SESSION 12 – ASSIGNMENT 12.1
GENERALIZED LINEAR MODELS

Date: 11th Feb 2019

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

Note: As the dataset provided at the above link was incomplete i.e. headers were missing, So I Have used Crimes data of Atlanta till 2017

```
library(readr)
library(data.table)

COBRA.YTD2017 <- read_csv("G:/DATA ANALYTICS/DATA/crime-in-atlanta-2017/COBRA-YTD2017.csv")

View(COBRA.YTD2017)
str(COBRA.YTD2017)
summary(COBRA.YTD2017)
sum(is.na(COBRA.YTD2017))

# finding the missing values
library(VIM)
missingvalue_plot <- aggr(COBRA.YTD2017, col=c('navyblue','red'), numbers=TRUE, sortVars=TRUE, labels=names(COBRA.YTD2017), cex.axis=.7, gap=3, ylab=c("Histogram of missing data","Pattern"))

COBRA_YTD<-COBRA.YTD2017[complete.cases(COBRA.YTD2017), ]

missingvalue_plot <- aggr(COBRA_YTD, col=c('green','yellow'), numbers=TRUE, sortVars=TRUE, labels=names(COBRA_YTD), cex.axis=.7, gap=3, ylab=c("Histogram of missing data","Pattern"))
```

```
> library(readr)
> library(data.table)
data.table 1.11.8  Latest news: r-datatable.com
> 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.
```

Filter

	MI_PRINX	offense_id	rpt_date	occur_date	occur_time	poss_date	poss_time	beat	apt_office_prefix	apt_office_num	location	MinOfucr	MinOfib
1	8924155	173650072	12/31/2017	12/30/2017	23:15:00	12/31/2017	00:30:00	510	NA	NA	43 JESSE HILL JR DR NE	0640	2305
2	8924156	173650102	12/31/2017	12/18/2017	13:00:00	12/30/2017	22:00:00	501	NA	NA	1169 ATLANTIC DR NW	0640	2305
3	8924157	173650144	12/31/2017	12/30/2017	22:01:00	12/31/2017	01:00:00	303	NA	NA	633 PRYOR ST SW	0640	2305
4	8924158	173650149	12/31/2017	12/30/2017	20:00:00	12/31/2017	01:06:00	507	NA	NA	333 NELSON ST SW	0640	2305
5	8924159	173650159	12/31/2017	12/31/2017	00:41:00	12/31/2017	00:48:00	409	NA	NA	2348 CASCADE RD SW	0640	2305
6	8924160	173650180	12/31/2017	12/30/2017	23:00:00	12/31/2017	01:26:00	612	NA	NA	1245 GLENWOOD AVE SE	0650	2304
7	8924161	173650236	12/31/2017	12/31/2017	01:55:00	12/31/2017	01:59:00	605	NA	13	351 CHEROKEE AVE SE	0311	1212
8	8924162	173650241	12/31/2017	12/31/2017	00:00:00	12/31/2017	02:00:00	603	NA	NA	461 PONCE DE LEON AVE NE	0640	2305
9	8924163	173650295	12/31/2017	12/30/2017	00:00:00	12/31/2017	03:02:00	605	NA	NA	437 MEMORIAL DR SE	0640	2305
10	8924164	173650389	12/31/2017	12/31/2017	00:00:00	12/31/2017	03:34:00	304	NA	8	1053 LINAM ST SE	0531	2202A
11	8924165	173650449	12/31/2017	12/31/2017	00:40:00	12/31/2017	04:10:00	303	NA	NA	683 PRYOR ST SW	0710	2404
12	8924166	173650562	12/31/2017	12/31/2017	00:00:00	12/31/2017	05:53:00	104	NA	NA	192 CHICAMAUGA AVE SW	0640	2305

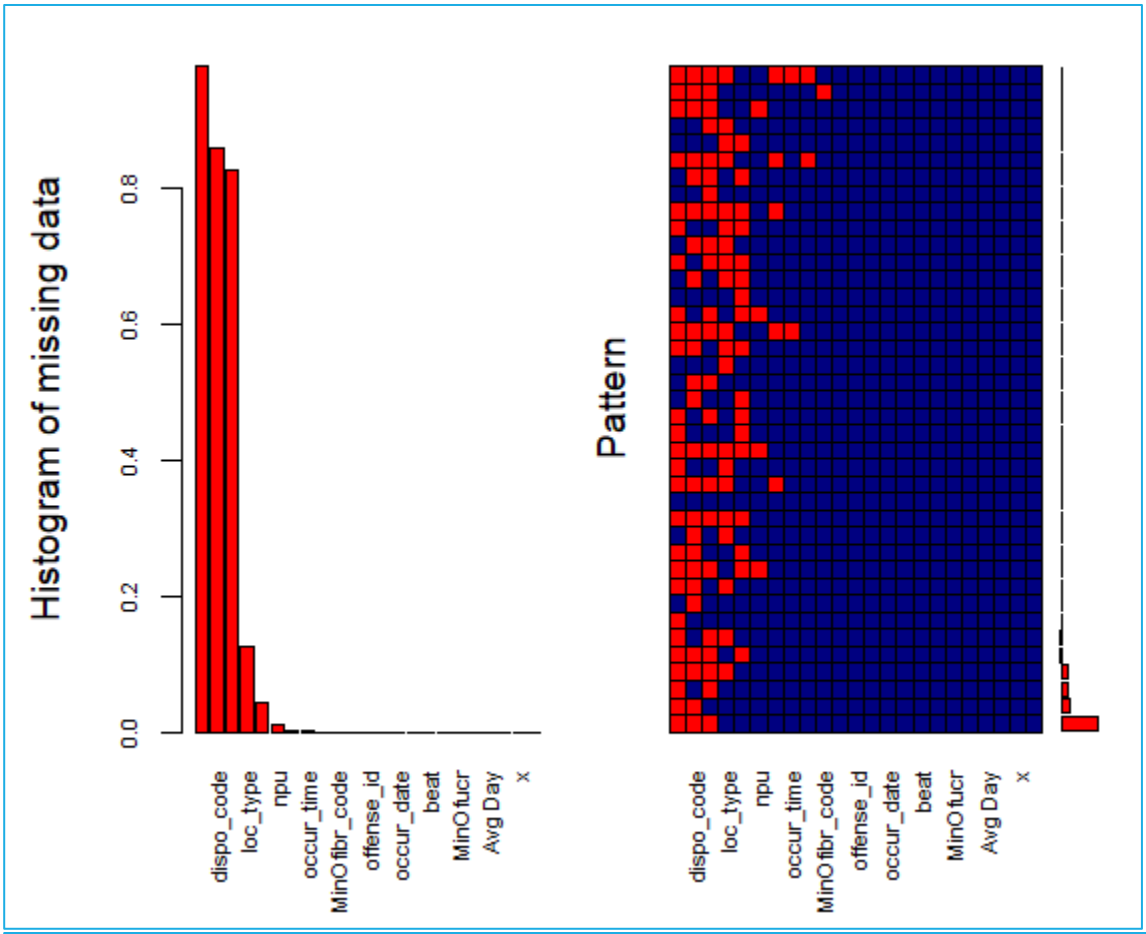
```
> str(COBRA.YTD2017)
Classes 'spec_tbl_df', 'tbl_df', 'tbl' and 'data.frame':        26759 obs. of  23 variables:
 $ MI_PRINX          : num  8924155 8924156 8924157 8924158 8924159 ...
 $ offense_id        : num  1.74e+08 1.74e+08 1.74e+08 1.74e+08 1.74e+08 ...
 $ rpt_date          : chr  "12/31/2017" "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          : num  13 13 18 18 18 18 26 18 13 26 ...
 $ 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 ...
 - 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/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()
  .. )
```

```
> summary(COBRA.YTD2017)
    MI_PRINX         offense_id          rpt_date          occur_date        occur_time       poss_date          poss_time            beat
 Min.   :8838438   Min.   :1.608e+08   Length:26759       Length:26759       Length:26759      Length:26759       Length:26759      Min.   :101.0
 1st Qu.:8904204   1st Qu.:1.711e+08   Class :character   Class :character   Class1:hms        Class :character   Class1:hms        1st Qu.:208.0
 Median :8910894   Median :1.720e+08   Mode  :character   Mode  :character   Class2:difftime   Mode  :character   Class2:difftime   Median :312.0
 Mean   :8910851   Mean   :6.523e+08                                         Mode  :numeric                       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

 apt_office_prefix  apt_office_num       location           MinOfucr         MinOfibr_code        dispo_code    MaxOfnum_victims     Shift
 Length:26759       Length:26759       Length:26759       Length:26759       Length:26759       Min.   :10.00   Min.   : 0.00    Length:26759
 Class :character   Class :character   Class :character   Class :character   Class :character   1st Qu.:10.00   1st Qu.: 1.00    Class :character
 Mode  :character   Mode  :character   Mode  :character   Mode  :character   Mode  :character   Median :10.00   Median : 1.00    Mode  :character
                                                                              Mean   :13.32   Mean   : 1.16
                                                                              3rd Qu.:10.00   3rd Qu.: 1.00
                                                                              Max.   :60.00   Max.   :27.00
                                                                              NA's   :22968   NA's   :75

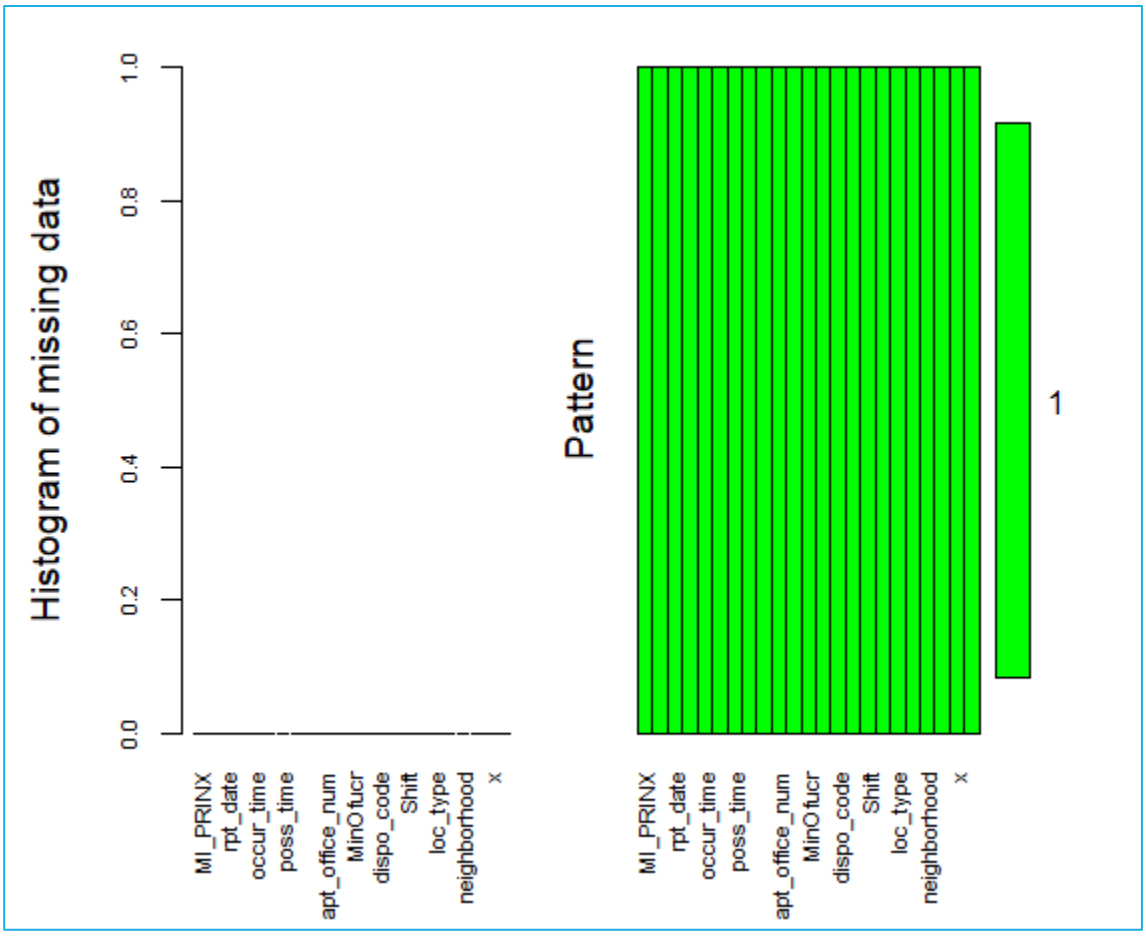
   Avg Day            loc_type      UC2 Literal        neighborhood          npu                  x                y
 Length:26759       Min.   : 1.00   Length:26759       Length:26759       Length:26759       Min.   :-84.55   Min.   : 0.00
 Class :character   1st Qu.:13.00   Class :character   Class :character   Class :character   1st Qu.:-84.43   1st Qu.:33.73
 Mode  :character   Median :18.00   Mode  :character   Mode  :character   Mode  :character   Median :-84.40   Median :33.76
                    Mean   :20.76                                                           Mean   :-83.69   Mean   :33.47
                    3rd Qu.:20.00                                                           3rd Qu.:-84.37   3rd Qu.:33.79
                    Max.   :99.00                                                           Max.   :  0.00   Max.   :33.88
                    NA's   :3344
>
```

```
> sum(is.na(COBRA.YTD2017))
[1] 76194
>
```




```
> missingvalue_plot <- aggr(COBRA_YTD, col=c('black','yellow'), numbers=TRUE, sortVars=TRUE
sing data","Pattern"))

 Variables sorted by number of missings:
          Variable Count
           MI_PRINX     0
         offense_id     0
           rpt_date     0
         occur_date     0
         occur_time     0
          poss_date     0
          poss_time     0
               beat     0
 apt_office_prefix     0
    apt_office_num     0
           location     0
           MinOfucr     0
     MinOfibr_code     0
        dispo_code     0
  MaxOfnum_victims     0
              Shift     0
            Avg Day     0
           loc_type     0
       UC2 Literal     0
      neighborhood     0
               npu     0
                 x     0
                 y     0
```



Perform the below operations:

a) **Find out top 5 attributes having highest correlation (select only Numeric features)**

```
#a. Find out top 5 attributes having highest correlation (select only Numeric features).

fit<-lm(beat~MinOfucr+MaxOfnum_victims+loc_type+neighborhood+x+y,data =COBRA.YTD2017,
na.action = na.omit)
fit
summary(fit)
fit1<-lm(formula=MinOfucr~beat+MaxOfnum_victims+loc_type+neighborhood+x+y,data
=COBRA.YTD2017)
fit1
summary(fit1)

vif(fit)
vif(fit1)
vif(fit)>5
vif(fit1)>5
```

```
> fit<-lm(beat~MinOfucr+MaxOfnum_victims+loc_type+neighborhood+x+y,data =COBRA.YTD2017, na.action = na.omit)
> fit

Call:
lm(formula = beat ~ MinOfucr + MaxOfnum_victims + loc_type +
    neighborhood + x + y, data = COBRA.YTD2017, na.action = na.omit)

Coefficients:
                (Intercept)                   MinOfucr0220                   MinOfucr0311
                  2.995e+02                   -1.754e+01                    4.436e+03
                MinOfucr0312                   MinOfucr0313                   MinOfucr0314
                  4.435e+03                    4.436e+03                    4.437e+03
                MinOfucr0315                   MinOfucr0316                   MinOfucr0317
                  4.438e+03                    4.435e+03                    4.438e+03
                MinOfucr0321                   MinOfucr0322                   MinOfucr0323
                  4.436e+03                    4.437e+03                    4.436e+03
                MinOfucr0324                   MinOfucr0325                   MinOfucr0327
                  4.436e+03                    4.436e+03                    4.434e+03
                MinOfucr0331                   MinOfucr0332                   MinOfucr0333
                  4.449e+03                    4.435e+03                    4.435e+03
                MinOfucr0334                   MinOfucr0335                   MinOfucr0336
                  4.435e+03                    4.435e+03                    4.438e+03
                MinOfucr0337                   MinOfucr0341                   MinOfucr0342
                  4.436e+03                    4.432e+03                    4.439e+03
                MinOfucr0343                   MinOfucr0344                   MinOfucr0345
                  4.440e+03                    4.435e+03                    4.429e+03
                MinOfucr0347                   MinOfucr0410                   MinOfucr0420
                  4.435e+03                    4.434e+03                    4.438e+03
```

```
> summary(fit)

Call:
lm(formula = beat ~ MinOfucr + MaxOfnum_victims + loc_type +
    neighborhood + x + y, data = COBRA.YTD2017, na.action = na.omit)

Residuals:
    Min      1Q  Median      3Q     Max
-502.97   -0.79    0.05    1.11  400.21

Coefficients:
                               Estimate Std. Error t value Pr(>|t|)
(Intercept)                   2.995e+02  3.177e+00  94.280  < 2e-16 ***
MinOfucr0220                 -1.754e+01  9.905e+00  -1.770  0.07667 .
MinOfucr0311                  4.436e+03  2.674e+03   1.659  0.09715 .
MinOfucr0312                  4.435e+03  2.674e+03   1.659  0.09717 .
MinOfucr0313                  4.436e+03  2.674e+03   1.659  0.09714 .
MinOfucr0314                  4.437e+03  2.674e+03   1.660  0.09702 .
MinOfucr0315                  4.438e+03  2.674e+03   1.660  0.09698 .
MinOfucr0316                  4.435e+03  2.674e+03   1.659  0.09720 .
MinOfucr0317                  4.438e+03  2.674e+03   1.660  0.09700 .
MinOfucr0321                  4.436e+03  2.674e+03   1.659  0.09709 .
MinOfucr0322                  4.437e+03  2.674e+03   1.659  0.09707 .
MinOfucr0323                  4.436e+03  2.674e+03   1.659  0.09717 .
MinOfucr0324                  4.436e+03  2.674e+03   1.659  0.09712 .
MinOfucr0325                  4.436e+03  2.674e+03   1.659  0.09715 .
MinOfucr0327                  4.434e+03  2.674e+03   1.658  0.09730 .
MinOfucr0331                  4.449e+03  2.674e+03   1.664  0.09615 .
MinOfucr0332                  4.435e+03  2.674e+03   1.659  0.09715 .
MinOfucr0333                  4.435e+03  2.674e+03   1.659  0.09719 .
MinOfucr0334                  4.435e+03  2.674e+03   1.659  0.09722 .
MinOfucr0335                  4.435e+03  2.674e+03   1.658  0.09724 .
MinOfucr0336                  4.438e+03  2.674e+03   1.660  0.09693 .
MinOfucr0337                  4.436e+03  2.674e+03   1.659  0.09714 .
MinOfucr0341                  4.432e+03  2.674e+03   1.657  0.09744 .
MinOfucr0342                  4.439e+03  2.674e+03   1.660  0.09688 .
MinOfucr0343                  4.440e+03  2.674e+03   1.661  0.09679 .
MinOfucr0344                  4.435e+03  2.674e+03   1.659  0.09722 .
MinOfucr0345                  4.429e+03  2.674e+03   1.656  0.09768 .
MinOfucr0347                  4.435e+03  2.674e+03   1.659  0.09718 .
MinOfucr0410                  4.434e+03  2.674e+03   1.658  0.09731 .
MinOfucr0420                  4.438e+03  2.674e+03   1.660  0.09699 .
MinOfucr0430                  4.436e+03  2.674e+03   1.659  0.09711 .
MinOfucr0440                  4.440e+03  2.674e+03   1.660  0.09683 .
MinOfucr0511                  4.435e+03  2.674e+03   1.659  0.09720 .
MinOfucr0512                  4.435e+03  2.674e+03   1.659  0.09717 .
MinOfucr0521                  4.435e+03  2.674e+03   1.659  0.09717 .
MinOfucr0522                  4.438e+03  2.674e+03   1.660  0.09700 .
MinOfucr0531                  4.434e+03  2.674e+03   1.658  0.09727 .
MinOfucr0532                  4.440e+03  2.674e+03   1.660  0.09684 .
MinOfucr0610                  4.436e+03  2.674e+03   1.659  0.09713 .
MinOfucr0620                  4.428e+03  2.674e+03   1.656  0.09775 .
MinOfucr0630                  4.436e+03  2.674e+03   1.659  0.09711 .
MinOfucr0640                  4.436e+03  2.674e+03   1.659  0.09714 .
MinOfucr0650                  4.436e+03  2.674e+03   1.659  0.09712 .
MinOfucr0660                  4.436e+03  2.674e+03   1.659  0.09709 .
MinOfucr0670                  4.435e+03  2.674e+03   1.659  0.09721 .
MinOfucr0680                  4.443e+03  2.674e+03   1.662  0.09659 .
```

Console ~/

```
neighborhoodGrant Park                          3.034e+02  2.792e+00 108.654  < 2e-16 ***
neighborhoodGreen Acres Valley                  1.034e+02  1.183e+01   8.744  < 2e-16 ***
neighborhoodGreen Forest Acres                  1.038e+02  9.532e+00  10.891  < 2e-16 ***
neighborhoodGreenbriar                          1.017e+02  3.669e+00  27.723  < 2e-16 ***
neighborhoodGreenbriar Village                  1.054e+02  9.953e+00  10.589  < 2e-16 ***
neighborhoodGrove Park                         -1.867e+02  3.108e+00 -60.074  < 2e-16 ***
neighborhoodHammond Park                        1.245e+00  3.379e+00   0.368  0.71261
neighborhoodHanover West                       -8.289e+01  1.192e+01  -6.956 3.59e-12 ***
neighborhoodHarland Terrace                     6.973e+01  3.438e+00  20.282  < 2e-16 ***
neighborhoodHarris Chiles                      -1.898e+02  3.977e+00 -47.723  < 2e-16 ***
neighborhoodHarvel Homes Community             -1.957e+02  1.832e+01 -10.681  < 2e-16 ***
neighborhoodHeritage Valley                     1.056e+02  7.222e+00  14.622  < 2e-16 ***
neighborhoodHigh Point                          1.494e+00  6.541e+00   0.228  0.81933
neighborhoodHills Park                         -8.706e+01  4.349e+00 -20.020  < 2e-16 ***
neighborhoodHome Park                           2.077e+02  2.970e+00  69.910  < 2e-16 ***
neighborhoodHorseshoe Community                 1.050e+02  1.826e+01   5.750 9.07e-09 ***
neighborhoodHunter Hills                       -1.900e+02  3.301e+00 -57.576  < 2e-16 ***
neighborhoodHuntington                          9.959e+01  1.531e+01   6.503 8.02e-11 ***
neighborhoodInman Park                          3.063e+02  3.092e+00  99.063  < 2e-16 ***
neighborhoodIvan Hill                           1.064e+02  8.624e+00  12.336  < 2e-16 ***
neighborhoodJoyland                             2.876e+00  5.018e+00   0.573  0.56647
neighborhoodJust Us                            -1.945e+02  2.549e+01  -7.628 2.48e-14 ***
neighborhoodKings Forest                        1.038e+02  5.123e+00  20.258  < 2e-16 ***
neighborhoodKingswood                          -7.802e+01  1.846e+01  -4.227 2.38e-05 ***
neighborhoodKirkwood                            3.136e+02  3.882e+00  80.783  < 2e-16 ***
neighborhoodKnight Park/Howell Station         -1.871e+02  5.181e+00 -36.112  < 2e-16 ***
neighborhoodLake Claire                         3.132e+02  4.936e+00  63.462  < 2e-16 ***
neighborhoodLake Estates                        1.017e+02  2.577e+01   3.945 7.99e-05 ***
neighborhoodLakewood                            3.189e+00  4.945e+00   0.645  0.51903
neighborhoodLakewood Heights                    1.256e+00  2.813e+00   0.447  0.65524
neighborhoodLaurens Valley                      1.028e+02  1.819e+01   5.651 1.62e-08 ***
neighborhoodLeila Valley                        9.150e-01  4.786e+00   0.191  0.84838
neighborhoodLenox                              -7.186e+01  4.580e+00 -15.690  < 2e-16 ***
neighborhoodLincoln Homes                      -1.777e+02  6.240e+00 -28.485  < 2e-16 ***
neighborhoodLindbergh/Morosgo                  -7.476e+01  3.924e+00 -19.052  < 2e-16 ***
neighborhoodLindridge/Martin Manor             -7.303e+01  4.154e+00 -17.579  < 2e-16 ***
neighborhoodLoring Heights                     -8.428e+01  3.594e+00 -23.452  < 2e-16 ***
neighborhoodMagnum Manor                        1.026e+02  9.038e+00  11.351  < 2e-16 ***
neighborhoodMargaret Mitchell                  -8.366e+01  1.108e+01  -7.549 4.57e-14 ***
neighborhoodMarietta Street Artery              2.108e+02  3.381e+00  62.332  < 2e-16 ***
neighborhoodMays                                1.069e+02  4.777e+00  22.377  < 2e-16 ***
neighborhoodMeadowbrook Forest                  1.037e+02  8.465e+00  12.245  < 2e-16 ***
neighborhoodMechanicsville                      3.271e+00  2.492e+00   1.312  0.18938
neighborhoodMellwood                           -5.193e+01  1.834e+01  -2.832  0.00463 **
neighborhoodMemorial Park                      -8.163e+01  1.830e+01  -4.461 8.20e-06 ***
neighborhoodMidtown                             2.107e+02  2.809e+00  75.008  < 2e-16 ***
neighborhoodMidwest Cascade                     1.085e+02  5.999e+00  18.085  < 2e-16 ***
neighborhoodMonroe Heights                     -1.788e+02  5.409e+00 -33.066  < 2e-16 ***
neighborhoodMorningside/Lenox Park             -7.618e+01  3.660e+00 -20.816  < 2e-16 ***
 [ reached getOption("max.print") -- omitted 90 rows ]
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 25.39 on 22091 degrees of freedom
  (4378 observations deleted due to missingness)
Multiple R-squared:  0.9774,    Adjusted R-squared:  0.9771
F-statistic:  3306 on 289 and 22091 DF,  p-value: < 2.2e-16
```

```
> fit1<-lm(formula=MinOfucr~beat+MaxOfnum_victims+loc_type+neighborhood+x+y,data =COBRA.YTD2017)
> fit1

Call:
lm(formula = MinOfucr ~ beat + MaxOfnum_victims + loc_type +
    neighborhood + x + y, data = COBRA.YTD2017)

Coefficients:
                              (Intercept)                                      beat                            MaxOfnum_victims
                                2.218e+02                                 7.126e-03                                -1.229e+01
                                 loc_type                  neighborhoodAdams Park                  neighborhoodAdamsville
                                -4.508e-02                                -9.749e+00                                -9.269e+00
                   neighborhoodAlmond Park                  neighborhoodAmal Heights                  neighborhoodAnsley Park
                                -1.903e+01                                -1.164e-01                                -1.197e+00
               neighborhoodArden/Habersham                  neighborhoodArdmore                  neighborhoodArgonne Forest
                                -3.377e+00                                 2.239e+01                                 6.209e+01
             neighborhoodArlington Estates                  neighborhoodAshley Courts                  neighborhoodAshview Heights
                                -3.531e+01                                -8.837e+00                                -3.203e+01
                  neighborhoodAtkins Park       neighborhoodAtlanta Industrial Park       neighborhoodAtlanta University Center
                                 3.540e+00                                 4.923e+01                                 6.809e-01
               neighborhoodAtlantic Station                neighborhoodAudobon Forest                neighborhoodAudobon Forest West
                                 1.603e+01                                 8.961e+00                                 5.861e+01
                   neighborhoodBaker Hills                  neighborhoodBakers Ferry                      neighborhoodBankhead
                                -2.243e+01                                -7.371e+00                                -7.140e+01
              neighborhoodBankhead/Bolton                  neighborhoodBeecher Hills                       neighborhoodBen Hill
                                 3.446e+01                                 4.918e+00                                -3.544e+00
                neighborhoodBen Hill Acres                neighborhoodBen Hill Forest                   neighborhoodBen Hill Pines
                                -1.669e+01                                 1.236e+02                                -4.936e+00
```

```
> summary(fit1)

Call:
lm(formula = MinOfucr ~ beat + MaxOfnum_victims + loc_type +
    neighborhood + x + y, data = COBRA.YTD2017)

Residuals:
    Min      1Q  Median      3Q     Max
-333.92  -35.53   20.95   61.95  429.07

Coefficients:
                                      Estimate Std. Error t value Pr(>|t|)
(Intercept)                          2.218e+02  1.461e+01  15.184  < 2e-16 ***
beat                                 7.126e-03  2.641e-02   0.270 0.787314
MaxOfnum_victims                    -1.229e+01  1.003e+00 -12.255  < 2e-16 ***
loc_type                            -4.508e-02  4.229e-02  -1.066 0.286378
neighborhoodAdams Park              -9.749e+00  1.633e+01  -0.597 0.550649
neighborhoodAdamsville              -9.269e+00  1.117e+01  -0.830 0.406568
neighborhoodAlmond Park             -1.903e+01  1.808e+01  -1.052 0.292635
neighborhoodAmal Heights            -1.164e-01  2.291e+01  -0.005 0.995947
neighborhoodAnsley Park             -1.197e+00  1.866e+01  -0.064 0.948858
neighborhoodArden/Habersham         -3.377e+00  4.704e+01  -0.072 0.942767
neighborhoodArdmore                  2.239e+01  2.280e+01   0.982 0.326053
neighborhoodArgonne Forest           6.209e+01  3.833e+01   1.620 0.105302
neighborhoodArlington Estates       -3.531e+01  2.595e+01  -1.361 0.173611
neighborhoodAshley Courts           -8.837e+00  1.854e+01  -0.477 0.633634
neighborhoodAshview Heights         -3.203e+01  1.351e+01  -2.371 0.017734 *
neighborhoodAtkins Park              3.540e+00  5.926e+01   0.060 0.952370
neighborhoodAtlanta Industrial Park  4.923e+01  2.278e+01   2.161 0.030671 *
neighborhoodAtlanta University Center 6.809e-01  1.396e+01   0.049 0.961095
neighborhoodAtlantic Station         1.603e+01  1.448e+01   1.107 0.268284
neighborhoodAudobon Forest           8.961e+00  2.658e+01   0.337 0.735972
neighborhoodAudobon Forest West      5.861e+01  3.888e+01   1.507 0.131752
neighborhoodBaker Hills             -2.243e+01  2.084e+01  -1.076 0.281915
neighborhoodBakers Ferry            -7.371e+00  4.557e+01  -0.162 0.871524
neighborhoodBankhead                -7.140e+01  1.342e+01  -5.322 1.04e-07 ***
neighborhoodBankhead/Bolton          3.446e+01  2.491e+01   1.383 0.166544
neighborhoodBeecher Hills            4.918e+00  2.909e+01   0.169 0.865739
neighborhoodBen Hill                -3.544e+00  2.230e+01  -0.159 0.873721
neighborhoodBen Hill Acres          -1.669e+01  2.347e+01  -0.711 0.476929
neighborhoodBen Hill Forest          1.236e+02  7.181e+01   1.722 0.085147 .
neighborhoodBen Hill Pines          -4.936e+00  4.275e+01  -0.115 0.908080
neighborhoodBen Hill Terrace         1.217e+00  2.194e+01   0.055 0.955768
neighborhoodBenteen Park            -2.507e+01  1.990e+01  -1.260 0.207583
neighborhoodBerkeley Park            2.098e+01  1.298e+01   1.616 0.106162
neighborhoodBetmar LaVilla           2.739e+01  1.687e+01   1.623 0.104539
neighborhoodBlair Villa/Poole Creek  2.762e+01  1.720e+01   1.606 0.108317
neighborhoodBlandtown                3.626e+01  1.273e+01   2.848 0.004406 **
neighborhoodBolton                   1.308e+01  1.527e+01   0.857 0.391730
neighborhoodBolton Hills             2.209e+00  4.210e+01   0.052 0.958159
neighborhoodBoulder Park            -2.241e+01  4.180e+01  -0.536 0.591895
neighborhoodBoulevard Heights        4.861e+00  1.947e+01   0.250 0.802878
neighborhoodBrandon                  5.670e+01  3.161e+01   1.794 0.072852 .
neighborhoodBrentwood               -7.443e+01  4.012e+01  -1.855 0.063549 .
neighborhoodBriar Glen               4.873e+01  4.238e+01   1.150 0.250262
neighborhoodBrookhaven               4.735e+00  3.674e+01   0.129 0.897448
neighborhoodBrookview Heights        9.546e+00  2.162e+01   0.441 0.658876
neighborhoodBrookwood               -8.286e+00  2.136e+01  -0.388 0.698026
```

```
neighborhoodMorningside/Lenox Park          1.639e+01  1.445e+01   1.135 0.256477
neighborhoodMozley Park                    -2.716e+01  1.429e+01  -1.900 0.057434 .
neighborhoodMt. Gilead Woods               -4.631e+01  3.944e+01  -1.174 0.240313
neighborhoodMt. Paran Parkway               2.164e+01  1.013e+02   0.213 0.830942
neighborhoodMt. Paran/Northside            -1.300e+01  2.964e+01  -0.439 0.660913
neighborhoodNiskey Cove                     3.107e+01  7.154e+01   0.434 0.664004
neighborhoodNiskey Lake                     6.724e+01  5.117e+01   1.314 0.188860
neighborhoodNorth Buckhead                  1.867e+01  1.819e+01   1.026 0.304853
neighborhoodNorwood Manor                  -1.205e+01  1.809e+01  -0.666 0.505368
neighborhoodOakcliff                        3.736e+01  3.895e+01   0.959 0.337453
neighborhoodOakland                         4.533e+00  2.489e+01   0.182 0.855482
neighborhoodOakland City                   -2.498e+01  1.108e+01  -2.255 0.024165 *
neighborhoodOld Fairburn Village            4.873e+01  1.004e+02   0.485 0.627339
neighborhoodOld Fourth Ward                -2.104e+00  1.343e+01  -0.157 0.875535
neighborhoodOld Gordon                     -1.341e+01  2.382e+01  -0.563 0.573585
neighborhoodOrchard Knob                    2.727e+00  1.970e+01   0.138 0.889909
neighborhoodOrmewood Park                  -2.503e+01  1.470e+01  -1.702 0.088719 .
neighborhoodPaces                           3.021e+01  2.446e+01   1.235 0.216919
neighborhoodPeachtree Battle Alliance       5.466e+01  3.078e+01   1.776 0.075811 .
neighborhoodPeachtree Heights East          2.207e+01  3.130e+01   0.705 0.480826
neighborhoodPeachtree Heights West          1.580e+01  1.856e+01   0.852 0.394469
neighborhoodPeachtree Hills                 2.217e+01  1.988e+01   1.115 0.264844
neighborhoodPeachtree Park                 -1.739e+00  2.034e+01  -0.085 0.931870
neighborhoodPenelope Neighbors             -9.972e+01  3.041e+01  -3.279 0.001043 **
neighborhoodPeoplestown                    -2.815e+01  1.172e+01  -2.403 0.016289 *
neighborhoodPerkerson                       1.361e+01  1.191e+01   1.143 0.253221
neighborhoodPeyton Forest                   2.500e+01  3.278e+01   0.763 0.445761
neighborhoodPiedmont Heights                3.562e-01  1.482e+01   0.024 0.980827
neighborhoodPine Hills                     -2.234e+00  1.860e+01  -0.120 0.904364
neighborhoodPittsburgh                     -2.804e+00  1.025e+01  -0.274 0.784408
neighborhoodPleasant Hill                   3.624e+01  4.720e+01   0.768 0.442645
neighborhoodPolar Rock                      4.473e+00  2.027e+01   0.221 0.825378
neighborhoodPomona Park                     1.397e+01  7.127e+01   0.196 0.844614
neighborhoodPoncey-Highland                 2.103e+01  1.548e+01   1.358 0.174405
neighborhoodPrinceton Lakes                 5.334e+01  1.607e+01   3.320 0.000902 ***
neighborhoodRandall Mill                    2.865e+01  2.346e+01   1.221 0.221968
neighborhoodRebel Valley Forest            -7.690e+00  1.941e+01  -0.396 0.692056
neighborhoodReynoldstown                   -1.769e+01  1.593e+01  -1.111 0.266663
neighborhoodRidgecrest Forest              -1.680e+01  3.149e+01  -0.533 0.593810
neighborhoodRidgedale Park                 -5.404e+00  2.641e+01  -0.205 0.837852
neighborhoodRidgewood Heights               1.853e+01  3.132e+01   0.591 0.554223
neighborhoodRiverside                       1.021e+01  1.471e+01   0.694 0.487558
neighborhoodRockdale                        2.647e+01  1.817e+01   1.457 0.145122
neighborhoodRosedale Heights               -2.206e+01  1.861e+01  -1.185 0.235855
neighborhoodRue Royal                      -1.624e+02  7.170e+01  -2.265 0.023504 *
neighborhoodSandlewood Estates              1.123e+01  3.141e+01   0.357 0.720790
neighborhoodScotts Crossing                -2.423e+01  1.787e+01  -1.356 0.175150
neighborhoodSherwood Forest                -3.203e+01  5.168e+01  -0.620 0.535337
neighborhoodSouth Atlanta                  -2.876e+01  1.279e+01  -2.247 0.024619 *
 [ reached getOption("max.print") -- omitted 42 rows ]
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 99.8 on 22139 degrees of freedom
  (4378 observations deleted due to missingness)
Multiple R-squared:  0.147,     Adjusted R-squared:  0.1377
F-statistic: 15.83 on 241 and 22139 DF,  p-value: < 2.2e-16
```

```
> vif(fit)
                  GVIF  Df GVIF^(1/(2*Df))
MinOfucr           NaN  49              NaN
MaxOfnum_victims   NaN   1              NaN
loc_type           NaN   1              NaN
neighborhood       NaN 236              NaN
x                  NaN   1              NaN
y                  NaN   1              NaN
> vif(fit1)
                         GVIF  Df GVIF^(1/(2*Df))
beat                4.411556e+01   1        6.641955
MaxOfnum_victims    1.017245e+00   1        1.008586
loc_type            1.025699e+00   1        1.012768
neighborhood        3.705006e+03 236        1.017562
x                   1.883397e+05   1      433.981262
y                   1.884420e+05   1      434.099027
> vif(fit)>5
                  GVIF    Df GVIF^(1/(2*Df))
MinOfucr            NA  TRUE              NA
MaxOfnum_victims    NA FALSE              NA
loc_type            NA FALSE              NA
neighborhood        NA  TRUE              NA
x                   NA FALSE              NA
y                   NA FALSE              NA
> vif(fit1)>5
                   GVIF    Df GVIF^(1/(2*Df))
beat               TRUE FALSE            TRUE
MaxOfnum_victims  FALSE FALSE           FALSE
loc_type          FALSE FALSE           FALSE
neighborhood       TRUE  TRUE           FALSE
x                  TRUE FALSE            TRUE
y                  TRUE FALSE            TRUE
>
```

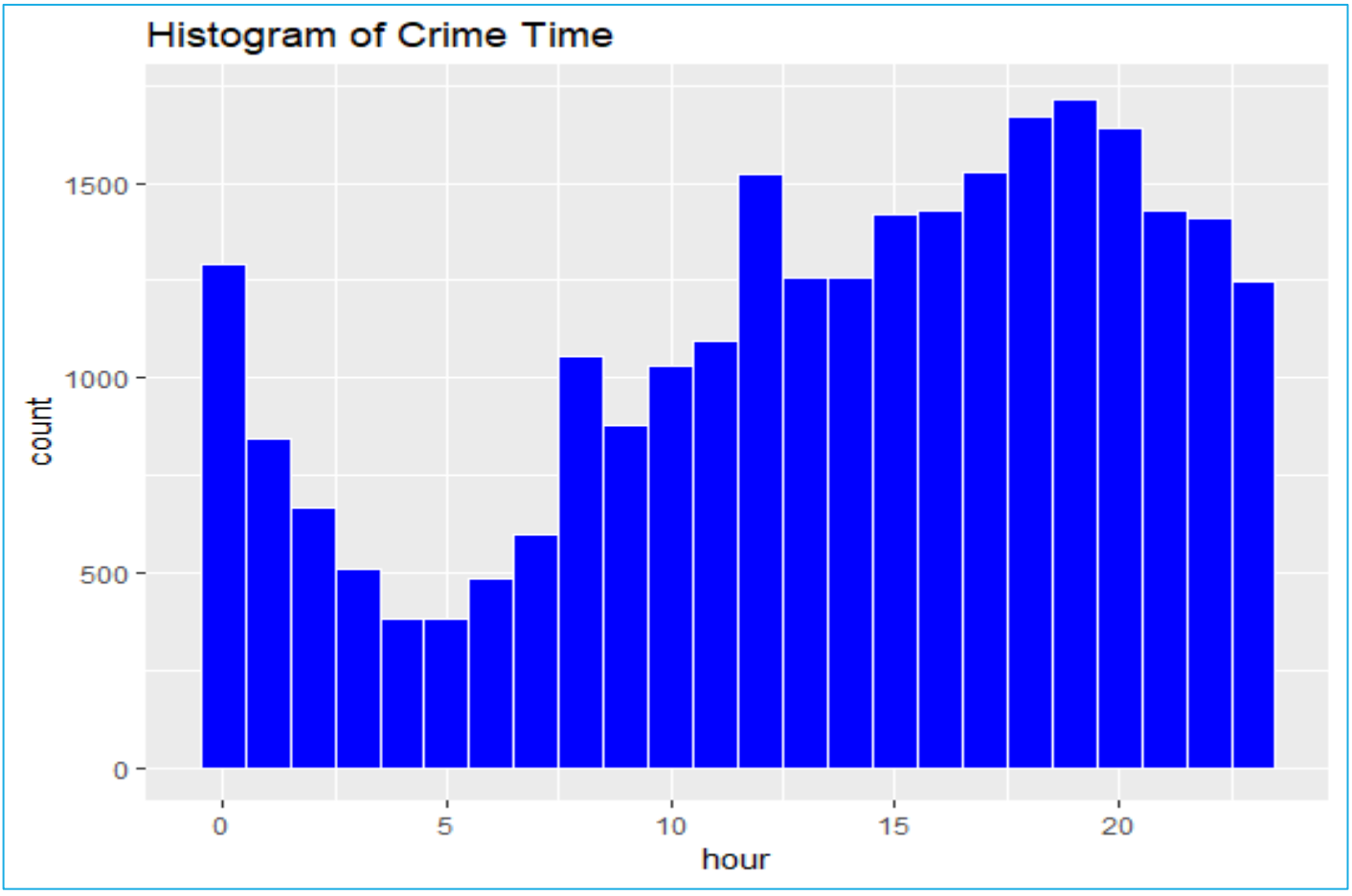
a) **P-values are very important because, we can consider linear model to be statistically significant only.**
b) **When both these p-values are less that the pre-determined statistical determined level, which is ideally 0.05.**
c) **This is visually interpreted by the significance stars at the end of the row.**
d) **The more stars beside the variable's p-value, the more significant the variable.**
e) **When there is a p-value, there is a null and alternative hypothesis associated with it.**
f) **Null and Alternate Hypothesis**
g) **In Linear regression, the Null Hypothesis is that the coefficients associated with the variables is equal to zero.**
h) **The alternate hypothesis is that the coefficients are not equal to zero.**
i) **There exists a relationship between the independent variable in question and the dependent variable.**

b) Find out top 3 reasons for having more crime in a city.

```
#b. Find out top 3 reasons for having more crime in a city.

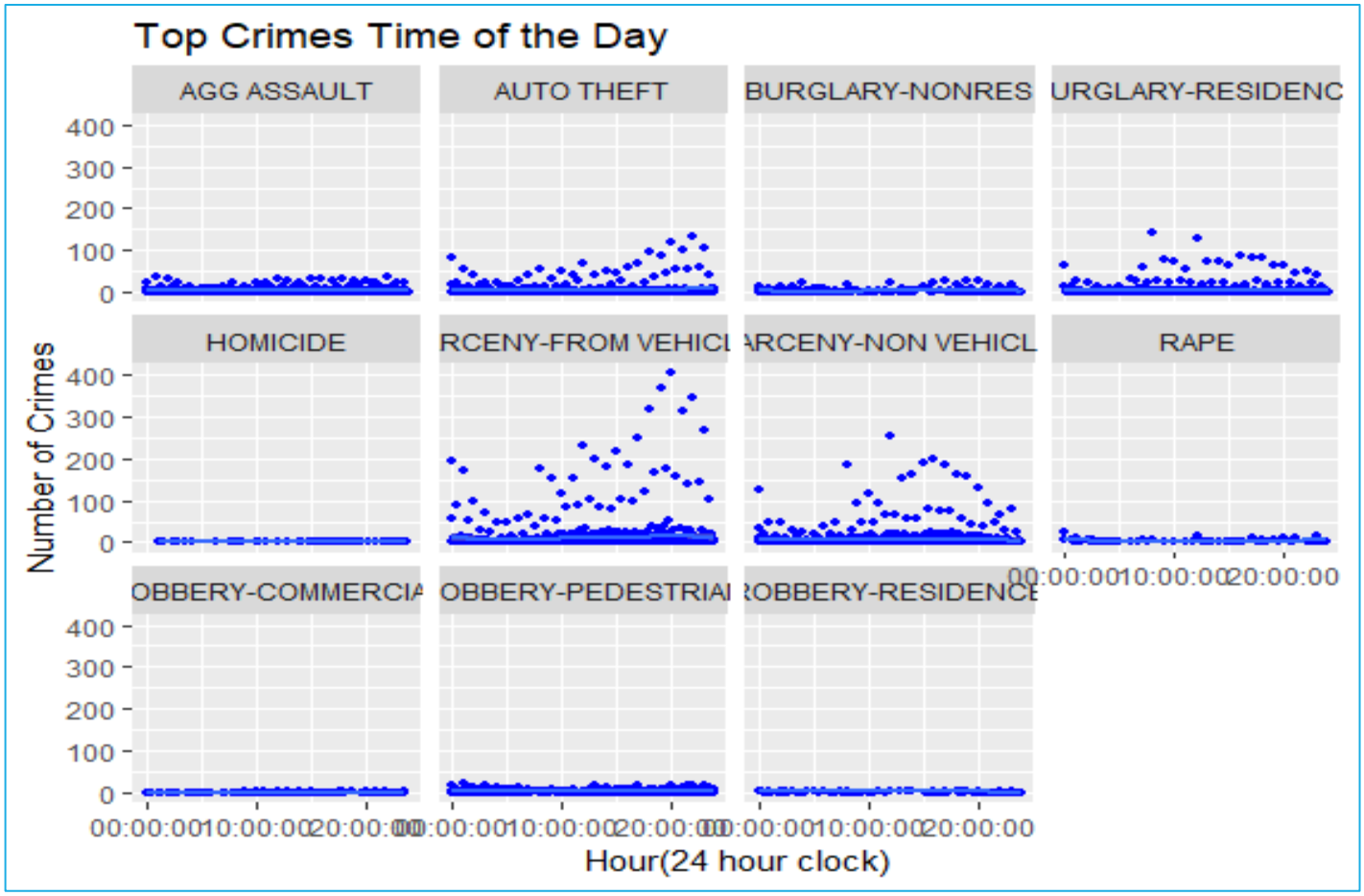
library(ggplot2)
COBRA.YTD2017$hour <- sub(":.*", "", COBRA.YTD2017$occur_time)
COBRA.YTD2017$hour <- as.numeric(COBRA.YTD2017$hour)
ggplot(aes(x = hour), data = COBRA.YTD2017) + geom_histogram(bins = 24, color='white', fill='blue')
+
  ggtitle('Histogram of Crime Time')


UC2<-table(COBRA.YTD2017$`UC2 Literal`)
hist(UC2)
```



```
library(dplyr)
COBRA <- COBRA.YTD2017 %>% group_by(`UC2 Literal`,occur_time) %>%
  summarise(total = n())

ggplot(aes(x = occur_time, y = total), data = COBRA) + 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. larceny theft are the top crimes in Atlanta followed by aggravated assault

```
library(knitr)
library(kableExtra)

kable(count(COBRA.YTD2017, COBRA.YTD2017$`UC2 Literal`, sort=TRUE), "html",
col.names=c("Crime Type", "Frequency")) %>%
  kable_styling(bootstrap_options="striped", full_width=FALSE)
```

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

c) Which all attributes have high correlation with crime rate?

```
#c. Which all attributes have correlation with crime rate?
library(ggplot2)
library(corrplot)
pairs(COBRA.YTD2017)

rank1<-sample(COBRA.YTD2017[1:100,22:23], 20, replace=T)
rank2<-sample(COBRA.YTD2017[1:100,22:23], 20, replace=T)
cbind(rank1,rank2)
plot(rank1, rank2)
cor(rank1,rank2, method="spearman")
cor(rank1,rank2, method="pearson")
```

```
> #c. Which all attributes have correlation with crime rate?
> library(ggplot2)
> library(corrplot)
> rank1<-sample(COBRA.YTD2017[1:100,22:23], 20, replace=T)
> rank2<-sample(COBRA.YTD2017[1:100,22:23], 20, replace=T)
> cbind(rank1,rank2)
        x        y        y        y        y        y        x        y        x        x        x        y        x        x        x        y
1  -84.38013 33.75582 33.75582 33.75582 33.75582 33.75582 -84.38013 33.75582 -84.38013 -84.38013 -84.38013 33.75582 -84.38013 -84.38013 -84.38013 33.75582
2  -84.39745 33.78674 33.78674 33.78674 33.78674 33.78674 -84.39745 33.78674 -84.39745 -84.39745 -84.39745 33.78674 -84.39745 -84.39745 -84.39745 33.78674
3  -84.39486 33.73760 33.73760 33.73760 33.73760 33.73760 -84.39486 33.73760 -84.39486 -84.39486 -84.39486 33.73760 -84.39486 -84.39486 -84.39486 33.73760
4  -84.39887 33.75156 33.75156 33.75156 33.75156 33.75156 -84.39887 33.75156 -84.39887 -84.39887 -84.39887 33.75156 -84.39887 -84.39887 -84.39887 33.75156
5  -84.46522 33.72146 33.72146 33.72146 33.72146 33.72146 -84.46522 33.72146 -84.46522 -84.46522 -84.46522 33.72146 -84.46522 -84.46522 -84.46522 33.72146
6  -84.34660 33.74006 33.74006 33.74006 33.74006 33.74006 -84.34660 33.74006 -84.34660 -84.34660 -84.34660 33.74006 -84.34660 -84.34660 -84.34660 33.74006
7  -84.37373 33.74505 33.74505 33.74505 33.74505 33.74505 -84.37373 33.74505 -84.37373 -84.37373 -84.37373 33.74505 -84.37373 -84.37373 -84.37373 33.74505
8  -84.37190 33.77303 33.77303 33.77303 33.77303 33.77303 -84.37190 33.77303 -84.37190 -84.37190 -84.37190 33.77303 -84.37190 -84.37190 -84.37190 33.77303
9  -84.37285 33.74639 33.74639 33.74639 33.74639 33.74639 -84.37285 33.74639 -84.37285 -84.37285 -84.37285 33.74639 -84.37285 -84.37285 -84.37285 33.74639
10 -84.38625 33.72579 33.72579 33.72579 33.72579 33.72579 -84.38625 33.72579 -84.38625 -84.38625 -84.38625 33.72579 -84.38625 -84.38625 -84.38625 33.72579
11 -84.39495 33.73616 33.73616 33.73616 33.73616 33.73616 -84.39495 33.73616 -84.39495 -84.39495 -84.39495 33.73616 -84.39495 -84.39495 -84.39495 33.73616
12 -84.43192 33.74974 33.74974 33.74974 33.74974 33.74974 -84.43192 33.74974 -84.43192 -84.43192 -84.43192 33.74974 -84.43192 -84.43192 -84.43192 33.74974
13 -84.40766 33.68243 33.68243 33.68243 33.68243 33.68243 -84.40766 33.68243 -84.40766 -84.40766 -84.40766 33.68243 -84.40766 -84.40766 -84.40766 33.68243
14 -84.39276 33.71691 33.71691 33.71691 33.71691 33.71691 -84.39276 33.71691 -84.39276 -84.39276 -84.39276 33.71691 -84.39276 -84.39276 -84.39276 33.71691
15 -84.38742 33.73048 33.73048 33.73048 33.73048 33.73048 -84.38742 33.73048 -84.38742 -84.38742 -84.38742 33.73048 -84.38742 -84.38742 -84.38742 33.73048
16 -84.46574 33.70087 33.70087 33.70087 33.70087 33.70087 -84.46574 33.70087 -84.46574 -84.46574 -84.46574 33.70087 -84.46574 -84.46574 -84.46574 33.70087
17 -84.43107 33.75831 33.75831 33.75831 33.75831 33.75831 -84.43107 33.75831 -84.43107 -84.43107 -84.43107 33.75831 -84.43107 -84.43107 -84.43107 33.75831
18 -84.47527 33.79671 33.79671 33.79671 33.79671 33.79671 -84.47527 33.79671 -84.47527 -84.47527 -84.47527 33.79671 -84.47527 -84.47527 -84.47527 33.79671
19 -84.38031 33.70678 33.70678 33.70678 33.70678 33.70678 -84.38031 33.70678 -84.38031 -84.38031 -84.38031 33.70678 -84.38031 -84.38031 -84.38031 33.70678
20 -84.36983 33.84746 33.84746 33.84746 33.84746 33.84746 -84.36983 33.84746 -84.36983 -84.36983 -84.36983 33.84746 -84.36983 -84.36983 -84.36983 33.84746
21 -84.33868 33.75757 33.75757 33.75757 33.75757 33.75757 -84.33868 33.75757 -84.33868 -84.33868 -84.33868 33.75757 -84.33868 -84.33868 -84.33868 33.75757
22 -84.38023 33.77067 33.77067 33.77067 33.77067 33.77067 -84.38023 33.77067 -84.38023 -84.38023 -84.38023 33.77067 -84.38023 -84.38023 -84.38023 33.77067
23 -84.40795 33.70369 33.70369 33.70369 33.70369 33.70369 -84.40795 33.70369 -84.40795 -84.40795 -84.40795 33.70369 -84.40795 -84.40795 -84.40795 33.70369
24 -84.43089 33.75437 33.75437 33.75437 33.75437 33.75437 -84.43089 33.75437 -84.43089 -84.43089 -84.43089 33.75437 -84.43089 -84.43089 -84.43089 33.75437
25 -84.42057 33.74647 33.74647 33.74647 33.74647 33.74647 -84.42057 33.74647 -84.42057 -84.42057 -84.42057 33.74647 -84.42057 -84.42057 -84.42057 33.74647
        y        y        x        x        y        x        y        x        y        y        x        y        y        x        x        x
1  33.75582 33.75582 -84.38013 -84.38013 33.75582 -84.38013 33.75582 -84.38013 33.75582 33.75582 -84.38013 33.75582 33.75582 -84.38013 -84.38013 -84.38013
2  33.78674 33.78674 -84.39745 -84.39745 33.78674 -84.39745 33.78674 -84.39745 33.78674 33.78674 -84.39745 33.78674 33.78674 -84.39745 -84.39745 -84.39745
3  33.73760 33.73760 -84.39486 -84.39486 33.73760 -84.39486 33.73760 -84.39486 33.73760 33.73760 -84.39486 33.73760 33.73760 -84.39486 -84.39486 -84.39486
4  33.75156 33.75156 -84.39887 -84.39887 33.75156 -84.39887 33.75156 -84.39887 33.75156 33.75156 -84.39887 33.75156 33.75156 -84.39887 -84.39887 -84.39887
5  33.72146 33.72146 -84.46522 -84.46522 33.72146 -84.46522 33.72146 -84.46522 33.72146 33.72146 -84.46522 33.72146 33.72146 -84.46522 -84.46522 -84.46522
6  33.74006 33.74006 -84.34660 -84.34660 33.74006 -84.34660 33.74006 -84.34660 33.74006 33.74006 -84.34660 33.74006 33.74006 -84.34660 -84.34660 -84.34660
7  33.74505 33.74505 -84.37373 -84.37373 33.74505 -84.37373 33.74505 -84.37373 33.74505 33.74505 -84.37373 33.74505 33.74505 -84.37373 -84.37373 -84.37373
8  33.77303 33.77303 -84.37190 -84.37190 33.77303 -84.37190 33.77303 -84.37190 33.77303 33.77303 -84.37190 33.77303 33.77303 -84.37190 -84.37190 -84.37190
9  33.74639 33.74639 -84.37285 -84.37285 33.74639 -84.37285 33.74639 -84.37285 33.74639 33.74639 -84.37285 33.74639 33.74639 -84.37285 -84.37285 -84.37285
10 33.72579 33.72579 -84.38625 -84.38625 33.72579 -84.38625 33.72579 -84.38625 33.72579 33.72579 -84.38625 33.72579 33.72579 -84.38625 -84.38625 -84.38625
11 33.73616 33.73616 -84.39495 -84.39495 33.73616 -84.39495 33.73616 -84.39495 33.73616 33.73616 -84.39495 33.73616 33.73616 -84.39495 -84.39495 -84.39495
12 33.74974 33.74974 -84.43192 -84.43192 33.74974 -84.43192 33.74974 -84.43192 33.74974 33.74974 -84.43192 33.74974 33.74974 -84.43192 -84.43192 -84.43192
13 33.68243 33.68243 -84.40766 -84.40766 33.68243 -84.40766 33.68243 -84.40766 33.68243 33.68243 -84.40766 33.68243 33.68243 -84.40766 -84.40766 -84.40766
14 33.71691 33.71691 -84.39276 -84.39276 33.71691 -84.39276 33.71691 -84.39276 33.71691 33.71691 -84.39276 33.71691 33.71691 -84.39276 -84.39276 -84.39276
15 33.73048 33.73048 -84.38742 -84.38742 33.73048 -84.38742 33.73048 -84.38742 33.73048 33.73048 -84.38742 33.73048 33.73048 -84.38742 -84.38742 -84.38742
16 33.70087 33.70087 -84.46574 -84.46574 33.70087 -84.46574 33.70087 -84.46574 33.70087 33.70087 -84.46574 33.70087 33.70087 -84.46574 -84.46574 -84.46574
17 33.75831 33.75831 -84.43107 -84.43107 33.75831 -84.43107 33.75831 -84.43107 33.75831 33.75831 -84.43107 33.75831 33.75831 -84.43107 -84.43107 -84.43107
18 33.79671 33.79671 -84.47527 -84.47527 33.79671 -84.47527 33.79671 -84.47527 33.79671 33.79671 -84.47527 33.79671 33.79671 -84.47527 -84.47527 -84.47527
19 33.70678 33.70678 -84.38031 -84.38031 33.70678 -84.38031 33.70678 -84.38031 33.70678 33.70678 -84.38031 33.70678 33.70678 -84.38031 -84.38031 -84.38031
20 33.84746 33.84746 -84.36983 -84.36983 33.84746 -84.36983 33.84746 -84.36983 33.84746 33.84746 -84.36983 33.84746 33.84746 -84.36983 -84.36983 -84.36983
21 33.75757 33.75757 -84.33868 -84.33868 33.75757 -84.33868 33.75757 -84.33868 33.75757 33.75757 -84.33868 33.75757 33.75757 -84.33868 -84.33868 -84.33868
22 33.77067 33.77067 -84.38023 -84.38023 33.77067 -84.38023 33.77067 -84.38023 33.77067 33.77067 -84.38023 33.77067 33.77067 -84.38023 -84.38023 -84.38023
23 33.70369 33.70369 -84.40795 -84.40795 33.70369 -84.40795 33.70369 -84.40795 33.70369 33.70369 -84.40795 33.70369 33.70369 -84.40795 -84.40795 -84.40795
24 33.75437 33.75437 -84.43089 -84.43089 33.75437 -84.43089 33.75437 -84.43089 33.75437 33.75437 -84.43089 33.75437 33.75437 -84.43089 -84.43089 -84.43089
25 33.74647 33.74647 -84.42057 -84.42057 33.74647 -84.42057 33.74647 -84.42057 33.74647 33.74647 -84.42057 33.74647 33.74647 -84.42057 -84.42057 -84.42057
```

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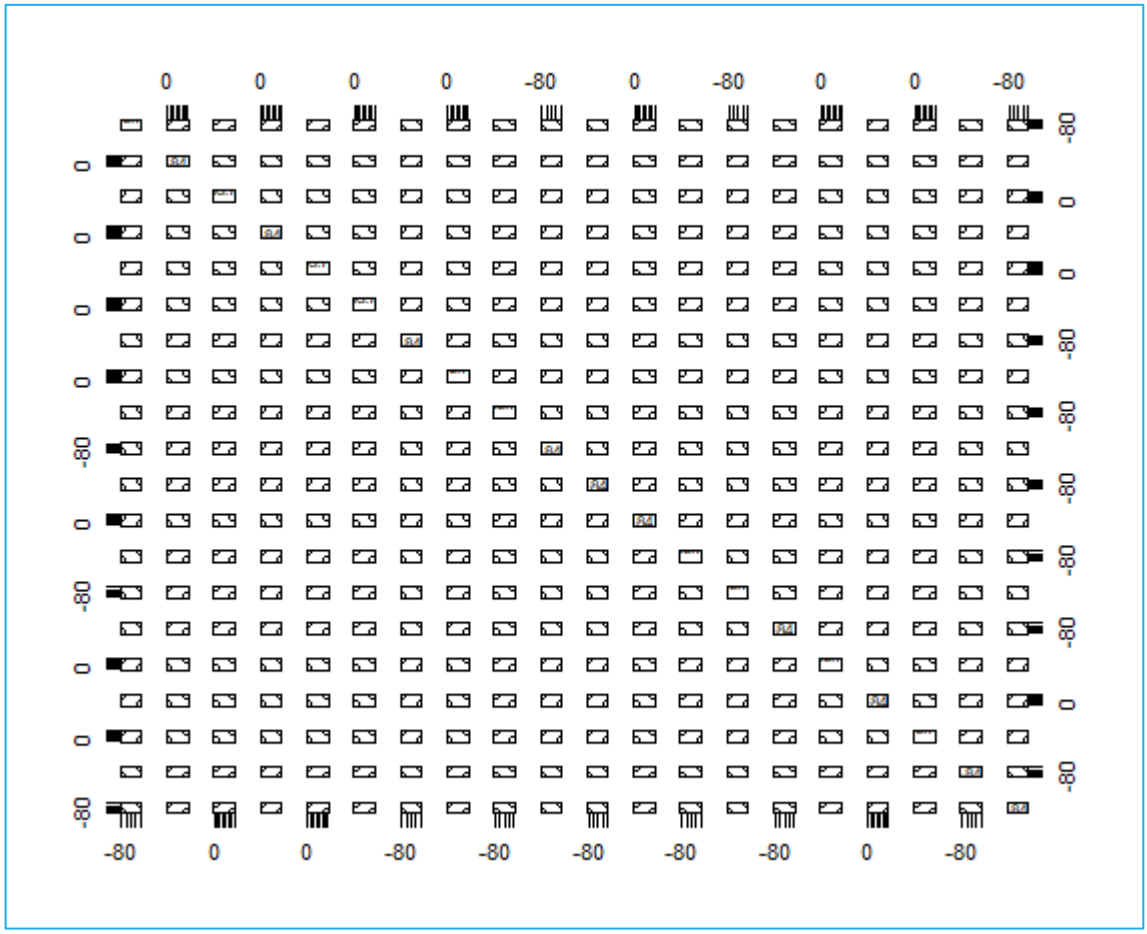
          y        y         x        y         x        y         x         x
1  33.75582 33.75582 -84.38013 33.75582 -84.38013 33.75582 -84.38013 -84.38013
2  33.78674 33.78674 -84.39745 33.78674 -84.39745 33.78674 -84.39745 -84.39745
3  33.73760 33.73760 -84.39486 33.73760 -84.39486 33.73760 -84.39486 -84.39486
4  33.75156 33.75156 -84.39887 33.75156 -84.39887 33.75156 -84.39887 -84.39887
5  33.72146 33.72146 -84.46522 33.72146 -84.46522 33.72146 -84.46522 -84.46522
6  33.74006 33.74006 -84.34660 33.74006 -84.34660 33.74006 -84.34660 -84.34660
7  33.74505 33.74505 -84.37373 33.74505 -84.37373 33.74505 -84.37373 -84.37373
8  33.77303 33.77303 -84.37190 33.77303 -84.37190 33.77303 -84.37190 -84.37190
9  33.74639 33.74639 -84.37285 33.74639 -84.37285 33.74639 -84.37285 -84.37285
10 33.72579 33.72579 -84.38625 33.72579 -84.38625 33.72579 -84.38625 -84.38625
11 33.73616 33.73616 -84.39495 33.73616 -84.39495 33.73616 -84.39495 -84.39495
12 33.74974 33.74974 -84.43192 33.74974 -84.43192 33.74974 -84.43192 -84.43192
13 33.68243 33.68243 -84.40766 33.68243 -84.40766 33.68243 -84.40766 -84.40766
14 33.71691 33.71691 -84.39276 33.71691 -84.39276 33.71691 -84.39276 -84.39276
15 33.73048 33.73048 -84.38742 33.73048 -84.38742 33.73048 -84.38742 -84.38742
16 33.70087 33.70087 -84.46574 33.70087 -84.46574 33.70087 -84.46574 -84.46574
17 33.75831 33.75831 -84.43107 33.75831 -84.43107 33.75831 -84.43107 -84.43107
18 33.79671 33.79671 -84.47527 33.79671 -84.47527 33.79671 -84.47527 -84.47527
19 33.70678 33.70678 -84.38031 33.70678 -84.38031 33.70678 -84.38031 -84.38031
20 33.84746 33.84746 -84.36983 33.84746 -84.36983 33.84746 -84.36983 -84.36983
21 33.75757 33.75757 -84.33868 33.75757 -84.33868 33.75757 -84.33868 -84.33868
22 33.77067 33.77067 -84.38023 33.77067 -84.38023 33.77067 -84.38023 -84.38023
23 33.70369 33.70369 -84.40795 33.70369 -84.40795 33.70369 -84.40795 -84.40795
24 33.75437 33.75437 -84.43089 33.75437 -84.43089 33.75437 -84.43089 -84.43089
25 33.74647 33.74647 -84.42057 33.74647 -84.42057 33.74647 -84.42057 -84.42057
 [ reached 'max' / getOption("max.print") -- omitted 75 rows ]
> 
```



```
> cor(rank1,rank2, method="spearman")
           y          x          y          x          y          y          x          y          y          x          x          x          y          y
x 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652 1.00000000 0.04033652 0.04033652 1.00000000 1.00000000 1.00000000 0.04033652 0.04033652
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x 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652 1.00000000 0.04033652 0.04033652 1.00000000 1.00000000 1.00000000 0.04033652 0.04033652
           x          y          x          y          x          x
x 1.00000000 0.04033652 1.00000000 0.04033652 1.00000000 1.00000000
y 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652
y 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652
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y 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652
y 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652
y 0.04033652 1.00000000 0.04033652 1.00000000 0.04033652 0.04033652
x 1.00000000 0.04033652 1.00000000 0.04033652 1.00000000 1.00000000
x 1.00000000 0.04033652 1.00000000 0.04033652 1.00000000 1.00000000
```

```
> cor(rank1,rank2, method="pearson")
           y          x          y          x          y          y          x          y          y          x          x          x          y          y
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
y  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385  1.0000000  1.0000000 -0.9999385 -0.9999385 -0.9999385  1.0000000  1.0000000
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
x -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000 -0.9999385 -0.9999385  1.0000000  1.0000000  1.0000000 -0.9999385 -0.9999385
           x          y          x          y          x          x
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
y -0.9999385  1.0000000 -0.9999385  1.0000000 -0.9999385 -0.9999385
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
x  1.0000000 -0.9999385  1.0000000 -0.9999385  1.0000000  1.0000000
```