Use the given link below:
https://archive.ics.uci.edu/ml/machine-learning-databases/communities

Perform the below operations:

a. **Visualize the correlation between all variable in a meaningful way, clear representation of correlations. Find out top 3 reasons for having more crime in a city.**

```
library(readr)
COBRA_YTD2017 <- read_csv("G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv")
library(data.table)
library(Amelia)
library(Rcpp)
data<-COBRA_YTD2017
data[4:10,3] <- rep(NA,7)
data[1:5,4] <- NA
data <- data[-c(5,6)]
summary(data)
```

```
> library(readr)
> COBRA_YTD2017 <- read_csv("G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv")
Parsed with column specification:
cols(
  .default = col_character(),
  MI_PRINX = col_double(),
  offense_id = col_double(),
  occur_time = col_time(format = ""),
  poss_time = col_time(format = ""),
  beat = col_double(),
  dispo_code = col_double(),
  MaxOfnum_victims = col_double(),
  loc_type = col_double(),
  x = col_double(),
  y = col_double()
)
See spec(...) for full column specifications.
Warning: 9 parsing failures.
  row        col expected actual                                                                file
 3239 dispo_code a double    COS    'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'
 7945 dispo_code a double    ADM    'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'
 8527 dispo_code a double    ADM    'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'
10145 dispo_code a double    ADM    'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'
11912 dispo_code a double    ADM    'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'
..... .......... ........ ...... ..........................................................................
See problems(...) for more details.

> library(data.table)
> library(Amelia)
> library(Rcpp)
> data<-COBRA_YTD2017
> data[4:10,3] <- rep(NA,7)
> data[1:5,4] <- NA
> data <- data[-c(5,6)]
```

```
> summary(data)
   MI_PRINX        offense_id          rpt_date          occur_date         poss_time            beat       apt_office_prefix  apt_office_num
Min.   :8838438   Min.   :1.608e+08   Length:26759       Length:26759       Length:26759       Min.   :101.0   Length:26759       Length:26759
1st Qu.:8904204   1st Qu.:1.711e+08   Class :character   Class :character   Class1:hms         1st Qu.:208.0   Class :character   Class :character
Median :8910894   Median :1.720e+08   Mode  :character   Mode  :character   Class2:difftime    Median :312.0   Mode  :character   Mode  :character
Mean   :8910851   Mean   :6.523e+08                                         Mode  :numeric     Mean   :355.6
3rd Qu.:8917584   3rd Qu.:1.728e+08                                                            3rd Qu.:505.0
Max.   :8924410   Max.   :1.735e+11                                                            Max.   :710.0

   location           MinOfucr         MinOfibr_code       dispo_code    MaxOfnum_victims     Shift              Avg Day             loc_type
Length:26759       Length:26759       Length:26759       Min.   :10.00   Min.   : 0.00    Length:26759       Length:26759       Min.   : 1.00
Class :character   Class :character   Class :character   1st Qu.:10.00   1st Qu.: 1.00    Class :character   Class :character   1st Qu.:13.00
Mode  :character   Mode  :character   Mode  :character   Median :10.00   Median : 1.00    Mode  :character   Mode  :character   Median :18.00
                                                         Mean   :13.32   Mean   : 1.16                                           Mean   :20.76
                                                         3rd Qu.:10.00   3rd Qu.: 1.00                                          3rd Qu.:20.00
                                                         Max.   :60.00   Max.   :27.00                                          Max.   :99.00
                                                         NA's   :22968   NA's   :75                                             NA's   :3344
  UC2 Literal        neighborhood           npu                x                y
Length:26759       Length:26759       Length:26759       Min.   :-84.55   Min.   : 0.00
Class :character   Class :character   Class :character   1st Qu.:-84.43   1st Qu.:33.73
Mode  :character   Mode  :character   Mode  :character   Median :-84.40   Median :33.76
                                                         Mean   :-83.69   Mean   :33.47
                                                         3rd Qu.:-84.37   3rd Qu.:33.79
                                                         Max.   :  0.00   Max.   :33.88
```

```
pMiss <- function(x){sum(is.na(x))/length(x)*100}
apply(data,2,pMiss)
apply(data,1,pMiss)
```

```
> pMiss <- function(x){sum(is.na(x))/length(x)*100}
> apply(data,2,pMiss)
        MI_PRINX        offense_id          rpt_date        occur_date         poss_time              beat apt_office_prefix    apt_office_num
      0.00000000        0.00000000        0.02615942        0.01868530        0.01494824        0.00000000        97.95956501        82.71235846
        location          MinOfucr     MinOfibr_code       dispo_code  MaxOfnum_victims             Shift           Avg Day           loc_type
      0.00000000        0.00000000        0.00373706       85.83280392        0.28027953        0.00000000        0.00000000        12.49673007
     UC2 Literal      neighborhood               npu                 x                 y
      0.00000000        4.42841661        0.97163571        0.00000000        0.00000000
> apply(data,1,pMiss)
   [1] 19.047619 19.047619 19.047619 23.809524 23.809524 19.047619 14.285714 19.047619 19.047619 14.285714 14.285714 19.047619 14.285714  9.523810 14.285714
  [16]  4.761905 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714
  [31]  9.523810 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 19.047619 14.285714
  [46]  4.761905  4.761905  9.523810  9.523810  9.523810 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714
  [61] 14.285714 14.285714 14.285714  9.523810  9.523810 14.285714 23.809524 19.047619 19.047619 14.285714 19.047619  9.523810 14.285714 14.285714 14.285714
  [76] 14.285714 14.285714 19.047619 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 19.047619 14.285714 14.285714
  [91]  9.523810 19.047619 14.285714 14.285714 14.285714 19.047619  9.523810 19.047619 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714  9.523810
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 [121] 19.047619 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714  9.523810 14.285714  9.523810 14.285714 14.285714 14.285714 19.047619
 [136] 23.809524 14.285714 14.285714 14.285714 14.285714  4.761905 19.047619 14.285714 14.285714 14.285714 14.285714  4.761905 14.285714 14.285714 14.285714
 [151] 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714  9.523810 14.285714 19.047619
 [166] 14.285714 23.809524 19.047619 14.285714 23.809524 14.285714  9.523810 19.047619 14.285714  9.523810 19.047619 14.285714 23.809524 14.285714 14.285714
 [181] 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714
 [196] 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714  4.761905 14.285714 14.285714 14.285714 14.285714
 [211] 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714
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 [241] 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 19.047619 14.285714  9.523810 14.285714 19.047619  4.761905 14.285714 19.047619 14.285714
 [256] 19.047619 14.285714 14.285714 14.285714  9.523810  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714
 [271] 14.285714  9.523810 14.285714  4.761905 14.285714 19.047619 14.285714 14.285714 14.285714 19.047619  9.523810 14.285714  9.523810 14.285714 14.285714
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 [346] 14.285714  9.523810  9.523810 14.285714 19.047619 19.047619 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619
 [361] 14.285714 14.285714 14.285714 23.809524 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714  9.523810 14.285714  9.523810  9.523810 14.285714
 [376]  9.523810 14.285714 14.285714 19.047619 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 19.047619 14.285714  9.523810
 [391] 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714
 [406] 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714  4.761905 14.285714
 [421] 14.285714 14.285714  4.761905 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714
 [436]  4.761905 23.809524 19.047619 14.285714  9.523810 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  4.761905 14.285714 14.285714
 [451] 14.285714  9.523810 14.285714 19.047619 19.047619 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 19.047619 14.285714  9.523810  9.523810
 [466]  9.523810 19.047619  9.523810 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 19.047619
 [481] 14.285714 14.285714  9.523810 14.285714 14.285714 19.047619 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714
 [496]  4.761905 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714  9.523810 14.285714 19.047619
 [511] 14.285714 14.285714 23.809524  9.523810  9.523810 14.285714 14.285714 14.285714 19.047619  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714
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 [541] 14.285714 14.285714 14.285714 19.047619  9.523810  9.523810  9.523810 14.285714 19.047619 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714
 [556] 14.285714  9.523810 14.285714 14.285714 14.285714 19.047619  9.523810 19.047619 14.285714  9.523810 14.285714 14.285714 14.285714  9.523810  9.523810
 [571] 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 23.809524 14.285714
 [586]  9.523810 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 19.047619 14.285714 23.809524 14.285714 14.285714 14.285714
 [601]  4.761905 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714
 [616] 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714  9.523810 14.285714  9.523810 14.285714 14.285714 14.285714  9.523810  9.523810 14.285714
 [631]  9.523810 19.047619 19.047619  9.523810 14.285714 14.285714 14.285714 19.047619 19.047619  9.523810 14.285714 14.285714 14.285714 14.285714 19.047619
 [646] 14.285714  9.523810 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714  9.523810 14.285714  9.523810  0.000000  9.523810  4.761905 14.285714
 [661]  9.523810  9.523810 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714
 [676] 14.285714 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714 23.809524 14.285714  9.523810  9.523810 14.285714 14.285714 14.285714 14.285714
 [691] 19.047619 14.285714 19.047619 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 19.047619 14.285714  9.523810
 [706]  4.761905 14.285714 14.285714 14.285714  9.523810  9.523810  9.523810 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714  9.523810 14.285714
 [721] 19.047619 14.285714 14.285714 14.285714 14.285714  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714
 [736]  9.523810  9.523810 14.285714 14.285714 14.285714 14.285714 14.285714 14.285714 19.047619 14.285714 14.285714  9.523810  9.523810 14.285714 14.285714
```
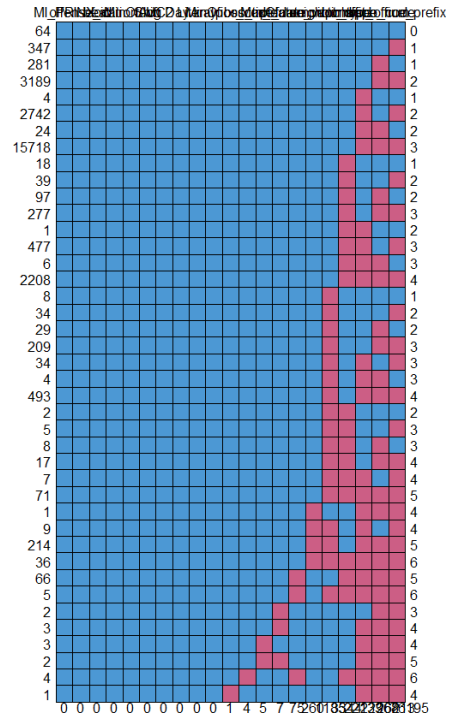
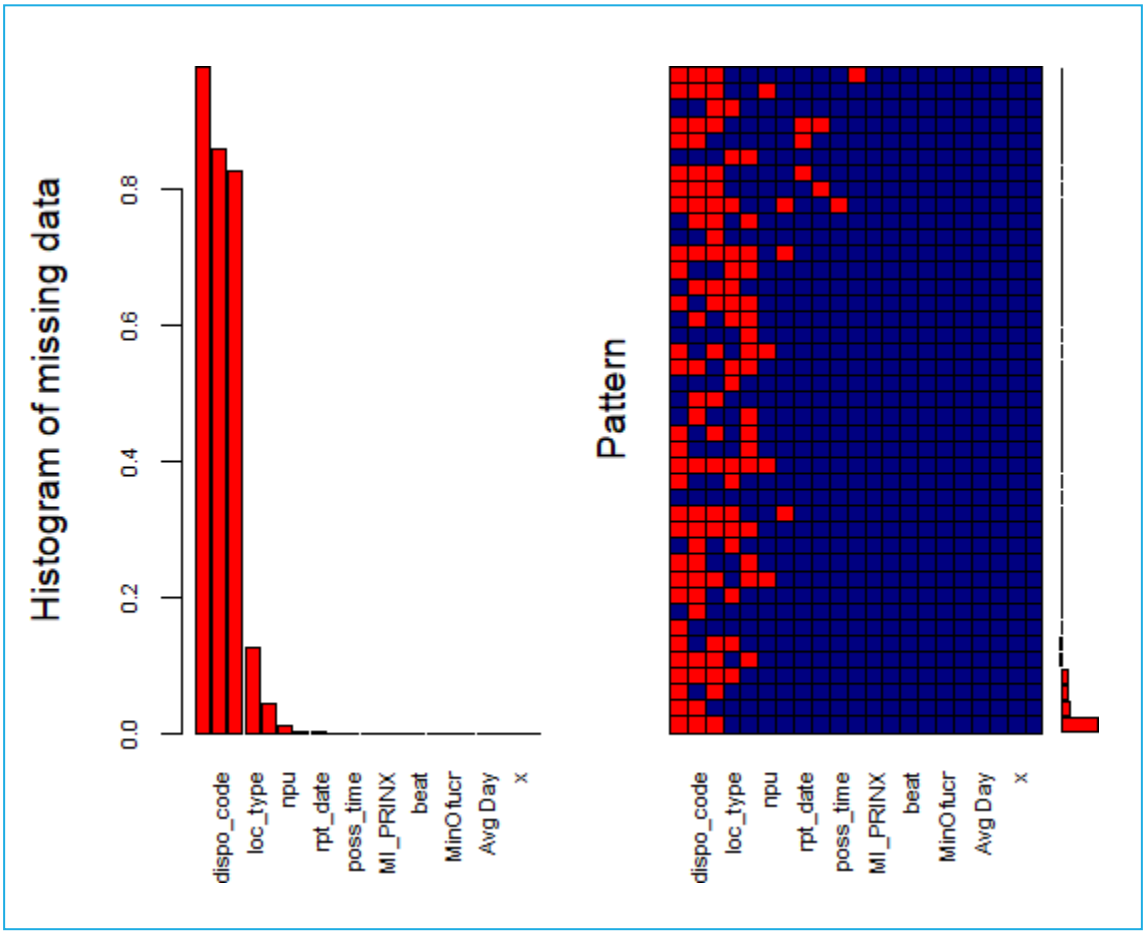
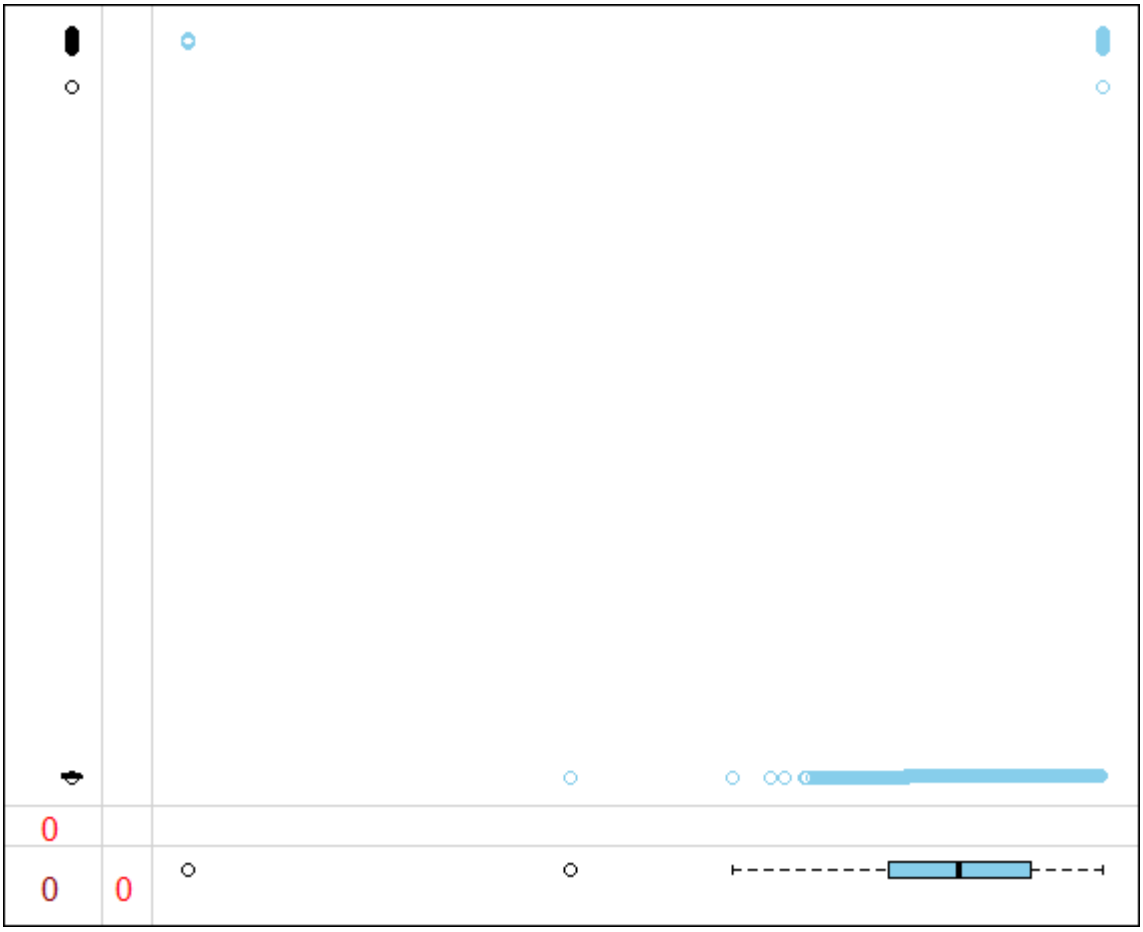

```
library(mice)
md.pattern(data)
library(VIM)
aggr_plot <- aggr(data, col=c('navyblue','red'), numbers=TRUE, sortVars=TRUE, labels=names(data), cex.axis=.7,
gap=3, ylab=c("Histogram of missing data","Pattern"))
marginplot(data[c(1,2)])
# All below charts provide the visualization of missing data in the data set
m <- matrix(data=cbind(rnorm(30, 0), rnorm(30, 2), rnorm(30, 5)), nrow=30, ncol=3)
apply(m, 1, mean)
apply(m, 2, function(x) length(x[x<0]))
apply(m, 2, function(x) is.matrix(x))
apply(m, 2, is.vector)
apply(m, 2, function(x) mean(x[x>0]))
sapply(1:3, function(x) x^2)
lapply(1:3, function(x) x^2)
sapply(1:3, function(x) mean(m[,x]))
sapply(1:3, function(x, y) mean(y[,x]), y=m)
```

```
> library(mice)
> md.pattern(data)
      MI_PRINX offense_id beat location MinOfucr Shift Avg Day UC2 Literal x y MinOfibr_code poss_time occur_date rpt_date MaxOfnum_victims npu neighborhood
64           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
347          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
281          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
3189         1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
4            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
2742         1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
24           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
15718        1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
18           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
39           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
97           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
277          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
1            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
477          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
6            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
2208         1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            1
8            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
34           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
29           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
209          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
34           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
4            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
493          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
2            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
5            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
8            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
17           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
7            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
71           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   1            0
1            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   0            1
9            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   0            0
214          1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   0            0
36           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 1   0            0
66           1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 0   1            1
5            1          1    1        1        1     1   1   1           1 1 1             1         1          1        1                 0   1            0
2            1          1    1        1        1     1   1   1           1 1 1             1         1          1        0                 1   1            1
3            1          1    1        1        1     1   1   1           1 1 1             1         1          1        0                 1   1            1
3            1          1    1        1        1     1   1   1           1 1 1             1         1          0        1                 1   1            1
2            1          1    1        1        1     1   1   1           1 1 1             1         1          0        0                 1   1            1
4            1          1    1        1        1     1   1   1           1 1 1             1         0          1        1                 0   1            1
1            1          1    1        1        1     1   1   1           1 1 1             0         1          1        1                 1   1            1
             0          0    0        0        0     0   0   0           0 0 0             1         4          5        7                75 260         1185
      loc_type apt_office_num dispo_code apt_office_prefix
64           1              1          1                 1     0
347          1              1          1                 0     1
281          1              1          0                 1     1
3189         1              1          0                 0     2
4            1              0          1                 1     1
2742         1              0          1                 0     2
24           1              0          0                 1     2
15718        1              0          0                 0     3
18           0              1          1                 1     1
39           0              1          1                 0     2
97           0              1          0                 1     2
```



```
> library(VIM)
> aggr_plot <- aggr(data, col=c('navyblue','red'), numbers=TRUE, sortVars=TRUE, labels=names(data), cex.axis=.7, gap=3, ylab=c("Histog
n"))

 Variables sorted by number of missings:
          Variable        Count
 apt_office_prefix 0.9795956501
        dispo_code 0.8583280392
    apt_office_num 0.8271235846
         loc_type 0.1249673007
      neighborhood 0.0442841661
               npu 0.0097163571
  MaxOfnum_victims 0.0028027953
         rpt_date 0.0002615942
        occur_date 0.0001868530
         poss_time 0.0001494824
     MinOfibr_code 0.0000373706
          MI_PRINX 0.0000000000
        offense_id 0.0000000000
              beat 0.0000000000
          location 0.0000000000
          MinOfucr 0.0000000000
             Shift 0.0000000000
           Avg Day 0.0000000000
       UC2 Literal 0.0000000000
                 x 0.0000000000
                 y 0.0000000000
Warning message:
In plot.aggr(res, ...) :
  not enough vertical space to display frequencies (too many combinations)
> marginplot(data[c(1,2)])
>
```





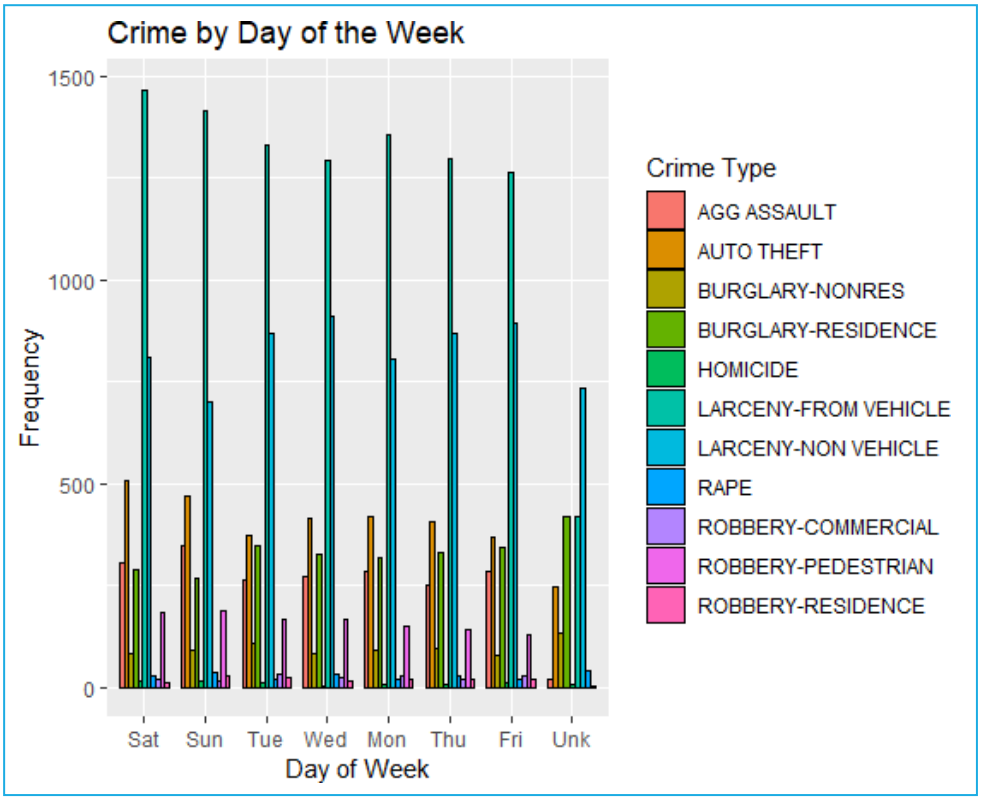

```
> marginplot(data[c(1,2)])
> # All below charts provide the visualization of missing data in the data set
> m <- matrix(data=cbind(rnorm(30, 0), rnorm(30, 2), rnorm(30, 5)), nrow=30, ncol=3)
> apply(m, 1, mean)
 [1] 1.099147 2.971292 2.510675 2.430693 2.643626 2.378484 2.331804 1.257356 3.150575 1.273153 3.292220 1.768180 2.267829 2.930361 2.250306 2.695800 2.081050
[18] 1.777808 1.879934 3.723583 3.050432 2.460920 1.894280 2.854330 1.331913 2.276818 1.768319 1.832987 2.196240 1.690000
> apply(m, 2, function(x) length(x[x<0]))
[1] 15  0  0
> apply(m, 2, function(x) is.matrix(x))
[1] FALSE FALSE FALSE
> apply(m, 2, is.vector)
[1] TRUE TRUE TRUE
> apply(m, 2, function(x) mean(x[x>0]))
[1] 0.7588953 1.9745714 4.9578357
> sapply(1:3, function(x) x^2)
[1] 1 4 9
> lapply(1:3, function(x) x^2)
[[1]]
[1] 1

[[2]]
[1] 4

[[3]]
[1] 9

> sapply(1:3, function(x) mean(m[,x]))
[1] -0.1253956  1.9745714  4.9578357
> sapply(1:3, function(x, y) mean(y[,x]), y=m)
[1] -0.1253956  1.9745714  4.9578357
```

```
library(tidyverse)
library(ggmap)
library(readxl)
library(kableExtra)
library(knitr)
str(COBRA_YTD2017)
COBRA_YTD2017$long <- COBRA_YTD2017$x %>%
  as.numeric()

COBRA_YTD2017$lat <- COBRA_YTD2017$y %>%
  as.numeric()

COBRA_YTD2017$loc_type <- COBRA_YTD2017$`UC2 Literal` %>% as.factor()

COBRA_YTD2017$days <- COBRA_YTD2017$`Avg Day` %>%
  as.factor()

kable(count(COBRA_YTD2017, loc_type, sort=TRUE), "html", col.names=c("Crime Type", "Frequency")) %>%
  kable_styling(bootstrap_options="striped", full_width=FALSE)

COBRA_YTD2017 %>%
  group_by(days, loc_type) %>%
  summarize(freq=n()) %>%
  ggplot(aes(reorder(days,-freq),freq))+
  geom_bar(aes(fill=loc_type), position="dodge", stat="identity", width=0.8, color="black")+
  xlab("Day of Week")+
  ylab("Frequency") +
  labs(fill="Crime Type") +
  ggtitle("Crime by Day of the Week")

kable

atlanta_map <- qmap("atlanta",
                    zoom=12,
                    source="stamen",
                    maptype="toner",
                    color="bw")
atlanta_map
```

```
> COBRA_YTD2017$days <- COBRA_YTD2017$`Avg Day` %>%
+   as.factor()
> kable(count(COBRA_YTD2017, loc_type, sort=TRUE), "html", col.names=c("Crime Type", "Frequency")) %>%
+   kable_styling(bootstrap_options="striped", full_width=FALSE)
<table class="table table-striped" style="width: auto !important; margin-left: auto; margin-right: auto;">
 <thead>
  <tr>
   <th style="text-align:left;"> Crime Type </th>
   <th style="text-align:right;"> Frequency </th>
  </tr>
 </thead>
<tbody>
  <tr>
   <td style="text-align:left;"> LARCENY-FROM VEHICLE </td>
   <td style="text-align:right;"> 9840 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> LARCENY-NON VEHICLE </td>
   <td style="text-align:right;"> 6589 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> AUTO THEFT </td>
   <td style="text-align:right;"> 3197 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> BURGLARY-RESIDENCE </td>
   <td style="text-align:right;"> 2635 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> AGG ASSAULT </td>
   <td style="text-align:right;"> 2024 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> ROBBERY-PEDESTRIAN </td>
   <td style="text-align:right;"> 1126 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> BURGLARY-NONRES </td>
   <td style="text-align:right;"> 758 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> RAPE </td>
   <td style="text-align:right;"> 226 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> ROBBERY-COMMERCIAL </td>
   <td style="text-align:right;"> 157 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> ROBBERY-RESIDENCE </td>
   <td style="text-align:right;"> 132 </td>
  </tr>
  <tr>
   <td style="text-align:left;"> HOMICIDE </td>
   <td style="text-align:right;"> 75 </td>
  </tr>
</tbody>
</table>
>
```

Crime Type	Frequency
LARCENY-FROM VEHICLE	9840
LARCENY-NON VEHICLE	6589
AUTO THEFT	3197
BURGLARY-RESIDENCE	2635
AGG ASSAULT	2024
ROBBERY-PEDESTRIAN	1126
BURGLARY-NONRES	758
RAPE	226
ROBBERY-COMMERCIAL	157
ROBBERY-RESIDENCE	132
HOMICIDE	75

```
> COBRA_YTD2017 %>%
+   group_by(days, loc_type) %>%
+   summarize(freq=n()) %>%
+   ggplot(aes(reorder(days, -freq), freq)) +
+   geom_bar(aes(fill=loc_type), position="dodge", stat="identity", width=0.8, color="black") +
+   xlab("Day of Week") +
+   ylab("Frequency") +
+   labs(fill="Crime Type") +
+   ggtitle("Crime by Day of the Week")
>
```



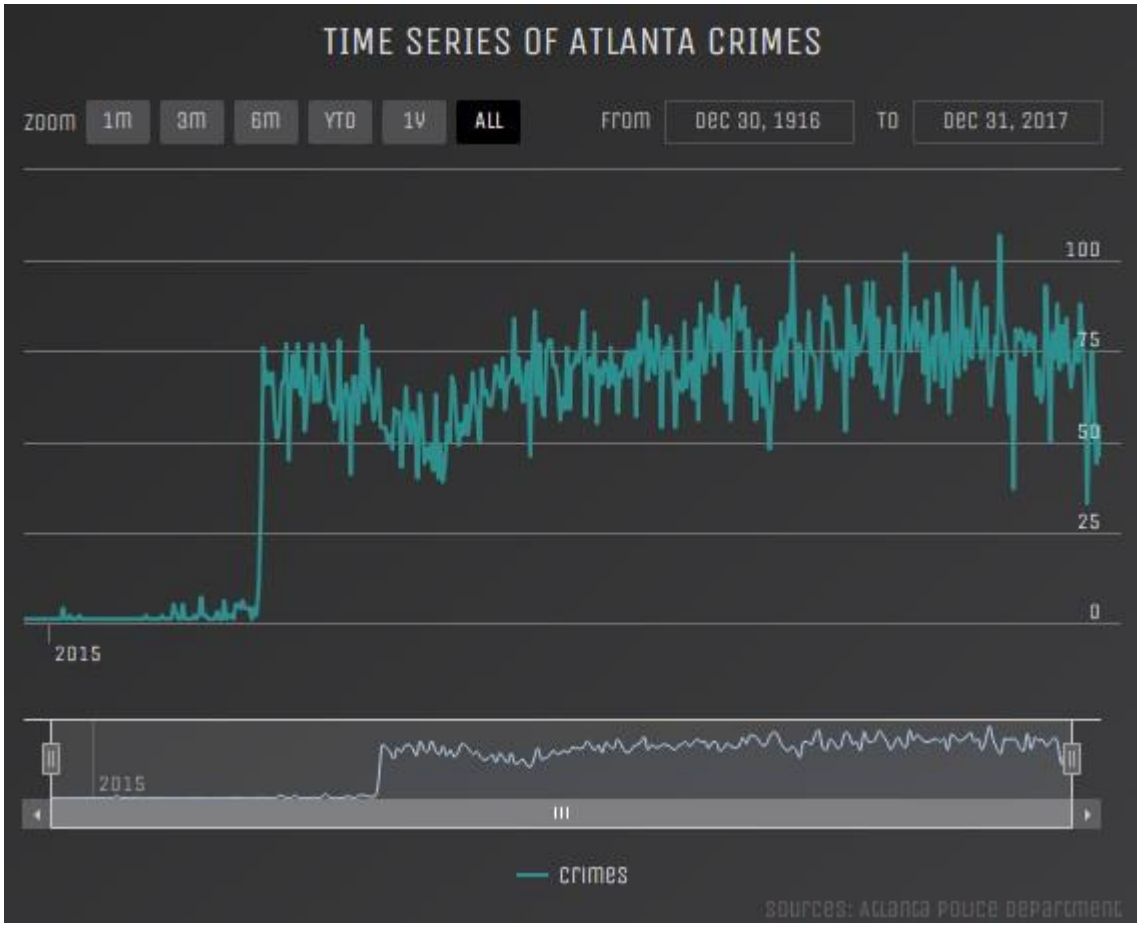
```
================================================================================
> kable
function (x, format, digits = getOption("digits"), row.names = NA, col.names =
    NA, align, caption = NULL, format.args = list(), escape = TRUE, ...)
{
    if (missing(format) || is.null(format)) format =
        getOption("knitr.table.format")
    if (is.null(format))
        format = if (is.null(pandoc_to()))
            switch(out_format() %n% "markdown", latex = "latex", listings =
                "latex", sweave = "latex", html = "html",
                markdown = "markdown", rst = "rst", stop("table format not implemented
yet!"))
        else if (isTRUE(opts_knit$get("kable.force.latex")) &&
            is_latex_output()) {
            "latex"
        }
        else "pandoc"
    if (is.function(format))
        format = format()
    if (format != "latex" && !missing(align) && length(align) == 1L)
        align = strsplit(align, "")[[1]]
    if (!is.null(caption) && !is.na(caption))
        caption = paste0(create_label("tab:", opts_current$get("label"), latex =
            (format == "latex")), caption)
    if (inherits(x, "list")) {
        if (format == "pandoc" && is_latex_output()) format =
            "latex"
        res = lapply(x, kable, format = format, digits = digits, row.names =
            row.names, col.names = col.names, align = align, caption = NA,
            format.args = format.args, escape = escape,
            ...)
        res = unlist(lapply(res, paste, collapse = "¥n")) res = if
        (format == "latex") {
            kable_latex_caption(res, caption)
        }
        else if (format == "html" || (format == "pandoc" && is_html_output()))
            kable_html(matrix(paste0("¥n¥n", res, "¥n¥n"), 1),
                caption = caption, escape = FALSE, table.attr = "class=¥"kable_wrapper¥
"")
        else {
            res = paste(res, collapse = "¥n¥n") if
            (format == "pandoc")
                kable_pandoc_caption(res, caption) else
            res
        }
        return(structure(res, format = format, class = "knitr_kable"))
    }
    if (!is.matrix(x))
        x = as.data.frame(x)
    if (identical(col.names, NA))
        col.names = colnames(x)
    m = ncol(x)
    isn = if (is.matrix(x))
        rep(is.numeric(x), m)
    else sapply(x, is.numeric)
    if (missing(align) || (format == "latex" && is.null(align))) align =
```

```
    ifelse(isn, "r", "l")
digits = rep(digits, length.out = m)
```

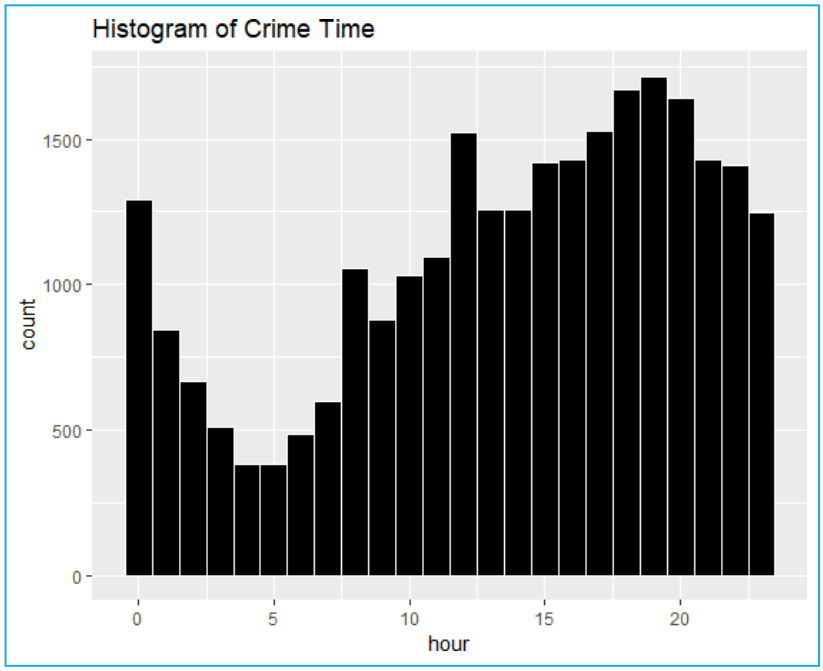
```
    for (j in seq_len(m)) {
        if (is_numeric(x[, j]))
            x[, j] = round(x[, j], digits[j])
    }
    if (any(isn)) {
        if (is.matrix(x)) {
            if (is.table(x) && length(dim(x)) == 2)
                class(x) = "matrix"
            x = format_matrix(x, format.args)
        }
        else x[, isn] = format_args(x[, isn], format.args)
    }
    if (is.na(row.names))
        row.names = has_rownames(x) if
    (!is.null(align))
        align = rep(align, length.out = m) if
    (row.names) {
        x = cbind(` ` = rownames(x), x) if
        (!is.null(col.names))
            col.names = c(" ", col.names) if
        (!is.null(align))
            align = c("l", align)
    }
    n = nrow(x)
    x = replace_na(to_character(as.matrix(x)), is.na(x)) if
    (!is.matrix(x))
        x = matrix(x, nrow = n) x =
    trimws(x)
    colnames(x) = col.names
    if (format != "latex" && length(align) && !all(align %in% c("l",
        "r", "c")))
        stop("'align' must be a character vector of possible values 'l', 'r', and 'c'") attr(x,
    "align") = align
    res = do.call(paste("kable", format, sep = "_"), list(x = x, caption =
        caption, escape = escape, ...))
    structure(res, format = format, class = "knitr_kable")
}
<bytecode: 0x000000001f56f938>
<environment: namespace:knitr>
```

```
library(dplyr)
library(data.table)
library(ggplot2)
at <- COBRA_YTD2017
str(at)
at$MI_PRINX <- at$apt_office_prefix <- at$apt_office_num <- at$location <- at$dispo_code <- at$loc_type <-
at$npu <- NULL
library(chron)
library(lubridate)
at$lon <- at$x
at$lat <- at$y
at$occur_date <- mdy(at$occur_date)
at$rpt_date <- mdy(at$rpt_date)
at$occur_time <- chron(times=at$occur_time)
at$lon <- as.numeric(at$lon)
at$lat <- as.numeric(at$lat)
at$x <- at$y <- NULL
library(xts)
by_Date <- na.omit(at) %>% group_by(occur_date) %>% summarise(Total = n())
tseries <- xts(by_Date$Total, order.by= by_Date$occur_date)
library(highcharter)
hchart(tseries, name = "Crimes") %>%
  hc_add_theme(hc_theme_darkunica()) %>%
  hc_credits(enabled = TRUE, text = "Sources: Atlanta Police Department", style = list(fontSize = "12px")) %>%
  hc_title(text = "Time Series of Atlanta Crimes") %>%
  hc_legend(enabled = TRUE)
hchart
#Graph provides the data spread of the crime during the year
at$dayofWeek <- weekdays(as.Date(at$occur_date))
at$hour <- sub(":.*", "", at$occur_time)
at$hour <- as.numeric(at$hour)
ggplot(aes(x = hour), data = at) + geom_histogram(bins = 24, color='white', fill='black') +
  ggtitle('Histogram of Crime Time')
```

```
> library(dplyr)
> library(data.table)
> library(ggplot2)
> at <- COBRA_YTD2017
> str(at)
Classes 'spec_tbl_df', 'tbl_df', 'tbl' and 'data.frame':        26759 obs. of  26 variables:
 $ MI_PRINX         : num  8924155 8924156 8924157 8924158 8924159 ...
 $ offense_id       : num  1.74e+08 1.74e+08 1.74e+08 1.74e+08 1.74e+08 ...
 $ rpt_date         : chr  "12/31/2017" "12/31/2017" "12/31/2017" "12/31/2017" ...
 $ occur_date       : chr  "12/30/2017" "12/18/2017" "12/30/2017" "12/30/2017" ...
 $ occur_time       : 'hms' num  23:15:00 13:00:00 22:01:00 20:00:00 ...
  ..- attr(*, "units")= chr "secs"
 $ poss_date        : chr  "12/31/2017" "12/30/2017" "12/31/2017" "12/31/2017" ...
 $ poss_time        : 'hms' num  00:30:00 22:00:00 01:00:00 01:06:00 ...
  ..- attr(*, "units")= chr "secs"
 $ beat             : num  510 501 303 507 409 612 605 603 605 304 ...
 $ apt_office_prefix: chr  NA NA NA NA ...
 $ apt_office_num   : chr  NA NA NA NA ...
 $ location         : chr  "43 JESSE HILL JR DR NE" "1169 ATLANTIC DR NW" "633 PRYOR ST SW" "333 NELSON ST SW" ...
 $ MinOfucr         : chr  "0640" "0640" "0640" "0640" ...
 $ MinOfibr_code    : chr  "2305" "2305" "2305" "2305" ...
 $ dispo_code       : num  NA NA NA NA NA NA NA NA NA NA ...
 $ MaxOfnum_victims : num  2 1 1 1 2 1 1 1 1 1 ...
 $ Shift            : chr  "Morn" "Unk" "Morn" "Eve" ...
 $ Avg Day          : chr  "Sat" "Unk" "Sat" "Sat" ...
 $ loc_type         : Factor w/ 11 levels "AGG ASSAULT",..: 6 6 6 6 6 6 10 6 6 4 ...
 $ UC2 Literal      : chr  "LARCENY-FROM VEHICLE" "LARCENY-FROM VEHICLE" "LARCENY-FROM VEHICLE" "LARCENY-FROM VEHICLE" ...
 $ neighborhood     : chr  "Downtown" "Home Park" "Mechanicsville" "Castleberry Hill" ...
 $ npu              : chr  "M" "E" "V" "M" ...
 $ x                : num  -84.4 -84.4 -84.4 -84.4 -84.5 ...
 $ y                : num  33.8 33.8 33.7 33.8 33.7 ...
 $ long             : num  -84.4 -84.4 -84.4 -84.4 -84.5 ...
 $ lat              : num  33.8 33.8 33.7 33.8 33.7 ...
 $ days             : Factor w/ 8 levels "Fri","Mon","Sat",..: 3 7 3 3 4 4 4 4 3 4 ...
 - attr(*, "problems")=Classes 'tbl_df', 'tbl' and 'data.frame':        9 obs. of  5 variables:
  ..$ row     : int  3239 7945 8527 10145 11912 12629 13305 17684 20632
  ..$ col     : chr  "dispo_code" "dispo_code" "dispo_code" "dispo_code" ...
  ..$ expected: chr  "a double" "a double" "a double" "a double" ...
  ..$ actual  : chr  "COS" "ADM" "ADM" "ADM" ...
  ..$ file    : chr  "'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'" "'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COB
TA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'" "'G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv'" ...
 - attr(*, "spec")=
  .. cols(
  ..   MI_PRINX = col_double(),
  ..   offense_id = col_double(),
  ..   rpt_date = col_character(),
  ..   occur_date = col_character(),
  ..   occur_time = col_time(format = ""),
  ..   poss_date = col_character(),
  ..   poss_time = col_time(format = ""),
  ..   beat = col_double(),
  ..   apt_office_prefix = col_character(),
  ..   apt_office_num = col_character(),
  ..   location = col_character(),
  ..   MinOfucr = col_character(),
  ..   MinOfibr_code = col_character(),
  ..   dispo_code = col_double(),
  ..   MaxOfnum_victims = col_double(),
  ..   Shift = col_character(),
  ..   `Avg Day` = col_character(),
  ..   loc_type = col_double(),
  ..   `UC2 Literal` = col_character(),
  ..   neighborhood = col_character(),
  ..   npu = col_character(),
  ..   x = col_double(),
  ..   y = col_double()
  .. )
> at$MI_PRINX <- at$apt_office_prefix <- at$apt_office_num <- at$location <- at$dispo_code <- at$loc_type <- at$npu <- NULL
> library(chron)
> library(lubridate)
> at$lon <- at$x
> at$lat <- at$y
> at$occur_date <- mdy(at$occur_date)
> at$rpt_date <- mdy(at$rpt_date)
> at$occur_time <- chron(times=at$occur_time)
> at$lon <- as.numeric(at$lon)
> at$lat <- as.numeric(at$lat)
> at$x <- at$y <- NULL
> library(xts)
> by_Date <- na.omit(at) %>% group_by(occur_date) %>% summarise(Total = n())
> tseries <- xts(by_Date$Total, order.by= by_Date$occur_date)
> library(highcharter)
> hchart(tseries, name = "Crimes") %>%
+   hc_add_theme(hc_theme_darkunica()) %>%
+   hc_credits(enabled = TRUE, text = "Sources: Atlanta Police Department", style = list(fontSize = "12px")) %>%
+   hc_title(text = "Time Series of Atlanta Crimes") %>%
+   hc_legend(enabled = TRUE)
>
```

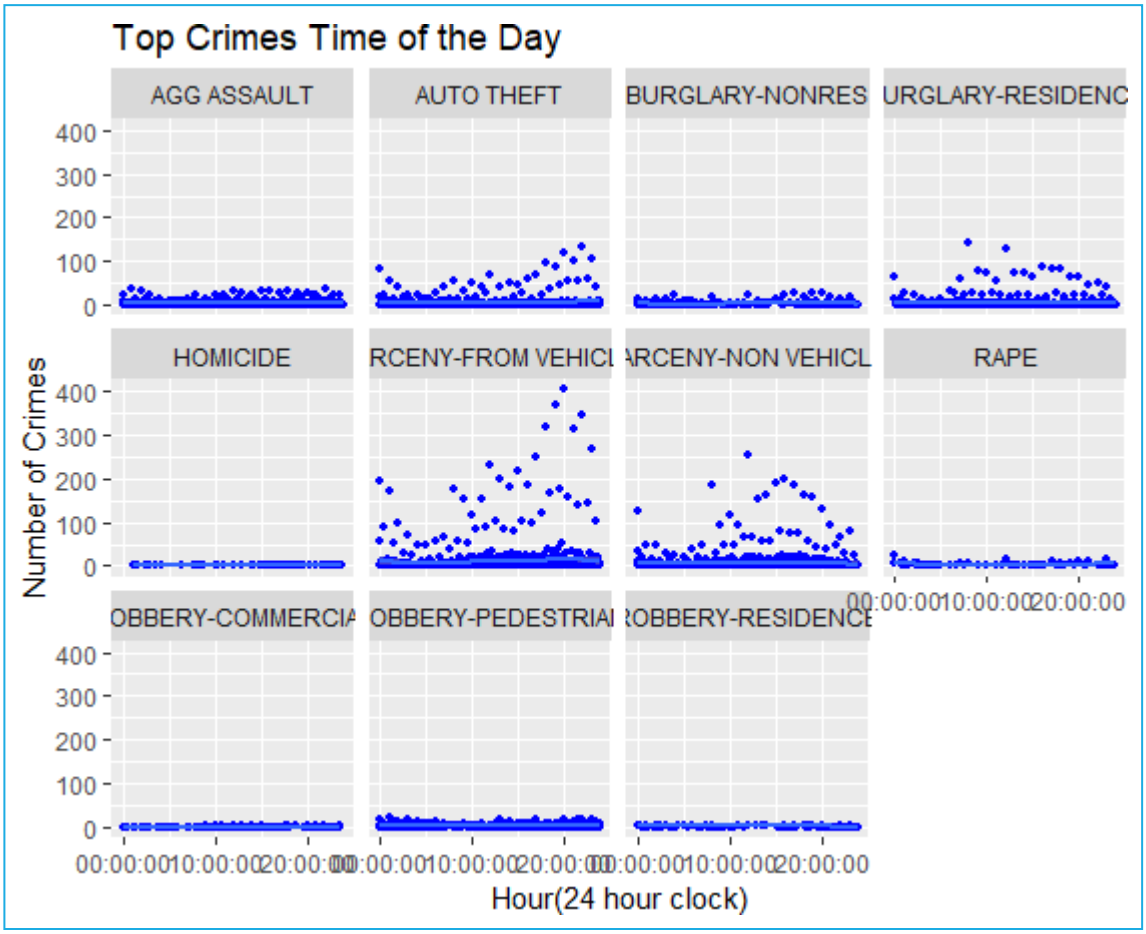



```
> #Graph provides the data spread of the crime during the year
> at$dayofweek <- weekdays(as.Date(at$occur_date))
> at$hour <- sub(":.*", "", at$occur_time)
> at$hour <- as.numeric(at$hour)
> ggplot(aes(x = hour), data = at) + geom_histogram(bins = 24, color='white', fill='black') +
+   ggtitle('Histogram of Crime Time')
```

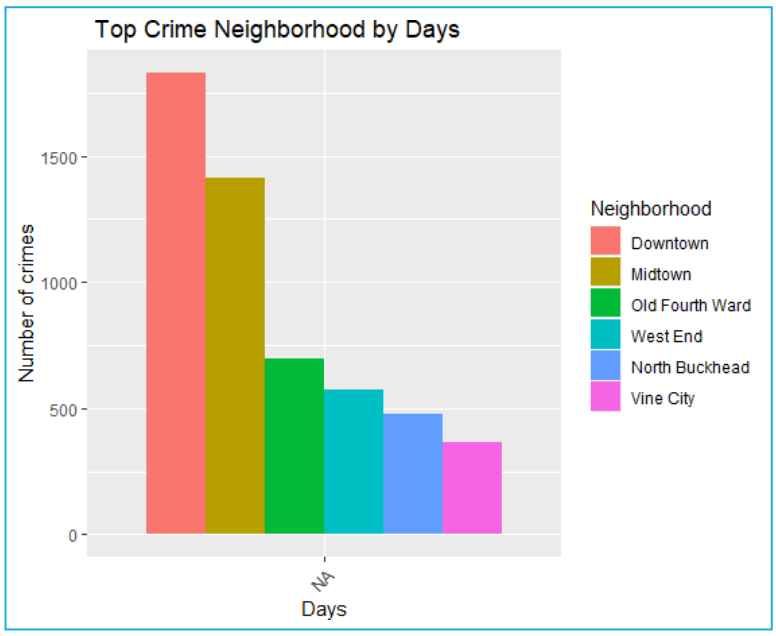


```
#The crime time distribution appears bimodal with peaking around midnight and again at the noon, then again between 6pm and 8pm.
topCrimes_1 <- COBRA_YTD2017 %>% group_by(`UC2 Literal`,occur_time) %>%
  summarise(total = n())

ggplot(aes(x = occur_time, y = total), data = topCrimes_1) +
  geom_point(colour="blue", size=1) +
  geom_smooth(method="loess") +
  xlab('Hour(24 hour clock)') +
  ylab('Number of Crimes') +
  ggtitle('Top Crimes Time of the Day') +
  facet_wrap(~`UC2 Literal`)


#Downtown and midtown are the most common locations where crimes take place, followed by Old Fourth Ward and West End.
topLocations <- subset(at, neighborhood =="Downtown"|neighborhood =="Midtown" | neighborhood=="Old Fourth Ward" | neighborhood=="West End" | neighborhood=="Vine City" | neighborhood=="North Buckhead")

topLocations <- within(topLocations, neighborhood <- factor(neighborhood, levels = names(sort(table(neighborhood), decreasing = T))))

topLocations$days <- ordered(topLocations$days,
                             levels = c('Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday'))

ggplot(data = topLocations, aes(x = days, fill = neighborhood)) +
  geom_bar(width = 0.9, position = position_dodge()) + ggtitle("Top Crime Neighborhood by Days") +
labs(x = "Days", y = "Number of crimes", fill = guide_legend(title = "Neighborhood")) + theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

```
> #The crime time distribution appears bimodal with peaking around midnight and again at the noon, then again between 6pm and 8pm.
> topCrimes_1 <- COBRA_YTD2017 %>% group_by(`UC2 Literal`,occur_time) %>%
+   summarise(total = n())
> ggplot(aes(x = occur_time, y = total), data = topCrimes_1) +
+   geom_point(colour="blue", size=1) +
+   geom_smooth(method="loess") +
+   xlab('Hour(24 hour clock)') +
+   ylab('Number of Crimes') +
+   ggtitle('Top Crimes Time of the Day') +
+   facet_wrap(~`UC2 Literal`)
```




```
> #Downtown and midtown are the most common locations where crimes take place, followed by Old Fourth Ward and West End.
> topLocations <- subset(at, neighborhood =="Downtown"|neighborhood =="Midtown" | neighborhood=="Old Fourth Ward" | neighborhood=="West End" | neighborh
ity" | neighborhood=="North Buckhead")
> topLocations <- within(topLocations,  neighborhood <- factor(neighborhood, levels = names(sort(table(neighborhood), decreasing = T))))
> topLocations$days <- ordered(topLocations$days,
+                              levels = c('Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday'))
> ggplot(data = topLocations, aes(x = days, fill = neighborhood)) +
+   geom_bar(width = 0.9, position = position_dodge()) + ggtitle(" Top Crime Neighborhood by Days") +
+   labs(x = "Days", y = "Number of crimes", fill = guide_legend(title = "Neighborhood")) + theme(axis.text.x = element_text(angle = 45, hjust = 1))
> |
```



b. What is the difference between covariance and correlation, take an example from this dataset and show the differences if any?

- Covariance and Correlation are two mathematical concepts which are quite commonly used in business statistics.
- Both of these two determine the relationship and measures the dependency between two random variables.
- Despite, some similarities between these two mathematical terms, they are different from each other. Correlation is when the change in one item may result in the change in another item.
- Correlation is considered as the best tool for for measuring and expressing the quantitative relationship between two variables in formula.
- Covariance is when two items vary together. Read the given article to know the differences between covariance and correlation.

BASIS FOR COMPARISON	CORRELATION	COVARIANCE
Meaning	Correlation is a statistical measure that indicates how strongly two variables are related.	Covariance is a measure indicating the extent to which two random variables change in tandem.
What is it?	Scaled version of covariance	Measure of correlation
Values	Lie between -1 and +1	Lie between $-\infty$ and $+\infty$
Change in scale	Does not affects correlation	Affects Covariance
Unit free measure	Yes	No

Similarities

- Both measures only linear relationship between two variables, i.e. when the correlation coefficient is zero, covariance is also zero. Further, the two measures are unaffected by the change in location.
- Correlation is a special case of covariance which can be obtained when the data is standardized. Now, when it comes to making a choice, which is a better measure of the relationship between two variables, correlation is preferred over covariance, because it remains unaffected by the change in location and scale, and can also be used to make a comparison between two pairs of variables.
- correlation is preferred over covariance, because it remains unaffected by the change in location and scale, and can also be used to make a comparison between two pairs of variables.

```
#Correlation & covariance
cor(COBRA_YTD2017$x,COBRA_YTD2017$y)
cov(COBRA_YTD2017$x,COBRA_YTD2017$y)
cor.test(COBRA_YTD2017$x,COBRA_YTD2017$y)
cor(COBRA_YTD2017$long,COBRA_YTD2017$lat)
cor.test(COBRA_YTD2017$long,COBRA_YTD2017$lat)
cov(COBRA_YTD2017$long,COBRA_YTD2017$lat)
plot(COBRA_YTD2017$x,COBRA_YTD2017$y)
mod=lm(COBRA_YTD2017$long~COBRA_YTD2017$lat)
summary(mod)
predict(mod)
pred= predict(mod)
COBRA_YTD2017$predicted=NA
COBRA_YTD2017$predicted=pred
COBRA_YTD2017$error=COBRA_YTD2017$residuals
library(car)
dwt(mod)
plot(COBRA_YTD2017$long,COBRA_YTD2017$lat,abline(COBRA_YTD2017$long~COBRA_YTD2017$lat),col='red')
```

```
> #Correlation & covariance
> cor(COBRA_YTD2017$x,COBRA_YTD2017$y)
[1] -0.9998355
> cov(COBRA_YTD2017$x,COBRA_YTD2017$y)
[1] -23.86342
> cor.test(COBRA_YTD2017$x,COBRA_YTD2017$y)

        Pearson's product-moment correlation

data:  COBRA_YTD2017$x and COBRA_YTD2017$y
t = -9017.2, df = 26757, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.9998394 -0.9998315
sample estimates:
       cor
-0.9998355

> cor(COBRA_YTD2017$long,COBRA_YTD2017$lat)
[1] -0.9998355
> cor.test(COBRA_YTD2017$long,COBRA_YTD2017$lat)

        Pearson's product-moment correlation

data:  COBRA_YTD2017$long and COBRA_YTD2017$lat
t = -9017.2, df = 26757, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.9998394 -0.9998315
sample estimates:
       cor
-0.9998355

> cov(COBRA_YTD2017$long,COBRA_YTD2017$lat)
[1] -23.86342
>
```

```
> cov(COBRA_YTD2017$long,COBRA_YTD2017$lat)
[1] -23.86342
> plot(COBRA_YTD2017$x,COBRA_YTD2017$y)
> mod=lm(COBRA_YTD2017$long~COBRA_YTD2017$lat)
> summary(mod)

Call:
lm(formula = COBRA_YTD2017$long ~ COBRA_YTD2017$lat)

Residuals:
     Min       1Q   Median       3Q      Max
-0.36967 -0.08504  0.01124  0.08245  0.35407

Coefficients:
                  Estimate Std. Error   t value Pr(>|t|)
(Intercept)       -0.0219717  0.0093186    -2.358   0.0184 *
COBRA_YTD2017$lat -2.4996054  0.0002772 -9017.210   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1401 on 26757 degrees of freedom
Multiple R-squared:  0.9997,    Adjusted R-squared:  0.9997
F-statistic: 8.131e+07 on 1 and 26757 DF,  p-value: < 2.2e-16

> predict(mod)
        1         2         3         4         5         6         7         8         9        10        11        12
-84.39820118 -84.47548898 -84.35265837 -84.38755286 -84.31231474 -84.35880740 -84.37128043 -84.44121939 -84.37462990 -84.32313803 -84.34905894 -84.38300358
       13        14        15        16        17        18        19        20        21        22        23        24
-84.21475514 -84.30094154 -84.33486118 -84.26084787 -84.40442520 -84.50041005 -84.27562054 -84.62726502 -84.40257549 -84.43532032 -84.26789675 -84.39457676
       25        26        27        28        29        30        31        32        33        34        35        36
-84.37482987 -84.47993828 -84.43552029 -84.40914946 -84.59552003 -84.62551530 -84.36765601 -84.67755708 -84.54125360 -84.40897448 -84.49868532 -84.62551530
       37        38        39        40        41        42        43        44        45        46        47        48
-84.32171326 -84.14966542 -84.42074762 -84.51900711 -84.37140541 -84.47193954 -84.39317698 -84.50428444 -84.54177852 -84.49201137 -84.39730133 -84.47231448
       49        50        51        52        53        54        55        56        57        58        59        60
-84.51813225 -84.36078209 -84.25194927 -84.64116283 -84.37765443 -84.35113361 -84.38260365 -84.51833222 -84.62579025 -84.40095075 -84.20833116 -84.44846825
       61        62        63        64        65        66        67        68        69        70        71        72
-84.29301779 -84.27956991 -84.40617492 -84.19038399 -84.39255208 -84.39640147 -84.11082155 -84.14291649  -0.02197167 -84.38292859 -84.61489197 -84.46364085
       73        74        75        76        77        78        79        80        81        82        83        84
-84.39747630 -84.42889634 -84.44316908 -84.38570316 -84.25712346  -0.02197167 -84.30936521 -84.38977751 -84.38400343 -84.38660301 -84.19140883 -84.59844457
       85        86        87        88        89        90        91        92        93        94        95        96
-84.38185376 -84.49811041 -84.21468016 -84.53642936 -84.61341721 -84.36613125 -84.45734185 -84.47238947 -84.36185692 -84.29046819 -84.56599969 -84.40050082
       97        98        99       100       101       102       103       104       105       106       107       108
-84.54245341 -84.54635280 -84.44779335 -84.43102100 -84.47436416 -84.40442520 -84.64116283 -84.64041295 -84.40732474 -84.46421576 -84.38490328 -84.35868242
      109       110       111       112       113       114       115       116       117       118       119       120
-84.51833222 -84.31738894 -84.22980277 -84.51833222 -84.52545609 -84.64113783 -84.40110073 -84.38357849 -84.38812777 -84.38822776 -84.62551530 -84.27489565
      121       122       123       124       125       126       127       128       129       130       131       132
-84.28179456 -84.63016456 -84.36115703 -84.37765443 -84.52678088 -84.39345193 -84.47336432 -84.43879478 -84.56487487 -84.21035584 -84.20810619 -84.34655934
      133       134       135       136       137       138       139       140       141       142       143       144
-84.34865900 -84.14526611 -84.35815751 -84.28024481 -84.15543951 -84.69247973 -84.29954176 -84.40075078 -84.19860769 -84.69242973 -84.38810278 -84.40050082
      145       146       147       148       149       150       151       152       153       154       155       156
-84.36903079 -84.42579683 -84.19813277 -84.46636542 -84.41444862 -84.53415472 -84.63821329 -84.54130359 -84.46306594 -84.25667353 -84.42139752 -84.42579683
      157       158       159       160       161       162       163       164       165       166       167       168
-84.51468279 -84.35395817 -84.32176325 -84.62601522 -84.24112598 -84.34355981 -84.61686666 -84.52210662 -84.55457650 -84.41107415 -84.52540610 -84.43749498
      169       170       171       172       173       174       175       176       177       178       179       180
-84.36698111 -84.53340484 -84.31936363 -84.41764811 -84.43677009 -84.36185692 -84.47736369 -84.42814646 -84.39302700 -84.11039662 -84.14436626 -84.41507352
      181       182       183       184       185       186       187       188       189       190       191       192
-84.41789807 -84.39345193 -84.35360822 -84.39540163 -84.39000248 -84.31583919 -84.30746551 -84.54732764 -84.49833538 -84.40007589 -84.57079894 -84.27072131
      193       194       195       196       197       198       199       200       201       202       203       204
-84.38625307 -84.52508115 -84.29791702 -84.38047898 -84.51438284 -84.19998248 -84.40202558 -84.27777020 -84.52418130 -84.35438310 -84.42687166 -84.39625149
```

```
> pred= predict(mod)
> COBRA_YTD2017$predicted=NA
> COBRA_YTD2017$predicted=pred
> COBRA_YTD2017$error=COBRA_YTD2017$residuals
Warning message:
Unknown or uninitialised column: 'residuals'.
> library(car)
> dwt(mod)
 lag Autocorrelation D-W Statistic p-value
   1      0.02809992       1.943799       0
 Alternative hypothesis: rho != 0
> plot(COBRA_YTD2017$long,COBRA_YTD2017$lat,abline(COBRA_YTD2017$long~COBRA_YTD2017$lat),col='red')
>
```