Assignment 10.1

Import dataset from the following link: AirQuality Data Set

Perform the following written operations:

1. Read the file in Zip format and get it into R.

2. Create Univariate for all the columns.

3. Check for missing values in all columns.

4. Impute the missing values using appropriate methods.

5. Create bi-variate analysis for all relationships.

6. Test relevant hypothesis for valid relations.

7. Create cross tabulations with derived variables.

8. Check for trends and patterns in time series. 9. Find out the most polluted time of the day and the name of the chemical compound.

1. Read the file in Zip format and get it into R.

Ans:-

```
mydata<-read_csv("AirqualityUCI.zip")

library(readr)

AirQualityUCI <- read_delim("AirQualityUCI.zip",

 ";", escape_double = FALSE, trim_ws = TRUE)

View(AirQualityUCI)
```

```
Multiple files in zip: reading 'AirQualityUCI.csv'
Parsed with column specification:
cols(`Date;Time;CO(GT);PT08.S1(CO);NMHC(GT);C6H6(GT);PT08.S2(NMHC);NOx(GT);PT
08.S3(NOx);NO2(GT);PT08.S4(NO2);PT08.S5(O3);T;RH;AH;;` = col_character()
```

```
)
number of columns of result is not a multiple of vector length (arg 1)9357
parsing failures.
row # A tibble: 5 x 5 col     row col   expected  actual    file
expected   <int> <chr> <chr>     <chr>     <chr>               actual 1     1
NA    1 columns 6 columns 'AirqualityUCI.zip' file 2     2 NA    1 columns 5
columns 'AirqualityUCI.zip' row 3     3 NA    1 columns 6 columns
'AirqualityUCI.zip' col 4     4 NA    1 columns 6 columns 'AirqualityUCI.zip'
expected 5     5 NA    1 columns 6 columns 'AirqualityUCI.zip'
... ................................. ...
.......................................... ........
.....................................................................
.....................................................................
.......................... ......
.....................................................................
.. ....
.....................................................................
.. ...
.....................................................................
.. ...
.....................................................................
.. ........
.....................................................................
..
See problems(...) for more details.
Multiple files in zip: reading 'AirQualityUCI.csv'
Missing column names filled in: 'X16' [16], 'X17' [17]Parsed with column
specification:
cols(
  Date = col_character(),
  Time = col_character(),
  `CO(GT)` = col_character(),
  `PT08.S1(CO)` = col_integer(),
  `NMHC(GT)` = col_integer(),
  `C6H6(GT)` = col_character(),
  `PT08.S2(NMHC)` = col_integer(),
  `NOx(GT)` = col_integer(),
  `PT08.S3(NOx)` = col_integer(),
  `NO2(GT)` = col_integer(),
  `PT08.S4(NO2)` = col_integer(),
  `PT08.S5(O3)` = col_integer(),
  T = col_number(),
  RH = col_number(),
  AH = col_character(),
  X16 = col_character(),
  X17 = col_character()
)
```

Other method

```
## a quicker way that doesnt require that you know which files - just does
all
## \ allows you to use the . in .zip, the . is a special character
## $ is tells the pattern to search is the end? not sure about this one
for (i in dir(pattern="\.zip$"))
unzip(i)
```

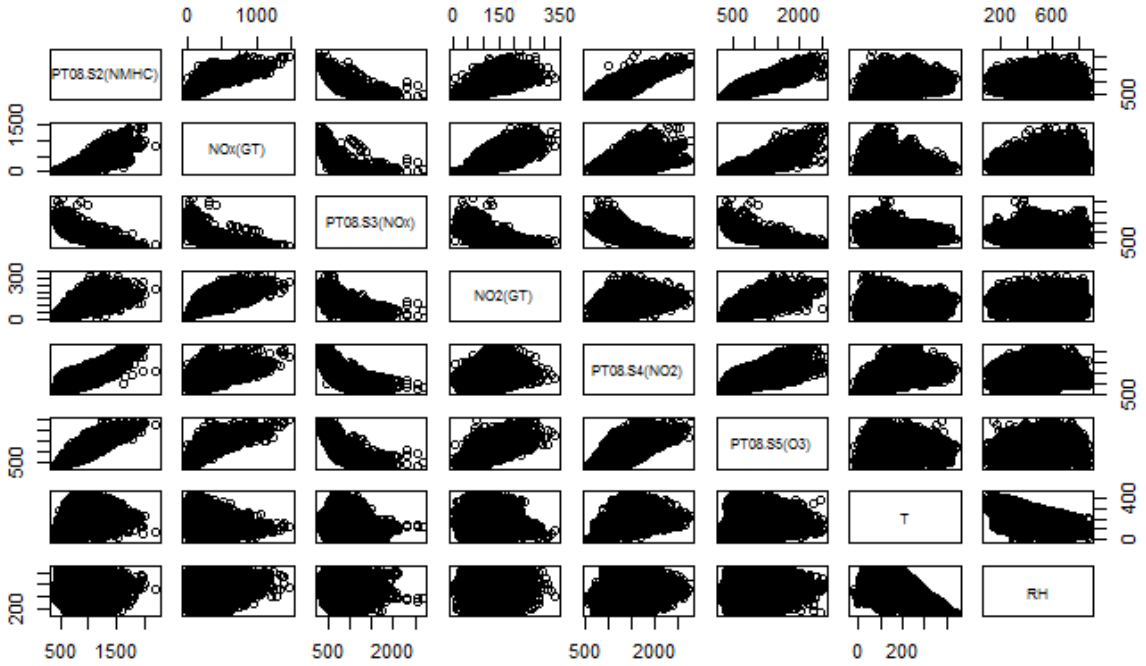
2. Create Univariate for all the columns.

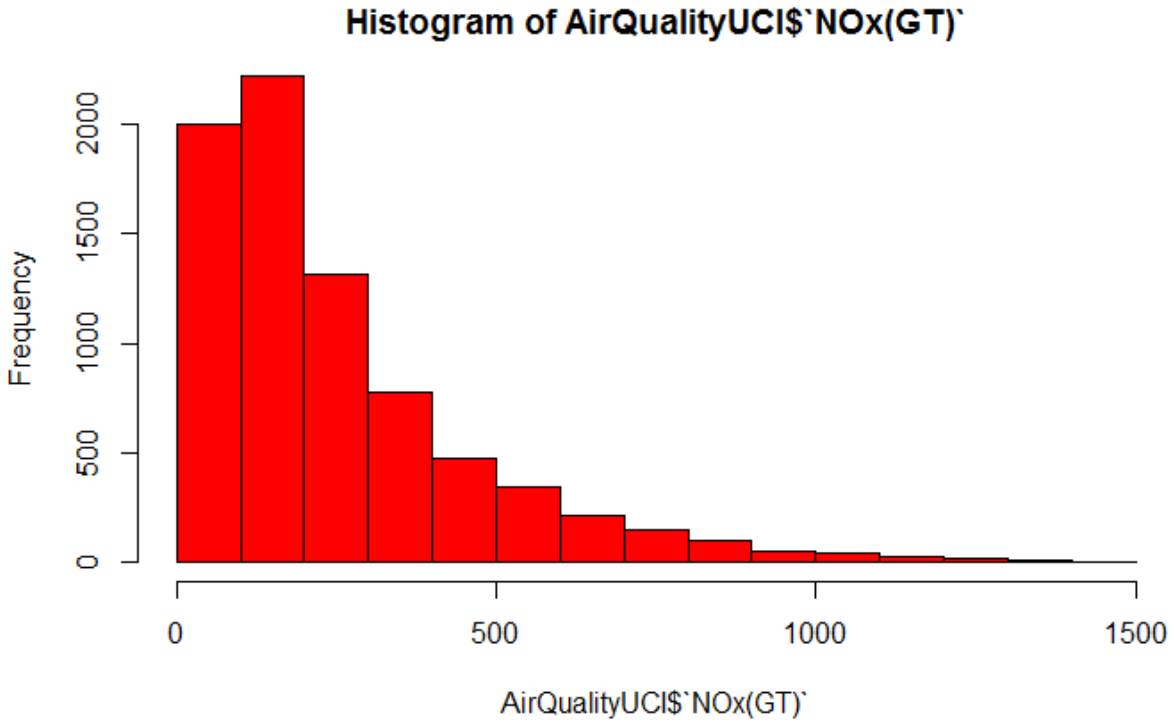
```
AirQualityUCI[AirQualityUCI==-200.0]<-NA

for(i in 1:ncol(AirQualityUCI)){AirQualityUCI[is.na(AirQualityUCI[,i]),i] <- mean(AirQualityUCI[,i], na.rm = TRUE)}

summary(AirQualityUCI)

AirQualityUCI[7:14,]

hist(AirQualityUCI$`NOx(GT)`,col="red")

dotchart(AirQualityUCI$`PT08.S2(NMHC)`,labels = row.names(AirQualityUCI$`PT08.S1(CO)`),cex=0.5, color = "blue")

pairs(AirQualityUCI[7:14])
```

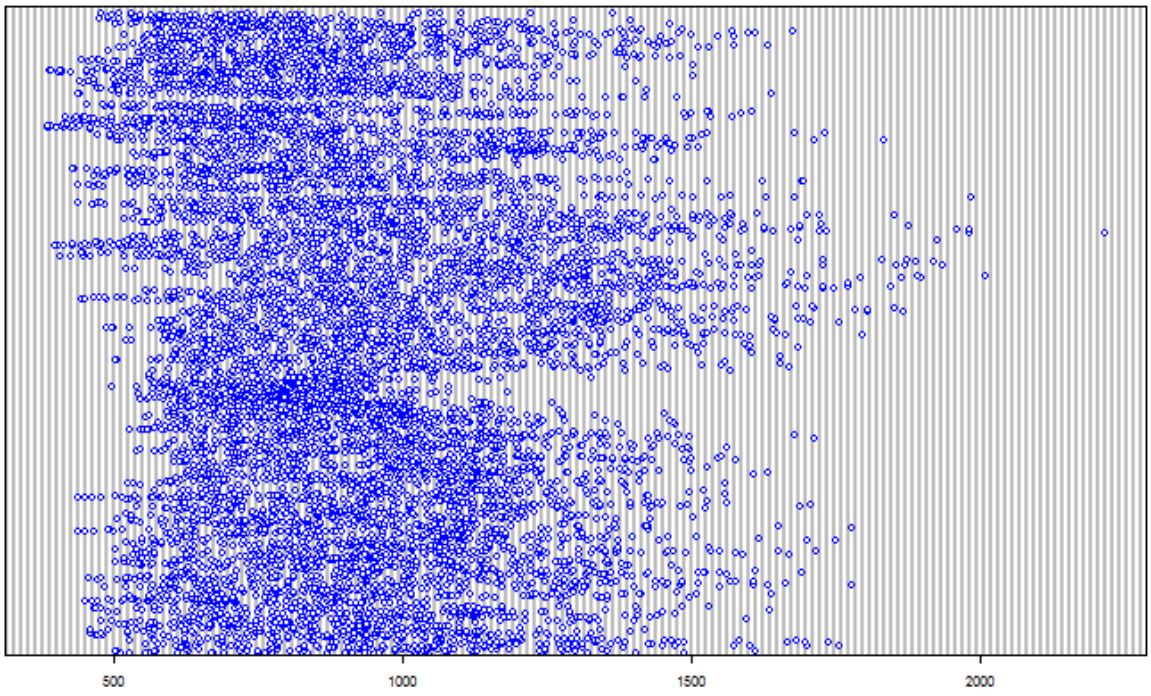
Date <chr>	Time <chr>	CO(GT) <chr>	PT08.S1(CO) <dbl>	NMHC(GT) <dbl>	C6H6(GT) <chr>	PT08.S2(NMHC) <dbl>
11/03/2004	00.00.00	1,2	1185	31	3,6	690
11/03/2004	01.00.00	1	1136	31	3,3	672
11/03/2004	02.00.00	0,9	1094	24	2,3	609
11/03/2004	03.00.00	0,6	1010	19	1,7	561
11/03/2004	04.00.00	*NA*	1011	14	1,3	527
11/03/2004	05.00.00	0,7	1066	8	1,1	512
11/03/2004	06.00.00	0,7	1052	16	1,6	553
11/03/2004	07.00.00	1,1	1144	29	3,2	667

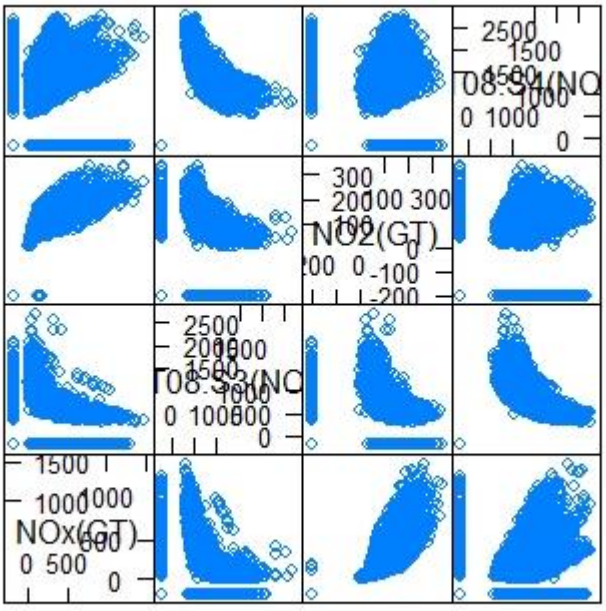
8 rows | 1-7 of 17 columns

```
univariateTable(~Date +Time + CO(GT) + PT08.S1(CO)+ NMHC(GT)+ C6H6(GT)+ PT08.S2(NMHC)+ NOx(GT)+ PT08.S3(NOx) ,data=AirqualityUCI)
```

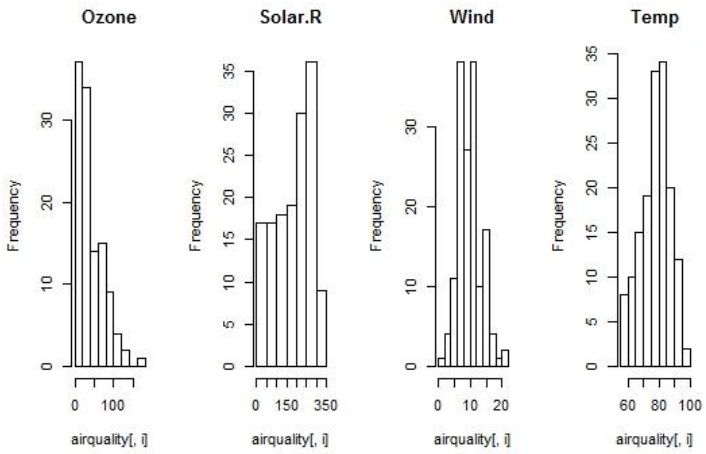

PT08.S2(NMHC)
NOx(GT)
PT08.S3(NOx)
NO2(GT)
PT08.S4(NO2)
PT08.S5(O3)
T
RH


Histogram of AirQualityUCI$`NOx(GT)`
Frequency
0
500
1000
1500
2000
AirQualityUCI$`NOx(GT)`





Scatter Plot Matrix



3. Check for missing values in all columns.

```
> colSums(is.na(AirQualityUCI))   # Number of missing per column/variable
          Date           Time        CO(GT)   PT08.S1(CO)      NMHC(GT)       C6
H6(GT)
           114            114            114           114            114
114
PT08.S2(NMHC)        NOx(GT)   PT08.S3(NOx)       NO2(GT)   PT08.S4(NO2)    PT08.
S5(O3)
           114            114            114           114            114
114
             T             RH             AH           X16            X17
           114            114            114          9471           9471
```

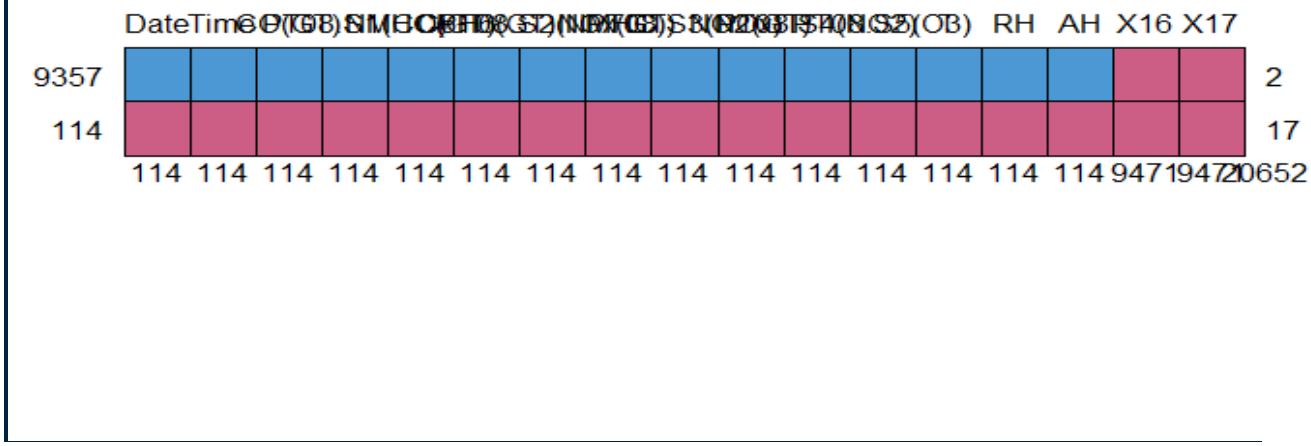
Pattern of missing values

library(mice)

md.pattern(AirQualityUCI) #pattern or missing values in data.

```
  Date Time CO(GT) PT08.S1(CO) NMHC(GT) C6H6(GT) PT08.S2(NMHC) NOx(GT)
9357    1    1       1            1         1          1             1       1
114     0    0       0            0         0          0             0       0
```

```
      114  114    114          114       114       114           114      114
     PT08.S3(NOx) NO2(GT) PT08.S4(NO2) PT08.S5(O3)   T  RH  AH  X16  X17
9357            1       1            1           1   1   1   1    0    0
2
114             0       0            0           0   0   0   0    0    0
17
              114     114          114         114 114 114 114 9471 9471
20652
```



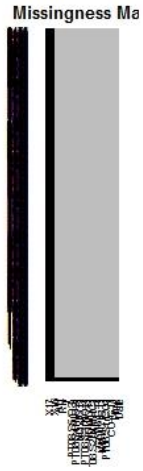

```
> str(AirQualityUCI)
Classes ‘tbl_df’, ‘tbl’ and 'data.frame':    9471 obs. of  17 variables:
 $ Date          : chr  "10/03/2004" "10/03/2004" "10/03/2004" "10/03/2004" ...
 $ Time          : chr  "18.00.00" "19.00.00" "20.00.00" "21.00.00" ...
 $ CO(GT)        : chr  "2,6" "2" "2,2" "2,2" ...
 $ PT08.S1(CO)   : int  1360 1292 1402 1376 1272 1197 1185 1136 1094 1010 ...
 $ NMHC(GT)      : int  150 112 88 80 51 38 31 31 24 19 ...
 $ C6H6(GT)      : chr  "11,9" "9,4" "9,0" "9,2" ...
 $ PT08.S2(NMHC): int  1046 955 939 948 836 750 690 672 609 561 ...
 $ NOx(GT)       : int  166 103 131 172 131 89 62 62 45 -200 ...
 $ PT08.S3(NOx)  : int  1056 1174 1140 1092 1205 1337 1462 1453 1579 1705 ...
 $ NO2(GT)       : int  113 92 114 122 116 96 77 76 60 -200 ...
 $ PT08.S4(NO2)  : int  1692 1559 1555 1584 1490 1393 1333 1333 1276 1235 ...
 $ PT08.S5(O3)   : int  1268 972 1074 1203 1110 949 733 730 620 501 ...
 $ T             : num  136 133 119 110 112 112 113 107 107 103 ...
 $ RH            : num  489 477 540 600 596 592 568 600 597 602 ...
 $ AH            : chr  "0,7578" "0,7255" "0,7502" "0,7867" ...
 $ X16           : chr  NA NA NA NA ...
 $ X17           : chr  NA NA NA NA ...
 - attr(*, "spec")=List of 2
  ..$ cols   :List of 17
  .. ..$ Date         : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ Time         : list()
```

```
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ CO(GT)       : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ PT08.S1(CO)  : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ NMHC(GT)     : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ C6H6(GT)     : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ PT08.S2(NMHC): list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ NOx(GT)      : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ PT08.S3(NOx) : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ NO2(GT)      : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ PT08.S4(NO2) : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ PT08.S5(O3)  : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ T            : list()
  .. .. ..- attr(*, "class")= chr  "collector_number" "collector"
  .. ..$ RH           : list()
  .. .. ..- attr(*, "class")= chr  "collector_number" "collector"
  .. ..$ AH           : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ X16          : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ X17          : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  ..$ default: list()
  .. ..- attr(*, "class")= chr  "collector_guess" "collector"
  ..- attr(*, "class")= chr "col_spec"
> summary(AirQualityUCI)
     Date               Time              CO(GT)           PT08.S1(CO)      NMHC(GT)
 Length:9471        Length:9471        Length:9471        Min.   :-200   Min.   :-200.0
 Class :character   Class :character   Class :character   1st Qu.: 921   1st Qu.:-200.0
 Mode  :character   Mode  :character   Mode  :character   Median :1053   Median :-200.0
                                                          Mean   :1049   Mean   :-159.1
                                                          3rd Qu.:1221   3rd Qu.:-200.0
                                                          Max.   :2040   Max.   :1189.0
                                                          NA's   :114    NA's   :114
   C6H6(GT)         PT08.S2(NMHC)       NOx(GT)         PT08.S3(NOx)     NO2(GT)
 Length:9471        Min.   :-200.0   Min.   :-200.0   Min.   :-200   Min.   :-200.00
 Class :character   1st Qu.: 711.0   1st Qu.:  50.0   1st Qu.: 637   1st Qu.:  53.00
 Mode  :character   Median : 895.0   Median : 141.0   Median : 794   Median :  96.00
                    Mean   : 894.6   Mean   : 168.6   Mean   : 795   Mean   :  58.15
                    3rd Qu.:1105.0   3rd Qu.: 284.0   3rd Qu.: 960   3rd Qu.: 133.00
                    Max.   :2214.0   Max.   :1479.0   Max.   :2683   Max.   : 340.00
                    NA's   :114      NA's   :114      NA's   :114    NA's   :114
  PT08.S4(NO2)   PT08.S5(O3)           T                RH               AH
 Min.   :-200   Min.   :-200.0   Min.   :-200.0   Min.   :-200.0   Length:9471
 1st Qu.:1185   1st Qu.: 700.0   1st Qu.: 109.0   1st Qu.: 341.0   Class :character
 Median :1446   Median : 942.0   Median : 172.0   Median : 486.0   Mode  :character
 Mean   :1391   Mean   : 975.1   Mean   : 168.2   Mean   : 465.3
 3rd Qu.:1662   3rd Qu.:1255.0   3rd Qu.: 241.0   3rd Qu.: 619.0
 Max.   :2775   Max.   :2523.0   Max.   : 446.0   Max.   : 887.0
 NA's   :114    NA's   :114      NA's   :114      NA's   :114
     X16                X17
 Length:9471        Length:9471
 Class :character   Class :character
 Mode  :character   Mode  :character
```

```
> is.na(AirQualityUCI)
        Date  Time CO(GT) PT08.S1(CO) NMHC(GT) C6H6(GT) PT08.S2(NMHC) NOx(GT) PT08.S3(NOx)
   [1,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [2,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [3,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [4,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [5,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [6,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [7,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [8,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
   [9,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [10,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [11,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [12,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [13,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [14,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [15,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [16,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [17,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [18,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [19,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [20,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [21,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [22,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [23,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [24,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [25,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [26,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [27,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [28,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [29,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [30,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [31,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [32,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [33,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [34,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [35,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [36,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [37,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [38,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [39,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [40,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [41,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [42,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [43,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [44,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [45,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [46,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [47,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [48,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [49,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [50,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [51,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [52,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [53,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [54,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [55,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [56,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [57,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
  [58,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE         FALSE
       NO2(GT) PT08.S4(NO2) PT08.S5(O3)     T    RH    AH  X16  X17
```

```
    [1,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [2,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [3,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [4,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [5,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [6,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [7,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [8,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
    [9,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [10,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [11,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [12,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [13,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [14,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [15,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [16,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [17,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [18,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [19,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [20,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [21,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [22,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [23,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [24,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [25,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [26,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [27,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [28,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [29,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [30,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [31,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [32,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [33,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [34,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [35,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [36,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [37,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [38,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [39,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [40,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [41,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [42,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [43,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [44,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [45,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [46,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [47,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [48,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [49,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [50,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [51,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [52,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [53,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [54,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [55,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [56,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [57,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [58,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
 [ reached getOption("max.print") -- omitted 9413 rows ]
> library(Amelia)
> library(mlbench)
> # create a missing map
> missmap(AirQualityUCI, col=c("black", "grey"), legend=FALSE)
Warning messages:
```

```
1: In if (class(obj) == "amelia") { :
  the condition has length > 1 and only the first element will be used
2: Unknown or uninitialised column: 'arguments'.
3: Unknown or uninitialised column: 'arguments'.
4: Unknown or uninitialised column: 'imputations'.

>
```




```
colSums(is.na(AirQualityUCI))   # Number of missing per column/variable
```

```
> colSums(is.na(AirQualityUCI))   # Number of missing per column/variable
        Date         Time       CO(GT)  PT08.S1(CO)     NMHC(GT)       C6H6(GT)
         114          114          114          114          114          114
PT08.S2(NMHC)      NOx(GT)  PT08.S3(NOx)      NO2(GT)  PT08.S4(NO2)  PT08.S5(O3)
         114          114          114          114          114          114
           T           RH           AH          X16          X17
         114          114          114         9471         9471
```

4. Impute the missing values using appropriate methods.

Ans:-

colSums(is.na(AirQualityUCI)) # Number of missing per column/variable

#filling the missing values by NA

library(plyr)

```
AirQualityUCI[AirQualityUCI==-200.0]<-NA

#Replacing the NA by mean of each columns

for(i in 1:ncol(AirQualityUCI)){

 AirQualityUCI[is.na(AirQualityUCI[,i]),i] <- mean(AirQualityUCI[,i], na.rm = TRUE)}

summary(AirQualityUCI)
```

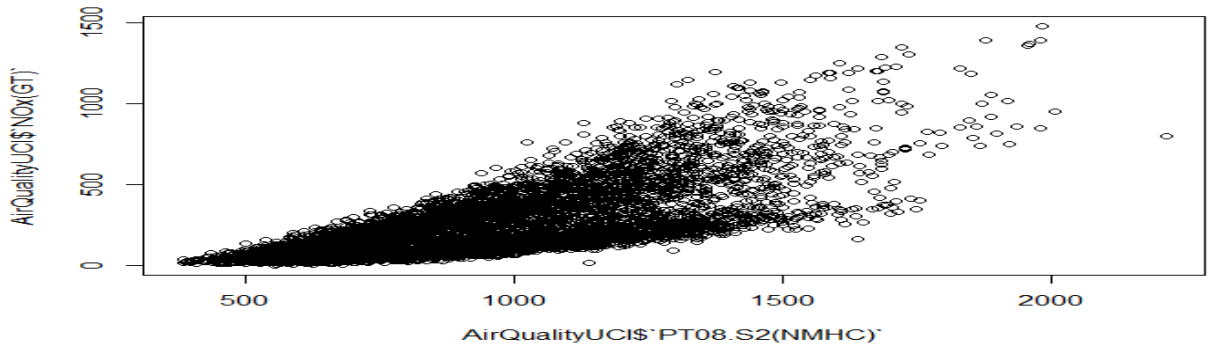
```
Mode  :character   Mode  :character   Mode  :character   Median :1063
                                                          Mean   :1100
                                                          3rd Qu.:1231
                                                          Max.   :2040
                                                          NA's   :480
    NMHC(GT)        C6H6(GT)         PT08.S2(NMHC)       NOx(GT)
 Min.   :   7.0   Length:9471        Min.   : 383.0   Min.   :   2.0
 1st Qu.:  67.0   Class :character   1st Qu.: 734.5   1st Qu.:  98.0
 Median : 150.0   Mode  :character   Median : 909.0   Median : 180.0
 Mean   : 218.8                      Mean   : 939.2   Mean   : 246.9
 3rd Qu.: 297.0                      3rd Qu.:1116.0   3rd Qu.: 326.0
 Max.   :1189.0                      Max.   :2214.0   Max.   :1479.0
 NA's   :8557                        NA's   :480      NA's   :1753
  PT08.S3(NOx)       NO2(GT)       PT08.S4(NO2)   PT08.S5(O3)           T
 Min.   : 322.0   Min.   :  2.0   Min.   : 551   Min.   : 221.0   Min.   :-
19.0
 1st Qu.: 658.0   1st Qu.: 78.0   1st Qu.:1227   1st Qu.: 731.5   1st
Qu.:118.0
 Median : 806.0   Median :109.0   Median :1463   Median : 963.0   Median
:178.0
 Mean   : 835.5   Mean   :113.1   Mean   :1456   Mean   :1022.9   Mean
:183.2
 3rd Qu.: 969.5   3rd Qu.:142.0   3rd Qu.:1674   3rd Qu.:1273.5   3rd
Qu.:244.0
 Max.   :2683.0   Max.   :340.0   Max.   :2775   Max.   :2523.0   Max.
:446.0
 NA's   :480      NA's   :1756    NA's   :480    NA's   :480      NA's   :480
       RH              AH                X16                X17
 Min.   : 92.0   Length:9471        Length:9471        Length:9471
 1st Qu.:358.0   Class :character   Class :character   Class :character
 Median :496.0   Mode  :character   Mode  :character   Mode  :character
 Mean   :492.3
 3rd Qu.:625.0
 Max.   :887.0
 NA's   :480
```

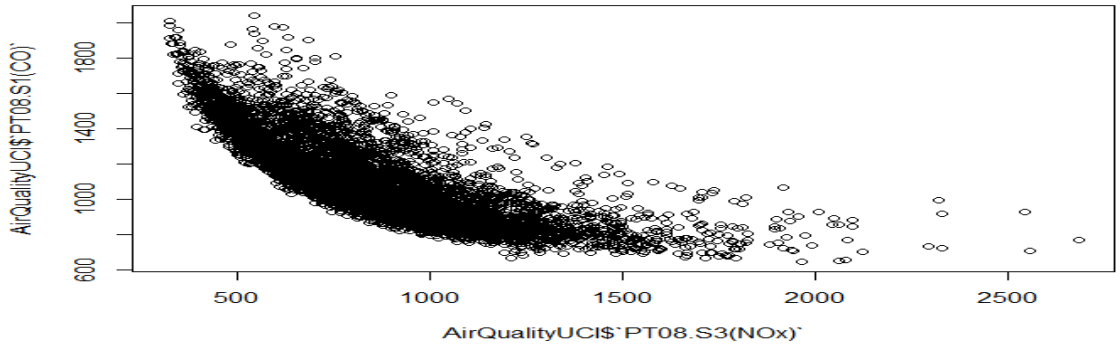
5. Create bi-variate analysis for all relationships.

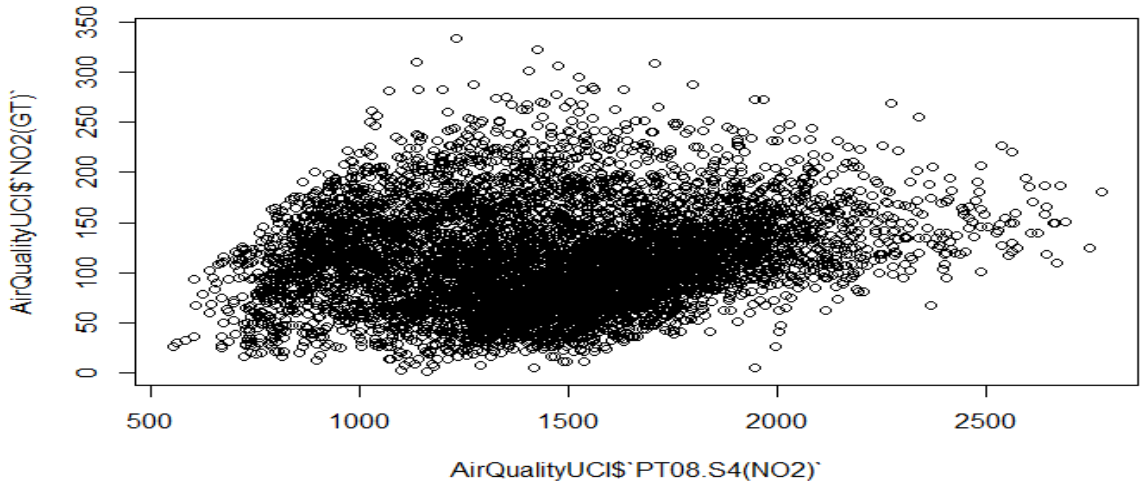
```
summary(AirQualityUCI)

plot(AirQualityUCI$`NOx(GT)`~AirQualityUCI$`PT08.S2(NMHC)`)

plot(AirQualityUCI$`PT08.S1(CO)`~AirQualityUCI$`PT08.S3(NOx)`)
```

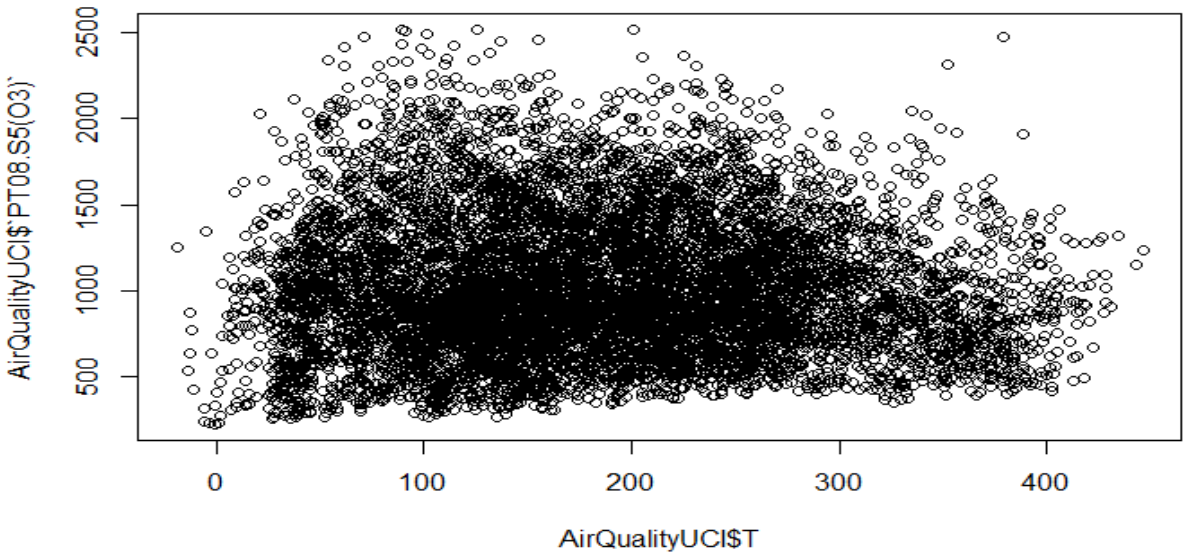
plot(AirQualityUCI$`NO2(GT)`~AirQualityUCI$`PT08.S4(NO2)`)

plot(AirQualityUCI$`PT08.S5(O3)`~AirQualityUCI$T)









6. Test relevant hypothesis for valid relations.

plot(AirQualityUCI$`PT08.S1(CO)`,AirQualityUCI$T)

lm(formula=AirQualityUCI$`PT08.S3(NOx)`~AirQualityUCI$`NOx(GT)`)

lm(formula = AirQualityUCI$`PT08.S1(CO)`~AirQualityUCI$T)

lm(formula = AirQualityUCI$`NMHC(GT)`~AirQualityUCI$`PT08.S2(NMHC)`)

plot(AirQualityUCI$`PT08.S5(O3)`,AirQualityUCI$`NOx(GT)`)

lm(formula =AirQualityUCI$`PT08.S5(O3)`~AirQualityUCI$`NOx(GT)`)

pnorm(1.49)

pnorm(1.097)

qnorm(0.9318879)

qnorm(0.8636793)

```
Call:
lm(formula = AirQualityUCI$`PT08.S3(NOx)` ~ AirQualityUCI$`NOx(GT)`)

Coefficients:
            (Intercept)  AirQualityUCI$`NOx(GT)`
              1022.2737                  -0.8165
```

```
Call:
lm(formula = AirQualityUCI$`PT08.S1(CO)` ~ AirQualityUCI$T)

Coefficients:
    (Intercept)  AirQualityUCI$T
      1077.9402           0.1195


Call:
lm(formula = AirQualityUCI$`NMHC(GT)` ~ AirQualityUCI$`PT08.S2(NMHC)`)

Coefficients:
                  (Intercept)  AirQualityUCI$`PT08.S2(NMHC)`
                    -410.0522                          0.6663


Call:
lm(formula = AirQualityUCI$`PT08.S5(O3)` ~ AirQualityUCI$`NOx(GT)`)

Coefficients:
            (Intercept)  AirQualityUCI$`NOx(GT)`
                670.796                    1.548
```

library(car)

mod=lm(AirQualityUCI$`PT08.S5(O3)` ~ AirQualityUCI$`NOx(GT)`)

summary(mod)

predict(mod)

```
Call:
lm(formula = AirQualityUCI$`PT08.S5(O3)` ~ AirQualityUCI$`NOx(GT)`)

Residuals:
    Min      1Q  Median      3Q     Max
-978.34 -172.18  -16.95  143.35 1324.95

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)
(Intercept)            670.79645    4.48936   149.4   <2e-16 ***
AirQualityUCI$`NOx(GT)`   1.54807    0.01411   109.7   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 250.4 on 7394 degrees of freedom
  (2075 observations deleted due to missingness)
Multiple R-squared:  0.6194,   Adjusted R-squared:  0.6194
F-statistic: 1.204e+04 on 1 and 7394 DF,  p-value: < 2.2e-16
```

```
pnorm(1.49)
pnorm(1.097)
qnorm(0.9318879)
qnorm(0.8636793)

[1] 0.9318879
[1] 0.8636793
[1] 1.49
[1] 1.097


        1         2         3         4         5         6         7
 927.7768  830.2481  873.5942  937.0653  873.5942  808.5751  766.7771
766.7771
        9        11        12        13        14        15        16
17
 740.4598  703.3060  695.5656  723.4310  822.5077  940.1614  870.4980
844.1808
       18        19        20        21        22        23        24
25
 817.8635  831.7962  896.8153  991.2479  955.6421  969.5748 1046.9785
1105.8054
       26        27        28        29        30        31        32
33
1263.7090 1214.1706 1042.3343  816.3154  743.5559  859.6615  876.6903
797.7386
       35        36        37        38        39        41        42
43
 703.3060  717.2387  757.4886  839.5366 1146.0553  960.2864 1005.1805
892.1711
       44        45        46        47        48        49        50
51
 918.4884  923.1326  964.9306  946.3537  903.0076  989.6998  983.5075
1197.1418
       52        53        54        55        56        57        59
60
1094.9688 1062.4593 1135.2188  969.5748  885.9788  799.2866  839.5366
766.7771
       61        62        63        64        65        66        67
68
 752.8444  885.9788 1067.1035 1127.4784 1057.8151 1129.0265 1040.7862
907.6518
       69        70        71        72        73        74        75
76
 853.4692  855.0173  884.4307  899.9115 1022.2093 1099.6131 1102.7092
1108.9015
       77        78        79        80        81        83        84
85
1002.0844  937.0653  964.9306  940.1614  868.9500  779.1617  752.8444
738.9117
```

```
       86        87        88        89        90        91        92
93
 785.3540  827.1520  853.4692  893.7192  943.2575  920.0364  845.7289
830.2481
       94        95        96        97        98        99       100
101
 844.1808  933.9691  949.4498  918.4884 1074.8439 1173.9206 1006.7286
896.8153
      102       103       104       105       107       108       109
110
 906.1038  831.7962  834.8923  837.9885  772.9694  807.0270  884.4307
1023.7574
      111       112       113       114       115       116       117
118
1228.1032 1410.7760 1280.7378 1164.6322  981.9594  935.5172  916.9403
907.6518
      119       120       121       122       123       124       125
126
 892.1711  912.2961 1156.8918 1296.2185 1166.1803 1067.1035  969.5748
808.5751
      127       128       129       131       132       133       134
135
 867.4019  793.0943  737.3636  762.1328  729.6233  797.7386  824.0558
1077.9400
      136       137       138       139       140       141       142
143
1025.3055 1283.8339 1156.8918 1006.7286 1060.9112 1077.9400  949.4498
955.6421
      144       145       146       147       148       149       150
151
 964.9306  955.6421  950.9979  927.7768 1161.5360  955.6421  872.0461
875.1423
      152       153       155       156       157       158       159
160
 817.8635  779.1617  754.3925  714.1425  742.0079  918.4884 1166.1803
1254.4205
      161       162       163       164       165       166       167
168
1104.2573 1012.9209  995.8921  986.6036  920.0364  879.7865  958.7383
898.3634
      169       170       171       172       173       174       175
176
1133.6707 1307.0550 1207.9783 1190.9495  983.5075  946.3537  909.1999
813.2193
      177       179       180       181       182       183       184
185
 765.2290  763.6809  728.0752  776.0655  885.9788 1195.5937 1322.5358
1211.0744
      186       187       188       189       190       191       192
193
1017.5651  935.5172  901.4595  882.8826  901.4595  937.0653  927.7768
1002.0844
      194       195       196       197       198       199       200
201
1104.2573 1098.0650  946.3537  870.4980  817.8635  865.8538  830.2481
745.1040
```

```
      203       204       205       206       207       208       209
210
 701.7579  698.6618  757.4886  848.8250 1166.1803 1223.4590 1062.4593
1008.2767
      211       212       213       214       215       216       217
218
 968.0267  943.2575  977.3152  998.9882 1056.2670 1088.7765 1028.4016
1059.3631
      219       220       221       222       223       224       225
227
 995.8921 1056.2670  892.1711  867.4019  831.7962  803.9308  785.3540
738.9117
      228       229       230       231       232       233       234
235
 735.8156  768.3251  848.8250  933.9691  898.3634  927.7768  972.6710
952.5460
      236       237       238       239       240       241       242
243
 930.8730  864.3058  817.8635  793.0943  855.0173  890.6230 1003.6325
1025.3055
      244       245       246       247       248       249       251
252
 989.6998  898.3634  859.6615  941.7095  876.6903  808.5751  802.3828
755.9405
      253       254       255       256       257       258       259
260
 707.9502  782.2578  859.6615  842.6327  861.2096  834.8923  830.2481
828.7000
      261       262       263       264       265       266       267
268
 745.1040  768.3251  822.5077  875.1423  938.6133  957.1902 1082.5842
961.8344
      269       270       271       272       273       275       276
277
 859.6615  844.1808  814.7674  785.3540  706.4022  697.1137  694.0176
734.2675
      278       279       280       281       282       283       284
285
 803.9308 1020.6613 1002.0844  848.8250  862.7577  859.6615  836.4404
876.6903
      286       287       288       289       290       291       292
293
 872.0461  903.0076  884.4307 1000.5363 1029.9497 1039.2382  949.4498
868.9500
      294       295       296       297       299       300       301
302
 771.4213  752.8444  743.5559  749.7482  701.7579  690.9214  721.8829
830.2481
      303       304       305       306       307       308       309
310
1017.5651 1048.5266 1037.6901 1011.3728  991.2479  992.7959  918.4884
873.5942
      311       312       313       314       315       316       317
318
 868.9500  943.2575  836.4404  873.5942  927.7768  808.5751  796.1905
791.5463
```

```
      319       320       321       323       324       325       326
327
 779.1617  788.4501  737.3636  738.9117  723.4310  737.3636  793.0943
940.1614
      328       329       330       331       332       333       334
335
1034.5939 1008.2767  881.3346  851.9212  855.0173  865.8538  825.6039
975.7671
      336       337       338       339       340       341       342
343
 972.6710  912.2961 1053.1708  964.9306  932.4210  853.4692  796.1905
794.6424
      344       345       347       348       349       350       351
352
 735.8156  729.6233  698.6618  689.3733  737.3636  800.8347  955.6421
983.5075
      353       354       355       356       357       358       359
360
 876.6903  872.0461  834.8923  875.1423  834.8923  864.3058  884.4307
856.5654
      361       362       363       364       365       366       367
368
 915.3922 1062.4593 1028.4016  903.0076  824.0558  786.9020  814.7674
793.0943
      369       371       372       373       374       375       376
377
 774.5174  740.4598  782.2578  830.2481  875.1423 1040.7862 1096.5169
1029.9497
      378       379       380       381       382       383       384
385
 949.4498  844.1808  850.3731  830.2481  808.5751  844.1808  867.4019
864.3058
      386       387       388       389       390       391       392
393
 856.5654  856.5654  824.0558  793.0943  772.9694  816.3154  779.1617
786.9020
      395       396       397       398       399       400       401
402
 759.0367  720.3348  754.3925  776.0655  822.5077  868.9500  870.4980
872.0461
      403       404       405       406       407       408       409
410
 842.6327  834.8923  882.8826  845.7289  859.6615  882.8826  926.2287
974.2190
      411       412       413       414       415       416       417
419
 940.1614  887.5269  828.7000  872.0461  858.1135  842.6327  805.4789
789.9982
      420       421       422       423       424       425       426
427
 731.1713  789.9982  811.6712  833.3443  876.6903  868.9500  865.8538
813.2193
      428       429       430       431       432       433       434
435
 772.9694  748.2002  779.1617  783.8059  789.9982  803.9308  814.7674
833.3443
```

```
      436       437       438       439       440       441       443
444
 774.5174  768.3251  768.3251  742.0079  703.3060  704.8541  731.1713
755.9405
      445       446       447       448       449       450       451
452
 788.4501  950.9979 1071.7477  853.4692  855.0173  861.2096  813.2193
811.6712
      453       454       455       456       457       458       459
460
 830.2481  828.7000  816.3154  822.5077  865.8538  837.9885  817.8635
791.5463
      461       462       463       464       465       467       468
469
 765.2290  755.9405  759.0367  734.2675  742.0079  734.2675  751.2963
842.6327
      470       471       472       473       474       475       476
477
 966.4787 1048.5266 1108.9015 1166.1803 1056.2670 1009.8247  980.4113
884.4307
      478       479       480       481       482       483       484
485
 853.4692  824.0558  844.1808  851.9212  870.4980  875.1423  783.8059
776.0655
      486       487       488       489       491       492       493
494
 794.6424  776.0655  738.9117  743.5559  694.0176  738.9117  802.3828
991.2479
      495       496       497       498       499       500       501
502
1026.8536  950.9979  893.7192  887.5269  986.6036  901.4595  935.5172
972.6710
      503       504       505       506       507       508       509
510
 906.1038  868.9500  858.1135  890.6230  873.5942  796.1905  763.6809
759.0367
      511       512       513       515       516       517       518
519
 819.4116  802.3828  748.2002  759.0367  769.8732  907.6518 1200.2379
1255.9686
      520       521       522       523       524       528       529
530
1141.4111  968.0267  872.0461  834.8923  828.7000  923.1326  997.4402
1084.1323
      531       532       533       534       535       536       537
539
1087.2285  909.1999  867.4019  859.6615  865.8538  800.8347  760.5848
728.0752
      540       541       542       543       544       545       546
547
 757.4886  811.6712  916.9403  964.9306 1056.2670  974.2190  949.4498
929.3249
      548       549       550       551       552       553       554
555
 916.9403  906.1038  901.4595  892.1711  957.1902 1016.0170 1003.6325
1090.3246
```

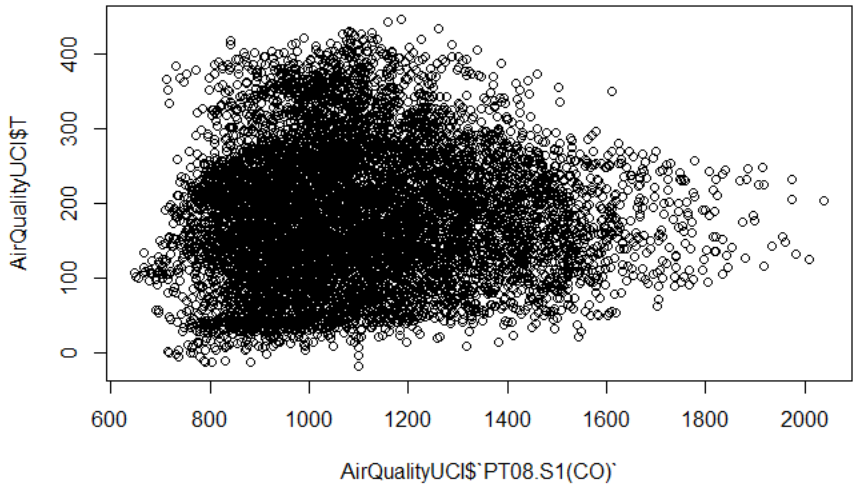
```
      556       557       558       559       560       561       563
564
 949.4498  848.8250  901.4595  822.5077  783.8059  777.6136  763.6809
757.4886
      565       566       567       568       617       618       619
620
 783.8059  916.9403  985.0556  997.4402 1036.1420 1023.7574  989.6998
961.8344
      621       622       623       624       625       626       627
628
 915.3922  862.7577  822.5077  918.4884  971.1229  940.1614  913.8441
839.5366
      629       630       631       632       633       635       636
637
 802.3828  810.1231  765.2290  726.5271  709.4983  707.9502  783.8059
924.6807
      638       639       640       641       642       643       644
645
1180.1129 1138.3149 1067.1035  952.5460  833.3443  881.3346  929.3249
927.7768
      646       647       648       649       650       651       652
653
 848.8250  839.5366  892.1711  916.9403  950.9979  946.3537  811.6712
788.4501
      654       655       656       657       659       660       661
662
 772.9694  757.4886  724.9791  703.3060  689.3733  704.8541  755.9405
906.1038
      663       664       665       666       667       668       669
670
 907.6518  906.1038  844.1808  855.0173  859.6615  848.8250  800.8347
896.8153
      671       672       673       674       675       676       677
678
 771.4213  856.5654  957.1902  913.8441  940.1614  766.7771  796.1905
853.4692
      679       680       681       683       684       685       686
687
 817.8635  800.8347  757.4886  737.3636  777.6136  785.3540  920.0364
1147.6034
      688       689       690       691       692       693       694
695
1135.2188  963.3825  924.6807  859.6615  927.7768  950.9979  867.4019
834.8923
      696       697       698       699       700       701       726
727
 968.0267 1043.8824 1175.4687 1029.9497  813.2193  817.8635  913.8441
799.2866
      728       729       731       732       733       734       735
736
 853.4692  827.1520  742.0079  796.1905  844.1808  903.0076  884.4307
862.7577
      737       738       739       740       741       742       743
744
 862.7577  848.8250  827.1520  810.1231  810.1231  808.5751  813.2193
830.2481
```

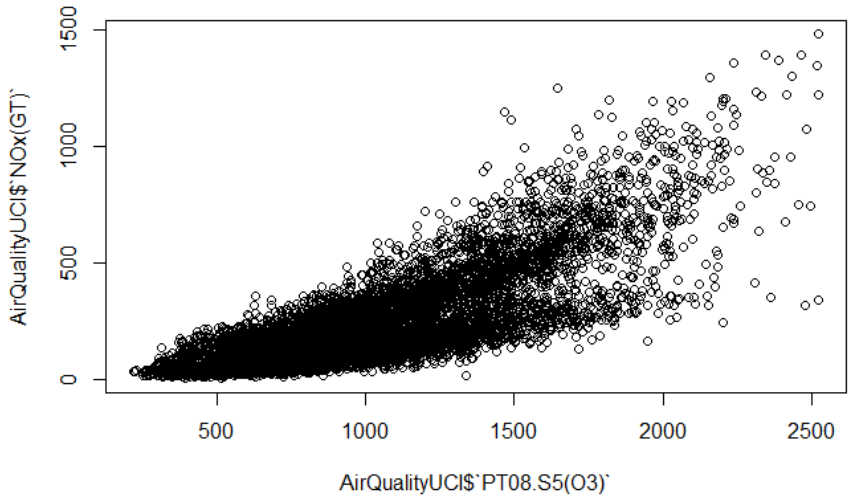
```
      745       746       747       748       749       750       751
752
 859.6615  916.9403  937.0653  864.3058  960.2864  940.1614  786.9020
745.1040
      753       755       756       757       758       759       760
761
 765.2290  729.6233  729.6233  734.2675  749.7482  765.2290  743.5559
805.4789
      762       763       764       765       766       767       768
769
 836.4404  920.0364  765.2290  711.0464  735.8156  755.9405  771.4213
786.9020
      770       771       772       773       774       775       776
777
 814.7674  768.3251  763.6809  768.3251  772.9694  734.2675  735.8156
726.5271
      779       780       781       782       783       784       785
786
 695.5656  695.5656  721.8829  731.1713  740.4598  768.3251  780.7097
831.7962
      787       788       789       790       791       792       793
794
 802.3828  752.8444  760.5848  808.5751  819.4116  807.0270  825.6039
867.4019
      795       796       797       798       799       800       801
803
 807.0270  772.9694  765.2290  754.3925  742.0079  709.4983  698.6618
703.3060
      804       805       806       807       808       809       810
811
 788.4501  901.4595 1178.5649 1107.3534  989.6998  876.6903  882.8826
850.3731
      812       813       814       815       816       817       818
819
 844.1808  868.9500  895.2672  841.0846  955.6421 1046.9785 1071.7477
988.1517
      820       821       822       823       824       825       827
828
 893.7192  906.1038  837.9885  769.8732  783.8059  743.5559  740.4598
793.0943
      829       830       831       832       833       834       835
856
 845.7289 1077.9400 1096.5169 1077.9400  954.0941  898.3634  875.1423
1149.1514
      857       858       859       860       861       862       863
864
1177.0168 1133.6707 1068.6516  972.6710 1028.4016  933.9691  968.0267
1059.3631
      865       866       867       868       869       870       871
872
1118.1900 1214.1706 1164.6322 1079.4881  893.7192  855.0173  856.5654
819.4116
      873       875       876       877       878       879       880
881
 789.9982  768.3251  820.9597  949.4498 1215.7187 1102.7092  958.7383
932.4210
```

```
      882       883       884       885       886       887       888
889
 937.0653  867.4019 1026.8536 1104.2573 1045.4305 1057.8151 1149.1514
1088.7765
      890       891       892       893       894       895       896
897
1170.8245 1146.0553 1017.5651  927.7768  935.5172  932.4210  856.5654
830.2481
     1044      1045      1046      1047      1048      1049      1050
1051
 762.1328  782.2578 1048.5266 1214.1706 1225.0071 1050.0747 1042.3343
947.9018
     1052      1053      1054      1055      1056      1057      1058
1059
 918.4884  940.1614 1073.2958 1105.8054 1110.4496 1057.8151 1105.8054
1026.8536
     1060      1061      1062      1063      1064      1065      1067
1068
 822.5077  858.1135  841.0846  920.0364  899.9115  839.5366  740.4598
780.7097
     1069      1070      1071      1072      1073      1074      1075
1076
 786.9020  834.8923  927.7768  961.8344  920.0364  885.9788  878.2384
800.8347
     1077      1078      1079      1080      1081      1082      1083
1084
 822.5077  811.6712  824.0558  810.1231  898.3634  944.8056  921.5845
807.0270
     1085      1086      1087      1088      1089      1091      1092
1093
 752.8444  776.0655  765.2290  780.7097  768.3251  706.4022  692.4695
723.4310
     1094      1095      1096      1097      1098      1099      1100
1101
 735.8156  732.7194  745.1040  765.2290  760.5848  759.0367  754.3925
734.2675
     1102      1103      1104      1105      1106      1107      1108
1109
 759.0367  799.2866  796.1905  822.5077  862.7577  876.6903  825.6039
850.3731
     1110      1111      1112      1113      1115      1116      1117
1118
 828.7000  755.9405  721.8829  697.1137  686.2772  724.9791  779.1617
850.3731
     1119      1120      1121      1122      1123      1124      1125
1126
 878.2384  845.7289  841.0846  822.5077  819.4116  817.8635  803.9308
803.9308
     1127      1128      1129      1130      1131      1132      1133
1134
 811.6712  855.0173  898.3634  879.7865  862.7577  808.5751  793.0943
768.3251
     1135      1136      1137      1139      1140      1141      1142
1143
 731.1713  709.4983  700.2099  723.4310  760.5848  844.1808 1156.8918
1042.3343
```

```
     1144      1145      1146      1147      1148      1149      1150
1151
 868.9500  889.0749  853.4692  875.1423  903.0076  858.1135  901.4595
856.5654
     1152      1153      1154      1155      1156      1157      1158
1159
 910.7480  937.0653  944.8056  950.9979  879.7865  824.0558  842.6327
782.2578
     1160      1161      1163      1164      1165      1166      1167
1168
 754.3925  734.2675  707.9502  715.6906  788.4501 1167.7283 1094.9688
1169.2764
     1169      1170      1171      1172      1173      1174      1175
1176
1065.5554  974.2190  881.3346  855.0173  932.4210  975.7671  887.5269
946.3537
     1177      1178      1179      1180      1181      1182      1183
1184
1016.0170 1014.4690 1081.0362  904.5557  793.0943  805.4789  807.0270
749.7482
     1185      1187      1188      1189      1190      1191      1192
1193
 723.4310  718.7868  788.4501  885.9788 1124.3823 1240.4878 1057.8151
895.2672
     1194      1195      1196      1197      1198      1199      1200
1201
 841.0846  831.7962  988.1517  981.9594 1082.5842 1051.6228 1053.1708
1090.3246
     1202      1203      1204      1205      1206      1207      1208
1209
1184.7572 1050.0747  949.4498  912.2961  937.0653  882.8826  811.6712
794.6424
     1211      1212      1213      1214      1215      1216      1217
1218
 742.0079  776.0655  921.5845 1000.5363  920.0364  994.3440  966.4787
1003.6325
     1219      1220      1221      1222      1223      1224      1225
1226
 998.9882  983.5075  907.6518  957.1902  995.8921 1003.6325 1003.6325
1105.8054
     1227      1228      1229      1230      1231      1232      1233
1235
1064.0074  963.3825  940.1614  929.3249  957.1902  870.4980  802.3828
724.9791
     1236      1237      1238      1239      1240      1241      1242
1243
 707.9502  717.2387  786.9020  793.0943  831.7962  853.4692  833.3443
827.1520
     1244      1245      1246      1247      1248      1249      1250
1251
 771.4213  762.1328  794.6424  822.5077  808.5751  847.2769  972.6710
912.2961
     1252      1253      1254      1255      1256      1257      1259
1260
 839.5366  955.6421  964.9306  833.3443  788.4501  729.6233  711.0464
721.8829
```

```
     1261      1262      1263      1264      1265      1266      1267
1268
 759.0367  745.1040  805.4789  816.3154  808.5751  791.5463  782.2578
769.8732
     1269      1270      1271      1272      1273      1274      1275
1276
 779.1617  813.2193  777.6136  873.5942  893.7192  994.3440  933.9691
906.1038
     1277      1278      1279      1280      1281      1283      1284
1285
 935.5172  907.6518  820.9597  728.0752  711.0464  709.4983  765.2290
906.1038
 [ reached getOption("max.print") -- omitted 6396 entries ]
```





7. Create cross tabulations with derived variables.

```
mydata<-AirQualityUCI

View(mydata)

# 2-Way Frequency Table

attach(mydata)

mytable <- table(A,B) # A will be rows, B will be columns

mytable # print table

margin.table(mytable, 1) # A frequencies (summed over B)

margin.table(mytable, 2) # B frequencies (summed over A)

prop.table(mytable) # cell percentages

prop.table(mytable, 1) # row percentages

prop.table(mytable, 2) # column percentages
```

```
Chi-squared approximation may be incorrect
        Pearson's Chi-squared test

data:  mytable
X-squared = 2450, df = 2401, p-value = 0.2382
```

8. Check for trends and patterns in time series.

ts (AirQualityUCI, frequency = 4, start = c(1959, 2)) # frequency 4 => Quarterly Data

ts (1:10, frequency = 12, start = 1990) # freq 12 => Monthly data.

ts (AirQualityUCI, start=c(2009), end=c(2014), frequency=1) # Yearly Data

ts (1:1000, frequency = 365, start = 1990)# freq 365 => daily data.

tsAirqualityUCI <- EuStockMarkets[, 1] # ts data

copied some time series data as below

NAs introduced by coercionNAs introduced by coercionNAs introduced by coercionNAs introduced by coercionNAs introduced by coercion Date Time

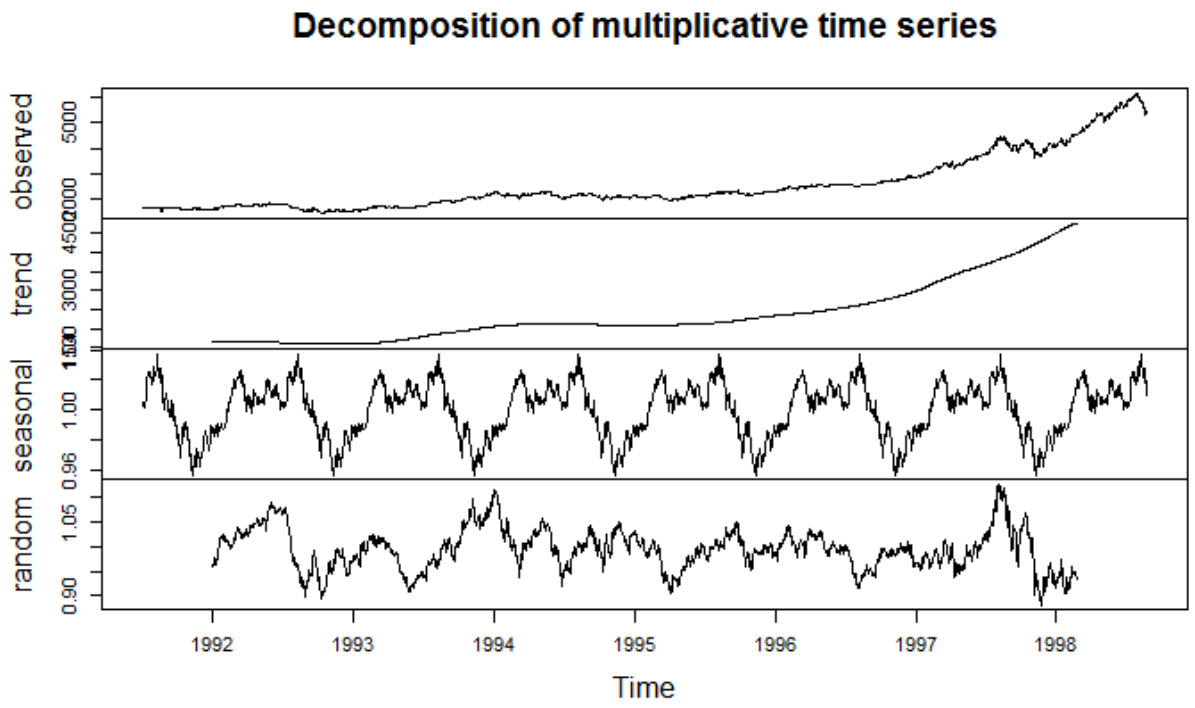
	CO(GT)	PT08.S1(CO)	NMHC(GT)	C6H6(GT)	PT08.S2(NMHC)		
1959 Q2	NA	NA	NA	1360	150	NA	1046
1959 Q3	NA	NA	2	1292	112	NA	955
1959 Q4	NA	NA	NA	1402	88	NA	939
1960 Q1	NA	NA	NA	1376	80	NA	948
1960 Q2	NA	NA	NA	1272	51	NA	836
1960 Q3	NA	NA	NA	1197	38	NA	750
1960 Q4	NA	NA	NA	1185	31	NA	690
1961 Q1	NA	NA	1	1136	31	NA	672
1961 Q2	NA	NA	NA	1094	24	NA	609
1961 Q3	NA	NA	NA	1010	19	NA	561
1961 Q4	NA	NA	NA	1011	14	NA	527
1962 Q1	NA	NA	NA	1066	8	NA	512
1962 Q2	NA	NA	NA	1052	16	NA	553
1962 Q3	NA	NA	NA	1144	29	NA	667
1962 Q4	NA	NA	2	1333	64	NA	900
1963 Q1	NA	NA	NA	1351	87	NA	960
1963 Q2	NA	NA	NA	1233	77	NA	827
1963 Q3	NA	NA	NA	1179	43	NA	762
1963 Q4	NA	NA	NA	1236	61	NA	774
1964 Q1	NA	NA	NA	1286	63	NA	869
1964 Q2	NA	NA	NA	1371	164	NA	1034
1964 Q3	NA	NA	NA	1310	79	NA	933
1964 Q4	NA	NA	NA	1292	95	NA	912
1965 Q1	NA	NA	NA	1383	150	NA	1020
1965 Q2	NA	NA	NA	1581	307	NA	1319
1965 Q3	NA	NA	NA	1776	461	NA	1488
1965 Q4	NA	NA	NA	1640	401	NA	1404
1966 Q1	NA	NA	NA	1313	197	NA	1076
1966 Q2	NA	NA	NA	965	61	NA	749
1966 Q3	NA	NA	1	913	26	NA	629
1966 Q4	NA	NA	NA	1080	55	NA	805

#plot time series

tsAirqualityUCI <- EuStockMarkets[, 1] # ts data

decomposedRes <- decompose(tsAirqualityUCI, type="mult") # use type = "additive" for additive components

plot(decomposedRes) # see plot below



9. Find out the most polluted time of the day and the name of the chemical compound

#plot time series

tsAirqualityUCI <- EuStockMarkets[, 1] # ts data

decomposedRes <- decompose(tsAirqualityUCI, type="mult") # use type = "additive" for additive components

plot(decomposedRes) # see plot below

stlRes <- stl(tsAirqualityUCI, s.window = "periodic")

plot(AirQualityUCI$T, type = "l")

PT08.S4(NO2) is the highest pollution at 18.00 hrs

Date	Time	NOx(GT)	PT08.S3(NOx)	NO2(GT)	PT08.S4(NO2)	PT08.S5(O3)
6/8/2004	8:00:00	376	525	125	2746	1708
6/9/2004	8:00:00	357	507	151	2691	2147
10/26/2004	18:00:00	952	325	180	2775	2372
max		1479.0	2682.8	339.7	2775.0	2522.8

NAs introduced by coercionNAs introduced by coercionNAs introduced by coercionNAs introduced by coercionNAs introduced by coercion Date Time

CO(GT)	PT08.S1(CO)	NMHC(GT)	C6H6(GT)	PT08.S2(NMHC)		
1959 Q2	NA	NA	NA	1360	150	NA	1046
1959 Q3	NA	NA	2	1292	112	NA	955
1959 Q4	NA	NA	NA	1402	88	NA	939
1960 Q1	NA	NA	NA	1376	80	NA	948
1960 Q2	NA	NA	NA	1272	51	NA	836
1960 Q3	NA	NA	NA	1197	38	NA	750
1960 Q4	NA	NA	NA	1185	31	NA	690
1961 Q1	NA	NA	1	1136	31	NA	672
1961 Q2	NA	NA	NA	1094	24	NA	609
1961 Q3	NA	NA	NA	1010	19	NA	561
1961 Q4	NA	NA	NA	1011	14	NA	527
1962 Q1	NA	NA	NA	1066	8	NA	512
1962 Q2	NA	NA	NA	1052	16	NA	553
1962 Q3	NA	NA	NA	1144	29	NA	667
1962 Q4	NA	NA	2	1333	64	NA	900
1963 Q1	NA	NA	NA	1351	87	NA	960
1963 Q2	NA	NA	NA	1233	77	NA	827
1963 Q3	NA	NA	NA	1179	43	NA	762
1963 Q4	NA	NA	NA	1236	61	NA	774
1964 Q1	NA	NA	NA	1286	63	NA	869
1964 Q2	NA	NA	NA	1371	164	NA	1034
1964 Q3	NA	NA	NA	1310	79	NA	933
1964 Q4	NA	NA	NA	1292	95	NA	912
1965 Q1	NA	NA	NA	1383	150	NA	1020
1965 Q2	NA	NA	NA	1581	307	NA	1319
1965 Q3	NA	NA	NA	1776	461	NA	1488
1965 Q4	NA	NA	NA	1640	401	NA	1404
1966 Q1	NA	NA	NA	1313	197	NA	1076
1966 Q2	NA	NA	NA	965	61	NA	749
1966 Q3	NA	NA	1	913	26	NA	629
1966 Q4	NA	NA	NA	1080	55	NA	805

Date	Time	CO(GT)	PT08.S1(CO)	NMHC(GT)	C6H6(GT)	PT08.S2(NMHC)
6/8/2004	8:00:00	5.8	1377	-200	36.1	1688
6/9/2004	8:00:00	6.4	1496	-200	36.9	1705
10/26/2004	18:00:00	9.5	1908	-200	52.1	2007
max		11.9	2039.8	1189.0	63.7	2214.0

Date	Time	NOx(GT)	PT08.S3(NOx)	NO2(GT)	PT08.S4(NO2)	PT08.S5(O3)
6/8/2004	8:00:00	376	525	125	2746	1708
6/9/2004	8:00:00	357	507	151	2691	2147
10/26/2004	18:00:00	952	325	180	2775	2372
max		1479.0	2682.8	339.7	2775.0	2522.8