions <- predict(rf_model, dataTest)

ggplot(dataTest) +
geom_line(aes(x = Temp + Snow + Humidity + Precip, y = Crime_Count), color =
"black")+
  labs(title = "Actual values of the dataset", x = "weather", y = "Crime
Count") +
  theme_minimal()
```




```
ggplot(dataTest) +
  geom_line(aes(x = Temp + Snow + Humidity + Precip, y = lr_predictions),
color = "red", linetype = "dashed") +
  geom_line(aes(x = Temp + Snow + Humidity + Precip, y = Crime_Count), color
= "black")+
  labs(title = "Actual values vs Predicted values of Linear model", x =
"weather", y = "Crime Count") +
  theme_minimal()
```




```
ggplot(dataTest) +
  geom_line(aes(x = Temp + Snow + Humidity + Precip, y = rf_predictions),
color = "blue", linetype = "dashed" )+
  geom_line(aes(x = Temp + Snow + Humidity + Precip, y = Crime_Count), color
= "black")+
  labs(title = "Actual values vs Predicted values of Random Forest Regression
model", x = "weather", y = "Crime Count") +
  theme_minimal()
```


Actual values vs Predicted values of Random Forest F
Crime Count
250
200
150
50
75
100
125
weather