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.
```

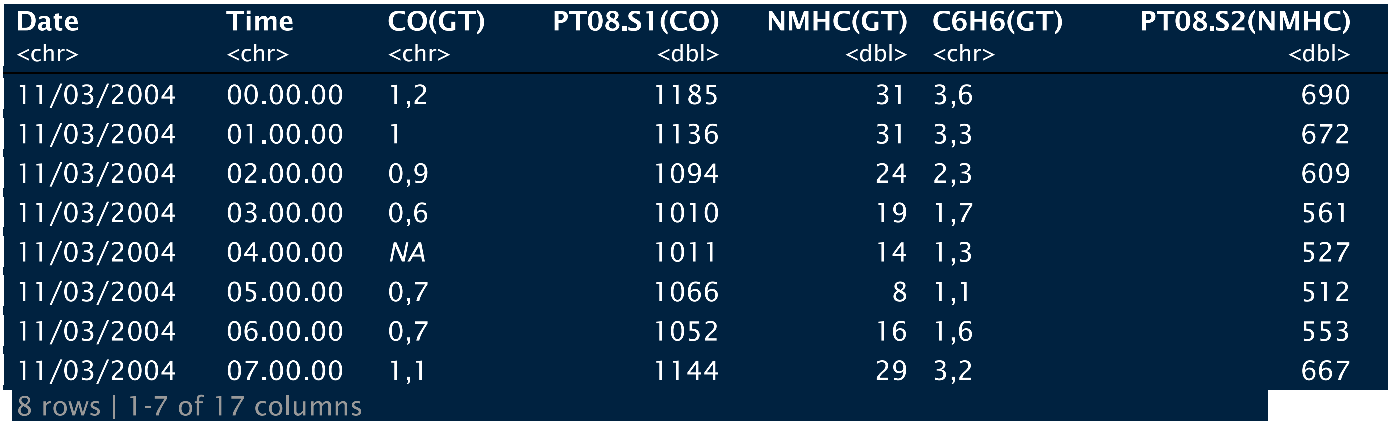
```
row # A tibble: 5 x 5 col      row col    expected   actual     file
expected    <int> <chr> <chr>      <chr>      <chr>               actual 1     1
NA     1 columns 6 columns 'AirqualityUCI.zip' file 2     2 NA     1 columns 5
columns 'AirqualityUCI.zip' row 3     3 NA     1 columns 6 columns
'AirqualityUCI.zip' 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.

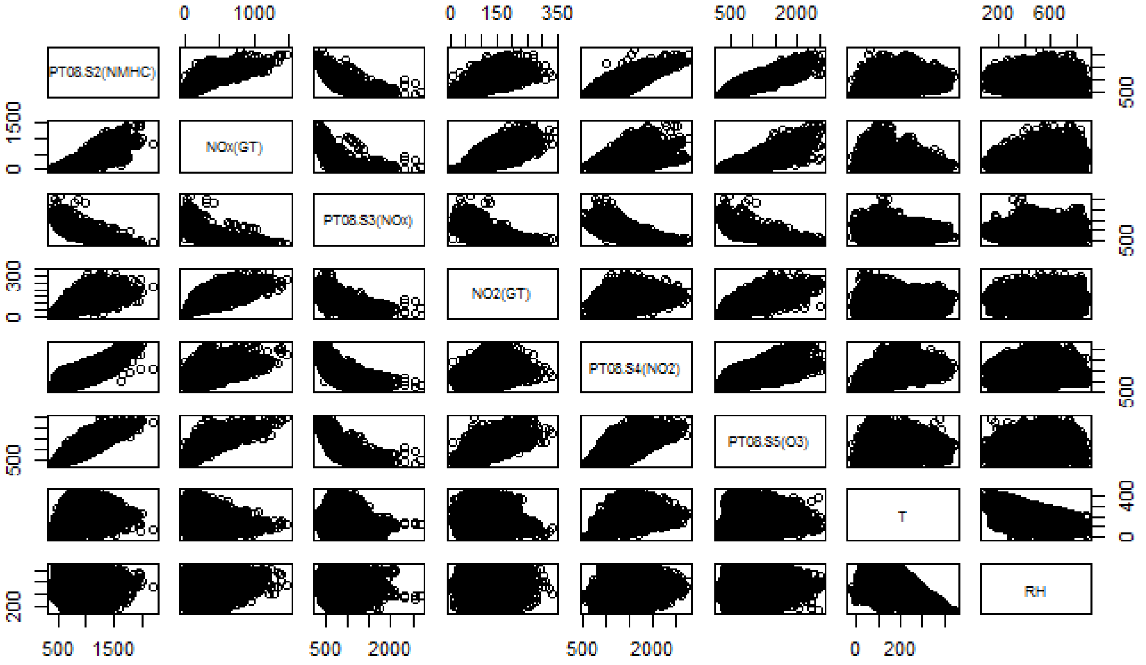
```
AirQualityUCI[AirQualityUCI==-200.0]<-NA

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])
```

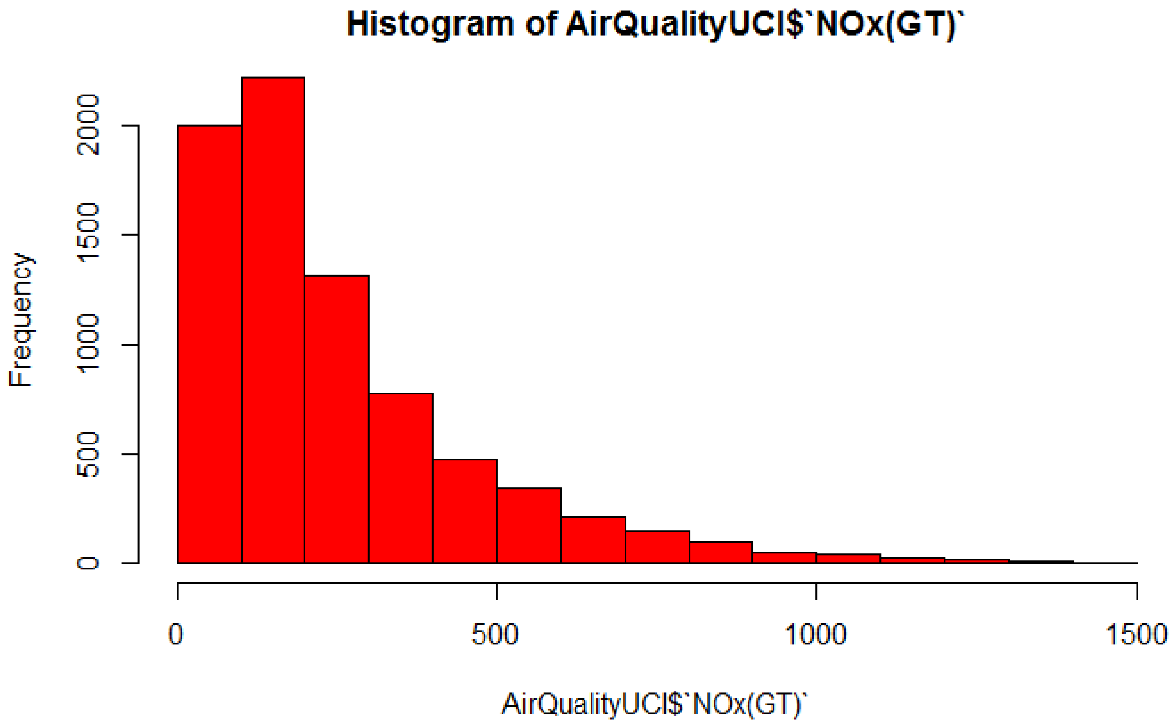


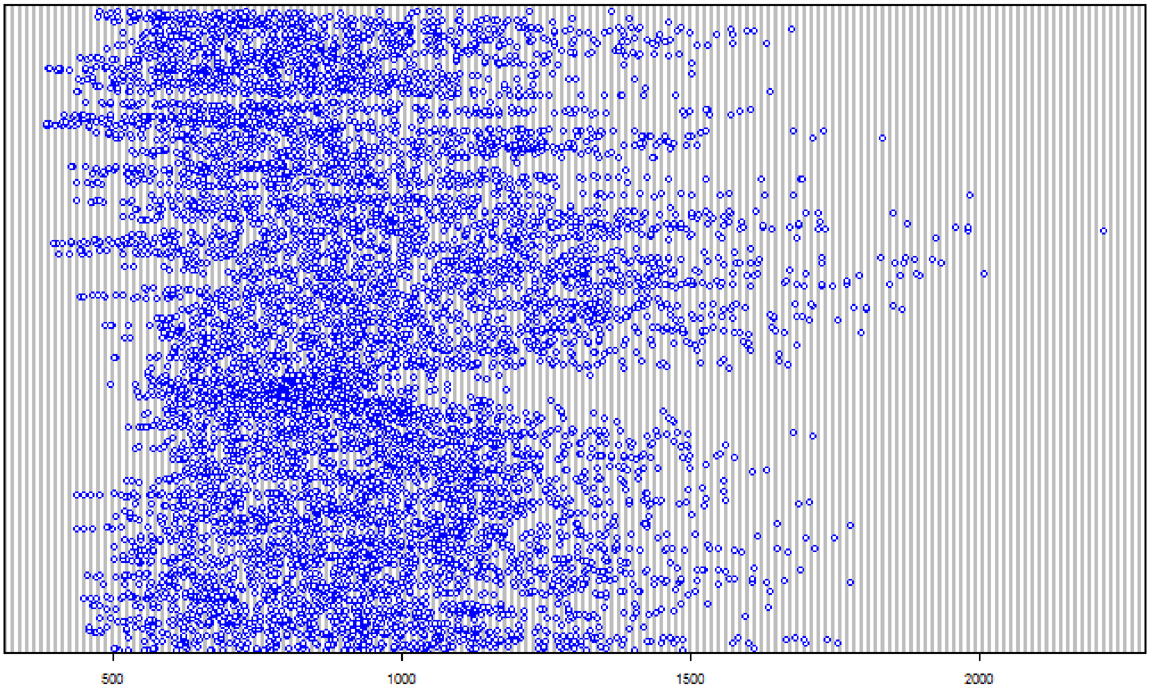
Date	Time	CO(GT)	PT08.S1(CO)	NMHC(GT)	C6H6(GT)	PT08.S2(NMHC)
<chr>	<chr>	<chr>	<dbl>	<dbl>	<chr>	<dbl>
11/03/2004	00.00.00	1,2	1185	31	3,6	690
11/03/2004	01.00.00	1	1136	31	3,3	672
11/03/2004	02.00.00	0,9	1094	24	2,3	609
11/03/2004	03.00.00	0,6	1010	19	1,7	561
11/03/2004	04.00.00	*NA*	1011	14	1,3	527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

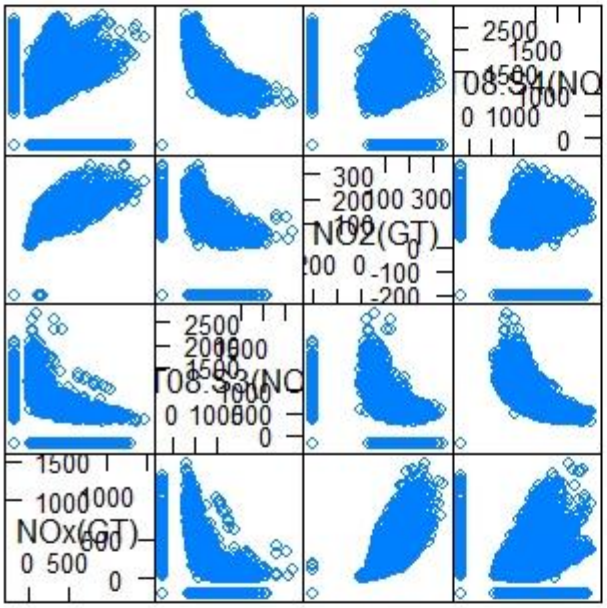
8 rows | 1-7 of 17 columns

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

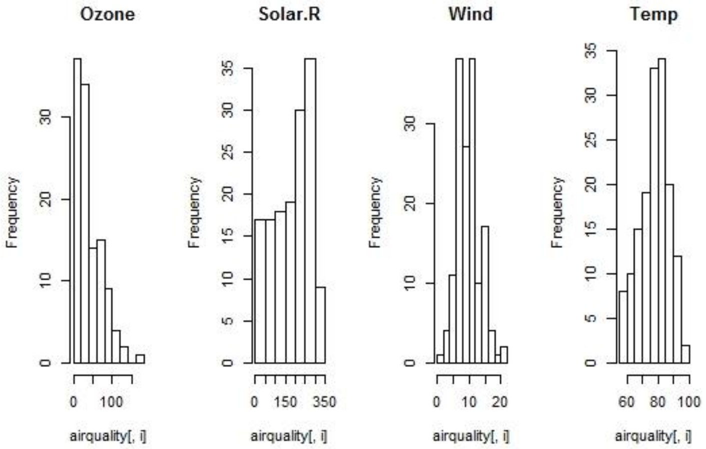

PT08.S2(NMHC)
NOx(GT)
PT08.S3(NOx)
NO2(GT)
PT08.S4(NO2)
PT08.S5(O3)
T
RH
0
1000
0
150
350
500
2000
200
600
500
1500
0
500
300
0
500
500
400
0
200
500
1500
500
2000
500
2000
0
200


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

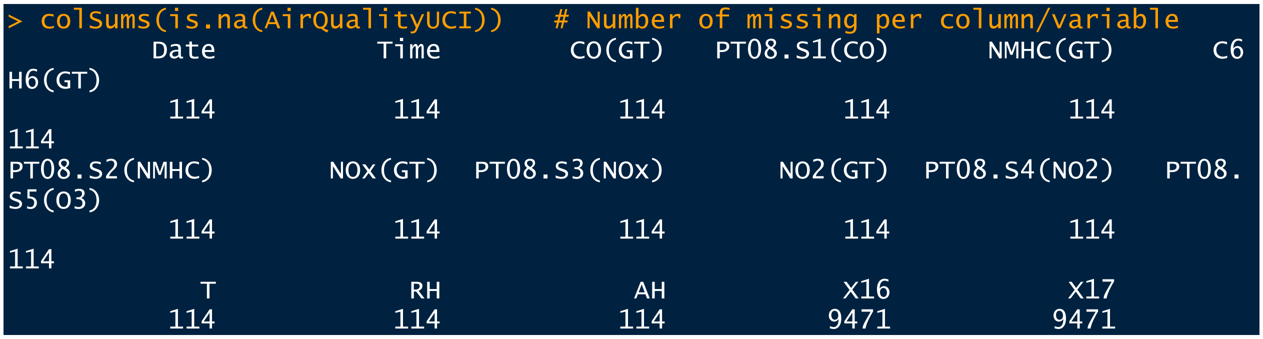




Scatter Plot Matrix



3. Check for missing values in all columns.

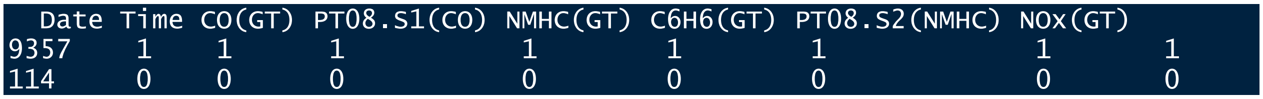


```
> colSums(is.na(AirQualityUCI))   # Number of missing per column/variable
          Date           Time         CO(GT)    PT08.S1(CO)       NMHC(GT)       C6
H6(GT)
           114            114            114            114            114            
114
PT08.S2(NMHC)        NOx(GT)   PT08.S3(NOx)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

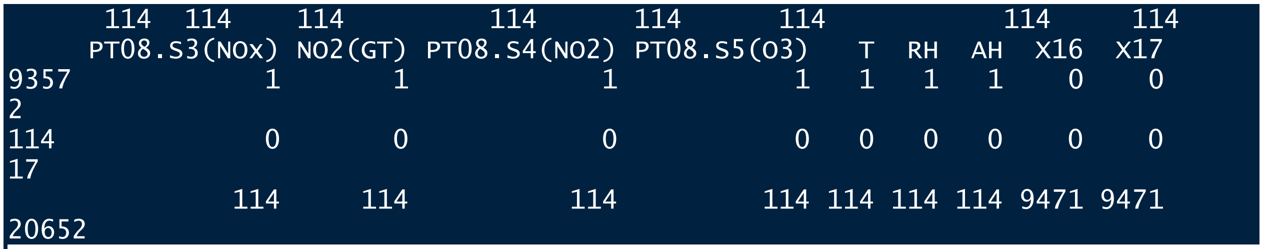
# Pattern of missing values

library(mice)

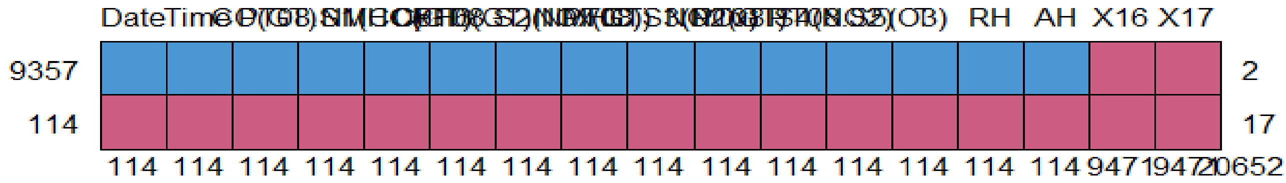
md.pattern(AirQualityUCI) # pattern or missing values in data.

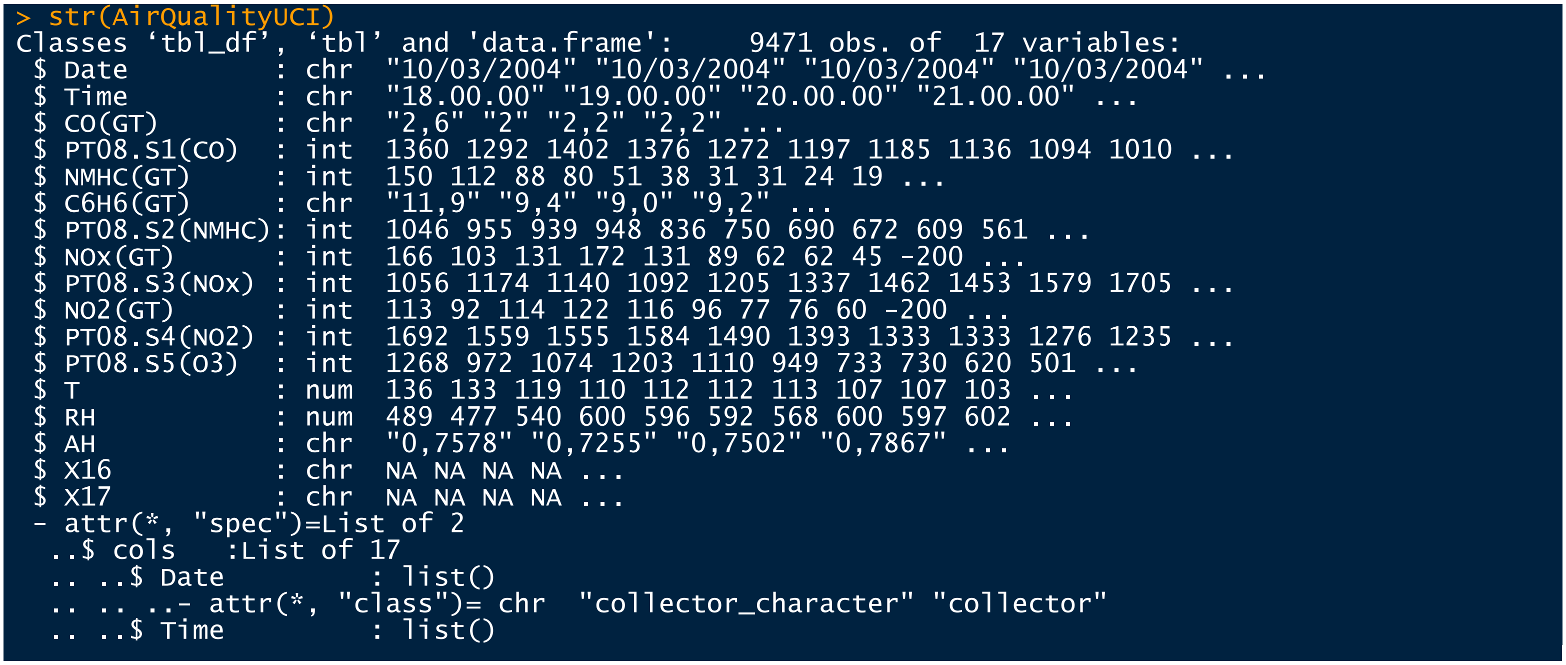


```
  Date Time CO(GT) PT08.S1(CO) NMHC(GT) C6H6(GT) PT08.S2(NMHC) NOx(GT)
9357    1    1      1           1        1        1             1       1
114     0    0      0           0        0        0             0       0
```

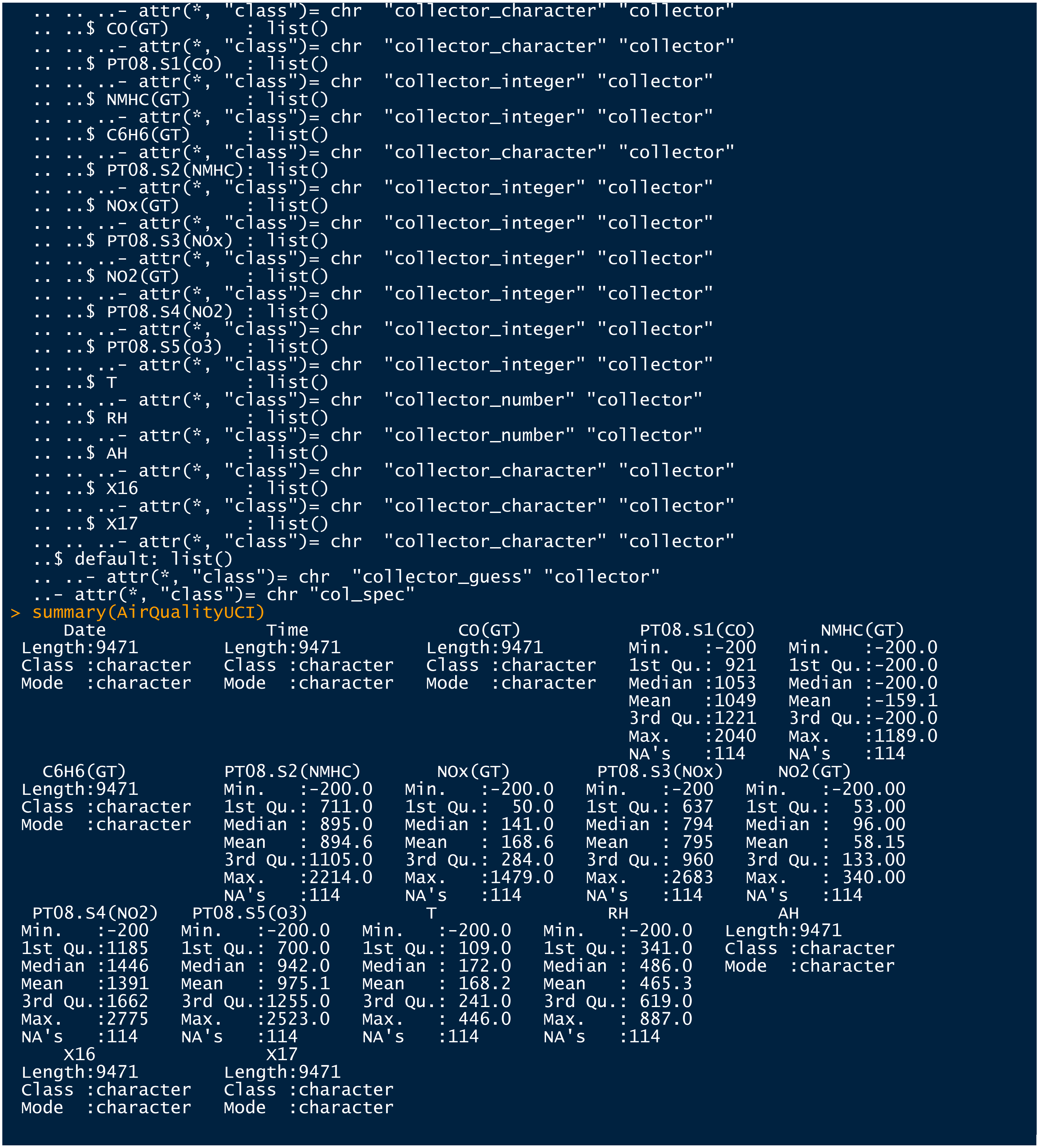


```
      114  114    114         114      114      114           114     114
     PT08.S3(NOx) NO2(GT) PT08.S4(NO2) PT08.S5(O3)   T  RH  AH  X16  X17
9357            1       1            1           1   1   1   1    0    0
2
114             0       0            0           0   0   0   0    0    0
17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

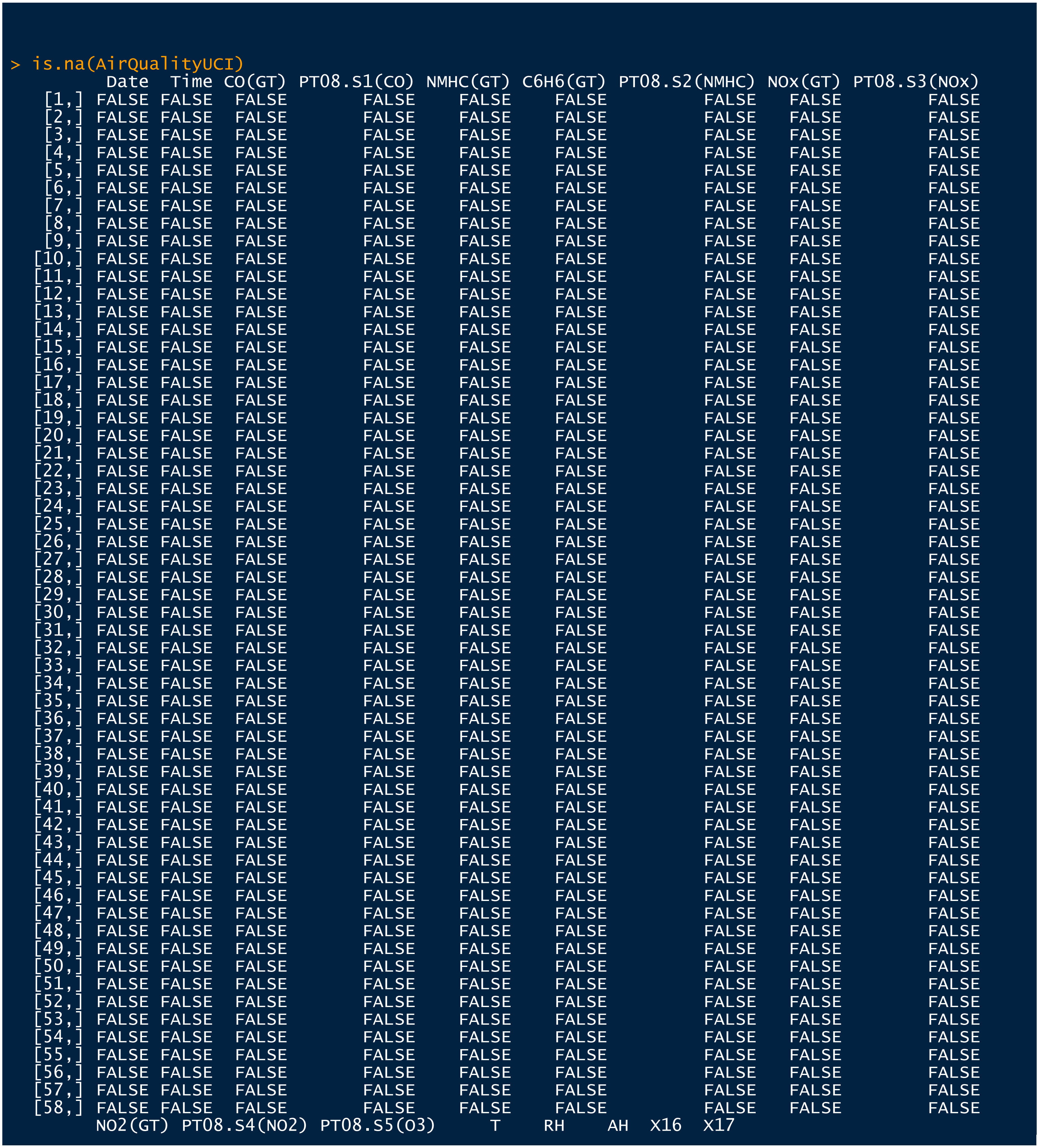




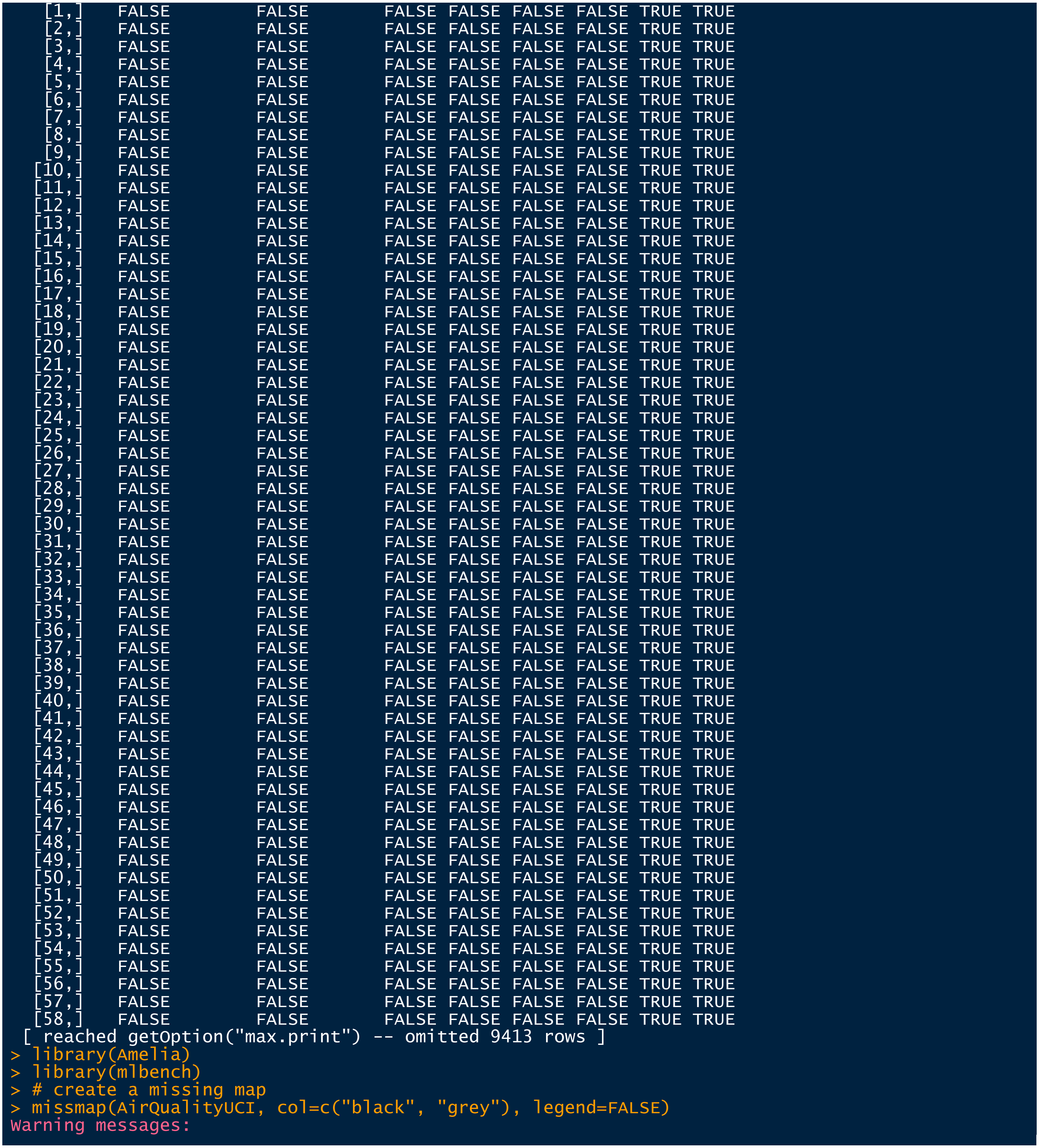
```
> str(AirQualityUCI)
Classes ‘tbl_df’, ‘tbl’ and 'data.frame':	9471 obs. of  17 variables:
 $ Date         : chr  "10/03/2004" "10/03/2004" "10/03/2004" "10/03/2004" ...
 $ Time         : chr  "18.00.00" "19.00.00" "20.00.00" "21.00.00" ...
 $ CO(GT)       : chr  "2,6" "2" "2,2" "2,2" ...
 $ PT08.S1(CO)  : 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()
```



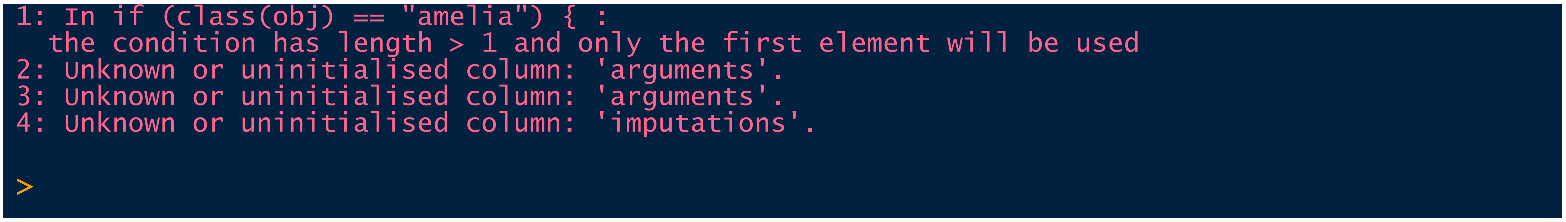
```
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ CO(GT)       : list()
  .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
  .. ..$ PT08.S1(CO)  : list()
  .. .. ..- attr(*, "class")= chr  "collector_integer" "collector"
  .. ..$ NMHC(GT)     : list()
  .. .. ..- 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  
```



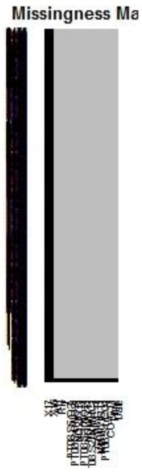
```
> is.na(AirQualityUCI)
         Date  Time CO(GT) PT08.S1(CO) NMHC(GT) C6H6(GT) PT08.S2(NMHC) NOx(GT) PT08.S3(NOx)
    [1,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE        FALSE
    [2,] FALSE FALSE  FALSE       FALSE    FALSE    FALSE         FALSE   FALSE        FALSE
    [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
```

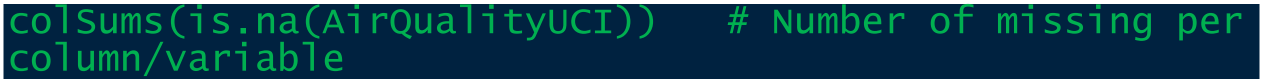


```
   [1,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [2,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [3,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [4,]   FALSE        FALSE       FALSE FALSE FALSE FALSE TRUE TRUE
   [5,]   FALSE        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:
```

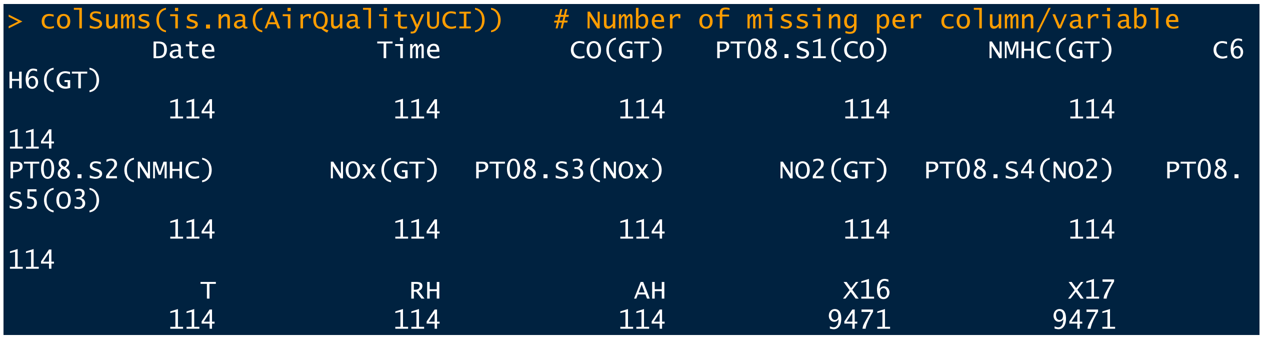


```
1: In if (class(obj) == "amelia") { :
  the condition has length > 1 and only the first element will be used
2: Unknown or uninitialised column: 'arguments'.
3: Unknown or uninitialised column: 'arguments'.
4: Unknown or uninitialised column: 'imputations'.

>
```





```
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)       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
```

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)

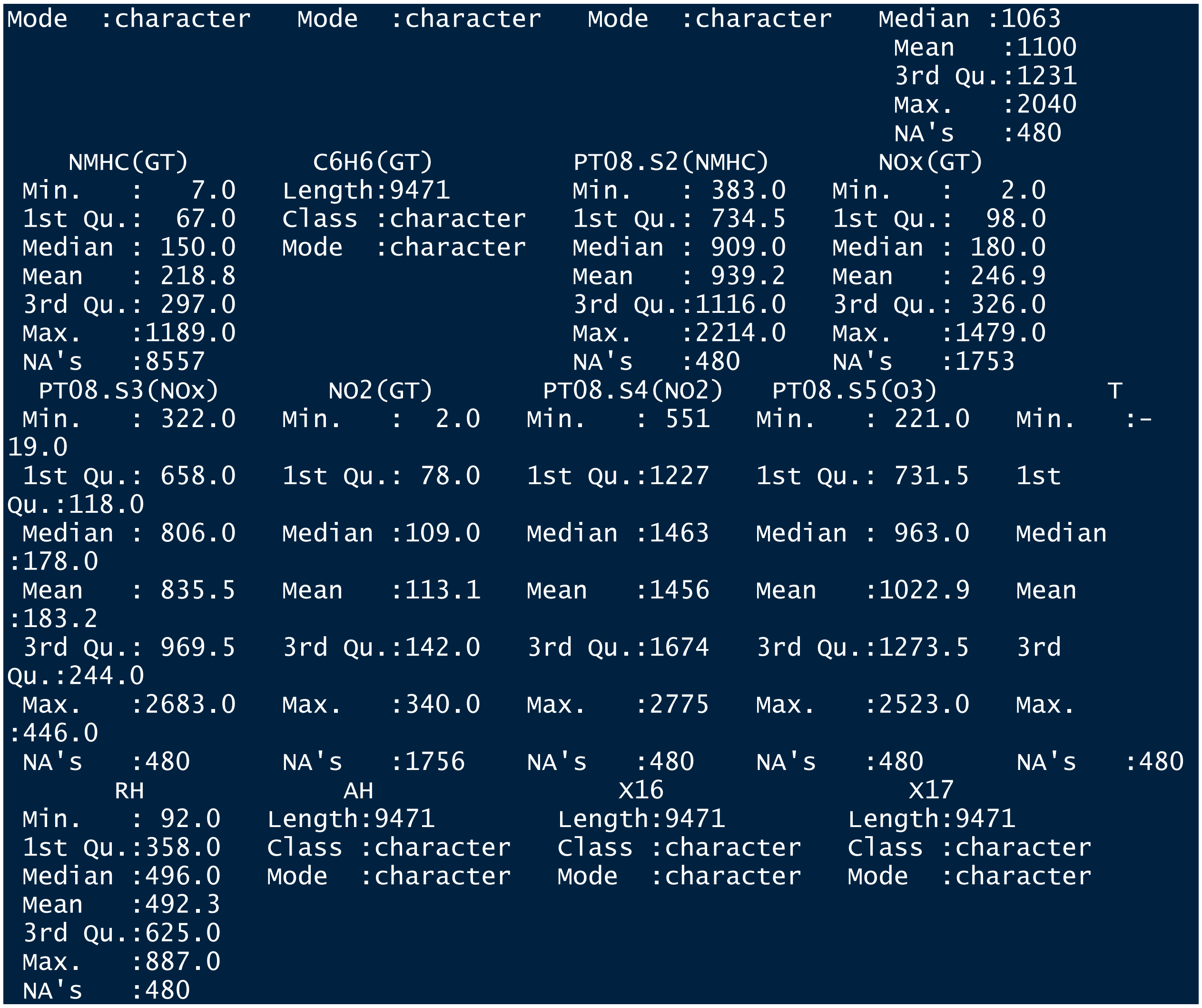
AirQualityUCI[AirQualityUCI==-200.0]<-NA

#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                                                             
```

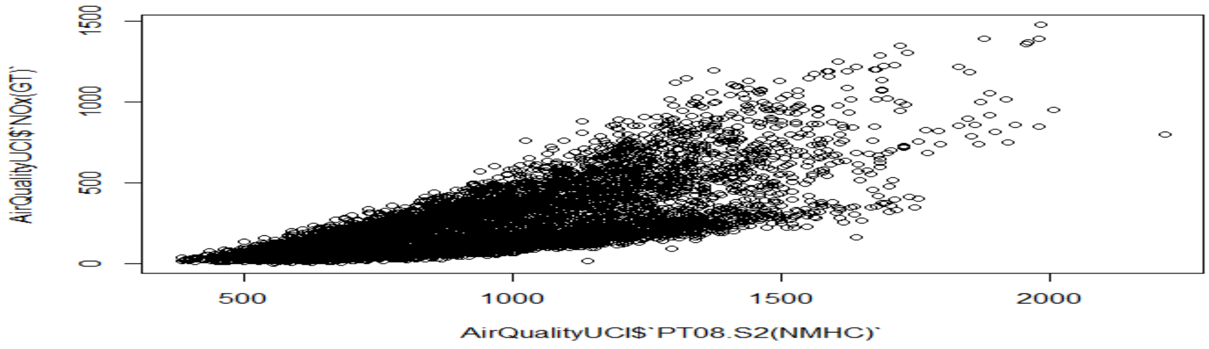
5. Create bi-variate analysis for all relationships.

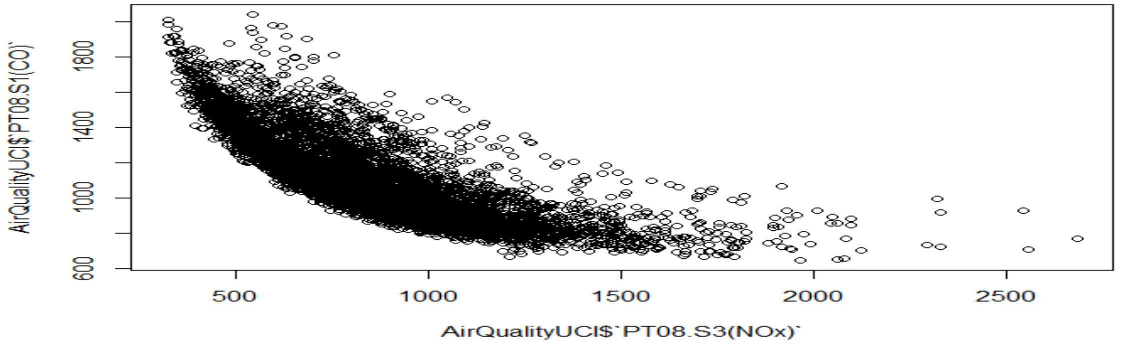
summary(AirQualityUCI)

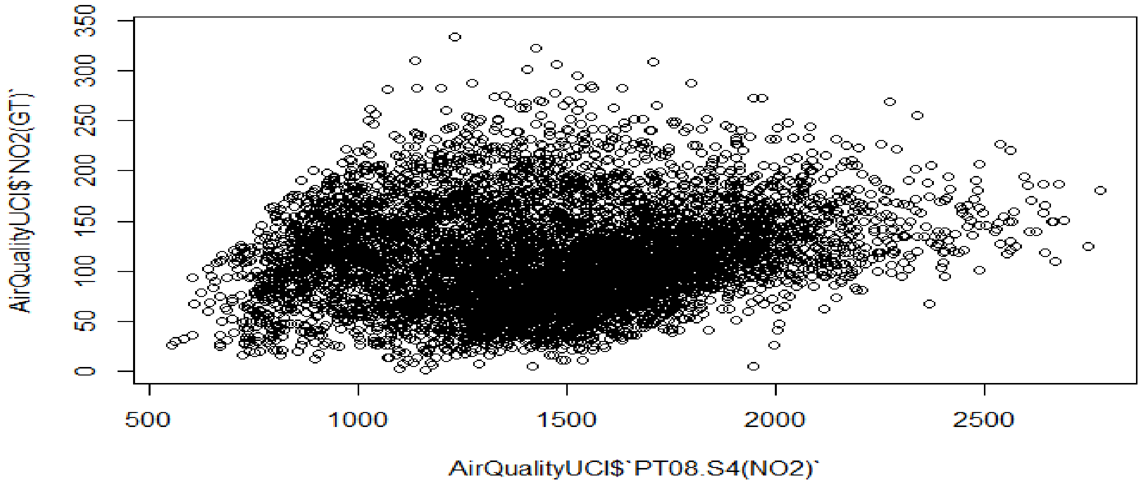
plot(AirQualityUCI$`NOx(GT)`~AirQualityUCI$`PT08.S2(NMHC)`)

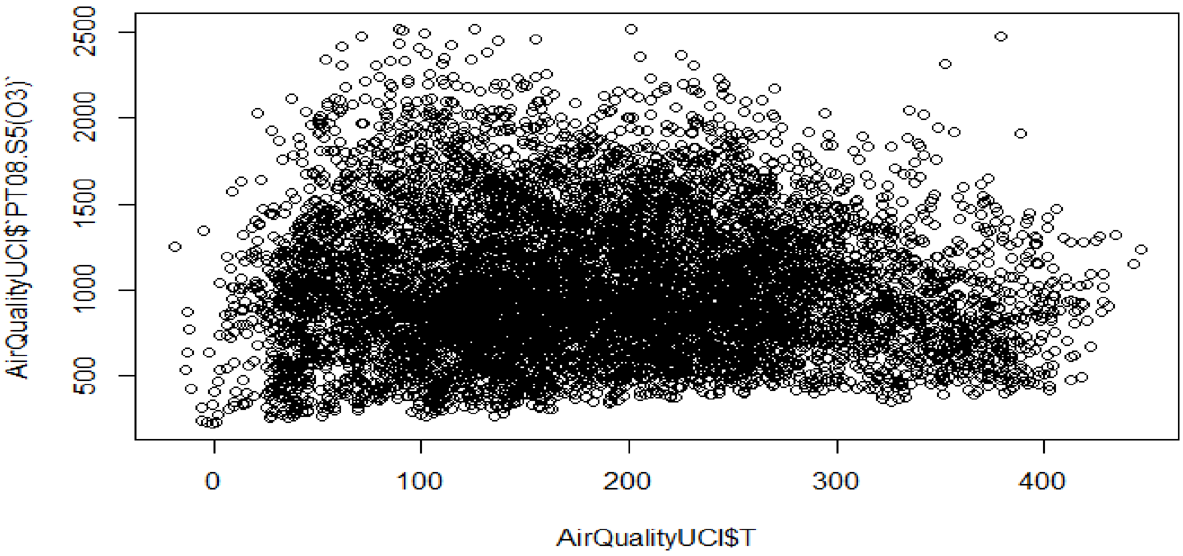
plot(AirQualityUCI$`PT08.S1(CO)`~AirQualityUCI$`PT08.S3(NOx)`)

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

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



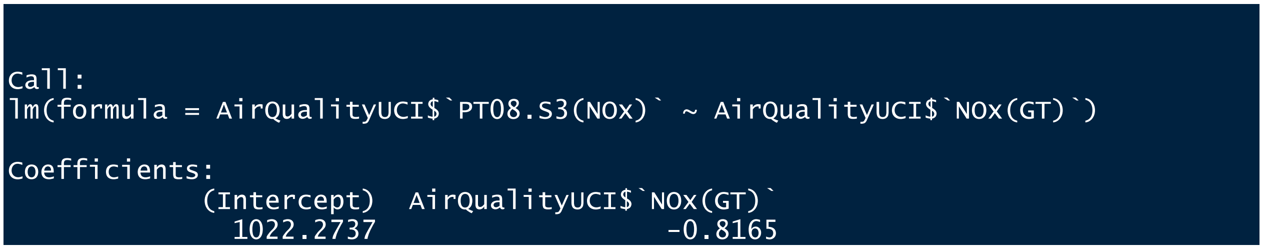




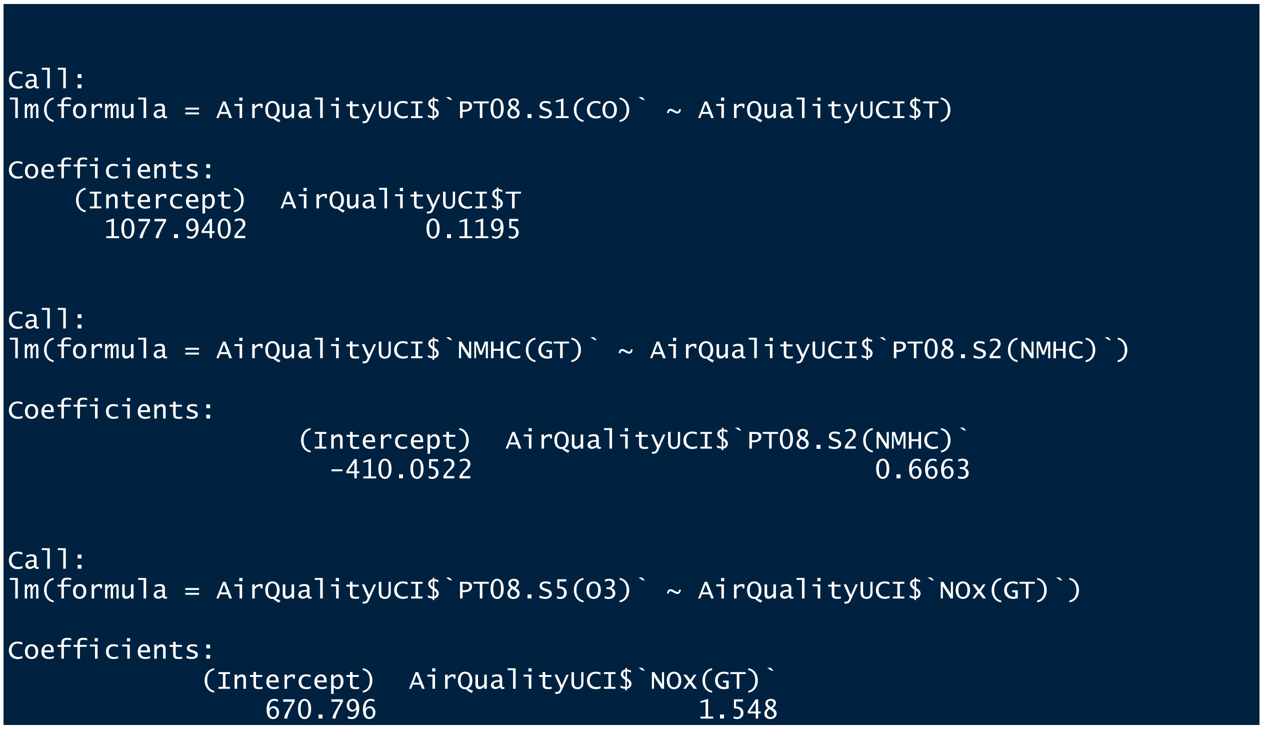


6. Test relevant hypothesis for valid relations.

```
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
```



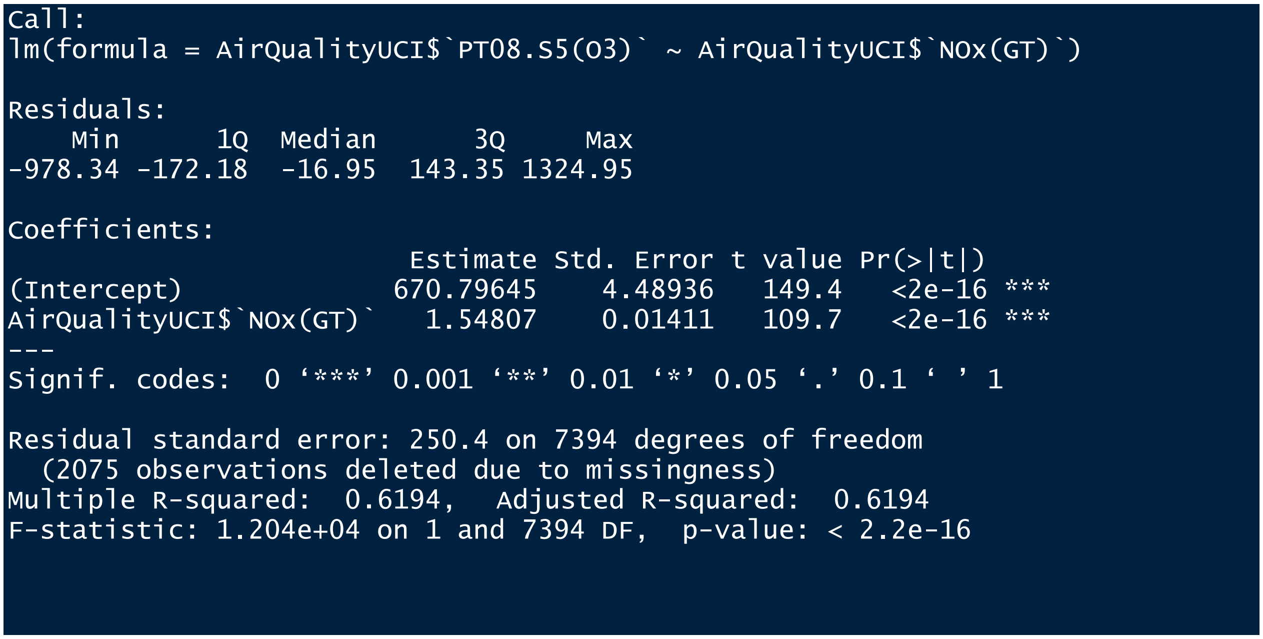
```
Call:
lm(formula = AirQualityUCI$`PT08.S1(CO)` ~ AirQualityUCI$T)

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)`)

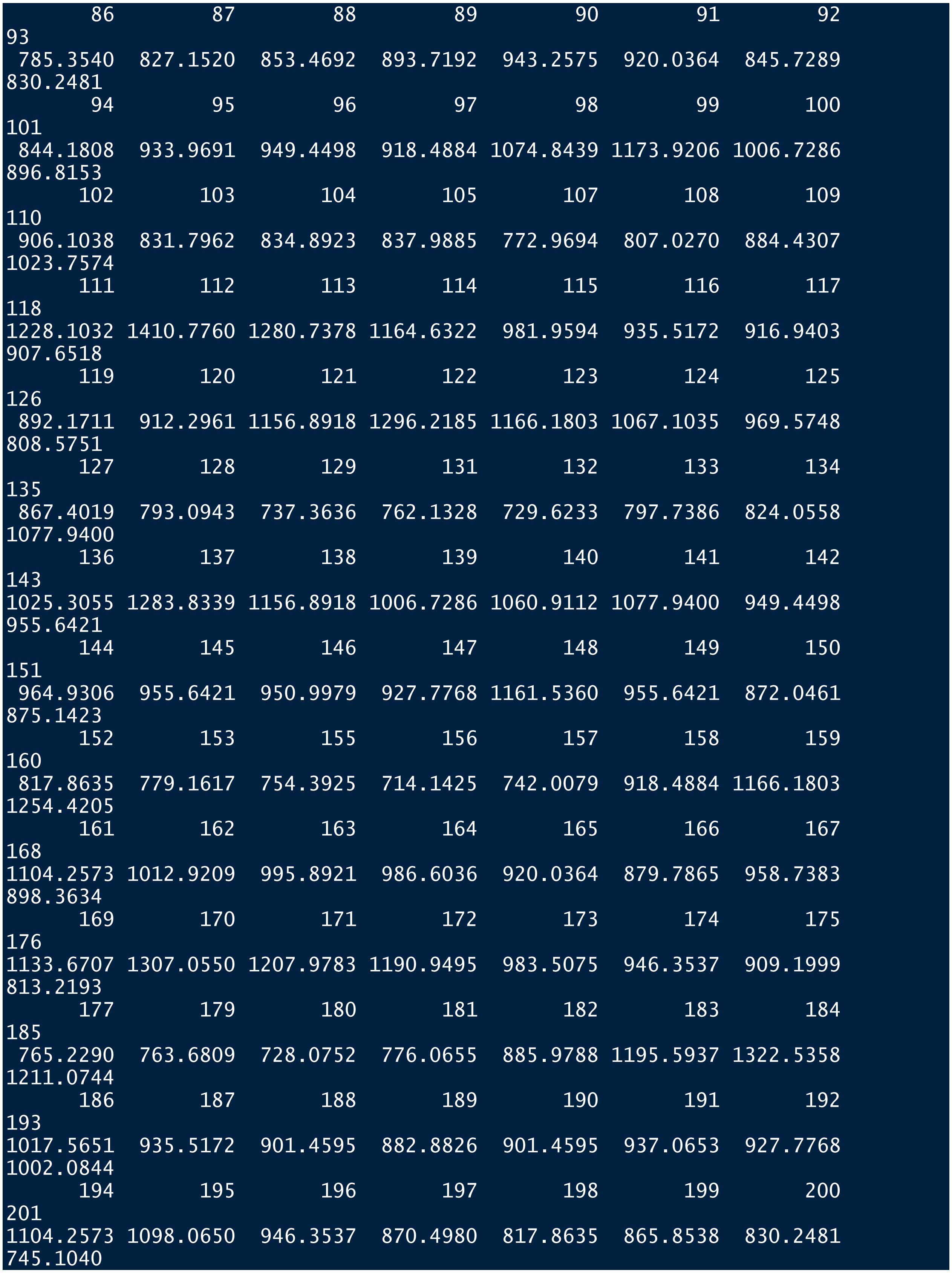
summary(mod)

predict(mod)

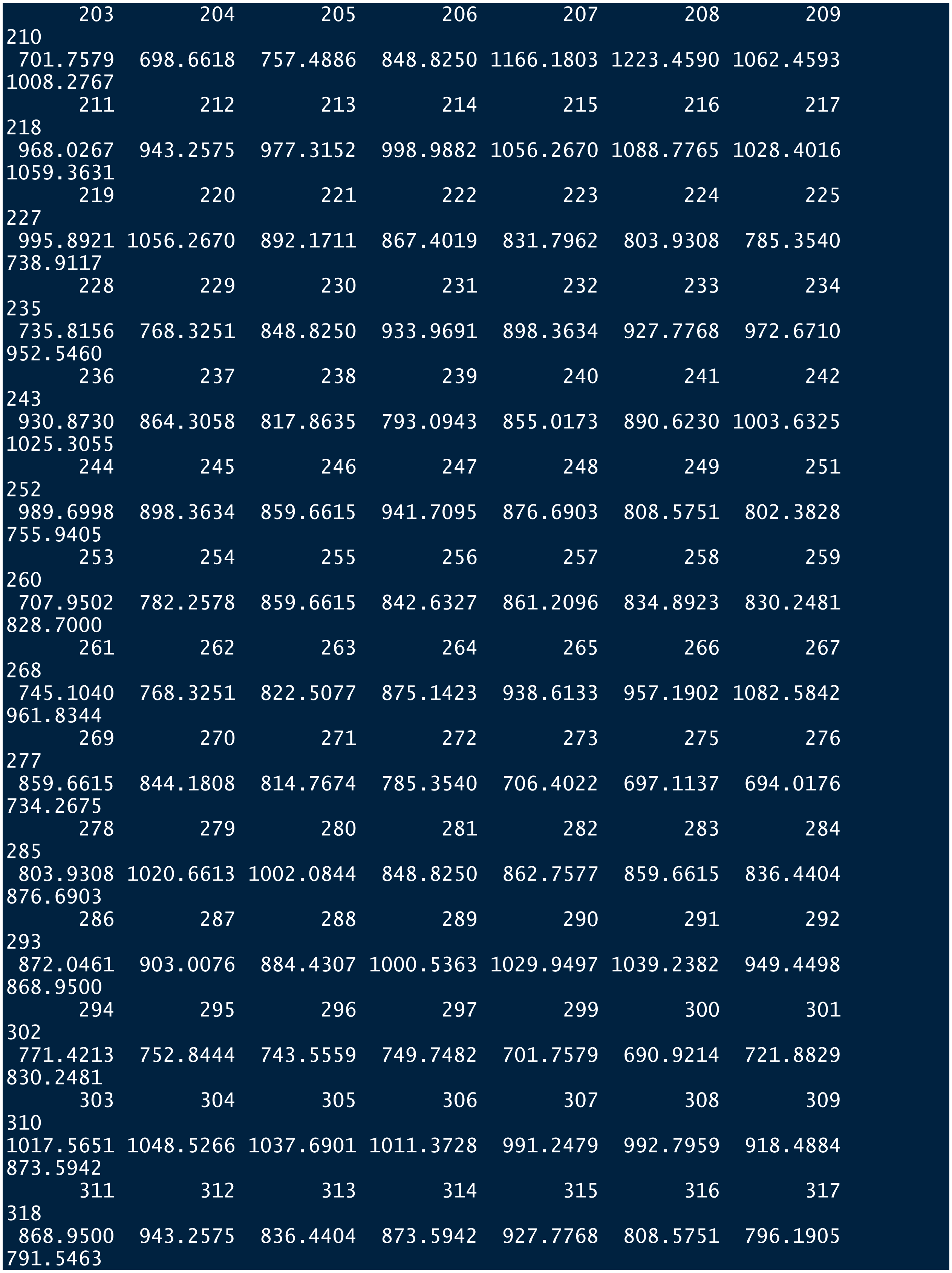


```
Call:
lm(formula = AirQualityUCI$`PT08.S5(O3)` ~ AirQualityUCI$`NOx(GT)`)

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
```

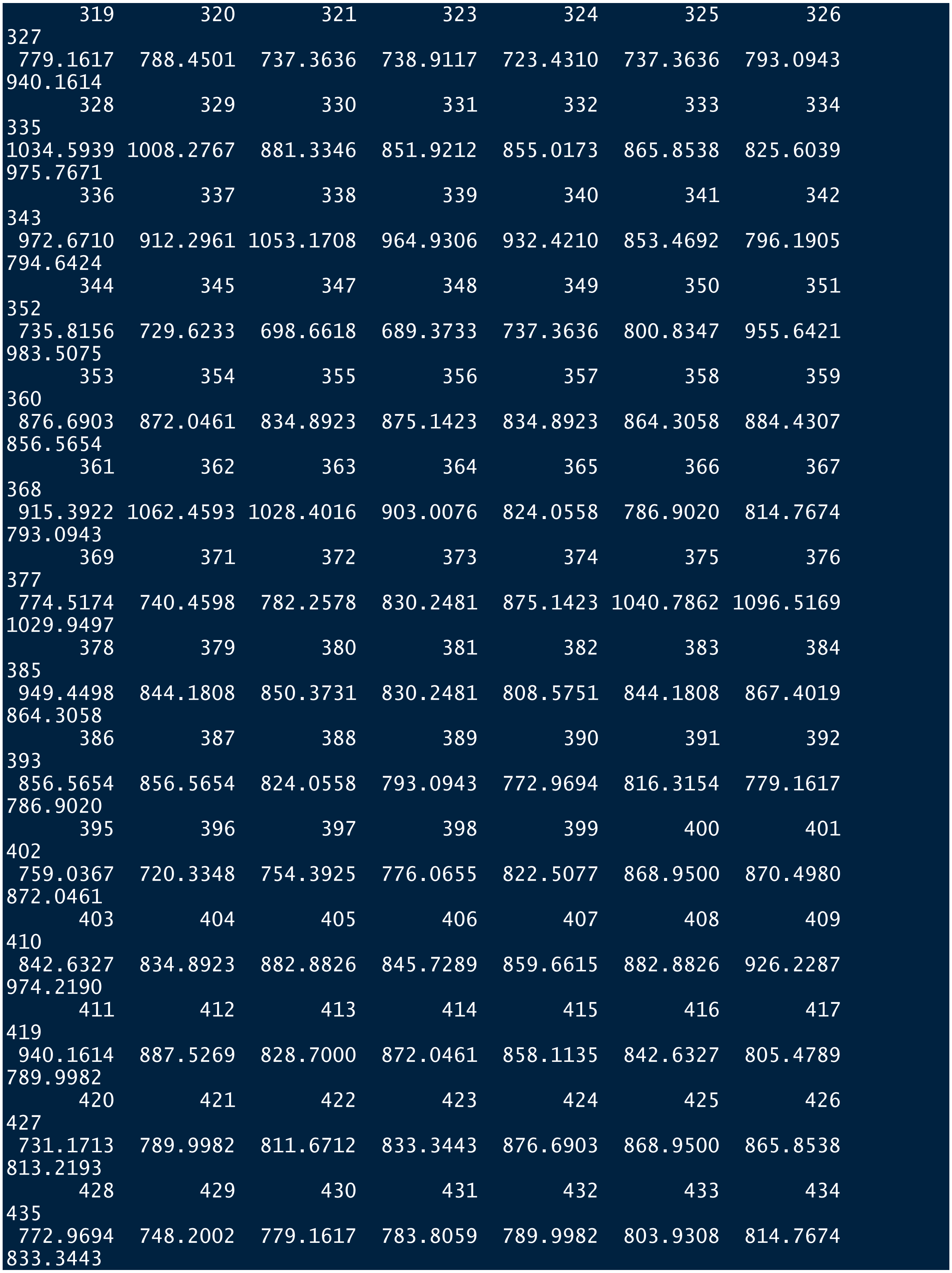
```
pnorm(1.49)
pnorm(1.097)
qnorm(0.9318879)
qnorm(0.8636793)

[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
```



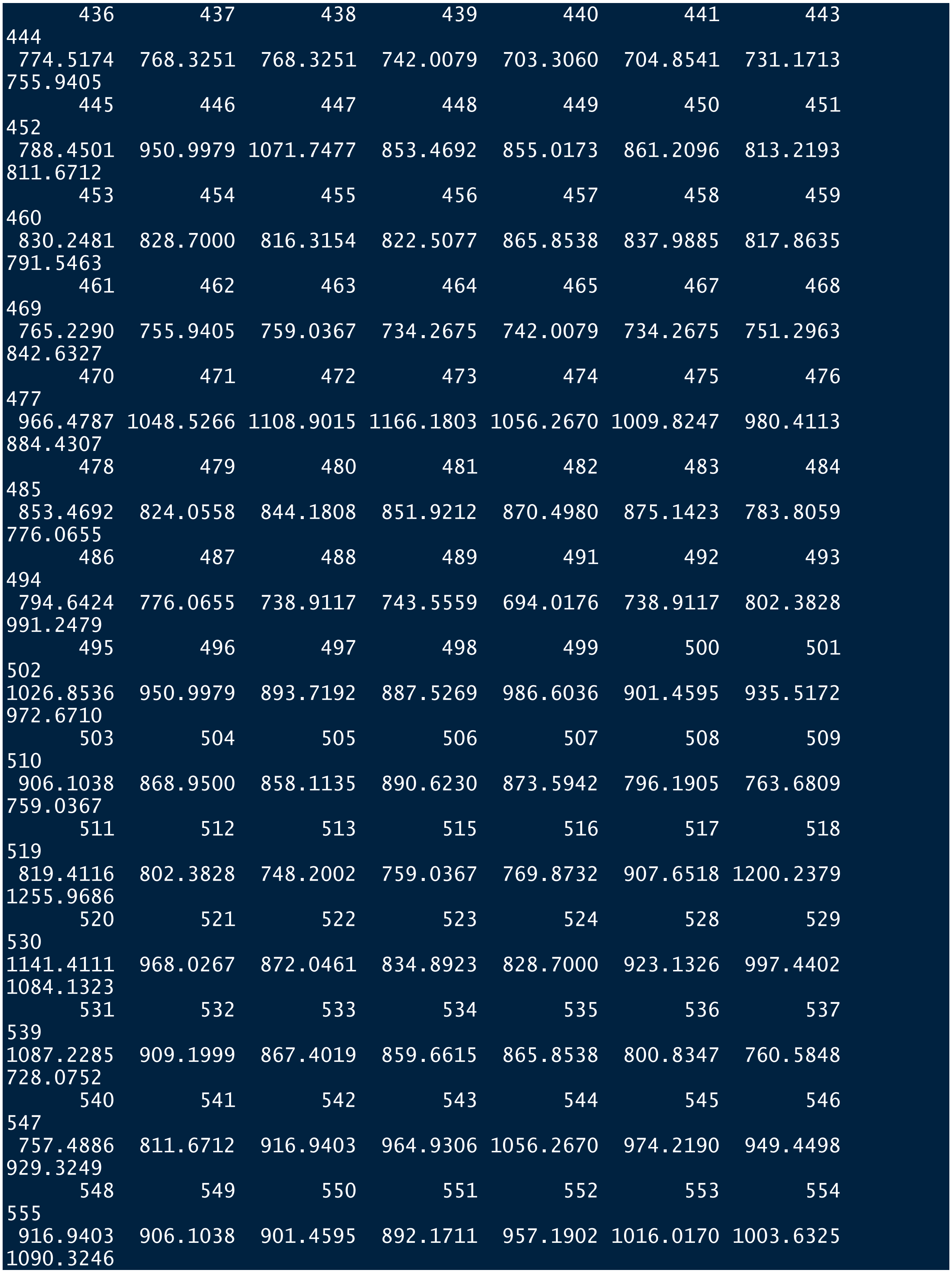
```
       86        87        88        89        90        91        92
93
 785.3540  827.1520  853.4692  893.7192  943.2575  920.0364  845.7289
830.2481
       94        95        96        97        98        99       100
101
 844.1808  933.9691  949.4498  918.4884 1074.8439 1173.9206 1006.7286
896.8153
      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
```



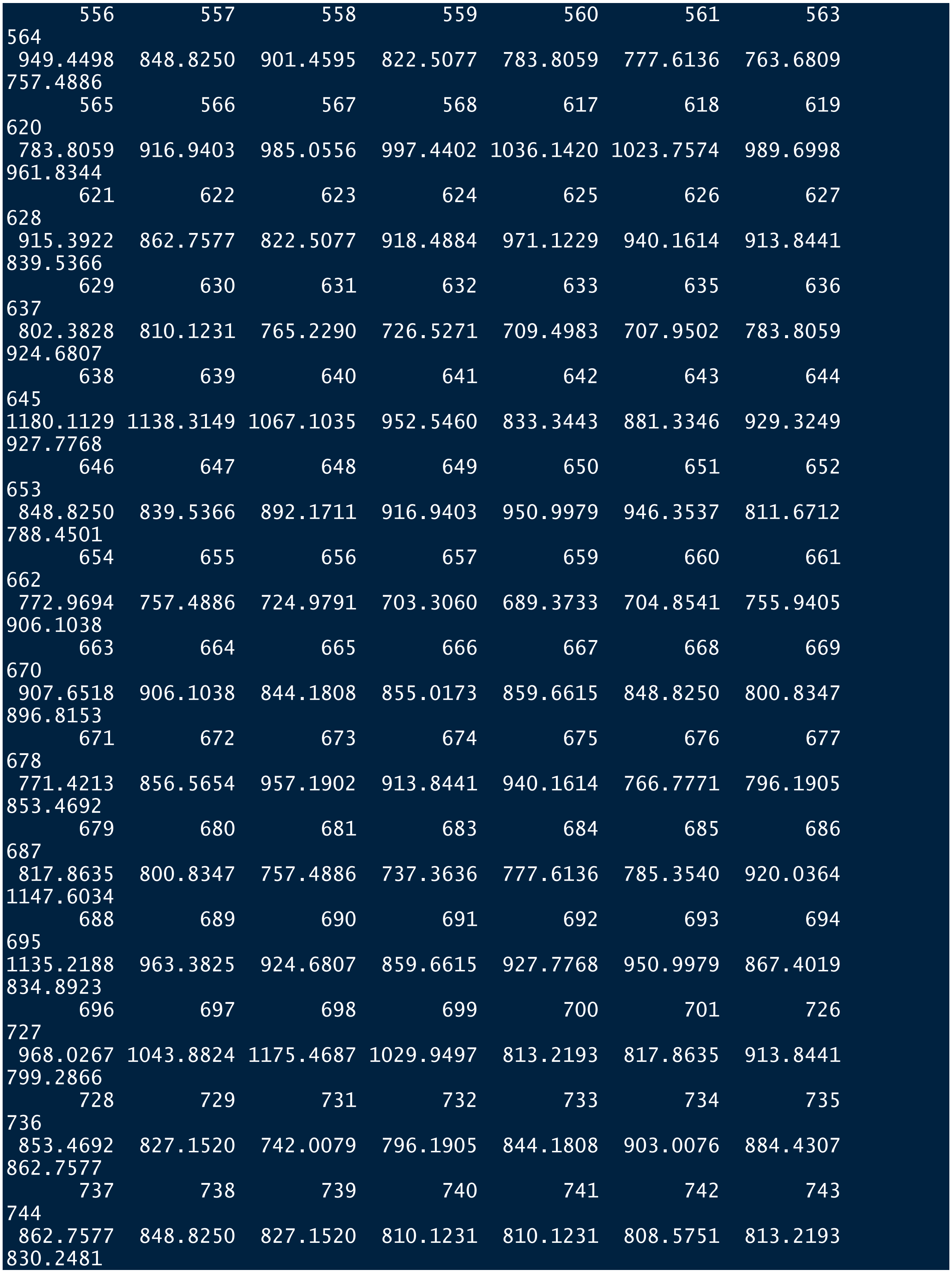
```
      203       204       205       206       207       208       209 
210 
 701.7579  698.6618  757.4886  848.8250 1166.1803 1223.4590 1062.4593 
1008.2767 
      211       212       213       214       215       216       217 
218 
 968.0267  943.2575  977.3152  998.9882 1056.2670 1088.7765 1028.4016 
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 
```

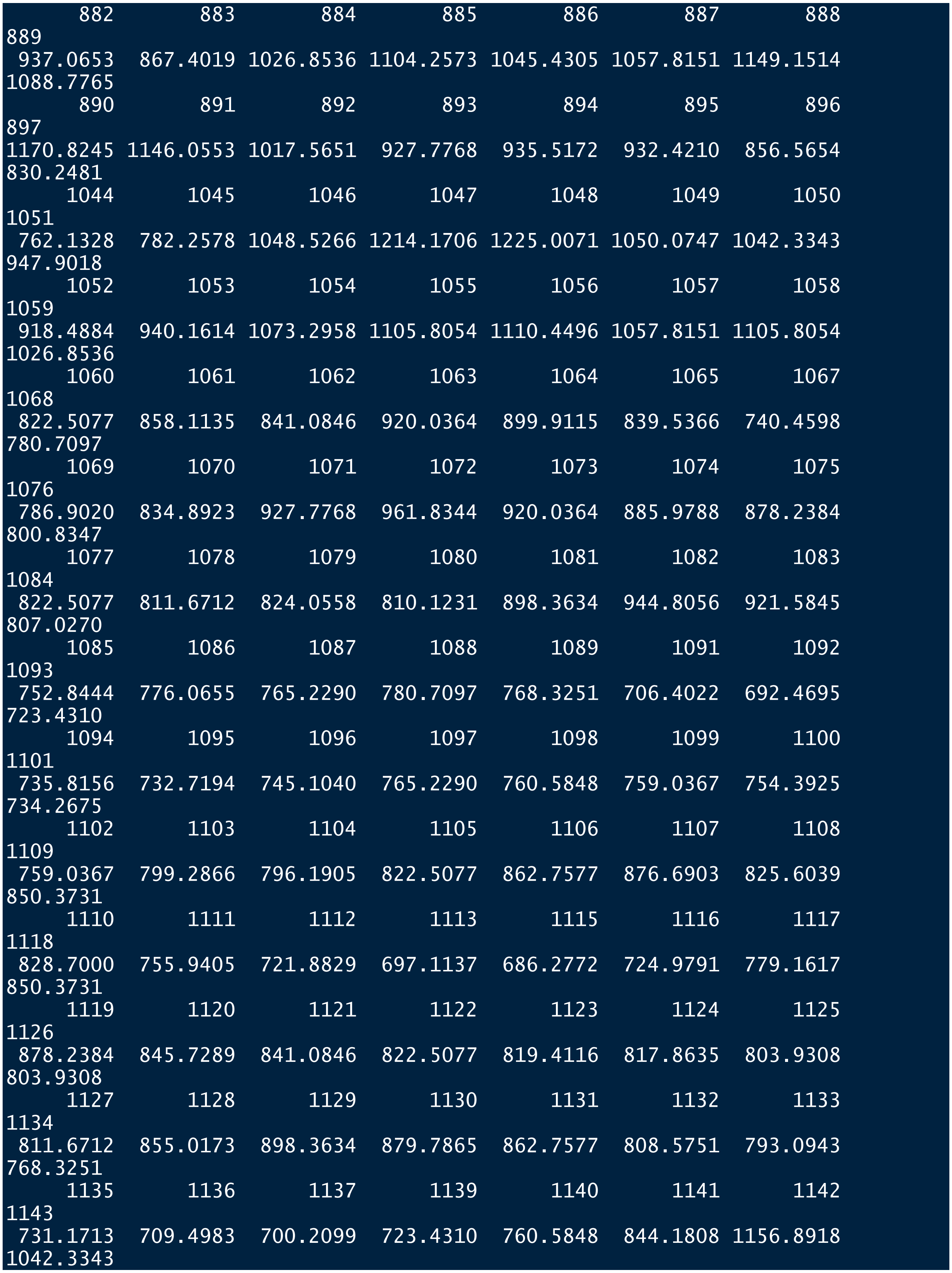


```
      436       437       438       439       440       441       443 
444 
 774.5174  768.3251  768.3251  742.0079  703.3060  704.8541  731.1713 
755.9405 
      445       446       447       448       449       450       451 
452 
 788.4501  950.9979 1071.7477  853.4692  855.0173  861.2096  813.2193 
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 
```

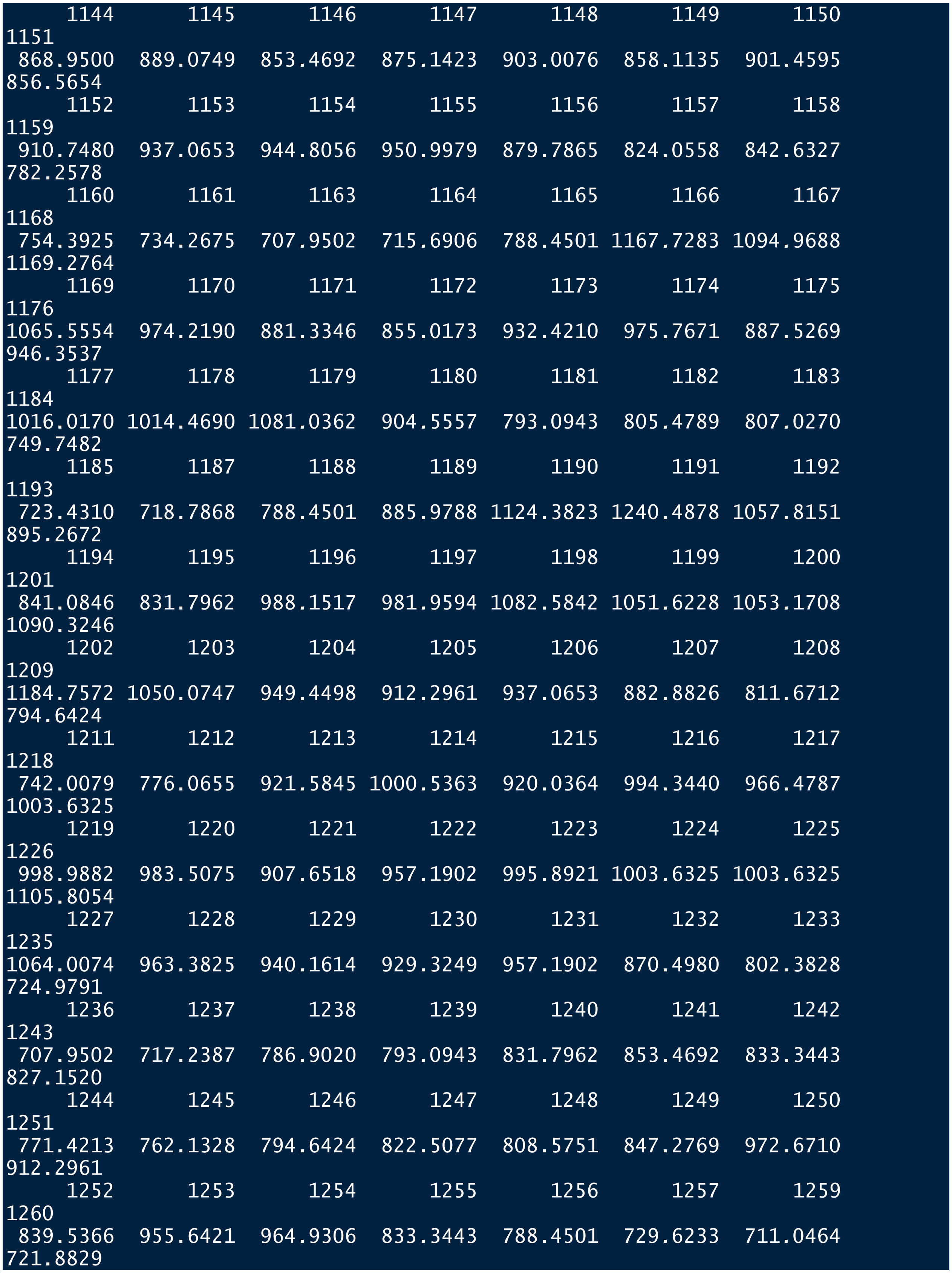


```
      556       557       558       559       560       561       563 
564 
 949.4498  848.8250  901.4595  822.5077  783.8059  777.6136  763.6809 
757.4886 
      565       566       567       568       617       618       619 
620 
 783.8059  916.9403  985.0556  997.4402 1036.1420 1023.7574  989.6998 
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 
```

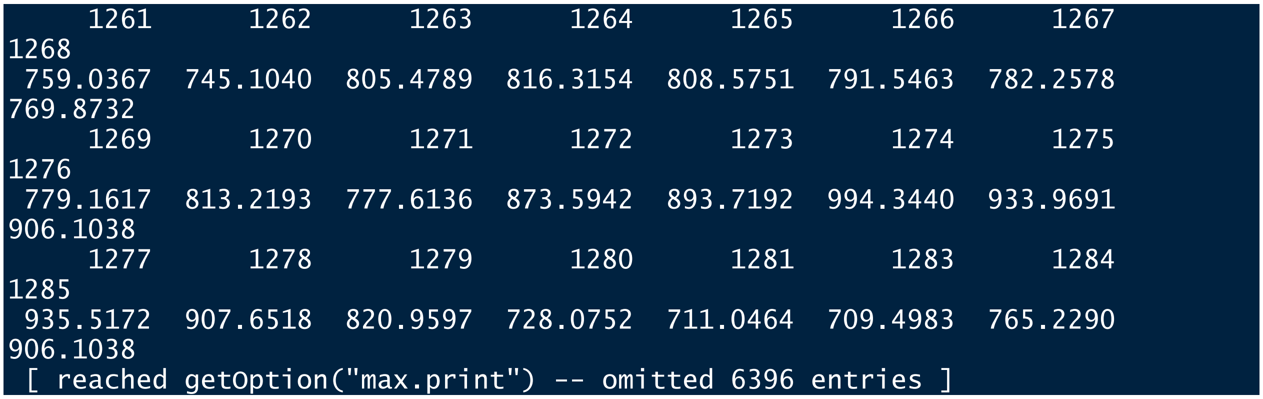
```
      745       746       747       748       749       750       751 
752 
 859.6615  916.9403  937.0653  864.3058  960.2864  940.1614  786.9020 
745.1040 
      753       755       756       757       758       759       760 
761 
 765.2290  729.6233  729.6233  734.2675  749.7482  765.2290  743.5559 
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 
```



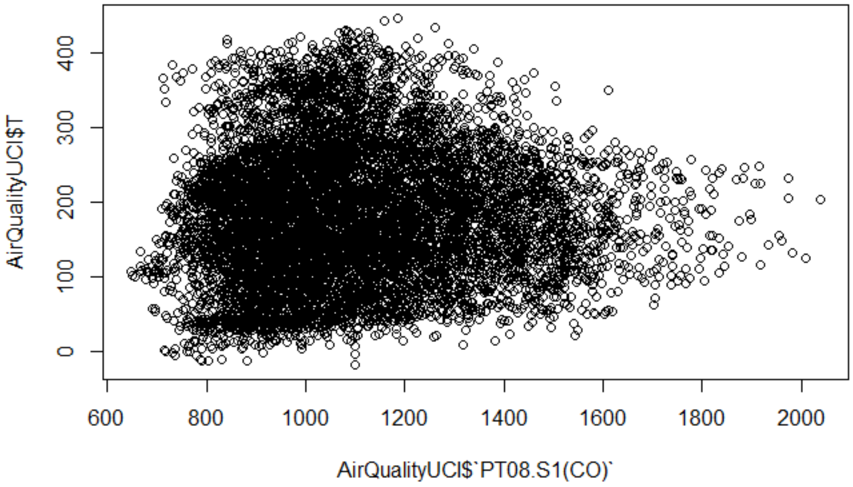
```
      882       883       884       885       886       887       888 
889 
 937.0653  867.4019 1026.8536 1104.2573 1045.4305 1057.8151 1149.1514 
1088.7765 
      890       891       892       893       894       895       896 
897 
1170.8245 1146.0553 1017.5651  927.7768  935.5172  932.4210  856.5654 
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 
```

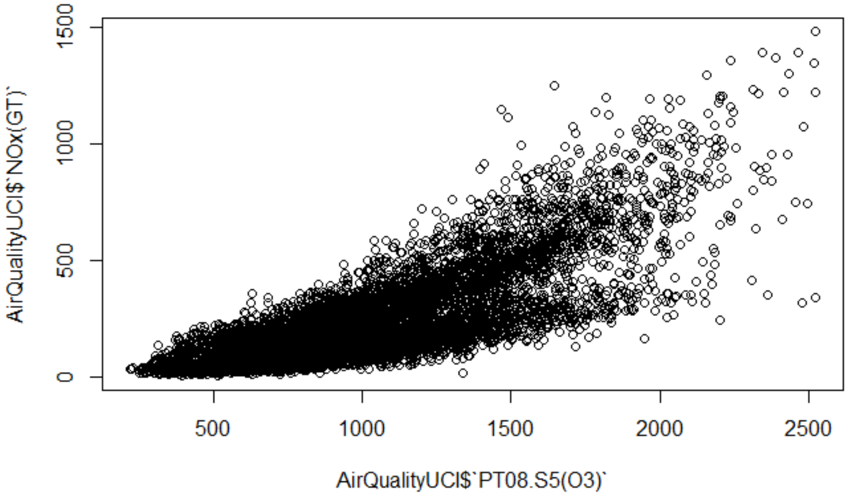


```
     1144      1145      1146      1147      1148      1149      1150 
1151 
 868.9500  889.0749  853.4692  875.1423  903.0076  858.1135  901.4595 
856.5654 
     1152      1153      1154      1155      1156      1157      1158 
1159 
 910.7480  937.0653  944.8056  950.9979  879.7865  824.0558  842.6327 
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
```



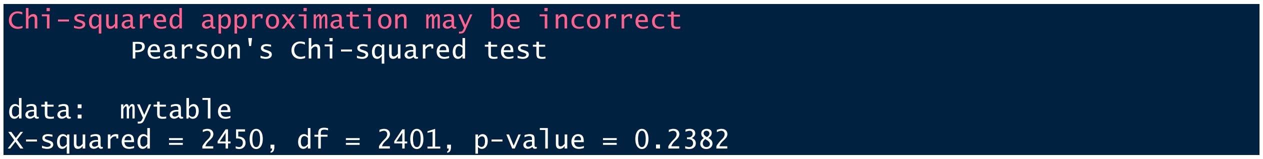
```
     1261      1262      1263      1264      1265      1266      1267
1268
 759.0367  745.1040  805.4789  816.3154  808.5751  791.5463  782.2578
769.8732
     1269      1270      1271      1272      1273      1274      1275
1276
 779.1617  813.2193  777.6136  873.5942  893.7192  994.3440  933.9691
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

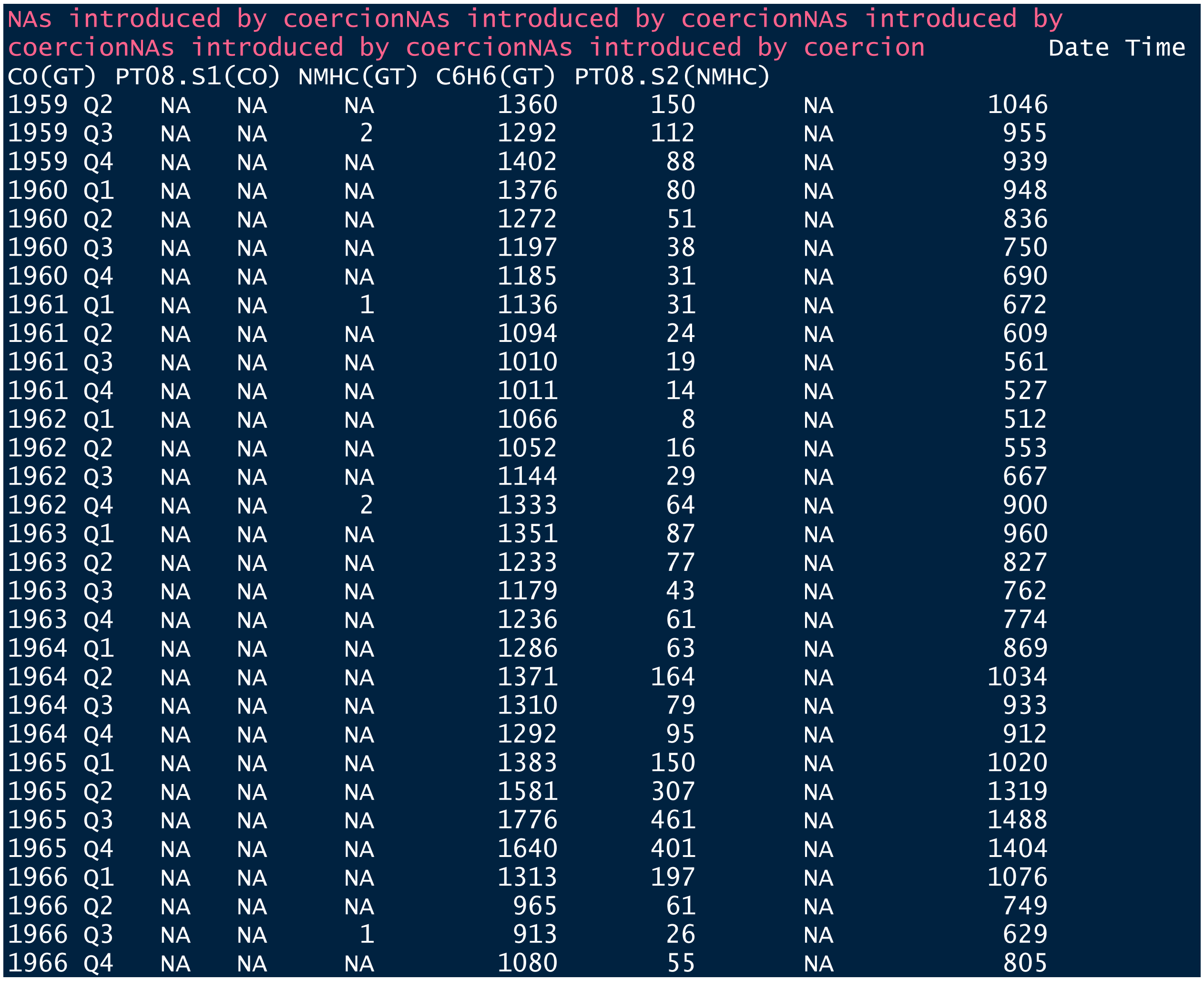
ts (1:10, frequency = 12, start = 1990) # freq 12 => Monthly data.

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

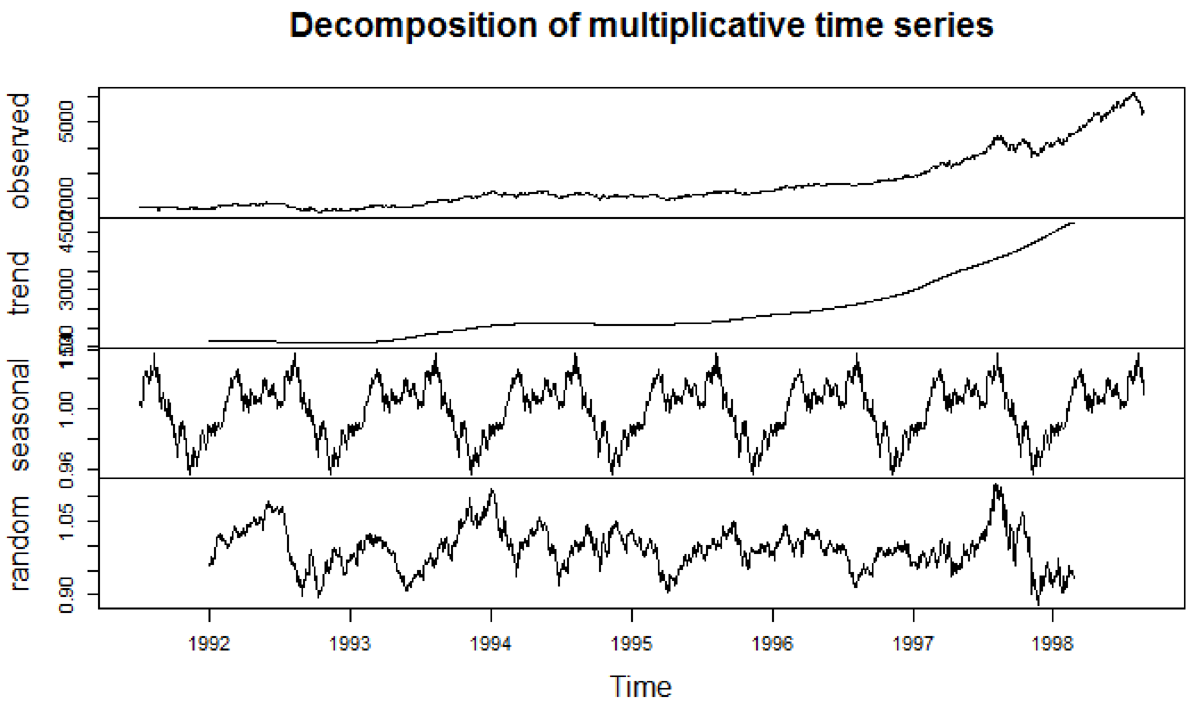


```
NAs introduced by coercionNAs introduced by coercionNAs introduced by
coercionNAs introduced by coercionNAs introduced by coercion         Date Time
CO(GT) PT08.S1(CO) NMHC(GT) C6H6(GT) PT08.S2(NMHC)
1959 Q2   NA   NA     NA        1360      150       NA           1046
1959 Q3   NA   NA      2        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

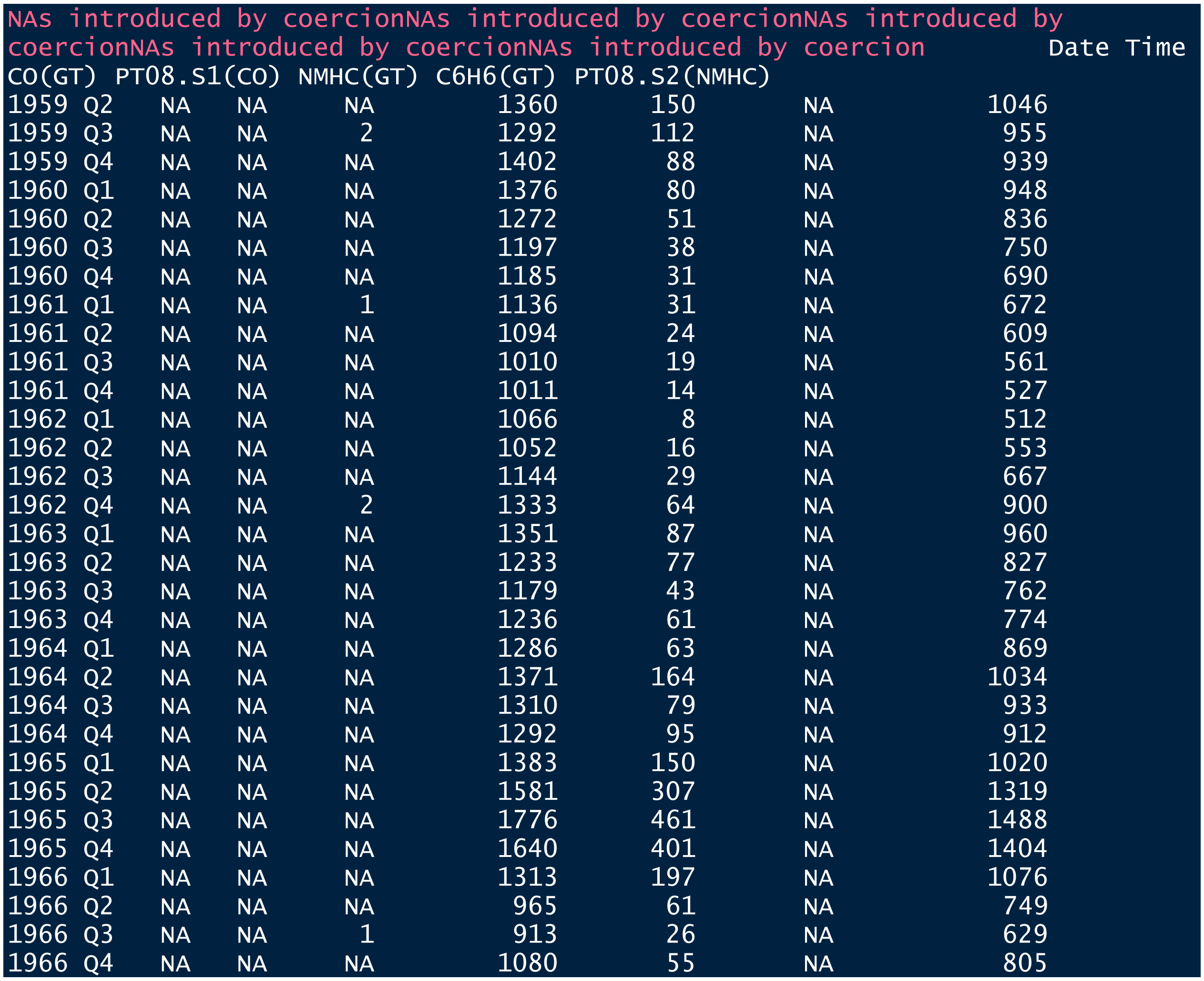
plot (decomposedRes) # see plot below

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