ACADGILD ASSIGNMENT 10
SESSION 10: Correlations

1. Import dataset from the following link: https://archive.ics.uci.edu/ml/machine-learning-databases/00360/ Perform the below written operations:

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

Answer:

```
library(readxl)
AirQualityUCI <-
read_excel("C:/Users/manojChowdary/Downloads/AirQualityUCI.xlsx"
)
View(AirQualityUCI)
str(AirQualityUCI)
```

Output from R-console

```
> View(AirQualityUCI)
> str(AirQualityUCI)
Classes ‘tbl_df’, ‘tbl’ and 'data.frame':  9357 obs. of
15 variables:
 $ Date          : POSIXct, format: "2004-03-10" "2004-
03-10" "2004-03-10" ...
 $ Time          : POSIXct, format: "1899-12-31
18:00:00" "1899-12-31 19:00:00" "1899-12-31 20:00:00"
...
 $ CO(GT)        : num  2.6 2 2.2 2.2 1.6 1.2 1.2 1 0.9
0.6 ...
 $ PT08.S1(CO)   : num  1360 1292 1402 1376 1272 ...
 $ NMHC(GT)      : num  150 112 88 80 51 38 31 31 24 19
...
 $ C6H6(GT)      : num  11.88 9.4 9 9.23 6.52 ...
 $ PT08.S2(NMHC): num  1046 955 939 948 836 ...
 $ NOx(GT)       : num  166 103 131 172 131 89 62 62 45
-200 ...
 $ PT08.S3(NOx) : num  1056 1174 1140 1092 1205 ...
 $ NO2(GT)       : num  113 92 114 122 116 96 77 76 60 -
200 ...
 $ PT08.S4(NO2) : num  1692 1559 1554 1584 1490 ...
 $ PT08.S5(O3)  : num  1268 972 1074 1203 1110 ...
 $ T             : num  13.6 13.3 11.9 11 11.2 ...
 $ RH            : num  48.9 47.7 54 60 59.6 ...
```

```
 $ AH             : num  0.758 0.725 0.75 0.787 0.789 ...
```

b.Create Univariate for all the columns.

Answer:

```
library(readxl)
AirQualityUCI <-
read_excel("C:/Users/manojChowdary/Downloads/AirQualityUCI.xlsx"
)
View(AirQualityUCI)
dim(AirQualityUCI)
summary(AirQualityUCI)
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")
```

Output from R-console

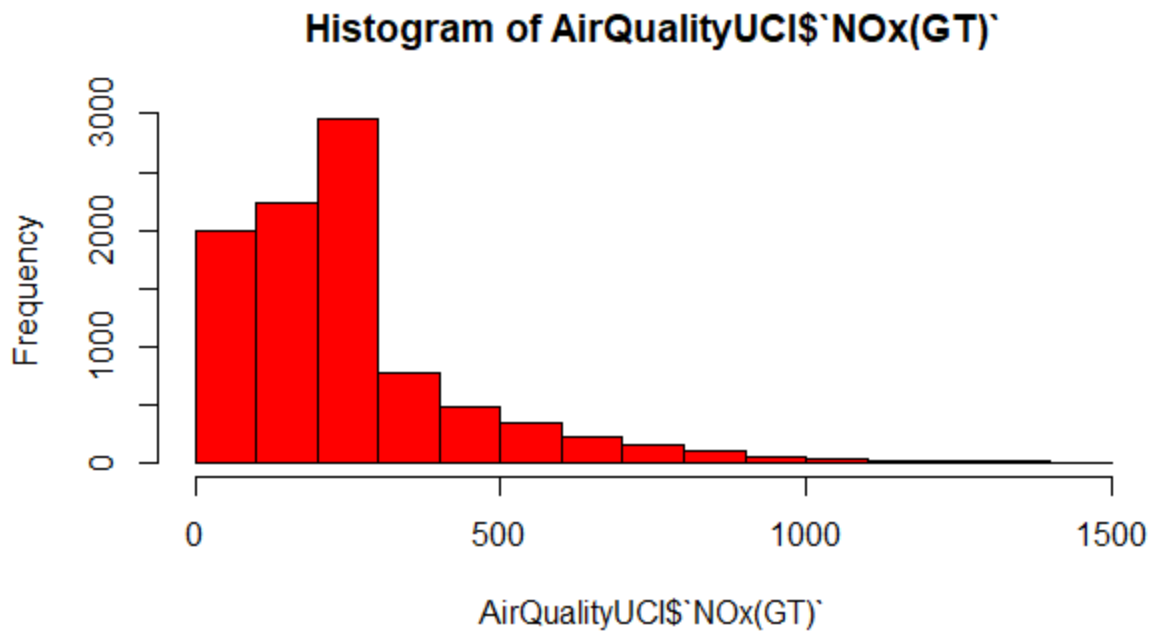
```
> dim(AirQualityUCI)
[1] 9357   15

> summary(AirQualityUCI)
      Date
 Min.   :2004-03-10 00:00:00
 1st Qu.:2004-06-16 00:00:00
 Median :2004-09-21 00:00:00
 Mean   :2004-09-21 04:30:05
 3rd Qu.:2004-12-28 00:00:00
 Max.   :2005-04-04 00:00:00
      Time
 Min.   :1899-12-31 00:00:00
 1st Qu.:1899-12-31 05:00:00
 Median :1899-12-31 11:00:00
 Mean   :1899-12-31 11:29:55
 3rd Qu.:1899-12-31 18:00:00
 Max.   :1899-12-31 23:00:00
    CO(GT)          PT08.S1(CO)
 Min.   :-200.00   Min.   :-200
 1st Qu.:   0.60   1st Qu.: 921
```

```
Median :   1.50   Median :1052
Mean   : -34.21   Mean   :1049
3rd Qu.:   2.60   3rd Qu.:1221
Max.   :  11.90   Max.   :2040
   NMHC(GT)         C6H6(GT)
Min.   :-200.0   Min.   :-200.000
1st Qu.:-200.0   1st Qu.:   4.005
Median :-200.0   Median :   7.887
Mean   :-159.1   Mean   :   1.866
3rd Qu.:-200.0   3rd Qu.:  13.636
Max.   :1189.0   Max.   :  63.741
PT08.S2(NMHC)       NOx(GT)
Min.   :-200.0   Min.   :-200.0
1st Qu.: 711.0   1st Qu.:  50.0
Median : 894.5   Median : 141.0
Mean   : 894.5   Mean   : 168.6
3rd Qu.:1104.8   3rd Qu.: 284.2
Max.   :2214.0   Max.   :1479.0
 PT08.S3(NOx)       NO2(GT)
Min.   :-200.0   Min.   :-200.00
1st Qu.: 637.0   1st Qu.:  53.00
Median : 794.2   Median :  96.00
Mean   : 794.9   Mean   :  58.14
3rd Qu.: 960.2   3rd Qu.: 133.00
Max.   :2682.8   Max.   : 339.70
 PT08.S4(NO2)   PT08.S5(O3)
Min.   :-200   Min.   :-200.0
1st Qu.:1185   1st Qu.: 699.8
Median :1446   Median : 942.0
Mean   :1391   Mean   : 975.0
3rd Qu.:1662   3rd Qu.:1255.2
Max.   :2775   Max.   :2522.8
       T                  RH
Min.   :-200.000   Min.   :-200.00
1st Qu.:  10.950   1st Qu.:  34.05
Median :  17.200   Median :  48.55
Mean   :   9.777   Mean   :  39.48
3rd Qu.:  24.075   3rd Qu.:  61.88
Max.   :  44.600   Max.   :  88.72
       AH
Min.   :-200.0000
1st Qu.:   0.6923
Median :   0.9768
Mean   :  -6.8376
3rd Qu.:   1.2962
```

```
 Max.   :   2.2310  > AirQualityUCI[7:14,]
         Date                 Time  CO(GT) PT08.S1(CO)
NMHC(GT) C6H6(GT) PT08.S2(NMHC)  NOx(GT)
7  2004-03-11 1899-12-31 00:00:00 1.20000     1185.00
31 3.624399         689.50  62.0000
8  2004-03-11 1899-12-31 01:00:00 1.00000     1136.25
31 3.326677         672.00  62.0000
9  2004-03-11 1899-12-31 02:00:00 0.90000     1094.00
24 2.339416         608.50  45.0000
10 2004-03-11 1899-12-31 03:00:00 0.60000     1009.75
19 1.696658         560.75 246.8813
11 2004-03-11 1899-12-31 04:00:00 2.15275     1011.00
14 1.293620         526.75  21.0000
12 2004-03-11 1899-12-31 05:00:00 0.70000     1066.00
8 1.133431         512.00  16.0000
13 2004-03-11 1899-12-31 06:00:00 0.70000     1051.75
16 1.603768         553.25  34.0000
14 2004-03-11 1899-12-31 07:00:00 1.10000     1144.00
29 3.243618         667.00  98.0000
   PT08.S3(NOx)  NO2(GT) PT08.S4(NO2) PT08.S5(O3)
T     RH        AH
7        1461.75  77.0000      1332.75      732.50
11.325 56.775 0.7603119
8        1453.25  76.0000      1332.75      729.50
10.675 60.000 0.7702385
9        1579.00  60.0000      1276.00      619.50
10.650 59.675 0.7648187
10       1705.00 113.0755      1234.75      501.25
10.250 60.200 0.7516572
11       1817.50  34.0000      1196.75      445.25
10.075 60.475 0.7464945
12       1918.00  28.0000      1182.00      421.75
11.000 56.175 0.7365596
13       1738.25  48.0000      1221.25      471.50
10.450 58.125 0.7352951
14       1489.75  82.0000      1339.00      729.75
10.200 59.600 0.7417362
> hist(AirQualityUCI$`NOx(GT)`,col="red")

>
```



C. Check for missing values in all columns.

Answer:

col1<- mapply(anyNA,AirQualityUCI)
col1
summary(AirQualityUCI)
is.na(AirQualityUCI)

Output from R-console

```
> colSums(is.na(AirQualityUCI))
          Date           Time        CO(GT)   PT08.S1(CO)
NMHC(GT)       C6H6(GT)
             0              0          1683           366
8443             366
PT08.S2(NMHC)        NOx(GT)   PT08.S3(NOx)        NO2(GT)
PT08.S4(NO2)   PT08.S5(O3)
           366           1639           366          1642
366            366
             T             RH             AH
           366            366            366


col1<- mapply(anyNA,AirQualityUCI)
> col1
```

```
          Date           Time         CO(GT)    PT08.S1(CO)
NMHC(GT)       C6H6(GT)
         FALSE          FALSE           TRUE           TRUE
TRUE           TRUE
PT08.S2(NMHC)        NOx(GT)   PT08.S3(NOx)        NO2(GT)
PT08.S4(NO2)    PT08.S5(O3)
          TRUE           TRUE           TRUE           TRUE
TRUE           TRUE
             T             RH             AH
          TRUE           TRUE           TRUE
```

```
is.na(AirQualityUCI)
```

```
        Date  Time CO(GT) PT08.S1(CO) NMHC(GT) C6H6(GT) PT08.S2(NMHC) NOx(GT)
   [1,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [2,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [3,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [4,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [5,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [6,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [7,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [8,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
   [9,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [10,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [11,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [12,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [13,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [14,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [15,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [16,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [17,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [18,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [19,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [20,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [21,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [22,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [23,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [24,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [25,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [26,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [27,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [28,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [29,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [30,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [31,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [32,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [33,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [34,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [35,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [36,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [37,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [38,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [39,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [40,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [41,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [42,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [43,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [44,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [45,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
  [46,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE          FALSE   FALSE
```

```
[47,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[48,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[49,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[50,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[51,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[52,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[53,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[54,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[55,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[56,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[57,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[58,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[59,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[60,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[61,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[62,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[63,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[64,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[65,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
[66,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE
      PT08.S3(NOx) NO2(GT) PT08.S4(NO2) PT08.S5(O3)     T    RH    AH
 [1,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [2,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [3,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [4,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [5,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [6,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [7,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [8,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
 [9,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[10,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[11,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[12,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[13,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[14,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[15,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[16,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[17,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[18,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[19,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[20,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[21,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[22,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[23,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[24,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[25,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[26,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[27,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[28,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[29,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[30,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[31,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[32,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[33,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[34,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[35,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[36,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[37,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[38,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[39,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[40,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[41,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[42,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
[43,]        FALSE   FALSE        FALSE       FALSE FALSE FALSE FALSE
```

```
 [44,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [45,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [46,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [47,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [48,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [49,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [50,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [51,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [52,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [53,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [54,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [55,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [56,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [57,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [58,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [59,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [60,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [61,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [62,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [63,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [64,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [65,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
 [66,]         FALSE   FALSE         FALSE        FALSE FALSE FALSE FALSE
[ reached getOption("max.print") -- omitted 9291 rows ]

>
```

D. Impute the missing values using appropriate methods.

Answer:

```
colSums(is.na(AirQualityUCI))
library(plyr)
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)
```

Output from R-console

```
> 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)
      Date                         Time                          CO(GT)
 Min.   :2004-03-10 00:00:00   Min.   :1899-12-31 00:00:00   Min.   : 0.100
 1st Qu.:2004-06-16 00:00:00   1st Qu.:1899-12-31 05:00:00   1st Qu.: 1.200
 Median :2004-09-21 00:00:00   Median :1899-12-31 11:00:00   Median : 2.153
 Mean   :2004-09-21 04:30:05   Mean   :1899-12-31 11:29:55   Mean   : 2.153
 3rd Qu.:2004-12-28 00:00:00   3rd Qu.:1899-12-31 18:00:00   3rd Qu.: 2.600
 Max.   :2005-04-04 00:00:00   Max.   :1899-12-31 23:00:00   Max.   :11.900
  PT08.S1(CO)        NMHC(GT)         C6H6(GT)      PT08.S2(NMHC)
 Min.   : 647.2   Min.   :   7.0   Min.   : 0.149   Min.   : 383.2
 1st Qu.: 941.2   1st Qu.: 218.8   1st Qu.: 4.591   1st Qu.: 742.5
 Median :1074.5   Median : 218.8   Median : 8.593   Median : 923.2
 Mean   :1099.7   Mean   : 218.8   Mean   :10.083   Mean   : 939.0
 3rd Qu.:1221.2   3rd Qu.: 218.8   3rd Qu.:13.636   3rd Qu.:1104.8
 Max.   :2039.8   Max.   :1189.0   Max.   :63.741   Max.   :2214.0
```

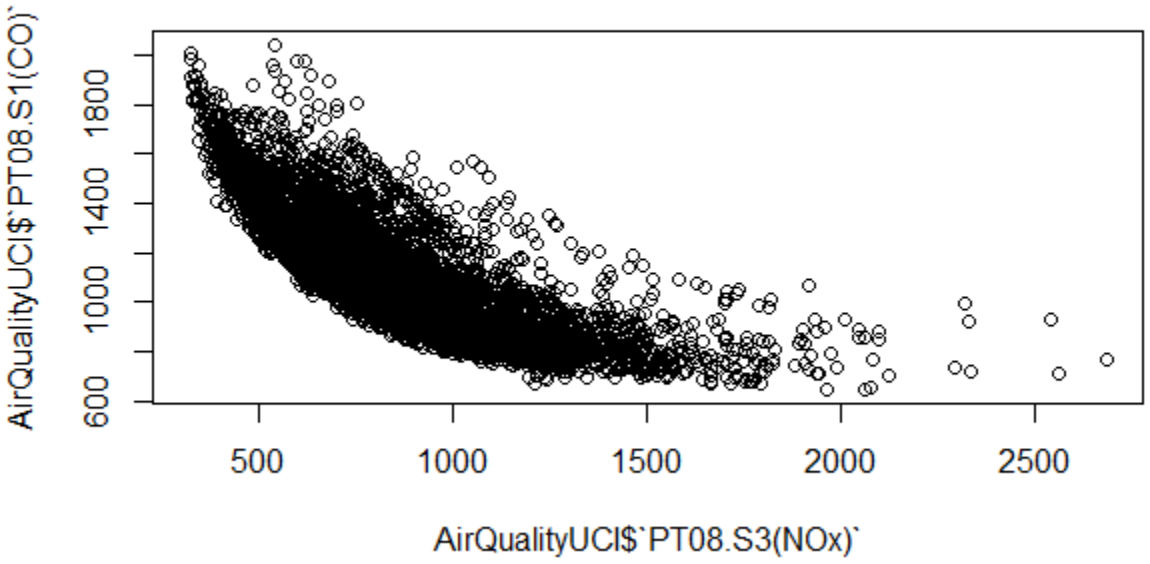
```
    NOx(GT)         PT08.S3(NOx)      NO2(GT)         PT08.S4(NO2)   PT08.S5(O3)
Min.   :   2.0   Min.   : 322.0   Min.   :  2.0   Min.   : 551   Min.   : 221.0
1st Qu.: 112.0   1st Qu.: 665.5   1st Qu.: 85.9   1st Qu.:1242   1st Qu.: 741.8
Median : 229.0   Median : 817.5   Median :113.1   Median :1456   Median : 982.5
Mean   : 246.9   Mean   : 835.4   Mean   :113.1   Mean   :1456   Mean   :1022.8
3rd Qu.: 284.2   3rd Qu.: 960.2   3rd Qu.:133.0   3rd Qu.:1662   3rd Qu.:1255.2
Max.   :1479.0   Max.   :2682.8   Max.   :339.7   Max.   :2775   Max.   :2522.8
       T                RH              AH
Min.   :-1.90   Min.   : 9.175   Min.   :0.1847
1st Qu.:12.03   1st Qu.:36.550   1st Qu.:0.7461
Median :18.27   Median :49.232   Median :1.0154
Mean   :18.32   Mean   :49.232   Mean   :1.0255
3rd Qu.:24.07   3rd Qu.:61.875   3rd Qu.:1.2962
Max.   :44.60   Max.   :88.725   Max.   :2.2310
```

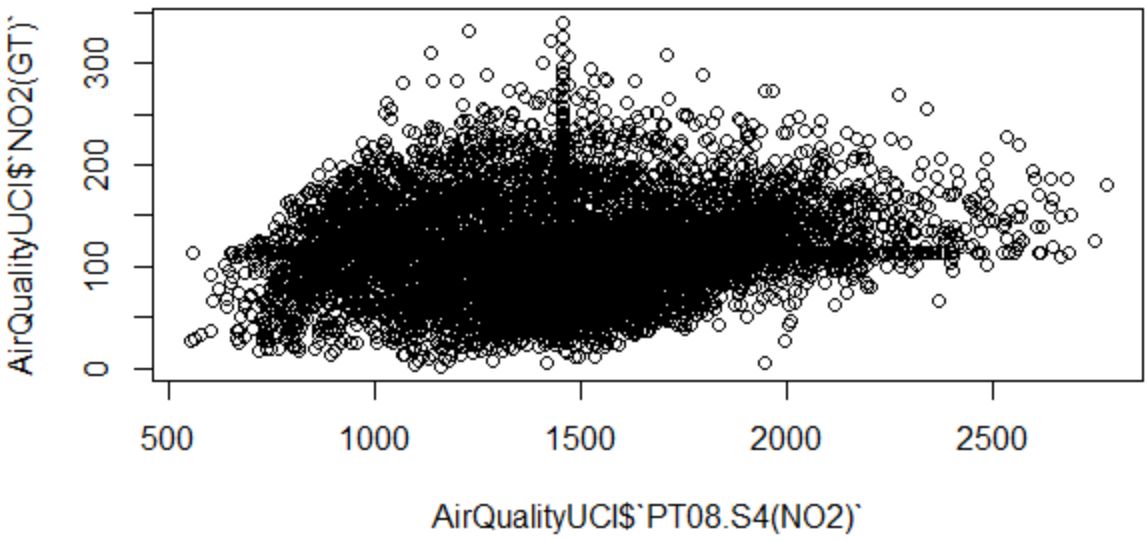
E. Create bi-variate analysis for all relationships

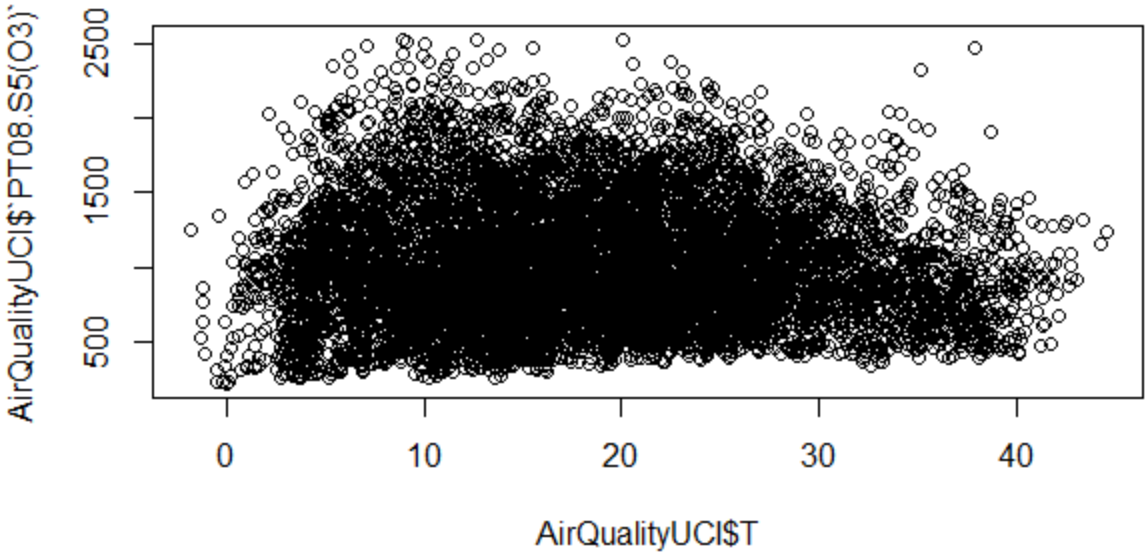
Answer:

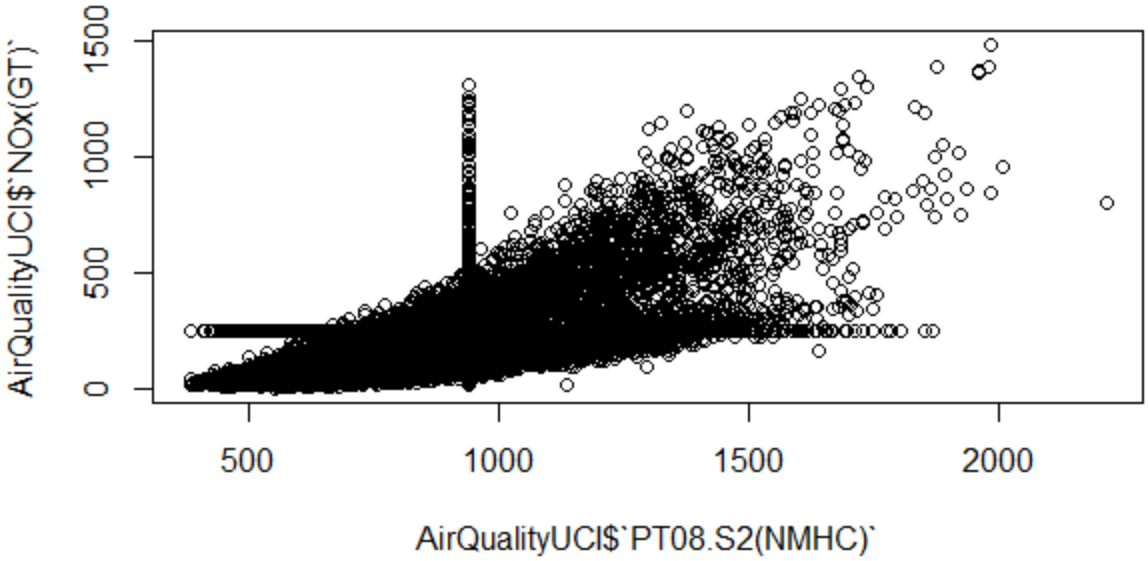
```
summary(AirQualityUCI)
plot(AirQualityUCI$`NOx(GT)`~AirQualityUCI$`PT08.S2(NMHC)`)
plot(AirQualityUCI$`PT08.S1(CO)`~AirQualityUCI$`PT08.S3(NOx)`)
plot(AirQualityUCI$`NO2(GT)`~AirQualityUCI$`PT08.S4(NO2)`)
plot(AirQualityUCI$`PT08.S5(O3)`~AirQualityUCI$T)
```

Output from Rconsole




AirQualityUCI$`NO2(GT)`
0
100
200
300
500
1000
1500
2000
2500
AirQualityUCI$`PT08.S4(NO2)`


AirQualityUCI$`PT08.S5(O3)`
500
1500
2500
0
10
20
30
40
AirQualityUCI$T



F.Test relevant hypothesis for valid relations

Answer:

```
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)
library(car)
mod=lm(AirQualityUCI$`PT08.S5(O3)` ~ AirQualityUCI$`NOx(GT)`)
summary(mod)
predict(mod)
```

Output from R console

```
> plot(AirQualityUCI$`PT08.S1(CO)`,AirQualityUCI$T)
> lm(formula=AirQualityUCI$`PT08.S3(NOx)`~AirQualityUCI$`NOx(GT)`)

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

Coefficients:
            (Intercept)  AirQualityUCI$`NOx(GT)`
              1016.3598                  -0.7331

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

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

Coefficients:
    (Intercept)  AirQualityUCI$T
       1077.818            1.195

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

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

Coefficients:
                  (Intercept)  AirQualityUCI$`PT08.S2(NMHC)`
                    154.66404                         0.06831

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

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

Coefficients:
            (Intercept)  AirQualityUCI$`NOx(GT)`
                 679.65                     1.39

> pnorm(1.49)
[1] 0.9318879
> pnorm(1.097)
[1] 0.8636793
> qnorm(0.9318879)
[1] 1.49
> qnorm(0.8636793)
[1] 1.097

> library(car)
Loading required package: carData
Warning messages:
```

```
1: package 'car' was built under R version 3.5.2
2: package 'carData' was built under R version 3.5.2
> mod=lm(AirQualityUCI$`PT08.S5(O3)` ~ AirQualityUCI$`NOx(GT)`)
> summary(mod)

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

Residuals:
     Min       1Q   Median       3Q      Max
-1477.57  -182.85   -10.98   168.81  1369.83

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)             679.65470    4.75079  143.06   <2e-16 ***
AirQualityUCI$`NOx(GT)`   1.38984    0.01515   91.75   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 283.4 on 9355 degrees of freedom
Multiple R-squared:  0.4736,   Adjusted R-squared:  0.4736
F-statistic:  8418 on 1 and 9355 DF,  p-value: < 2.2e-16

> predict(mod)
       1        2        3        4        5        6        7        8
 910.3685  822.8085  861.7241  918.7076  861.7241  803.3507  765.8249  765.8249
       9       10       11       12       13       14       15       16
 742.1976 1022.7807  708.8414  701.8922  726.9093  815.8593  921.4873  858.9444
      17       18       19       20       21       22       23       24
 835.3170  811.6897  824.1983  882.5717  967.3521  935.3857  947.8943 1017.3864
      25       26       27       28       29       30       31       32
1070.2004 1211.9643 1167.4894 1013.2169  810.2999  744.9773  849.2155  864.5037
      33       34       35       36       37       38       39       40
 793.6218 1022.7807  708.8414  721.3500  757.4859  831.1475 1106.3363 1022.7807
      41       42       43       44       45       46       47       48
 939.5552  979.8607  878.4022  902.0295  906.1990  943.7248  927.0466  888.1311
      49       50       51       52       53       54       55       56
 965.9622  960.4029 1152.2011 1060.4715 1031.2848 1096.6074  947.8943  872.8428
      57       58       59       60       61       62       63       64
 795.0116 1022.7807  831.1475  765.8249  753.3163  872.8428 1035.4543 1089.6582
      65       66       67       68       69       70       71       72
1027.1153 1091.0480 1011.8270  892.3006  843.6561  845.0459  871.4529  885.3514
      73       74       75       76       77       78       79       80
 995.1489 1064.6410 1067.4207 1072.9801  977.0810  918.7076  943.7248  921.4873
      81       82       83       84       85       86       87       88
 857.5545 1022.7807  776.9437  753.3163  740.8078  782.5030  820.0288  843.6561
      89       90       91       92       93       94       95       96
 879.7920  924.2670  903.4193  836.7069  822.8085  835.3170  915.9279  929.8263
      97       98       99      100      101      102      103      104
 902.0295 1042.4036 1131.3535  981.2505  882.5717  890.9107  824.1983  826.9780
     105      106      107      108      109      110      111      112
 829.7577 1022.7807  771.3843  801.9608  871.4529  996.5388 1179.9980 1343.9994
     113      114      115      116      117      118      119      120
1227.2526 1123.0144  959.0130  917.3177  900.6396  892.3006  878.4022  896.4701
     121      122      123      124      125      126      127      128
1116.0652 1241.1510 1124.4043 1035.4543  947.8943  803.3507  856.1647  789.4522
     129      130      131      132      133      134      135      136
 739.4179 1022.7807  761.6554  732.4687  793.6218  817.2491 1045.1832  997.9286
     137      138      139      140      141      142      143      144
1230.0323 1116.0652  981.2505 1029.8950 1045.1832  929.8263  935.3857  943.7248
     145      146      147      148      149      150      151      152
 935.3857  931.2162  910.3685 1120.2347  935.3857  860.3342  863.1139  811.6897
     153      154      155      156      157      158      159      160
 776.9437 1022.7807  754.7062  718.5703  743.5874  902.0295 1124.4043 1203.6253
```

161	162	163	164	165	166	167	168
1068.8106	986.8099	971.5216	963.1825	903.4193	867.2834	938.1654	883.9615
169	170	171	172	173	174	175	176
1095.2176	1250.8799	1161.9300	1146.6417	960.4029	927.0466	893.6904	807.5202
177	178	179	180	181	182	183	184
764.4351	1022.7807	763.0452	731.0789	774.1640	872.8428	1150.8113	1264.7783
185	186	187	188	189	190	191	192
1164.7097	990.9794	917.3177	886.7412	870.0631	886.7412	918.7076	910.3685
193	194	195	196	197	198	199	200
977.0810	1068.8106	1063.2512	927.0466	858.9444	811.6897	854.7748	822.8085
201	202	203	204	205	206	207	208
746.3671	1022.7807	707.4515	704.6719	757.4859	839.4866	1124.4043	1175.8284
209	210	211	212	213	214	215	216
1031.2848	982.6403	946.5044	924.2670	954.8435	974.3013	1025.7255	1054.9121
217	218	219	220	221	222	223	224
1000.7083	1028.5051	971.5216	1025.7255	878.4022	856.1647	824.1983	799.1811
225	226	227	228	229	230	231	232
782.5030	1022.7807	740.8078	738.0281	767.2148	839.4866	915.9279	883.9615
233	234	235	236	237	238	239	240
910.3685	950.6740	932.6060	913.1482	853.3850	811.6897	789.4522	845.0459
241	242	243	244	245	246	247	248
877.0123	978.4708	997.9286	965.9622	883.9615	849.2155	922.8771	864.5037
249	250	251	252	253	254	255	256
803.3507	1022.7807	797.7913	756.0960	713.0109	779.7234	849.2155	833.9272
257	258	259	260	261	262	263	264
850.6053	826.9780	822.8085	821.4186	746.3671	767.2148	815.8593	863.1139
265	266	267	268	269	270	271	272
920.0974	936.7755	1049.3528	940.9451	849.2155	835.3170	808.9100	782.5030
273	274	275	276	277	278	279	280
711.6211	1022.7807	703.2820	700.5023	736.6382	799.1811	993.7591	977.0810
281	282	283	284	285	286	287	288
839.4866	851.9952	849.2155	828.3678	864.5037	860.3342	888.1311	871.4529
289	290	291	292	293	294	295	296
975.6911	1002.0981	1010.4372	929.8263	857.5545	769.9945	753.3163	744.9773
297	298	299	300	301	302	303	304
750.5367	1022.7807	707.4515	697.7226	725.5195	822.8085	990.9794	1018.7762
305	306	307	308	309	310	311	312
1009.0473	985.4200	967.3521	968.7419	902.0295	861.7241	857.5545	924.2670
313	314	315	316	317	318	319	320
828.3678	861.7241	910.3685	803.3507	792.2319	788.0624	776.9437	785.2827
321	322	323	324	325	326	327	328
739.4179	1022.7807	740.8078	726.9093	739.4179	789.4522	921.4873	1006.2677
329	330	331	332	333	334	335	336
982.6403	868.6733	842.2663	845.0459	854.7748	818.6389	953.4536	950.6740
337	338	339	340	341	342	343	344
896.4701	1022.9458	943.7248	914.5381	843.6561	792.2319	790.8421	738.0281
345	346	347	348	349	350	351	352
732.4687	1022.7807	704.6719	696.3328	739.4179	796.4015	935.3857	960.4029
353	354	355	356	357	358	359	360
864.5037	860.3342	826.9780	863.1139	826.9780	853.3850	871.4529	846.4358
361	362	363	364	365	366	367	368
899.2498	1031.2848	1000.7083	888.1311	817.2491	783.8929	808.9100	789.4522
369	370	371	372	373	374	375	376
772.7741	1022.7807	742.1976	779.7234	822.8085	863.1139	1011.8270	1061.8614
377	378	379	380	381	382	383	384
1002.0981	929.8263	835.3170	840.8764	822.8085	803.3507	835.3170	856.1647
385	386	387	388	389	390	391	392
853.3850	846.4358	846.4358	817.2491	789.4522	771.3843	810.2999	776.9437
393	394	395	396	397	398	399	400
783.8929	1022.7807	758.8757	724.1297	754.7062	774.1640	815.8593	857.5545
401	402	403	404	405	406	407	408
858.9444	860.3342	833.9272	826.9780	870.0631	836.7069	849.2155	870.0631
409	410	411	412	413	414	415	416
908.9787	952.0638	921.4873	874.2326	821.4186	860.3342	847.8256	833.9272

417	418	419	420	421	422	423	424
800.5710	1022.7807	786.6726	733.8586	786.6726	806.1304	825.5881	864.5037
425	426	427	428	429	430	431	432
857.5545	854.7748	807.5202	771.3843	749.1468	776.9437	781.1132	786.6726
433	434	435	436	437	438	439	440
799.1811	808.9100	825.5881	772.7741	767.2148	767.2148	743.5874	708.8414
441	442	443	444	445	446	447	448
710.2312	1022.7807	733.8586	756.0960	785.2827	931.2162	1039.6239	843.6561
449	450	451	452	453	454	455	456
845.0459	850.6053	807.5202	806.1304	822.8085	821.4186	810.2999	815.8593
457	458	459	460	461	462	463	464
854.7748	829.7577	811.6897	788.0624	764.4351	756.0960	758.8757	736.6382
465	466	467	468	469	470	471	472
743.5874	1022.7807	736.6382	751.9265	833.9272	945.1146	1018.7762	1072.9801
473	474	475	476	477	478	479	480
1124.4043	1025.7255	984.0302	957.6232	871.4529	843.6561	817.2491	835.3170
481	482	483	484	485	486	487	488
842.2663	858.9444	863.1139	781.1132	774.1640	790.8421	774.1640	740.8078
489	490	491	492	493	494	495	496
744.9773	1022.7807	700.5023	740.8078	797.7913	967.3521	999.3184	931.2162
497	498	499	500	501	502	503	504
879.7920	874.2326	963.1825	886.7412	917.3177	950.6740	890.9107	857.5545
505	506	507	508	509	510	511	512
847.8256	877.0123	861.7241	792.2319	763.0452	758.8757	813.0796	797.7913
513	514	515	516	517	518	519	520
749.1468	1022.7807	758.8757	768.6046	892.3006	1154.9808	1205.0151	1102.1668
521	522	523	524	525	526	527	528
946.5044	860.3342	826.9780	821.4186	817.2491	829.7577	861.7241	906.1990
529	530	531	532	533	534	535	536
972.9114	1050.7426	1053.5223	893.6904	856.1647	849.2155	854.7748	796.4015
537	538	539	540	541	542	543	544
760.2656	1022.7807	731.0789	757.4859	806.1304	900.6396	943.7248	1025.7255
545	546	547	548	549	550	551	552
952.0638	929.8263	911.7584	900.6396	890.9107	886.7412	878.4022	936.7755
553	554	555	556	557	558	559	560
989.5895	978.4708	1056.3020	929.8263	839.4866	886.7412	815.8593	781.1132
561	562	563	564	565	566	567	568
775.5538	1022.7807	763.0452	757.4859	781.1132	900.6396	961.7927	972.9114
569	570	571	572	573	574	575	576
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
577	578	579	580	581	582	583	584
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
585	586	587	588	589	590	591	592
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
593	594	595	596	597	598	599	600
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
601	602	603	604	605	606	607	608
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
609	610	611	612	613	614	615	616
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
617	618	619	620	621	622	623	624
1007.6575	996.5388	965.9622	940.9451	899.2498	851.9952	815.8593	902.0295
625	626	627	628	629	630	631	632
949.2841	921.4873	897.8600	831.1475	797.7913	804.7405	764.4351	729.6890
633	634	635	636	637	638	639	640
714.4008	1022.7807	713.0109	781.1132	907.5888	1136.9128	1099.3871	1035.4543
641	642	643	644	645	646	647	648
932.6060	825.5881	868.6733	911.7584	910.3685	839.4866	831.1475	878.4022
649	650	651	652	653	654	655	656
900.6396	931.2162	927.0466	806.1304	785.2827	771.3843	757.4859	728.2992
657	658	659	660	661	662	663	664
708.8414	1022.7807	696.3328	710.2312	756.0960	890.9107	892.3006	890.9107
665	666	667	668	669	670	671	672
835.3170	845.0459	849.2155	839.4866	796.4015	882.5717	769.9945	846.4358

673	674	675	676	677	678	679	680
936.7755	897.8600	921.4873	765.8249	792.2319	843.6561	811.6897	796.4015
681	682	683	684	685	686	687	688
757.4859	1022.7807	739.4179	775.5538	782.5030	903.4193	1107.7262	1096.6074
689	690	691	692	693	694	695	696
942.3349	907.5888	849.2155	910.3685	931.2162	856.1647	826.9780	946.5044
697	698	699	700	701	702	703	704
1014.6067	1132.7433	1002.0981	807.5202	811.6897	858.9444	893.6904	843.6561
705	706	707	708	709	710	711	712
775.5538	1022.7807	814.4694	881.1818	914.5381	1027.1153	978.4708	1009.0473
713	714	715	716	717	718	719	720
943.7248	984.0302	1088.2684	1031.2848	924.2670	1017.3864	977.0810	875.6225
721	722	723	724	725	726	727	728
910.3685	953.4536	945.1146	900.6396	922.8771	897.8600	795.0116	843.6561
729	730	731	732	733	734	735	736
820.0288	1022.7807	743.5874	792.2319	835.3170	888.1311	871.4529	851.9952
737	738	739	740	741	742	743	744
851.9952	839.4866	820.0288	804.7405	804.7405	803.3507	807.5202	822.8085
745	746	747	748	749	750	751	752
849.2155	900.6396	918.7076	853.3850	939.5552	921.4873	783.8929	746.3671
753	754	755	756	757	758	759	760
764.4351	1022.7807	732.4687	732.4687	736.6382	750.5367	764.4351	744.9773
761	762	763	764	765	766	767	768
800.5710	828.3678	903.4193	764.4351	715.7906	738.0281	756.0960	769.9945
769	770	771	772	773	774	775	776
783.8929	808.9100	767.2148	763.0452	767.2148	771.3843	736.6382	738.0281
777	778	779	780	781	782	783	784
729.6890	1022.7807	701.8922	701.8922	725.5195	733.8586	742.1976	767.2148
785	786	787	788	789	790	791	792
778.3335	824.1983	797.7913	753.3163	760.2656	803.3507	813.0796	801.9608
793	794	795	796	797	798	799	800
818.6389	856.1647	801.9608	771.3843	764.4351	754.7062	743.5874	714.4008
801	802	803	804	805	806	807	808
704.6719	1022.7807	708.8414	785.2827	886.7412	1135.5230	1071.5902	965.9622
809	810	811	812	813	814	815	816
864.5037	870.0631	840.8764	835.3170	857.5545	881.1818	832.5374	935.3857
817	818	819	820	821	822	823	824
1017.3864	1039.6239	964.5724	879.7920	890.9107	829.7577	768.6046	781.1132
825	826	827	828	829	830	831	832
744.9773	1022.7807	742.1976	789.4522	836.7069	1045.1832	1061.8614	1045.1832
833	834	835	836	837	838	839	840
933.9959	883.9615	863.1139	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
841	842	843	844	845	846	847	848
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
849	850	851	852	853	854	855	856
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1109.1160
857	858	859	860	861	862	863	864
1134.1332	1095.2176	1036.8442	950.6740	1000.7083	915.9279	946.5044	1028.5051
865	866	867	868	869	870	871	872
1081.3191	1167.4894	1123.0144	1046.5731	879.7920	845.0459	846.4358	813.0796
873	874	875	876	877	878	879	880
786.6726	1022.7807	767.2148	814.4694	929.8263	1168.8792	1067.4207	938.1654
881	882	883	884	885	886	887	888
914.5381	918.7076	856.1647	999.3184	1068.8106	1015.9966	1027.1153	1109.1160
889	890	891	892	893	894	895	896
1054.9121	1128.5738	1106.3363	990.9794	910.3685	917.3177	914.5381	846.4358
897	898	899	900	901	902	903	904
822.8085	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
905	906	907	908	909	910	911	912
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
913	914	915	916	917	918	919	920
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807
921	922	923	924	925	926	927	928
1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807	1022.7807

```
      929       930       931       932       933       934       935       936
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      937       938       939       940       941       942       943       944
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      945       946       947       948       949       950       951       952
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      953       954       955       956       957       958       959       960
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      961       962       963       964       965       966       967       968
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      969       970       971       972       973       974       975       976
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      977       978       979       980       981       982       983       984
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      985       986       987       988       989       990       991       992
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
      993       994       995       996       997       998       999      1000
1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807 1022.7807
 [ reached getOption("max.print") -- omitted 8357 entries ]
```

>

G. Create cross tabulations with derived variables

Answer:

```
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
```

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

H. Check for trends and patterns in time series.

Answer:

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

#plot time series
tsAirqualityUCI <- EuStockMarkets[, 1] # ts data
decomposedRes <- decompose(tsAirqualityUCI, type="mult") # use type = "additive" for additive components
plot (decomposedRes) # see plot below

Output from Rconsole

```
> ts (AirQualityUCI, frequency = 4, start = c(1959, 2))# frequency 4 =>
Quarterly Data
              Date        Time   CO(GT) PT08.S1(CO)  NMHC(GT)   C6H6(GT)
1959 Q2 1078876800 -2209010400  2.60000   1360.0000  150.0000 11.8817235
1959 Q3 1078876800 -2209006800  2.00000   1292.2500  112.0000  9.3971649
1959 Q4 1078876800 -2209003200  2.20000   1402.0000   88.0000  8.9978169
1960 Q1 1078876800 -2208999600  2.20000   1375.5000   80.0000  9.2287964
1960 Q2 1078876800 -2208996000  1.60000   1272.2500   51.0000  6.5182237
1960 Q3 1078876800 -2208992400  1.20000   1197.0000   38.0000  4.7410124
1960 Q4 1078963200 -2209075200  1.20000   1185.0000   31.0000  3.6243992
1961 Q1 1078963200 -2209071600  1.00000   1136.2500   31.0000  3.3266770
1961 Q2 1078963200 -2209068000  0.90000   1094.0000   24.0000  2.3394162
1961 Q3 1078963200 -2209064400  0.60000   1009.7500   19.0000  1.6966583
1961 Q4 1078963200 -2209060800  2.15275   1011.0000   14.0000  1.2936198
1962 Q1 1078963200 -2209057200  0.70000   1066.0000    8.0000  1.1334306
1962 Q2 1078963200 -2209053600  0.70000   1051.7500   16.0000  1.6037679
1962 Q3 1078963200 -2209050000  1.10000   1144.0000   29.0000  3.2436181
1962 Q4 1078963200 -2209046400  2.00000   1333.2500   64.0000  8.0137730
1963 Q1 1078963200 -2209042800  2.20000   1351.0000   87.0000  9.5406429
1963 Q2 1078963200 -2209039200  1.70000   1233.2500   77.0000  6.3357824
1963 Q3 1078963200 -2209035600  1.50000   1178.7500   43.0000  4.9715838
1963 Q4 1078963200 -2209032000  1.60000   1236.0000   61.0000  5.2169190
1964 Q1 1078963200 -2209028400  1.90000   1285.5000   63.0000  7.2699334
1964 Q2 1078963200 -2209024800  2.90000   1371.0000  164.0000 11.5390072
1964 Q3 1078963200 -2209021200  2.20000   1310.0000   79.0000  8.8262227
1964 Q4 1078963200 -2209017600  2.20000   1291.7500   95.0000  8.3014134
1965 Q1 1078963200 -2209014000  2.90000   1383.0000  150.0000 11.1515812
1965 Q2 1078963200 -2209010400  4.80000   1580.7500  307.0000 20.7992169
1965 Q3 1078963200 -2209006800  6.90000   1775.5000  461.0000 27.3598075
1965 Q4 1078963200 -2209003200  6.10000   1640.0000  401.0000 24.0177569
1966 Q1 1078963200 -2208999600  3.90000   1312.7500  197.0000 12.7793682
```

```
1966 Q2 1078963200 -2208996000  1.50000    964.5000   61.0000  4.7070719
1966 Q3 1078963200 -2208992400  1.00000    912.7500   26.0000  2.6457215
1966 Q4 1079049600 -2209075200  1.70000   1080.2500   55.0000  5.8548015
1967 Q1 1079049600 -2209071600  1.90000   1043.7500   53.0000  6.3742975
1967 Q2 1079049600 -2209068000  1.40000    987.7500   40.0000  4.1323418
1967 Q3 1079049600 -2209064400  0.80000    888.7500   21.0000  1.8694446
1967 Q4 1079049600 -2209060800  2.15275    831.0000   10.0000  1.0682926
1968 Q1 1079049600 -2209057200  0.60000    847.2500    7.0000  1.0224146
1968 Q2 1079049600 -2209053600  0.80000    927.0000   17.0000  1.8304312
1968 Q3 1079049600 -2209050000  1.40000   1090.5000   33.0000  4.3593410
1968 Q4 1079049600 -2209046400  4.40000   1587.0000  202.0000 17.8655867
1969 Q1 1079049600 -2209042800  2.15275   1544.5000  218.8118 22.0741621
1969 Q2 1079049600 -2209039200  3.10000   1350.2500  208.0000 14.0270114
1969 Q3 1079049600 -2209035600  2.70000   1262.7500  166.0000 11.6456466
1969 Q4 1079049600 -2209032000  2.10000   1206.2500  114.0000 10.2246621
1970 Q1 1079049600 -2209028400  2.50000   1251.5000  140.0000 11.0399360
1970 Q2 1079049600 -2209024800  2.70000   1287.0000  169.0000 12.8164462
1970 Q3 1079049600 -2209021200  2.90000   1352.7500  185.0000 14.1738512
1970 Q4 1079049600 -2209017600  2.80000   1309.0000  165.0000 12.6905681
1971 Q1 1079049600 -2209014000  2.40000   1274.0000  133.0000 11.7384054
1971 Q2 1079049600 -2209010400  3.90000   1509.5000  233.0000 19.2909749
1971 Q3 1079049600 -2209006800  3.70000   1525.2500  242.0000 18.2261783
1971 Q4 1079049600 -2209003200  6.60000   1843.0000  488.0000 32.5562783
1972 Q1 1079049600 -2208999600  4.40000   1597.7500  333.0000 20.0929436
1972 Q2 1079049600 -2208996000  3.50000   1483.5000  215.0000 14.3213424
1972 Q3 1079049600 -2208992400  5.40000   1677.2500  367.0000 21.8128651
1972 Q4 1079136000 -2209075200  2.70000   1279.5000  122.0000  9.6389998
1973 Q1 1079136000 -2209071600  1.90000   1196.2500   67.0000  7.3751395
1973 Q2 1079136000 -2209068000  1.60000   1183.7500   43.0000  5.3696042
1973 Q3 1079136000 -2209064400  1.70000   1171.7500   46.0000  5.3901039
1973 Q4 1079136000 -2209060800  2.15275   1147.0000   56.0000  6.1990420
1974 Q1 1079136000 -2209057200  1.00000    978.2500   30.0000  2.5779322
1974 Q2 1079136000 -2209053600  1.20000   1099.5000   27.0000  2.9085480
1974 Q3 1079136000 -2209050000  1.50000   1112.2500   47.0000  5.1362558
1974 Q4 1079136000 -2209046400  2.70000   1335.5000  132.0000 11.8171386
1975 Q1 1079136000 -2209042800  3.70000   1408.3333  239.0000 15.1401612
1975 Q2 1079136000 -2209039200  3.20000   1447.0000  160.0000 12.9130631
1975 Q3 1079136000 -2209035600  4.10000   1541.5000  283.0000 16.1335088
        PT08.S2(NMHC)   NOx(GT) PT08.S3(NOx)  NO2(GT) PT08.S4(NO2)
PT08.S5(O3)
1959 Q2     1045.5000  166.0000    1056.2500 113.0000    1692.0000
1267.5000
1959 Q3      954.7500  103.0000    1173.7500  92.0000    1558.7500
972.2500
1959 Q4      939.2500  131.0000    1140.0000 114.0000    1554.5000
1074.0000
1960 Q1      948.2500  172.0000    1092.0000 122.0000    1583.7500
1203.2500
1960 Q2      835.5000  131.0000    1205.0000 116.0000    1490.0000
1110.0000
1960 Q3      750.2500   89.0000    1336.5000  96.0000    1393.0000
949.2500
1960 Q4      689.5000   62.0000    1461.7500  77.0000    1332.7500
732.5000
1961 Q1      672.0000   62.0000    1453.2500  76.0000    1332.7500
729.5000
```

1961 Q2	608.5000	45.0000	1579.0000	60.0000	1276.0000
619.5000					
1961 Q3	560.7500	246.8813	1705.0000	113.0755	1234.7500
501.2500					
1961 Q4	526.7500	21.0000	1817.5000	34.0000	1196.7500
445.2500					
1962 Q1	512.0000	16.0000	1918.0000	28.0000	1182.0000
421.7500					
1962 Q2	553.2500	34.0000	1738.2500	48.0000	1221.2500
471.5000					
1962 Q3	667.0000	98.0000	1489.7500	82.0000	1339.0000
729.7500					
1962 Q4	899.7500	174.0000	1136.0000	112.0000	1517.0000
1101.5000					
1963 Q1	960.2500	129.0000	1079.0000	101.0000	1582.7500
1027.7500					
1963 Q2	827.2500	112.0000	1218.0000	98.0000	1445.7500
859.7500					
1963 Q3	762.0000	95.0000	1327.5000	92.0000	1361.7500
670.5000					
1963 Q4	774.2500	104.0000	1301.2500	95.0000	1401.2500
664.0000					
1964 Q1	868.5000	146.0000	1162.2500	112.0000	1536.7500
799.0000					
1964 Q2	1033.5000	207.0000	983.2500	128.0000	1730.2500
1036.5000					
1964 Q3	932.5000	184.0000	1081.7500	126.0000	1646.5000
946.2500					
1964 Q4	911.5000	193.0000	1102.5000	131.0000	1590.7500
956.7500					
1965 Q1	1019.7500	243.0000	1008.0000	135.0000	1718.7500
1104.0000					
1965 Q2	1318.5000	281.0000	798.5000	151.0000	2083.0000
1408.5000					
1965 Q3	1487.7500	383.0000	702.2500	172.0000	2332.5000
1704.0000					
1965 Q4	1404.0000	351.0000	742.7500	165.0000	2191.2500
1653.7500					
1966 Q1	1076.2500	240.0000	957.2500	136.0000	1706.5000
1284.7500					
1966 Q2	748.5000	94.0000	1325.2500	85.0000	1332.5000
821.0000					
1966 Q3	629.2500	47.0000	1564.5000	53.0000	1252.2500
551.7500					
1966 Q4	805.0000	122.0000	1253.5000	97.0000	1375.0000
815.5000					
1967 Q1	829.0000	133.0000	1247.2500	110.0000	1378.2500
831.5000					
1967 Q2	718.0000	82.0000	1395.5000	91.0000	1303.5000
691.5000					
1967 Q3	574.2500	246.8813	1680.2500	113.0755	1187.0000
512.0000					
1967 Q4	505.7500	21.0000	1892.7500	32.0000	1133.7500
384.0000					
1968 Q1	501.2500	30.0000	1894.5000	44.0000	1154.7500
394.0000					

1968 Q2 571.2500 56.0000 1684.7500 71.0000 1222.7500
486.5000
1968 Q3 730.2500 109.0000 1387.0000 104.0000 1360.7500
748.2500
1968 Q4 1235.5000 307.0000 896.5000 141.0000 1900.2500
1400.2500
1969 Q1 1353.0000 246.8813 767.2500 113.0755 2058.0000
1587.7500
1969 Q2 1117.5000 187.0000 912.0000 122.0000 1711.7500
1237.0000
1969 Q3 1037.2500 216.0000 969.0000 143.0000 1598.2500
1166.5000
1969 Q4 986.0000 143.0000 1034.5000 113.0000 1537.0000
959.0000
1970 Q1 1015.7500 160.0000 1007.5000 116.0000 1592.7500
983.0000
1970 Q2 1077.5000 163.0000 948.7500 123.0000 1660.2500
1060.7500
1970 Q3 1122.2500 190.0000 921.7500 126.0000 1740.0000
1139.2500
1970 Q4 1073.2500 178.0000 954.0000 120.0000 1657.2500
1112.2500
1971 Q1 1040.5000 150.0000 1005.7500 119.0000 1609.7500
993.7500
1971 Q2 1276.5000 206.0000 812.2500 149.0000 1909.7500
1409.5000
1971 Q3 1246.0000 202.0000 821.0000 145.0000 1846.7500
1447.7500
1971 Q4 1609.7500 340.0000 624.0000 170.0000 2390.2500
1886.5000
1972 Q1 1299.0000 274.0000 752.0000 149.0000 1940.5000
1626.7500
1972 Q2 1127.0000 253.0000 839.0000 139.0000 1723.0000
1491.0000
1972 Q3 1346.0000 300.0000 740.5000 134.0000 2062.0000
1657.0000
1972 Q4 964.0000 193.0000 962.5000 113.0000 1543.5000
1285.2500
1973 Q1 873.0000 139.0000 1071.2500 97.0000 1463.2500
1144.2500
1973 Q2 781.7500 83.0000 1176.2500 82.0000 1364.5000
1042.7500
1973 Q3 782.7500 246.8813 1178.5000 113.0755 1379.7500
995.5000
1973 Q4 821.0000 109.0000 1132.2500 83.0000 1411.7500
991.5000
1974 Q1 624.7500 62.0000 1420.2500 65.0000 1274.2500
819.2500
1974 Q2 646.2500 53.0000 1406.2500 60.0000 1267.5000
835.0000
1974 Q3 770.2500 139.0000 1228.0000 77.0000 1408.5000
939.7500
1974 Q4 1043.2500 256.0000 935.2500 96.0000 1678.0000
1191.7500
1975 Q1 1153.0000 295.0000 830.3333 119.0000 1776.6667
1411.0000

1975 Q2   1080.7500 250.0000   868.5000 126.0000   1666.7500
1465.0000
1975 Q3   1183.7500 296.0000   808.2500 158.0000   1779.7500
1582.5000

	T	RH	AH
1959 Q2	13.600000	48.87500	0.7577538
1959 Q3	13.300000	47.70000	0.7254874
1959 Q4	11.900000	53.97500	0.7502391
1960 Q1	11.000000	60.00000	0.7867125
1960 Q2	11.150000	59.57500	0.7887942
1960 Q3	11.175000	59.17500	0.7847717
1960 Q4	11.325000	56.77500	0.7603119
1961 Q1	10.675000	60.00000	0.7702385
1961 Q2	10.650000	59.67500	0.7648187
1961 Q3	10.250000	60.20000	0.7516572
1961 Q4	10.075000	60.47500	0.7464945
1962 Q1	11.000000	56.17500	0.7365596
1962 Q2	10.450000	58.12500	0.7352951
1962 Q3	10.200000	59.60000	0.7417362
1962 Q4	10.750000	57.42500	0.7407946
1963 Q1	10.500000	60.60000	0.7691108
1963 Q2	10.800000	58.35000	0.7551831
1963 Q3	10.500000	57.92500	0.7351608
1963 Q4	9.525000	66.77500	0.7950538
1964 Q1	8.300000	76.42500	0.8392681
1964 Q2	8.000000	81.15000	0.8735885
1964 Q3	8.325000	79.80000	0.8777844
1964 Q4	9.700000	71.15000	0.8569381
1965 Q1	9.775000	67.62500	0.8185012
1965 Q2	10.350000	64.17500	0.8065436
1965 Q3	9.650000	69.30000	0.8319211
1965 Q4	9.650000	67.75000	0.8133139
1966 Q1	9.125000	63.97500	0.7419242
1966 Q2	8.175000	63.40000	0.6904844
1966 Q3	8.250000	60.82500	0.6657444
1966 Q4	8.325000	58.52500	0.6437636
1967 Q1	7.725000	59.67500	0.6307661
1967 Q2	7.125000	61.80000	0.6275974
1967 Q3	6.975000	62.27500	0.6261075
1967 Q4	6.100000	65.90000	0.6247536
1968 Q1	6.275000	64.97500	0.6232823
1968 Q2	6.750000	62.95000	0.6234275
1968 Q3	6.450000	65.07500	0.6316281
1968 Q4	7.325000	63.15000	0.6499331
1969 Q1	9.225000	56.20000	0.6560651
1969 Q2	13.225000	41.75000	0.6319501
1969 Q3	14.325000	38.45000	0.6243043
1969 Q4	15.025000	36.50000	0.6195323
1970 Q1	16.100000	34.47500	0.6261647
1970 Q2	16.275001	35.72500	0.6560306
1970 Q3	15.825000	37.02500	0.6609611
1970 Q4	15.875000	37.17500	0.6657285
1971 Q1	16.875000	34.35000	0.6549085
1971 Q2	15.150000	39.55000	0.6766265
1971 Q3	14.400000	43.42500	0.7084498
1971 Q4	12.875000	50.52500	0.7478032
1972 Q1	12.150000	53.35000	0.7536202

```
1972 Q2 10.975000 59.12500 0.7739800
1972 Q3  9.675000 64.62500 0.7770739
1972 Q4  9.450000 64.12500 0.7597465
1973 Q1  9.150000 63.90000 0.7422764
1973 Q2  8.800000 63.92500 0.7256154
1973 Q3  7.800000 67.52500 0.7173121
1973 Q4  7.000000 71.07500 0.7157785
1974 Q1  8.300000 63.57500 0.6981546
1974 Q2  7.200000 67.47500 0.6886721
1974 Q3  6.350000 71.90000 0.6931986
1974 Q4  6.450000 71.55000 0.6944755
1975 Q1  9.566667 59.66667 0.7123666
1975 Q2 12.375000 51.17500 0.7334584
1975 Q3 15.650000 42.20000 0.7450938
 [ reached getOption("max.print") -- omitted 9291 rows ]
> ts (1:10, frequency = 12, start = 1990)        # freq 12 => Monthly data.
     Jan Feb Mar Apr May Jun Jul Aug Sep Oct
1990   1   2   3   4   5   6   7   8   9  10
> ts (AirQualityUCI, start=c(2009), end=c(2014), frequency=1)  # Yearly Data
Time Series:
Start = 2009
End = 2014
Frequency = 1
           Date        Time CO(GT) PT08.S1(CO) NMHC(GT)  C6H6(GT)
PT08.S2(NMHC)
2009 1078876800 -2209010400    2.6     1360.00      150 11.881723
1045.50
2010 1078876800 -2209006800    2.0     1292.25      112  9.397165
954.75
2011 1078876800 -2209003200    2.2     1402.00       88  8.997817
939.25
2012 1078876800 -2208999600    2.2     1375.50       80  9.228796
948.25
2013 1078876800 -2208996000    1.6     1272.25       51  6.518224
835.50
2014 1078876800 -2208992400    1.2     1197.00       38  4.741012
750.25
     NOx(GT) PT08.S3(NOx) NO2(GT) PT08.S4(NO2) PT08.S5(O3)      T     RH
AH
2009     166      1056.25     113      1692.00     1267.50 13.600 48.875
0.7577538
2010     103      1173.75      92      1558.75      972.25 13.300 47.700
0.7254874
2011     131      1140.00     114      1554.50     1074.00 11.900 53.975
0.7502391
2012     172      1092.00     122      1583.75     1203.25 11.000 60.000
0.7867125
2013     131      1205.00     116      1490.00     1110.00 11.150 59.575
0.7887942
2014      89      1336.50      96      1393.00      949.25 11.175 59.175
0.7847717
> ts (1:1000, frequency = 365, start = 1990)  # freq 365 => daily data.
Time Series:
Start = c(1990, 1)
End = c(1992, 270)
Frequency = 365
```

```
   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13  14
15
  [16]  16  17  18  19  20  21  22  23  24  25  26  27  28  29
30
  [31]  31  32  33  34  35  36  37  38  39  40  41  42  43  44
45
  [46]  46  47  48  49  50  51  52  53  54  55  56  57  58  59
60
  [61]  61  62  63  64  65  66  67  68  69  70  71  72  73  74
75
  [76]  76  77  78  79  80  81  82  83  84  85  86  87  88  89
90
  [91]  91  92  93  94  95  96  97  98  99 100 101 102 103 104
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> tsAirqualityUCI <- EuStockMarkets[, 1]
```

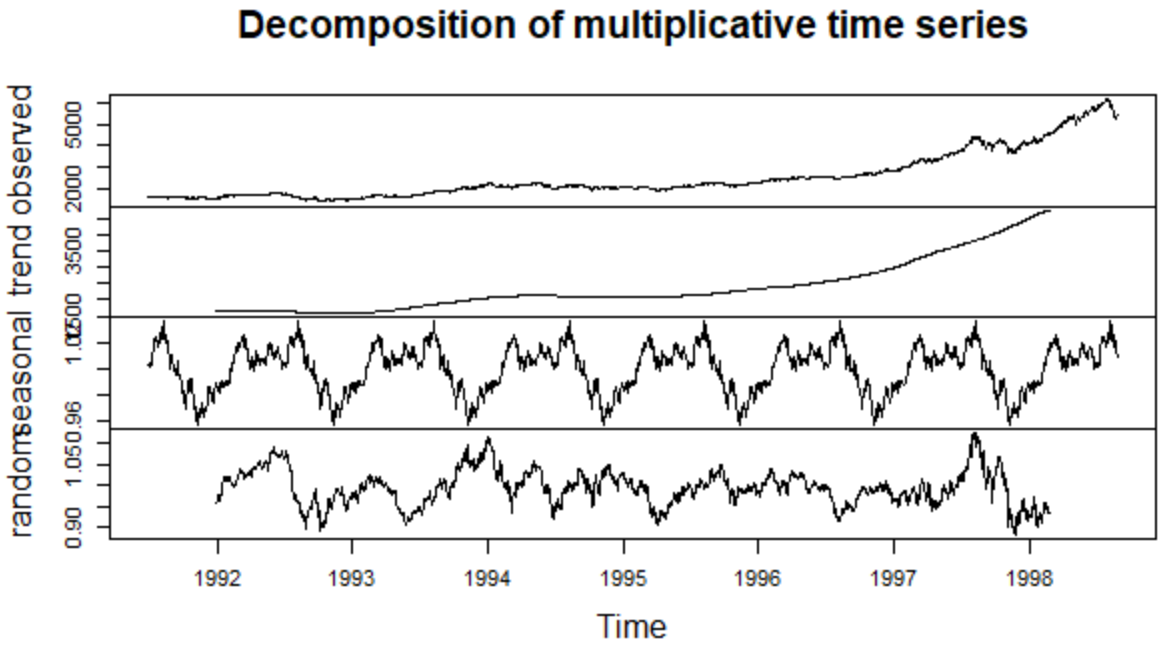

I. Find out the most polluted time of the day and the name of the chemical compound

Answer

#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")
```

Output from Rconsole

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

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