Assignment 13.2

Visualize the correlation between all variables in a meaningful and clear way of representing. Find out top 3 reasons for having more crime in a city.

What is the difference between co-variance and correlation? Take an example from this dataset and show the differences if any?

```
COBRA_YTD2017<-read.csv('C:/Sourav/R/COBRA-YTD2017.csv')
require(Amelia)
## Loading required package: Amelia
## Loading required package: Rcpp
## ##
## ## Amelia II: Multiple Imputation
## ## (Version 1.7.5, built: 2018-05-07)
## ## Copyright (C) 2005-2018 James Honaker, Gary King and Matth
ew Blackwell
## ## Refer to http://gking.harvard.edu/amelia/ for more informa
tion
## ##
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
##  Min.   :8838438   Min.   :1.608e+08   7/26/2017 :  106
##  1st Qu.:8904204   1st Qu.:1.711e+08   10/16/2017:  103
##  Median :8910894   Median :1.720e+08   11/1/2017 :  103
##  Mean   :8910851   Mean   :6.523e+08   9/21/2017 :  101
##  3rd Qu.:8917584   3rd Qu.:1.728e+08   11/28/2017:  100
##  Max.   :8924410   Max.   :1.730e+11   (Other)   :26239
##                                        NA's      :    7
##      occur_date        poss_time         beat        apt_offi
## ce_prefix
##  11/17/2017:  110   8:00:00 :  526   Min.   :101.0           :
## 26213
##  10/7/2017 :  106   7:00:00 :  430   1st Qu.:208.0   APT    :
## 314
##  8/19/2017 :  105   12:00:00:  426   Median :312.0   STE    :
## 25
##  10/28/2017:  102   10:00:00:  376   Mean   :355.6   ROOM   :
## 21
##  10/31/2017:   99   9:00:00 :  376   3rd Qu.:505.0   BLDG   :
## 12
##  (Other)   :26232   16:00:00:  375   Max.   :710.0   UNIT   :
## 12
##  NA's      :    5   (Other) :24250                   (Other):
## 162
##  apt_office_num                              location
##          :22133   1801 HOWELL MILL RD NW             :  1
## 42
##  A     :  120   3393 PEACHTREE RD NE @LENOX MALL     :  1
## 40
##  B     :  108   1275 CAROLINE ST NE @TARGET - CAROLINE :  1
## 36
##  1     :   61   3393 PEACHTREE RD NE                 :  1
## 29
```

```
##   2      :   48    835 MARTIN L KING JR DR NW                 :  1
08
##   5      :   46    2841 GREENBRIAR PKWY SW @GREENBRIAR MALL:
95
##  (Other): 4243    (Other)                                :260
09
##     MinOfucr     MinOfibr_code    dispo_code    MaxOfnum_vict
ims
##  Min.   :110.0   2305   :9024            :22959   Min.   : 0.00
##  1st Qu.:521.0   2404   :2774   10    : 2893   1st Qu.: 1.00
##  Median :640.0   2303   :2486   20    :  632   Median : 1.00
##  Mean   :598.8   2399   :1946   30    :  210   Mean   : 1.16
##  3rd Qu.:660.0   2202   :1802   40    :   36   3rd Qu.: 1.00
##  Max.   :730.0   2308   :1381   60    :   20   Max.   :27.00
##                  (Other):7346   (Other):    9   NA's   :75
##    Shift         Avg.Day        loc_type                    UC2
.Literal
##  Day :6882   Sat    :3713   Min.   : 1.00   LARCENY-FROM VEHI
CLE:9840
##  Eve :9151   Sun    :3569   1st Qu.:13.00   LARCENY-NON VEHIC
LE :6589
##  Morn:7014   Tue    :3542   Median :18.00   AUTO THEFT
:3197
##  Unk :3712   Wed    :3539   Mean   :20.76   BURGLARY-RESIDENC
E  :2635
##              Mon    :3492   3rd Qu.:20.00   AGG ASSAULT
:2024
##              Thu    :3455   Max.   :99.00   ROBBERY-PEDESTRIA
N  :1126
##              (Other):5449   NA's   :3344   (Other)
:1348
##              neighborhood        npu              x
##  Downtown         : 1828   M    : 3077   Min.   :-84.55
##  Midtown          : 1410   E    : 2742   1st Qu.:-84.43
```

```
##                       : 1185    B       : 2716    Median :-84.40
##   Old Fourth Ward  :  697    D       : 1281    Mean   :-83.69
##   Lindbergh/Morosgo:  595    V       : 1281    3rd Qu.:-84.37
##   West End         :  571    T       : 1140    Max.   :  0.00
##   (Other)          :20473    (Other):14522
##         y
##   Min.   : 0.00
##   1st Qu.:33.73
##   Median :33.76
##   Mean   :33.47
##   3rd Qu.:33.79
##   Max.   :33.88
##
```

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

```
##        MI_PRINX        offense_id        rpt_date
## occur_date
##      0.00000000        0.00000000        0.02615942
## 0.01868530
##        poss_time              beat apt_office_prefix     apt_
## office_num
##      0.00000000        0.00000000        0.00000000
## 0.00000000
##        location           MinOfucr    MinOfibr_code
## dispo_code
##      0.00000000        0.00000000        0.00000000
## 0.00000000
##   MaxOfnum victims            Shift          Avg.Day
## loc_type
##      0.28027953        0.00000000        0.00000000           1
## 2.49673007
##       UC2.Literal      neighborhood             npu
## x
```

```
##        0.00000000         0.00000000         0.00000000
0.00000000
##                 y
##        0.00000000
```

```r
apply(data,1,pMiss)
```

```
##      [1] 4.761905 4.761905 4.761905 9.523810 9.523810 4.761905
4.761905
##      [8] 4.761905 4.761905 4.761905 0.000000 4.761905 4.761905
0.000000
##     [15] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [22] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [29] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [36] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [43] 0.000000 4.761905 0.000000 0.000000 0.000000 0.000000
0.000000
##     [50] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
##     [57] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [64] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
##     [71] 4.761905 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [78] 4.761905 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
##     [85] 0.000000 4.761905 0.000000 4.761905 0.000000 0.000000
0.000000
##     [92] 4.761905 0.000000 0.000000 0.000000 4.761905 0.000000
4.761905
##     [99] 0.000000 0.000000 4.761905 0.000000 0.000000 0.000000
0.000000
```

```
##    [106] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

##    [113] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

##    [120] 4.761905 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000

##    [127] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000

##    [134] 0.000000 4.761905 4.761905 0.000000 0.000000 0.000000
0.000000

##    [141] 0.000000 4.761905 0.000000 0.000000 0.000000 0.000000
0.000000

##    [148] 0.000000 0.000000 4.761905 0.000000 0.000000 0.000000
0.000000

##    [155] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
4.761905

##    [162] 0.000000 0.000000 0.000000 4.761905 0.000000 4.761905
4.761905

##    [169] 0.000000 4.761905 0.000000 0.000000 4.761905 0.000000
0.000000

##    [176] 4.761905 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

##    [183] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

##    [190] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

##    [197] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000

##    [204] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26419] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26426] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26433] 0.000000 0.000000 4.761905 0.000000 0.000000 4.761905
0.000000
```

```
## [26440] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
## [26447] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
## [26454] 0.000000 0.000000 0.000000 0.000000 4.761905 0.000000
0.000000
## [26461] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
## [26468] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
4.761905
## [26475] 0.000000 0.000000 4.761905 0.000000 0.000000 0.000000
0.000000
## [26482] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
## [26489] 4.761905 4.761905 0.000000 0.000000 0.000000 4.761905
0.000000
## [26496] 0.000000 4.761905 0.000000 0.000000 4.761905 0.000000
0.000000
## [26503] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
## [26510] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
## [26517] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
## [26524] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
## [26531] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
## [26538] 4.761905 0.000000 0.000000 4.761905 0.000000 0.000000
0.000000
## [26545] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000
## [26552] 0.000000 4.761905 0.000000 0.000000 0.000000 0.000000
0.000000
## [26559] 0.000000 0.000000 0.000000 0.000000 4.761905 0.000000
0.000000
```

```
## [26566] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26573] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26580] 0.000000 4.761905 0.000000 0.000000 0.000000 0.000000
0.000000

## [26587] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26594] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26601] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26608] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000

## [26615] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26622] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26629] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26636] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26643] 0.000000 0.000000 0.000000 4.761905 4.761905 0.000000
0.000000

## [26650] 0.000000 0.000000 0.000000 0.000000 4.761905 0.000000
0.000000

## [26657] 0.000000 0.000000 0.000000 4.761905 0.000000 0.000000
0.000000

## [26664] 4.761905 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26671] 0.000000 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000

## [26678] 9.523810 4.761905 0.000000 0.000000 4.761905 0.000000
4.761905

## [26685] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000
```

```
## [26692] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26699] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26706] 4.761905 0.000000 0.000000 0.000000 0.000000 4.761905
0.000000

## [26713] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26720] 0.000000 0.000000 0.000000 0.000000 4.761905 0.000000
0.000000

## [26727] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26734] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26741] 0.000000 0.000000 0.000000 4.761905 0.000000 4.761905
0.000000

## [26748] 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000

## [26755] 0.000000 0.000000 0.000000 0.000000 0.000000
```

```r
library(mice)
```

```
## Warning: package 'mice' was built under R version 3.5.1

## Loading required package: lattice

##

## Attaching package: 'mice'

## The following objects are masked from 'package:base':

##

##     cbind, rbind
```

```r
md.pattern(data)
```

```
##       MI_PRINX offense_id poss_time beat apt_office_prefix ap
t_office_num
## 23405        1          1         1    1                 1
1
```

```
## 3269             1         1        1    1                    1
1
## 75              1         1        1    1                    1
1
## 5               1         1        1    1                    1
1
## 3               1         1        1    1                    1
1
## 2               1         1        1    1                    1
1
##                 0         0        0    0                    0
0
##        location MinOfucr MinOfibr code dispo code Shift Avg.Da
y UC2.Literal
## 23405         1         1             1         1     1
1           1
## 3269          1         1             1         1     1
1           1
## 75            1         1             1         1     1
1           1
## 5             1         1             1         1     1
1           1
## 3             1         1             1         1     1
1           1
## 2             1         1             1         1     1
1           1
##               0         0             0         0     0
0           0
##        neighborhood npu x y occur_date rpt_date MaxOfnum_victi
ms loc_type
## 23405             1   1 1 1          1        1
1           1
## 3269              1   1 1 1          1        1
1           0
## 75                1   1 1 1          1        1
0           0
```

```
## 5                       1   1 1 1         1         0
1         1
## 3                       1   1 1 1         0         1
1         1
## 2                       1   1 1 1         0         0
1         1
##                         0   0 0 0         5         7
75      3344
##
## 23405     0
## 3269      1
## 75        2
## 5         1
## 3         1
## 2         2
##        3431
```

```r
library(VIM)
```

```
## Warning: package 'VIM' was built under R version 3.5.1
## Loading required package: colorspace
## Loading required package: grid
## Loading required package: data.table
## VIM is ready to use.
##  Since version 4.0.0 the GUI is in its own package VIMGUI.
##
##           Please use the package to use the new (and old) GUI
.
## Suggestions and bug-reports can be submitted at: https://gith
ub.com/alexkowa/VIM/issues
##
## Attaching package: 'VIM'
## The following object is masked from 'package:datasets':
##
```

```
##       sleep
```

```
aggr_plot <- aggr(data, col=c('navyblue','red'), numbers=TRUE, s
ortVars=TRUE, labels=names(data), cex.axis=.7, gap=3, ylab=c("Hi
stogram of missing data","Pattern"))
```

```
## Warning in plot.aggr(res, ...): not enough horizontal space t
o display
```

```
## frequencies
```

```
##
##  Variables sorted by number of missings:
##            Variable        Count
##             loc_type 0.1249673007
##    MaxOfnum_victims 0.0028027953
##             rpt_date 0.0002615942
##          occur_date 0.0001868530
##             MI_PRINX 0.0000000000
##           offense_id 0.0000000000
##            poss_time 0.0000000000
##                 beat 0.0000000000
##   apt_office_prefix 0.0000000000
##      apt_office_num 0.0000000000
##             location 0.0000000000
##             MinOfucr 0.0000000000
##        MinOfibr_code 0.0000000000
##           dispo_code 0.0000000000
##                Shift 0.0000000000
##              Avg.Day 0.0000000000
##          UC2.Literal 0.0000000000
##         neighborhood 0.0000000000
##                  npu 0.0000000000
```

```
##                         x 0.0000000000
##                         y 0.0000000000
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] 3.6966102 2.5742466 2.7391286 2.1355486 2.0897085 2.2097
172 2.5066403
##  [8] 1.3674533 1.2135926 2.3049017 1.5394682 2.4264711 2.3560
555 1.4429536
## [15] 1.9525326 2.8921570 2.8218232 2.0948454 2.9282604 1.6813
430 2.8007640
## [22] 2.4313354 2.7598386 2.5998863 3.1127215 2.0842223 1.5925
865 0.5778122
## [29] 2.3238416 1.2541749
apply(m, 2, function(x) length(x[x<0]))
## [1] 14  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] 0.5386839 1.9773260 4.7891772
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] -0.1154391  1.9773260  4.7891772
sapply(1:3, function(x, y) mean(y[,x]), y=m)
## [1] -0.1154391  1.9773260  4.7891772
library(tidyverse)
## -- Attaching packages ---------------------------------------
------ tidyverse 1.2.1 --
## v ggplot2 3.0.0      v purrr   0.2.5
## v tibble  1.4.2      v dplyr   0.7.6
## v tidyr   0.8.1      v stringr 1.3.1
## v readr   1.1.1      v forcats 0.3.0
## -- Conflicts ------------------------------------------------
tidyverse_conflicts() --
## x dplyr::between()   masks data.table::between()
## x tidyr::complete()  masks mice::complete()
## x dplyr::filter()    masks stats::filter()
## x dplyr::first()     masks data.table::first()
## x dplyr::lag()       masks stats::lag()
## x dplyr::last()      masks data.table::last()
## x purrr::transpose() masks data.table::transpose()
library(ggmap)
## Warning: package 'ggmap' was built under R version 3.5.1
library(readxl)
library(kableExtra)
```

```
## Warning: package 'kableExtra' was built under R version 3.5.1
```

```
library(knitr)
```

```
str(COBRA_YTD2017)
```

```
## 'data.frame':    26759 obs. of  23 variables:
##  $ MI_PRINX        : int  8924155 8924156 8924157 8924158 89
24159 8924160 8924161 8924162 8924163 8924164 ...
##  $ offense_id      : num  1.74e+08 1.74e+08 1.74e+08 1.74e+0
8 1.74e+08 ...
##  $ rpt_date        : Factor w/ 365 levels "1/1/2017","1/10/2
017",..: 117 117 117 117 117 117 117 117 117 117 ...
##  $ occur_date      : Factor w/ 471 levels "1/1/2008","1/1/20
15",..: 174 145 174 174 176 174 176 176 174 176 ...
##  $ occur time      : Factor w/ 1355 levels "","0:00:00","0:0
1:00",..: 955 290 883 763 43 940 112 2 2 2 ...
##  $ poss date       : Factor w/ 412 levels "1/1/2015","1/1/20
17",..: 147 145 147 147 147 147 147 147 147 147 ...
##  $ poss_time       : Factor w/ 1434 levels "","0:00:00","0:0
1:00",..: 32 902 62 68 50 88 121 722 1024 1056 ...
##  $ beat            : int  510 501 303 507 409 612 605 603 60
5 304 ...
##  $ apt_office_prefix: Factor w/ 88 levels "","#8","1","10",..
: 1 1 1 1 1 1 1 1 1 1 ...
##  $ apt_office_num  : Factor w/ 2044 levels "","#5","]","`",.
.: 1 1 1 1 1 1 213 1 1 1372 ...
##  $ location        : Factor w/ 13865 levels ": 565 Main St N
E",..: 9394 1133 10955 7860 5557 1525 8250 9706 9456 455 ...
##  $ MinOfucr        : int  640 640 640 640 640 650 311 640 64
0 531 ...
##  $ MinOfibr_code   : Factor w/ 68 levels "","1101","1101A",.
.: 51 51 51 51 51 50 30 51 51 42 ...
##  $ dispo_code      : Factor w/ 8 levels "","10","20","30",..
: 1 1 1 1 1 1 1 1 1 1 ...
##  $ MaxOfnum_victims : int  2 1 1 1 2 1 1 1 1 1 ...
##  $ Shift           : Factor w/ 4 levels "Day","Eve","Morn",.
.: 3 4 3 2 3 3 3 3 4 3 ...
```

```
##  $ Avg.Day        : Factor w/ 8 levels "Fri","Mon","Sat",..
: 3 7 3 3 4 4 4 4 3 4 ...
##  $ loc_type       : int  13 13 18 18 18 18 26 18 13 26 ...
##  $ UC2.Literal    : Factor w/ 11 levels "AGG ASSAULT",..: 6
6 6 6 6 6 10 6 6 4 ...
##  $ neighborhood   : Factor w/ 239 levels "","Adair Park",..
: 80 117 145 64 3 83 103 164 103 175 ...
##  $ npu            : Factor w/ 26 levels "","A","B","C",..:
14 6 22 14 19 23 23 14 23 22 ...
##  $ x              : num  -84.4 -84.4 -84.4 -84.4 -84.5 ...
##  $ y              : num  33.8 33.8 33.7 33.8 33.7 ...
```

```
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.fac
tor()


COBRA_YTD2017$days <- COBRA_YTD2017$Avg.Day %>%
  as.factor()
kable(count(COBRA_YTD2017, loc_type, sort=TRUE), "html", col.nam
es=c("Crime Type", "Frequency")) %>%
kable_styling(bootstrap_options="striped", full_width=FALSE)
```

Crime Type	Frequency
LARCENY-FROM VEHICLE	9840
LARCENY-NON VEHICLE	6589

Crime Type	Frequency
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

```r
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 = "late
x",
##                 listings = "latex", sweave = "latex", html =
"html",
##                 markdown = "markdown", rst = "rst", stop("tab
le format not implemented yet!"))
##         else if (isTRUE(opts_knit$get("kable.force.latex")) &
&
##             is_latex_output()) {
##             "latex"
##         }
##         else "pandoc"
##     if (is.function(format))
##         format = format()
##     if (format != "latex" && !missing(align) && length(align)
==
##         1L)
##         align = strsplit(align, "")[[1]]
##     if (!is.null(caption) && !is.na(caption))
##         caption = paste0(create label("tab:", opts current$ge
t("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: 0x0000000024a52558>
## <environment: namespace:knitr>
```

```
#The data provides crime type frequency and crime by day of the week.#Among the high crime categories, larceny tend to increase on Fridays and Saturdays. while burglary residence generally occurred more often during the weekdays than the weekends. Auto theft were least reported on Thursdays and increase for the weekends.

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

```
## Map from URL : http://maps.googleapis.com/maps/api/staticmap?
center=atlanta&zoom=12&size=640x640&scale=2&maptype=terrain&sens
or=false

## Information from URL : http://maps.googleapis.com/maps/api/ge
ocode/json?address=atlanta&sensor=false

## Map from URL : http://tile.stamen.com/toner/12/1086/1638.png

## Map from URL : http://tile.stamen.com/toner/12/1087/1638.png

## Map from URL : http://tile.stamen.com/toner/12/1088/1638.png

## Map from URL : http://tile.stamen.com/toner/12/1089/1638.png

## Map from URL : http://tile.stamen.com/toner/12/1086/1639.png

## Map from URL : http://tile.stamen.com/toner/12/1087/1639.png

## Map from URL : http://tile.stamen.com/toner/12/1088/1639.png

## Map from URL : http://tile.stamen.com/toner/12/1089/1639.png

## Map from URL : http://tile.stamen.com/toner/12/1086/1640.png

## Map from URL : http://tile.stamen.com/toner/12/1087/1640.png

## Map from URL : http://tile.stamen.com/toner/12/1088/1640.png

## Map from URL : http://tile.stamen.com/toner/12/1089/1640.png

## Warning: `panel.margin` is deprecated. Please use `panel.spac
ing` property

## instead

atlanta_map

## Theme element panel.border missing

## Theme element axis.line.x.bottom missing

## Theme element axis.ticks.x.bottom missing

## Theme element axis.line.x.top missing

## Theme element axis.ticks.x.top missing

## Theme element axis.line.y.left missing

## Theme element axis.ticks.y.left missing

## Theme element axis.line.y.right missing

## Theme element axis.ticks.y.right missing

## Theme element plot.title missing
```

```
## Theme element plot.subtitle missing

## Theme element plot.tag missing

## Theme element plot.caption missing
```

```
library(dplyr)

library(data.table)

library(ggplot2)

at <- COBRA_YTD2017

str(at)
```
```
## 'data.frame':    26759 obs. of  26 variables:
##  $ MI PRINX        : int  8924155 8924156 8924157 8924158 89
24159 8924160 8924161 8924162 8924163 8924164 ...
##  $ offense_id      : num  1.74e+08 1.74e+08 1.74e+08 1.74e+0
8 1.74e+08 ...
##  $ rpt_date        : Factor w/ 365 levels "1/1/2017","1/10/2
017",..: 117 117 117 117 117 117 117 117 117 117 ...
##  $ occur_date      : Factor w/ 471 levels "1/1/2008","1/1/20
15",..: 174 145 174 174 176 174 176 176 174 176 ...
##  $ occur_time      : Factor w/ 1355 levels "","0:00:00","0:0
1:00",..: 955 290 883 763 43 940 112 2 2 2 ...
##  $ poss_date       : Factor w/ 412 levels "1/1/2015","1/1/20
17",..: 147 145 147 147 147 147 147 147 147 147 ...
##  $ poss_time       : Factor w/ 1434 levels "","0:00:00","0:0
1:00",..: 32 902 62 68 50 88 121 722 1024 1056 ...
##  $ beat            : int  510 501 303 507 409 612 605 603 60
5 304 ...
##  $ apt_office_prefix: Factor w/ 88 levels "","#8","1","10",..
: 1 1 1 1 1 1 1 1 1 1 ...
##  $ apt office num   : Factor w/ 2044 levels "","#5","]","`",.
.: 1 1 1 1 1 1 213 1 1 1372 ...
##  $ location         : Factor w/ 13865 levels ": 565 Main St N
E",..: 9394 1133 10955 7860 5557 1525 8250 9706 9456 455 ...
```

```
##  $ MinOfucr        : int  640 640 640 640 640 650 311 640 64
0 531 ...

##  $ MinOfibr_code   : Factor w/ 68 levels "","1101","1101A",.
.: 51 51 51 51 51 50 30 51 51 42 ...

##  $ dispo_code      : Factor w/ 8 levels "","10","20","30",..
: 1 1 1 1 1 1 1 1 1 1 ...

##  $ MaxOfnum_victims : int  2 1 1 1 2 1 1 1 1 1 ...

##  $ Shift           : Factor w/ 4 levels "Day","Eve","Morn",.
.: 3 4 3 2 3 3 3 3 4 3 ...

##  $ Avg.Day         : Factor w/ 8 levels "Fri","Mon","Sat",..
: 3 7 3 3 4 4 4 4 3 4 ...

##  $ loc_type        : Factor w/ 11 levels "AGG ASSAULT",..: 6
6 6 6 6 6 10 6 6 4 ...

##  $ UC2.Literal     : Factor w/ 11 levels "AGG ASSAULT",..: 6
6 6 6 6 6 10 6 6 4 ...

##  $ neighborhood    : Factor w/ 239 levels "","Adair Park",..
: 80 117 145 64 3 83 103 164 103 175 ...

##  $ npu             : Factor w/ 26 levels "","A","B","C",..:
14 6 22 14 19 23 23 14 23 22 ...

##  $ 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 ...
```

```r
at$MI_PRINX <- at$apt_office_prefix <- at$apt_office_num <- at$l
ocation <- at$dispo_code <- at$loc_type <- at$npu <- NULL

library(chron)

library(lubridate)
```

```
##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:chron':

##

##     days, hours, minutes, seconds, years
```

```
## The following objects are masked from 'package:data.table':
##
##      hour, isoweek, mday, minute, month, quarter, second, wday
,
##      week, yday, year
## The following object is masked from 'package:base':
##
##      date
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)
## Loading required package: zoo
##
## Attaching package: 'zoo'
## The following objects are masked from 'package:base':
##
##      as.Date, as.Date.numeric
##
## Attaching package: 'xts'
## The following objects are masked from 'package:dplyr':
##
##      first, last
## The following objects are masked from 'package:data.table':
##
```

```
##      first, last

by_Date <- na.omit(at) %>% group_by(occur_date) %>% summarise(To
tal = n())

tseries <- xts(by_Date$Total, order.by= by_Date$occur_date)

library(highcharter)

## Warning: package 'highcharter' was built under R version 3.5.
1

## Highcharts (www.highcharts.com) is a Highsoft software produc
t which is

## not free for commercial and Governmental use

hchart(tseries, name = "Crimes") %>%

  hc_add_theme(hc_theme_darkunica()) %>%

  hc_credits(enabled = TRUE, text = "Sources: Atlanta Police Dep
artment", style = list(fontSize = "12px")) %>%

  hc_title(text = "Time Series of Atlanta Crimes") %>%

  hc_legend(enabled = TRUE)
```

Zoom1m3m6mYTD1yAllFromDec 30, 1916ToDec 31, 2017Time Series of Atlanta
CrimesCrimes20162016025507510012 5Sources: Atlanta Police Department

```
hchart

## function (object, ...)

## {

##      UseMethod("hchart")

## }

## <bytecode: 0x0000000021bb6d30>

## <environment: namespace:highcharter>

#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, col
or='white', fill='black') +

    ggtitle('Histogram of Crime Time')
## Warning: Removed 11 rows containing non-finite values (stat_b
in).
```

```
#The crime time distribution appears bimodal with peaki
ng around midnight and again at the noon, then again be
tween 6pm and 8pm.
#topCrimes_1 <- topCrimes %>% 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 whe
re crimes take place, followed by Old Fourth Ward and W
est End.
topLocations <- subset(at, neighborhood =="Downtown"|neighborhoo
d =="Midtown" | neighborhood=="Old Fourth Ward" | neighborhood==
"West End" | neighborhood=="Vine City" | neighborhood=="North Bu
ckhead")

topLocations <- within(topLocations,  neighborhood <- factor(nei
ghborhood, 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(t
itle = "Neighborhood")) + theme(axis.text.x = element_text(angle
= 45, hjust = 1))
```

```
#among the high crime categories, larceny tend to incre
ase on Fridays and Saturdays. while burglary residence
generally occurred more often during the weekdays than
the weekends. Auto theft were least reported on Thursda
ys and increase for the weekends.
```

Plots and graphs are attached in the HTML document attached along with the session 13
Assignment```

Visualize the correlation between all variables in a meaningful and clear way of representing. Find out top 3 reasons for having more crime in a city.

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

Top Crime Neighborhood by Days

Crime by Day of the Week

Histogram of missing data

Pattern

loc_type
rpt_date
occur_date
MI_PRINX
offense_id
poss_time
beat
apt_office_num
location
MinOfucr
MinOfibr_code
dispo_code
Shift
Avg.Day
UC2.Literal
neighborhood
npu
x
y

MI_ Offenses appoaffic effire fMiriOtfispcocdolarg Daygtenahpud x oy cMap3latehc type s

23405 — 0
3269 — 1
75 — 2
5 — 1
3 — 1
2 — 2

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 7 75334431
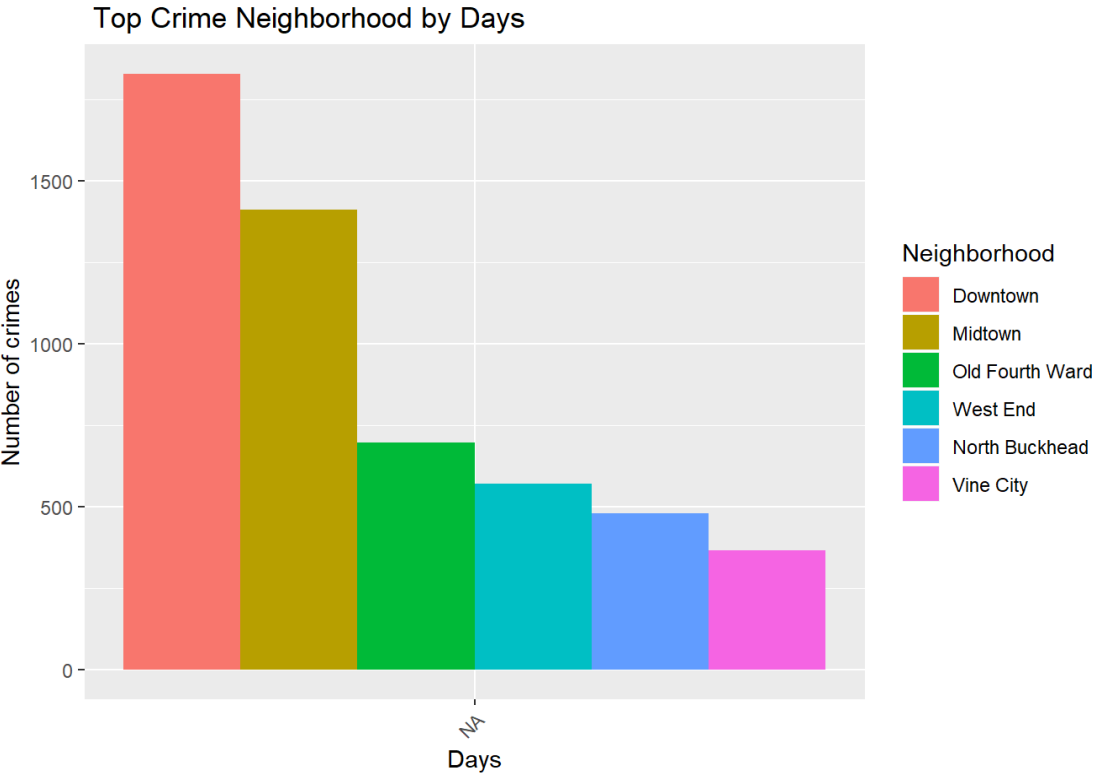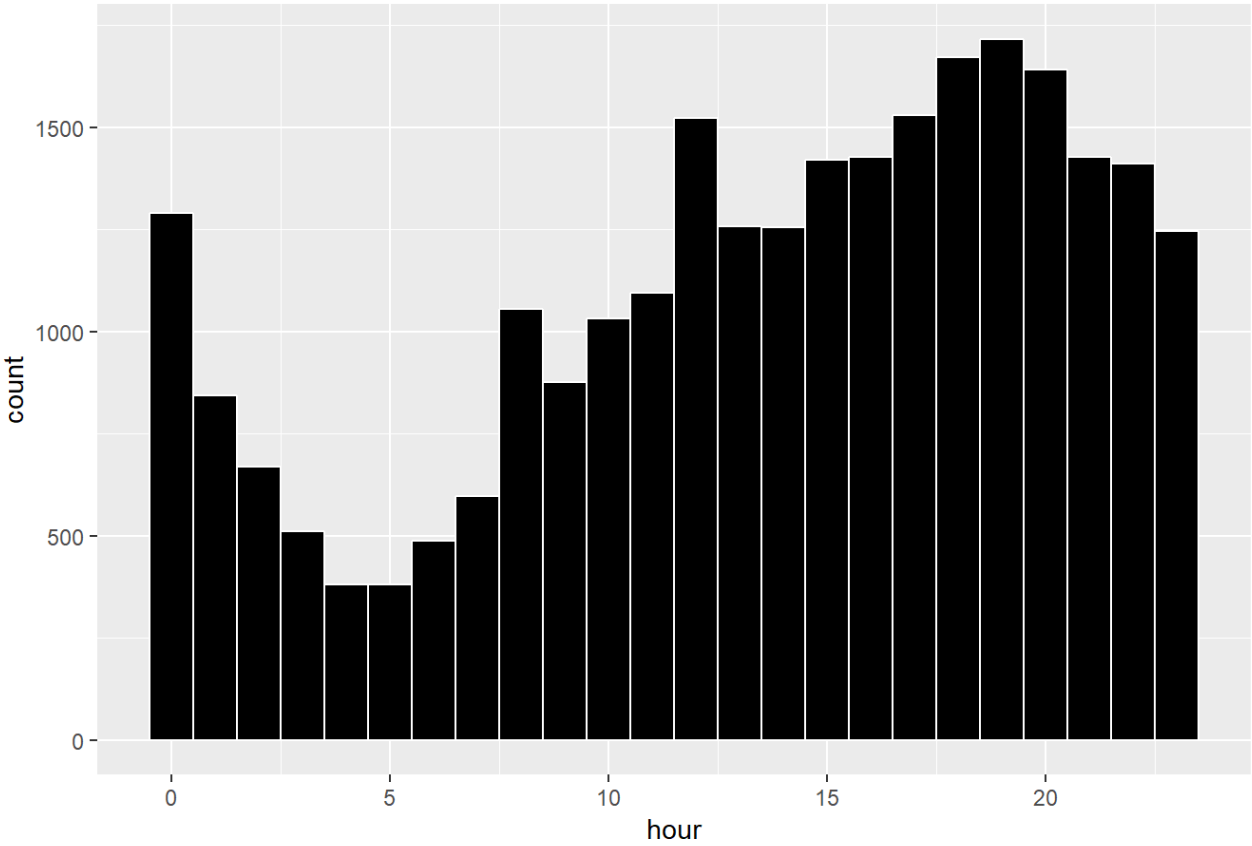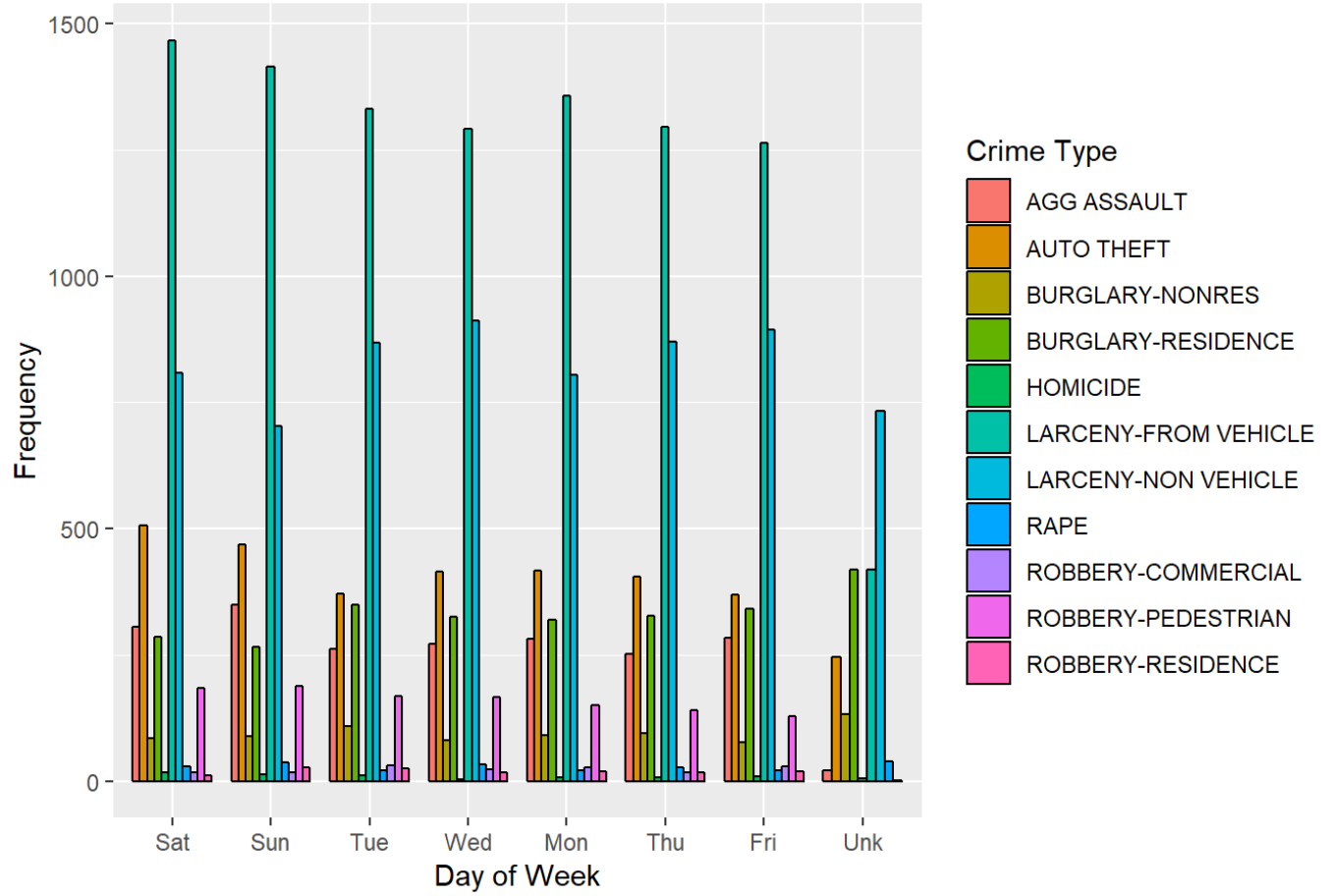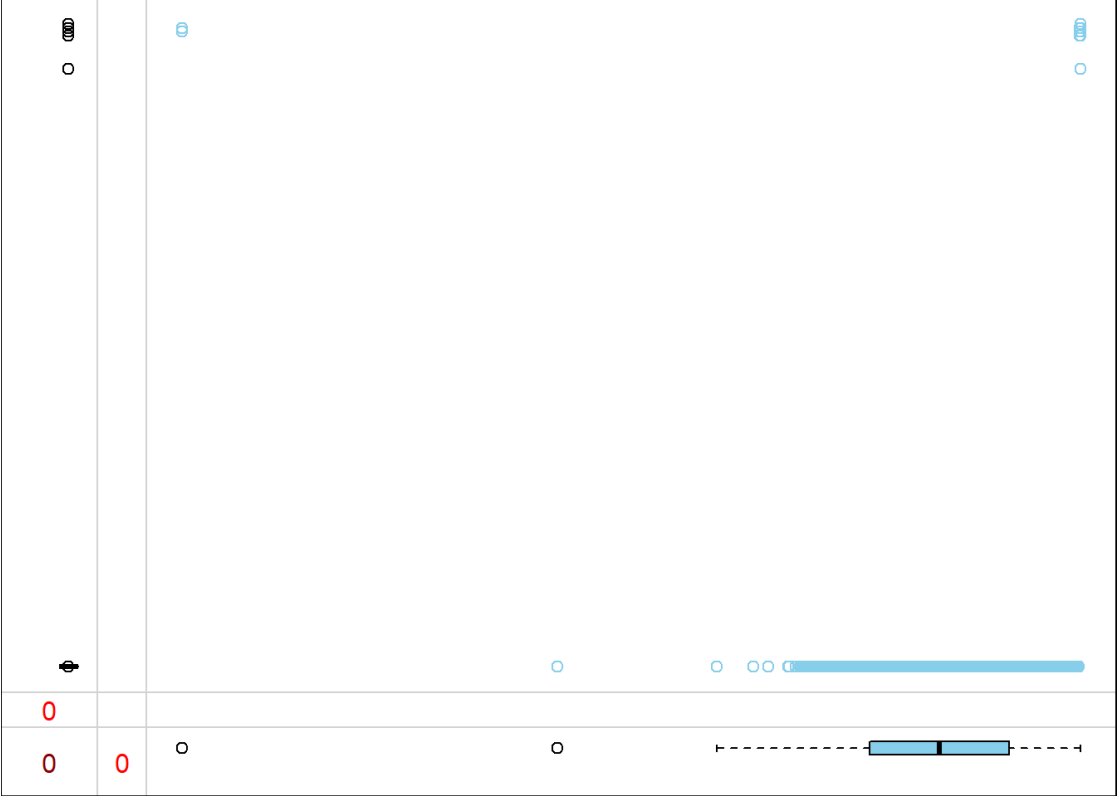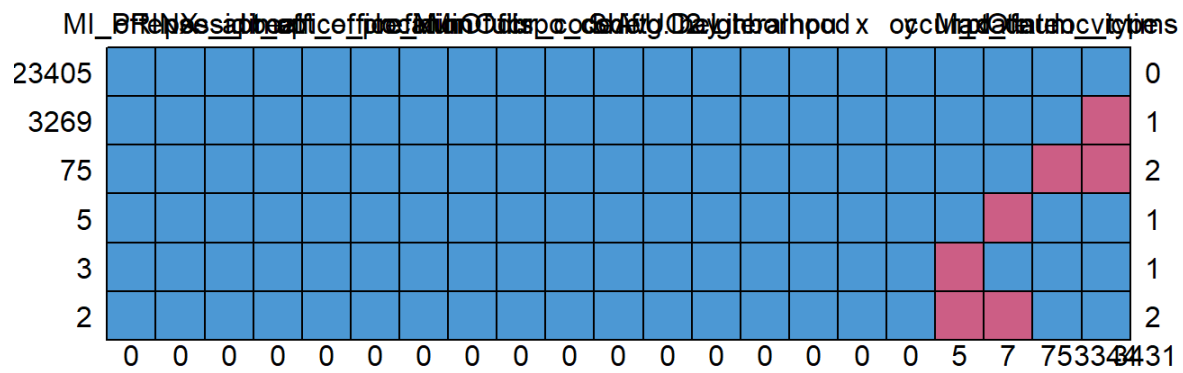
Crime Type	Frequency
LARCENY-FROM VEHICLE	9840
LARCENY-NON VEHICLE	6589
AUTO THEFT	3197
BURGLARY-RESIDENCE	2635
AGG ASSAULT	2024
ROBBERY-PEDESTRIAN	1126
BURGLARY-NONRES	758
RAPE	226
ROBBERY-COMMERCIAL	157

graph6.svg

TIME SERIES OF ATLANTA CRIMES

What is the difference between co-variance 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. On the other hand, covariance is when two items vary together. Read the given article to know the differences between covariance and correlation.

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

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.*

Take an example from this dataset and show the differences if any?

#Correlation & covariance

#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')
```

```
[1] -0.9998355
[1] -23.86342

        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

[1] -0.9998355

        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


[1] -23.86342


        156          157          158          159          160
-84.42579683 -84.51468279 -84.35395817 -84.32176325 -84.62601522
        161          162          163          164          165
-84.24112598 -84.34355981 -84.61686666 -84.52210662 -84.55457650
        166          167          168          169          170
-84.41107415 -84.52540610 -84.43749498 -84.36698111 -84.53340484
        171          172          173          174          175
-84.31936363 -84.41764811 -84.43677009 -84.36185692 -84.47736369
        176          177          178          179          180
-84.42814646 -84.39302700 -84.11039662 -84.14436626 -84.41507352
        181          182          183          184          185
-84.41789807 -84.39345193 -84.35360822 -84.39540163 -84.39000248
        186          187          188          189          190
-84.31583919 -84.30746551 -84.54732764 -84.49833538 -84.40007589
        191          192          193          194          195
-84.57079894 -84.27072131 -84.38625307 -84.52508115 -84.29791702
        196          197          198          199          200
-84.38047898 -84.51438284 -84.19998248 -84.40202558 -84.27777020
        201          202          203          204          205
-84.52418130 -84.35438310 -84.42687166 -84.39625149 -84.38500327
        206          207          208          209          210
 -0.02197167 -84.47451414 -84.48048819 -84.41507352 -84.29656723
        211          212          213          214          215
-84.37737947 -84.39345193 -84.40407526 -84.39315198 -84.21048082
        216          217          218          219          220
-84.29579235 -84.40952440 -84.43936968 -84.35825749 -84.35383319
        221          222          223          224          225
-84.53747920 -84.53502958 -84.62551530 -84.39052740 -84.49731054
        226          227          228          229          230
-84.42054766 -84.63816330 -84.53415472 -84.39392686 -84.41342378
        231          232          233          234          235
-84.49196138 -84.43989460 -84.21553002 -84.40719976 -84.51833222
        236          237          238          239          240
-84.41532348 -84.31583919 -84.46421576 -84.35043372 -84.41179904
        241          242          243          244          245
-84.38017903 -84.26067290 -84.41802305 -84.40050082 -84.41952282
        246          247          248          249          250
-84.23052765 -84.47738868 -84.49191139 -84.48818698 -84.21835458
        251          252          253          254          255
-84.38622807 -84.55887582 -84.60241894 -84.32358796 -84.28719371
        256          257          258          259          260
-84.27984487 -84.54230343 -84.32371294 -84.39055239 -84.41917287
        261          262          263          264          265
-84.39442678 -84.45599206 -84.38162880 -84.65446073 -84.55635122
        266          267          268          269          270
-84.20898106 -84.60816804 -84.45214267 -84.30629069 -84.36395659
        271          272          273          274          275
-84.30826538 -84.54475305 -84.39625149 -84.56537479 -84.35955728
        276          277          278          279          280
-84.31356455 -84.41579841 -84.46339089 -84.23057765 -84.28134463
```

281	282	283	284	285
-84.18293517	-84.19333353	-84.27127122	-84.42034769	-84.39312698
286	287	288	289	290
-84.44826828	-84.51308305	-84.41889792	-84.56869927	-84.32543767
291	292	293	294	295
-84.34570947	-84.29084313	-84.63991302	-84.45231764	-84.34728422
296	297	298	299	300
-84.40375031	-84.46004142	-84.44054450	-84.41414867	-84.32133832
301	302	303	304	305
-84.21700479	-84.62551530	-84.50588418	-84.35433311	-84.41237395
306	307	308	309	310
-84.41452361	-84.25629859	-84.68728055	-84.15311488	-84.42184745
311	312	313	314	315
-84.26084787	-84.29046819	-84.62551530	-84.64116283	-84.51833222
316	317	318	319	320
-84.35440810	-84.18495985	-84.39165222	-84.40517508	-84.34943388
321	322	323	324	325
-84.38160380	-84.27779519	-84.21553002	-84.22970278	-84.40215056
326	327	328	329	330
-84.68663065	-84.22970278	-84.22560343	-84.54260339	-84.48048819
331	332	333	334	335
-84.40395028	-84.32476278	-84.31073999	-84.38280361	-84.57717293
336	337	338	339	340
-84.63108942	-84.45221766	-84.43951966	-84.51833222	-84.46486566
341	342	343	344	345
-84.48978673	-84.38730290	-84.43127096	-84.41257391	-84.41969779
346	347	348	349	350
-84.44914314	-84.41184903	-84.53003037	-84.33776073	-84.40410025
351	352	353	354	355
-84.55367664	-84.55750104	-84.48253787	-84.68920524	-84.56992407
356	357	358	359	360
-84.44214425	-84.56907421	-84.31683903	-84.36780598	-84.48018824
361	362	363	364	365
-84.41479856	-84.25817329	-84.44739342	-84.49701058	-84.35080867
366	367	368	369	370
-84.59796965	-84.49233632	-84.28214451	-84.62551530	-84.17831090
371	372	373	374	375
-84.51833222	-84.40050082	-84.52305647	-84.41404868	-84.26879661
376	377	378	379	380
-84.40050082	-84.31738894	-84.62551530	-84.40337537	-84.41784808
381	382	383	384	385
-84.51183324	-84.61924129	-84.39072736	-84.59854456	-84.45254260
386	387	388	389	390
-84.44069448	-84.39145225	-84.24954965	-84.37987908	-84.57672300
391	392	393	394	395
-84.44284414	-84.26667195	-84.40262549	-84.63016456	-84.43989460
396	397	398	399	400
-84.36748103	-84.62066606	-84.70332801	-84.31468937	-84.55627623
401	402	403	404	405
-84.44179430	-84.41449861	-84.46544057	-84.38017903	-84.44494380
406	407	408	409	410
-84.49191139	-84.46079130	-84.42114756	-84.44831827	-84.36680614
411	412	413	414	415
-84.41889792	-84.55887582	-84.23717660	-84.32443783	-84.16458806
416	417	418	419	420
-84.39820118	-84.34548451	-84.46381583	-84.39162722	-84.46171616
421	422	423	424	425

```
-84.40977436 -84.33368637 -84.46506563 -84.21700479 -84.53875399
         426          427          428          429          430
-84.31786387 -84.38760286 -84.39100232 -84.42057265 -84.36668116
         431          432          433          434          435
-84.40322539 -84.38347851 -84.27612046 -84.47823855 -84.39622650
         436          437          438          439          440
-84.28366926 -84.10247287 -84.61531691 -84.56557476 -84.29739210
         441          442          443          444          445
-84.27817013 -84.37747946 -84.45769179 -84.40487513 -84.47823855
         446          447          448          449          450
-84.57097391 -84.45919156 -84.18293517 -84.45176773 -84.44466885
         451          452          453          454          455
-84.45334248 -84.55597628 -84.42512193 -84.54177852 -84.39942599
         456          457          458          459          460
-84.37173036 -84.19158380 -84.43314567 -84.39625149 -84.14796569
         461          462          463          464          465
-84.44536874 -84.35265837 -84.49811041 -84.51833222 -84.55877583
         466          467          468          469          470
-84.41917287 -84.59886950 -84.56869927 -84.34913393 -84.22050424
         471          472          473          474          475
-84.39477672 -84.61839142 -84.31231474 -84.62551530 -84.40217556
         476          477          478          479          480
-84.43032111 -84.43841983 -84.53642936 -84.56869927 -84.53775415
         481          482          483          484          485
-84.53357981 -84.35998222 -84.42507194 -84.60919287 -84.25712346
         486          487          488          489          490
-84.39170221 -84.50133490 -84.39032743 -84.64116283 -84.49068658
         491          492          493          494          495
-84.37837931 -84.64983646 -84.43117098 -84.43514535 -84.57097391
         496          497          498          499          500
 -0.02197167 -84.38667800 -84.42582182 -84.38737789 -84.18293517
         501          502          503          504          505
-84.29589234 -84.29046819 -84.28134463 -84.36815593 -84.53457965
         506          507          508          509          510
-84.42189744 -84.30731553 -84.42314725 -84.19020902 -84.38095391
         511          512          513          514          515
-84.40634990 -84.38935258 -84.31528927 -84.35443309 -84.42132253
         516          517          518          519          520
-84.37710451 -84.40357534 -84.41854797 -84.23755155 -84.35443309
         521          522          523          524          525
-84.44256918 -84.27944493 -84.52678088 -84.43289571 -84.38900264
         526          527          528          529          530
-84.48018824 -84.30391607 -84.42814646 -84.33518613 -84.68013168
         531          532          533          534          535
-84.41644830 -84.34403474 -84.40050082 -84.39625149 -84.55427654
         536          537          538          539          540
-84.62536532 -84.35443309 -84.23450203 -84.48341273 -84.39345193
         541          542          543          544          545
-84.62551530 -84.54485303 -84.53080525 -84.62751498 -84.35295833
         546          547          548          549          550
-84.41754813 -84.51833222 -84.41739815 -84.46331590 -84.62579025
         551          552          553          554          555
-84.36568132 -84.54340326 -84.41439863 -84.15229001 -84.14786570
         556          557          558          559          560
-84.40050082 -84.40050082 -84.26562211 -84.63816330 -84.22560343
         561          562          563          564          565
-84.35998222 -84.15881398 -84.48253787 -84.70070343 -84.40050082
```

```
        566              567              568              569              570
-84.41832301 -84.38107889 -84.41384871 -84.63991302 -84.47026481
        571              572              573              574              575
-84.48346272 -84.45249261 -84.21553002 -84.45889160 -84.41917287
        576              577              578              579              580
-84.47493907 -84.62551530 -84.61839142 -84.25734842 -84.45889160
        581              582              583              584              585
-84.35118361 -84.39640147 -84.60261891              990
-84.43074605 -84.63256418 -84.45636700 -84.52885556 -84.11329616
        991              992              993              994              995
-84.41797306 -84.54272837 -84.56177536 -84.63261418 -84.38785282
        996              997              998              999             1000
-84.39625149 -84.36688113 -84.44059449 -84.45641699 -84.17181192
 [ reached get Option("max.print") -- omitted 25759 entries ]


lag Autocorrelation D-W Statistic p-value
   1       0.02809992        1.943799            0
 Alternative hypothesis: rho != 0
```
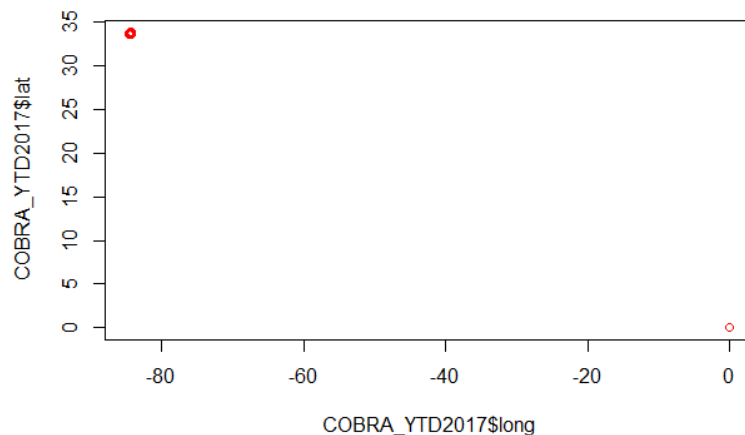

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed             dist
##  Min.   : 4.0   Min.   :  2.00
##  1st Qu.:12.0   1st Qu.: 26.00
##  Median :15.0   Median : 36.00
##  Mean   :15.4   Mean   : 42.98
##  3rd Qu.:19.0   3rd Qu.: 56.00
##  Max.   :25.0   Max.   :120.00
```

Including Plots

You can also embed plots, for example:

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.