Projeto Data Mining I

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Data importation, clean-up and pre-processing

Importando os Dados

Inicialmente importamos todos as bibliotecas que utilizaresmos neste trabalho Foi importado o dataset "PRSA_Data_Aotizhongxin_20130301-20170228" - Foi utilizado o DataFrame do R para manipular os dados, pois este tipo de estrutura de dados possui um conjunto de funcionalidades e ferrantas que auxiliam neste processo

```
library(na.tools)
library(naniar)
```

```
##
## Attaching package: 'naniar'
```

```
## The following objects are masked from 'package:na.tools':
##
##     all_na, any_na, is_na, which_na
```

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(zoo)
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
library(ggplot2)
library(caret)
```

```
## Loading required package: lattice
```

```
library(tidyimpute)
```

```
##
## Attaching package: 'tidyimpute'
```

```
## The following objects are masked from 'package:naniar':
##
```

```
##     impute_mean, impute_mean_all, impute_mean_at, impute_mean_if,
##     impute_median, impute_median_all, impute_median_at,
##     impute_median_if
```

```
df = read.csv('data/PRSA_Data_Aotizhongxin_20130301-20170228.csv')
```

Analisando os dados

Utilizando a função "summary" da linguagem R foi feita uma análise dos dados.

```
summary(df)
```

```
##        No             year          month             day
##  Min.   :    1   Min.   :2013   Min.   : 1.000   Min.   : 1.00
##  1st Qu.: 8767   1st Qu.:2014   1st Qu.: 4.000   1st Qu.: 8.00
##  Median :17532   Median :2015   Median : 7.000   Median :16.00
##  Mean   :17532   Mean   :2015   Mean   : 6.523   Mean   :15.73
##  3rd Qu.:26298   3rd Qu.:2016   3rd Qu.:10.000   3rd Qu.:23.00
##  Max.   :35064   Max.   :2017   Max.   :12.000   Max.   :31.00
##
##       hour           PM2.5             PM10            SO2
##  Min.   : 0.00   Min.   :  3.00   Min.   :  2.0   Min.   :  0.2856
##  1st Qu.: 5.75   1st Qu.: 22.00   1st Qu.: 38.0   1st Qu.:  3.0000
##  Median :11.50   Median : 58.00   Median : 87.0   Median :  9.0000
##  Mean   :11.50   Mean   : 82.77   Mean   :110.1   Mean   : 17.3759
##  3rd Qu.:17.25   3rd Qu.:114.00   3rd Qu.:155.0   3rd Qu.: 21.0000
##  Max.   :23.00   Max.   :898.00   Max.   :984.0   Max.   :341.0000
##                  NA's   :925      NA's   :718     NA's   :935
##       NO2              CO              O3               TEMP
##  Min.   :  2.00   Min.   :  100   Min.   :  0.2142   Min.   :-16.80
##  1st Qu.: 30.00   1st Qu.:  500   1st Qu.:  8.0000   1st Qu.:  3.10
##  Median : 53.00   Median :  900   Median : 42.0000   Median : 14.50
##  Mean   : 59.31   Mean   : 1263   Mean   : 56.3534   Mean   : 13.58
##  3rd Qu.: 82.00   3rd Qu.: 1500   3rd Qu.: 82.0000   3rd Qu.: 23.30
##  Max.   :290.00   Max.   :10000   Max.   :423.0000   Max.   : 40.50
##  NA's   :1023     NA's   :1776    NA's   :1719       NA's   :20
##       PRES             DEWP              RAIN                wd
##  Min.   : 985.9   Min.   :-35.300   Min.   : 0.00000   NE     : 5140
##  1st Qu.:1003.3   1st Qu.: -8.100   1st Qu.: 0.00000   ENE    : 3950
##  Median :1011.4   Median :  3.800   Median : 0.00000   SW     : 3359
##  Mean   :1011.8   Mean   :  3.123   Mean   : 0.06742   E      : 2608
##  3rd Qu.:1020.1   3rd Qu.: 15.600   3rd Qu.: 0.00000   NNE    : 2445
##  Max.   :1042.0   Max.   : 28.500   Max.   :72.50000   (Other):17481
##  NA's   :20       NA's   :20        NA's   :20         NA's   :   81
##       WSPM               station
##  Min.   : 0.000   Aotizhongxin:35064
##  1st Qu.: 0.900
##  Median : 1.400
##  Mean   : 1.708
##  3rd Qu.: 2.200
##  Max.   :11.200
##  NA's   :14
```

Começamos por verificar se existia algum dia em falta no dataframe e vimos que nao. Samendo que o dataset possui os valores referentes a 4 anos completos especificados por hora então sevem existir $(4365+1)24 = 35064$ rows

```r
  #samendo que o dataset possui os valores referentes a 4 anos completos especificados por hora então s
dim(df)
```

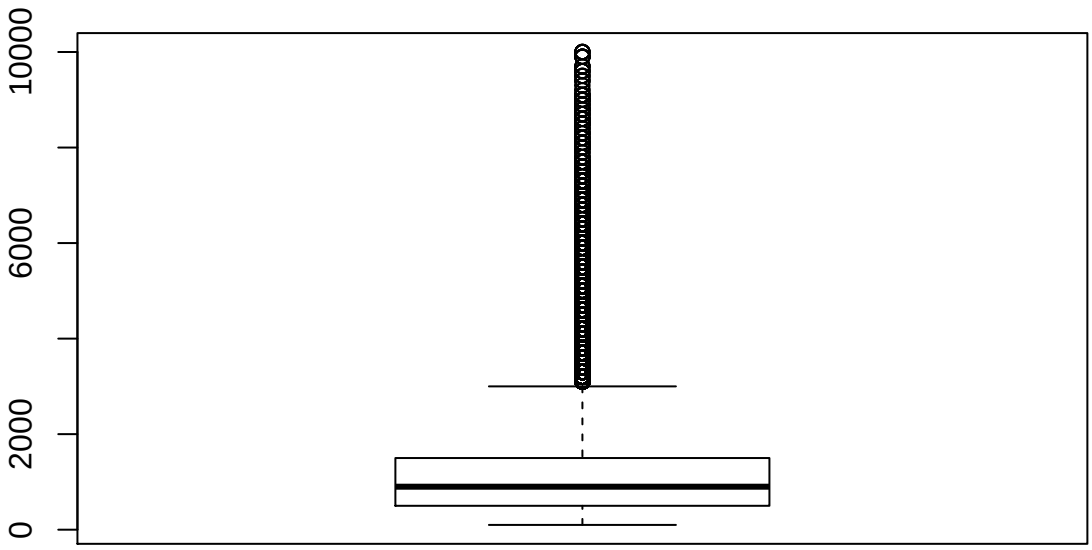
```
## [1] 35064    18
```

Outliers

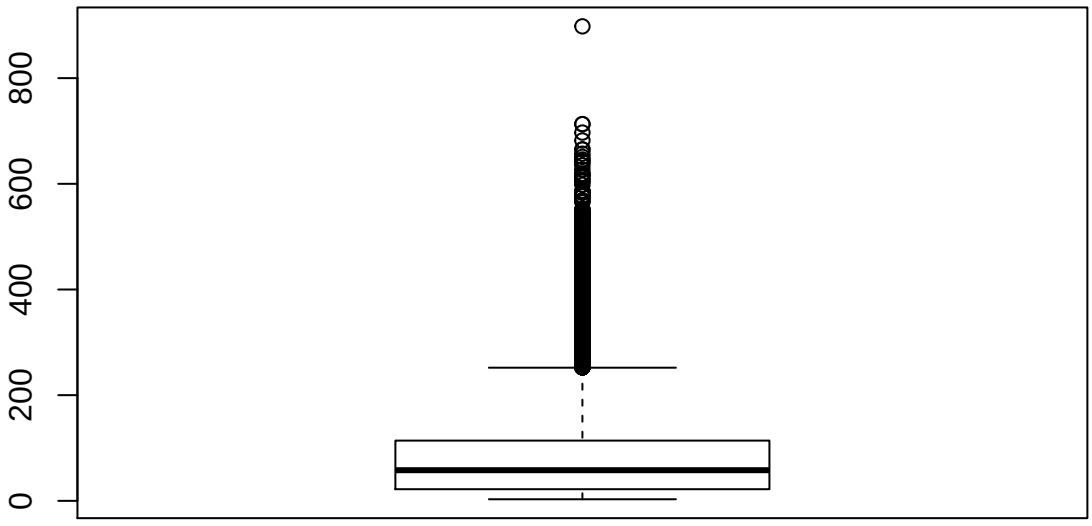
Seguimos com a analise da existencia de outliers em variáveis numericas. Começando por ver fazer a análise por variavel como um todo, em seguida fizemos a análise por variavel tendo em conta a estação do ano e por último por variavel por mês.

Como um todo

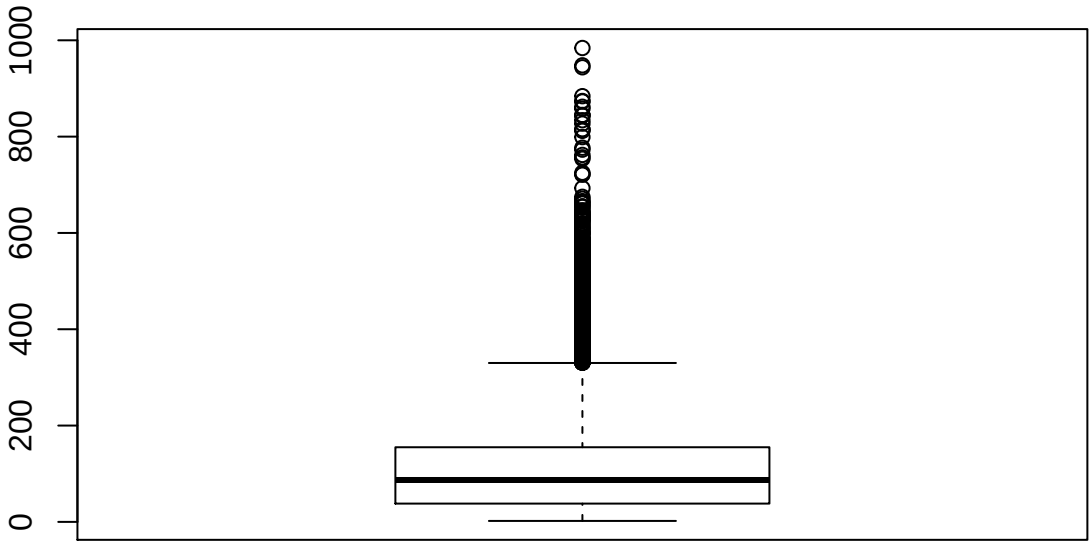
```r
boxplot(x = df$CO)
```



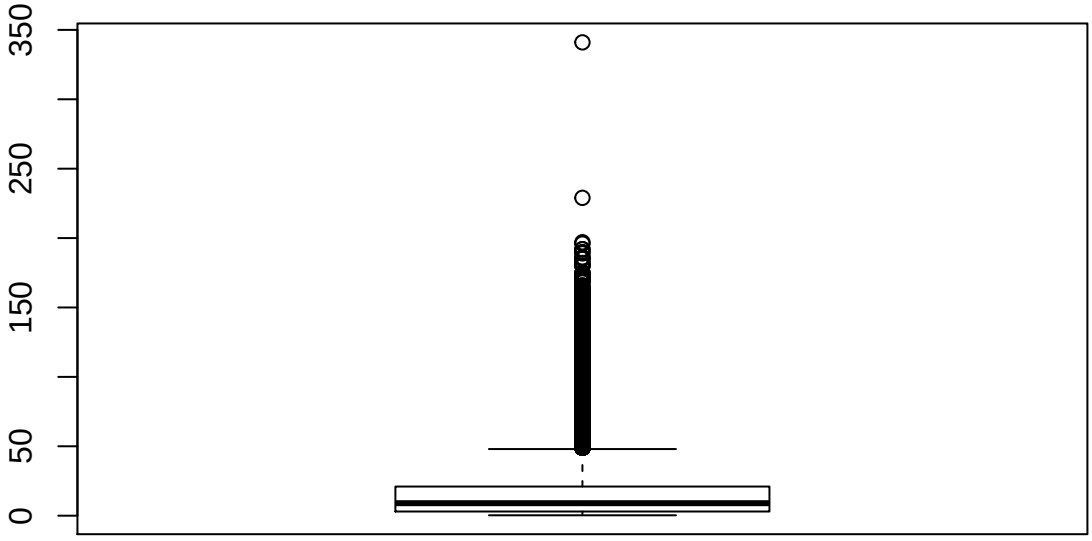

```r
boxplot(x = df$PM2.5)
```



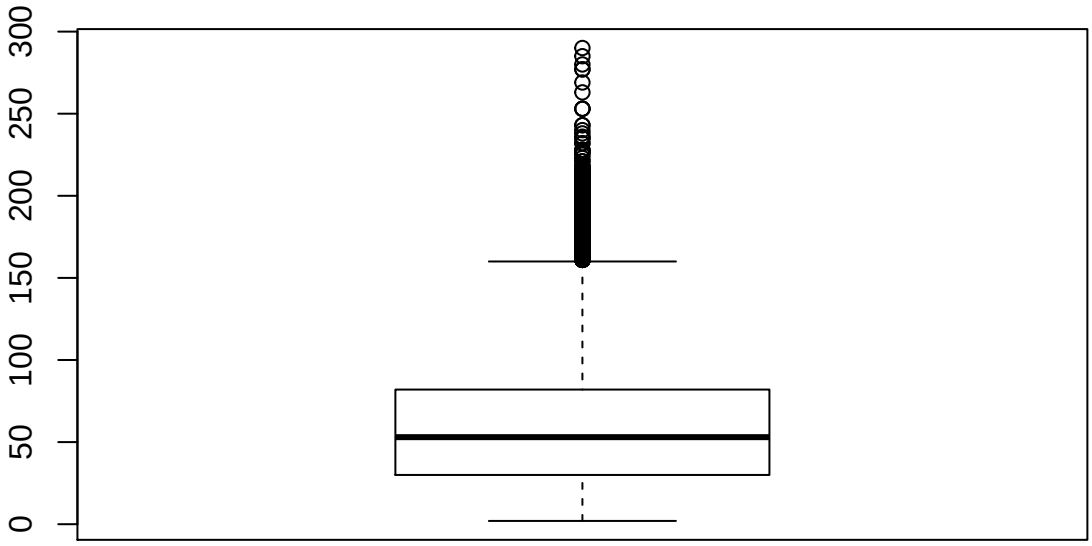

```r
boxplot(x = df$PM10)
```



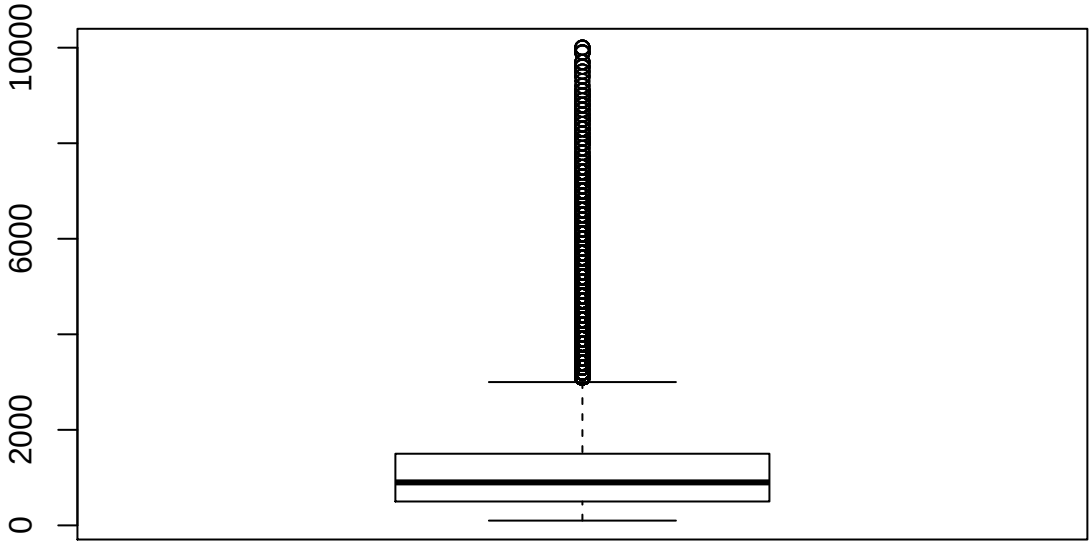

```r
boxplot(x = df$SO2)
```



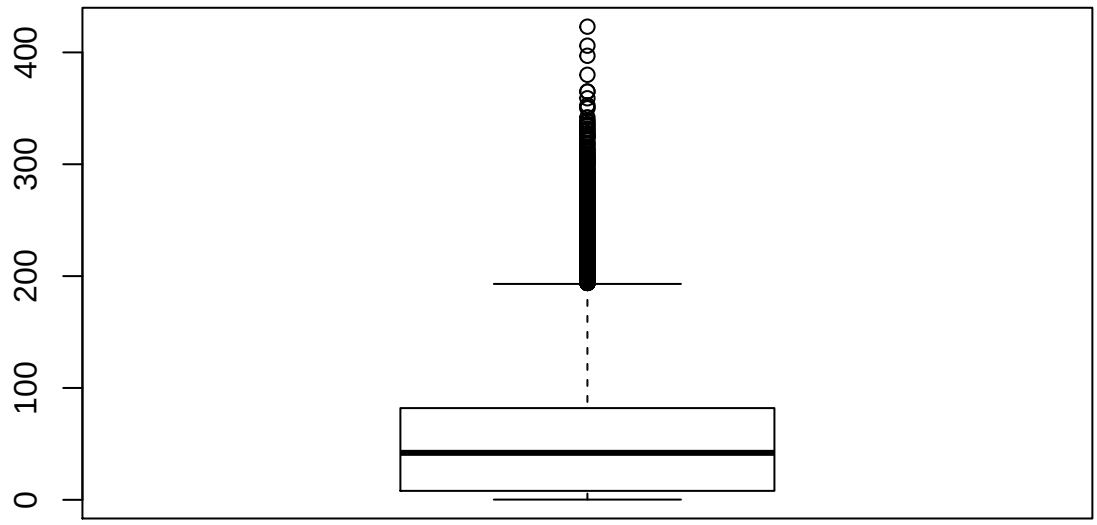

```r
boxplot(x = df$NO2)
```



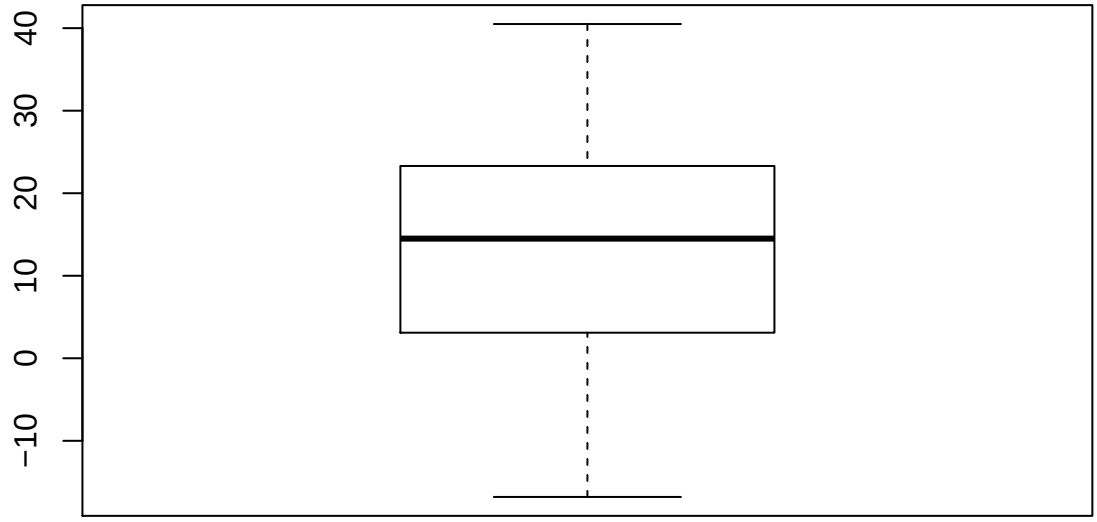

```
boxplot(x = df$CO)
```



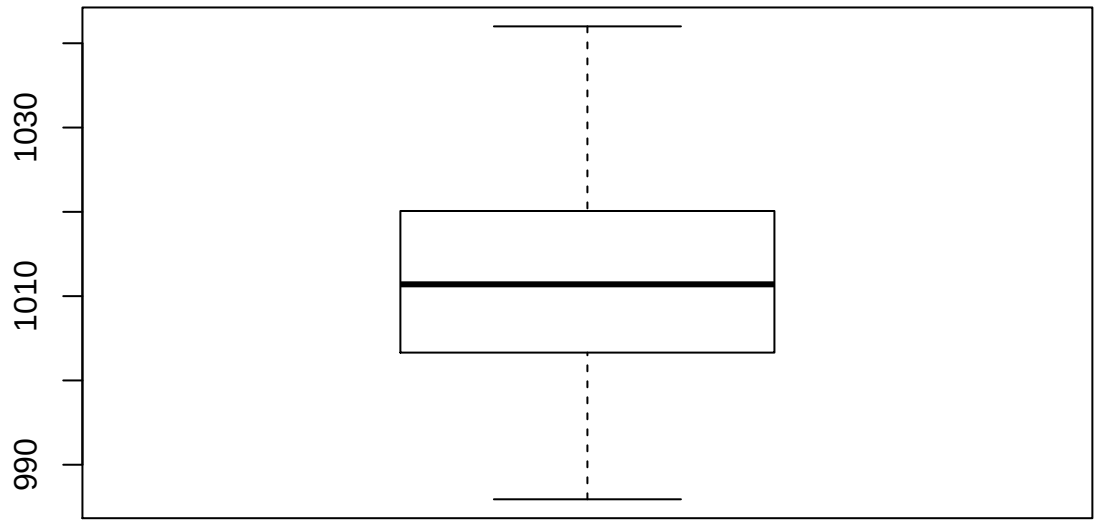

```
boxplot(x = df$O3)
```



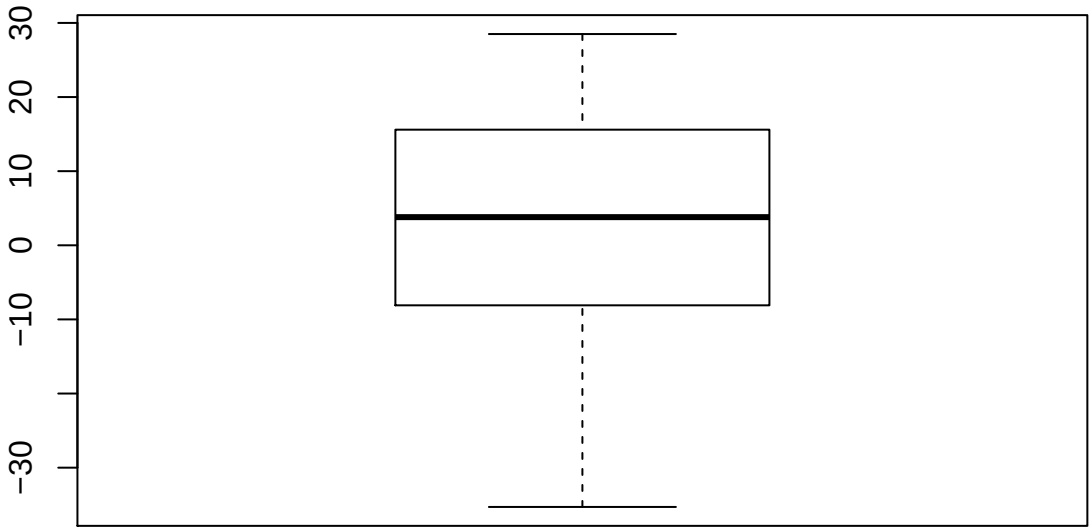

```
boxplot(x = df$TEMP)
```



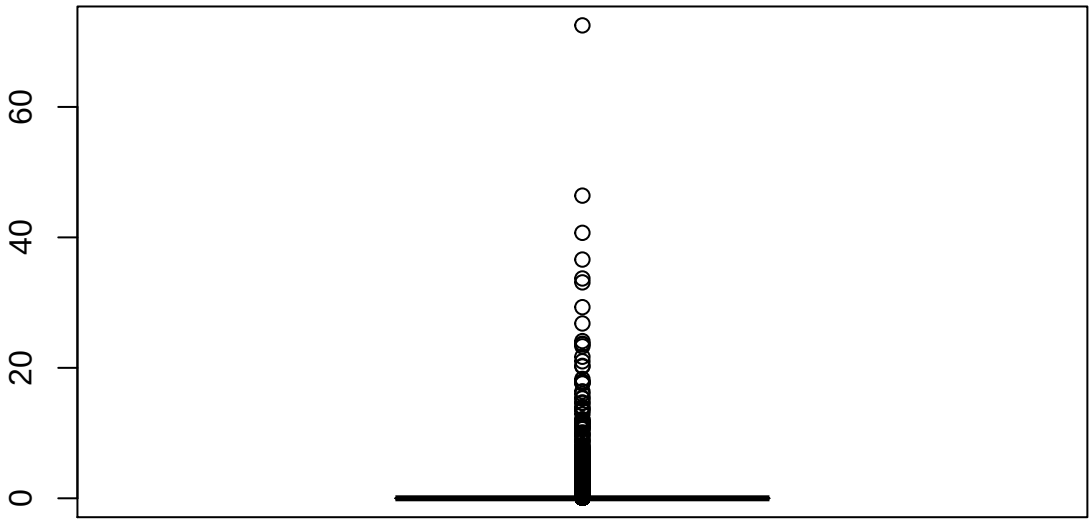

```
boxplot(x = df$PRES)
```



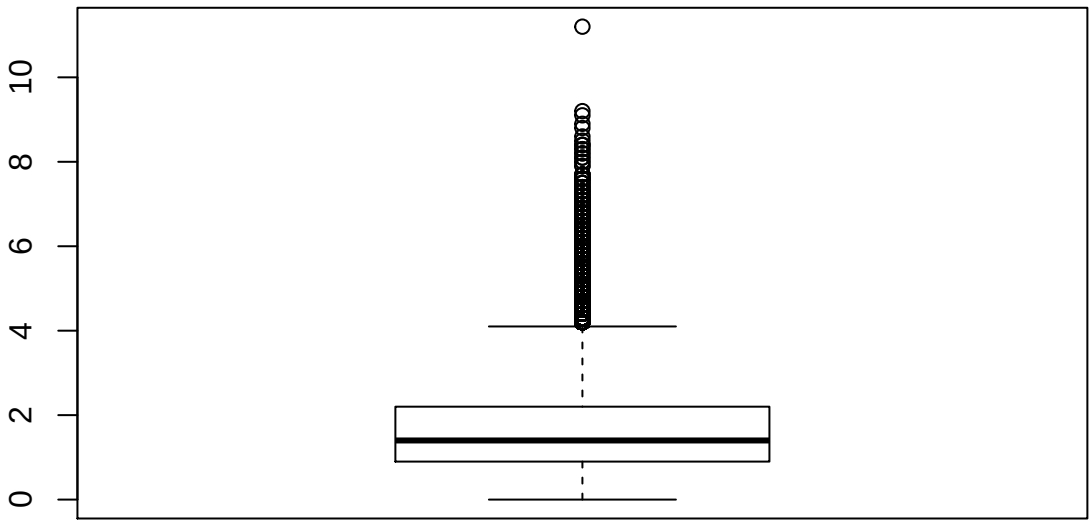
```r
boxplot(x = df$DEWP)
```



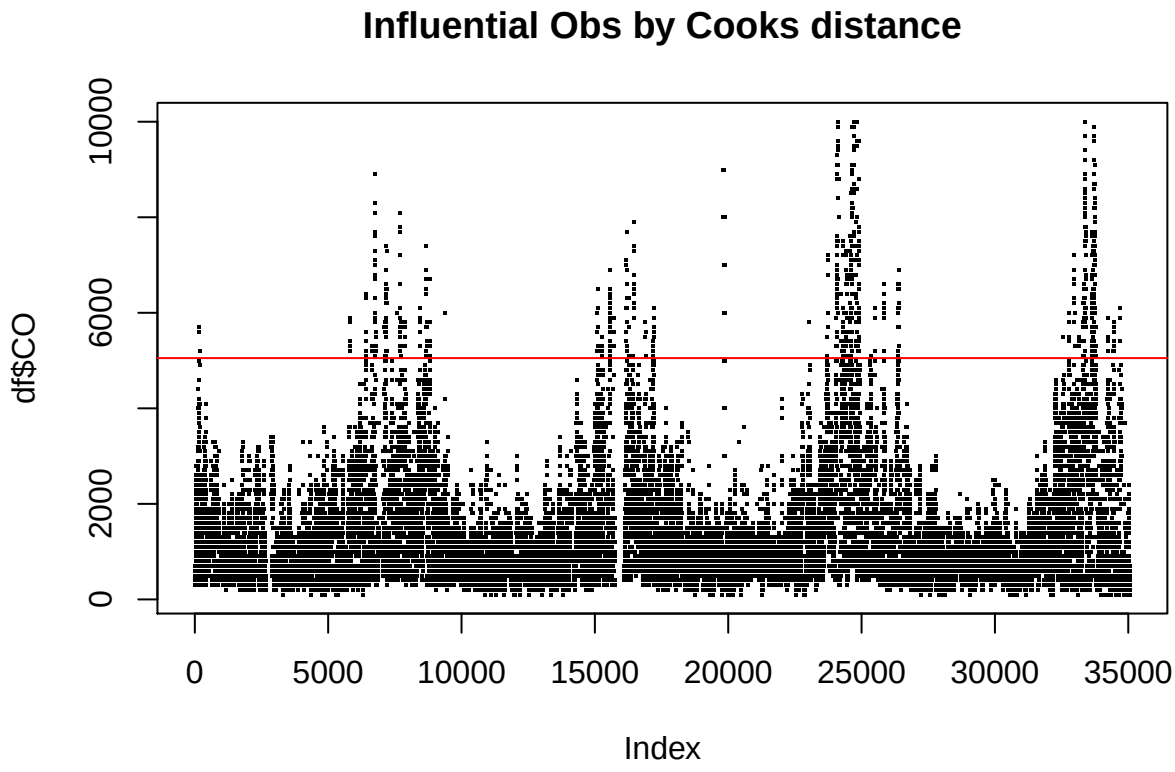

```r
boxplot(x = df$RAIN)
```




```r
boxplot(x = df$WSPM)
```




```
plot(df$CO, pch=".", cex=2, main="Influential Obs by Cooks distance")  # plot cook's distance
abline(h = 4*mean(df$CO, na.rm=T), col="red")  # add cutoff line
```




```
#text(x=1:length(df$CO)+1, y=df$CO, labels=ifelse(df$CO>4*mean(df$CO, na.rm=T),names(df$CO),""), col="r
```

Como

Por estação do ano

Por mês

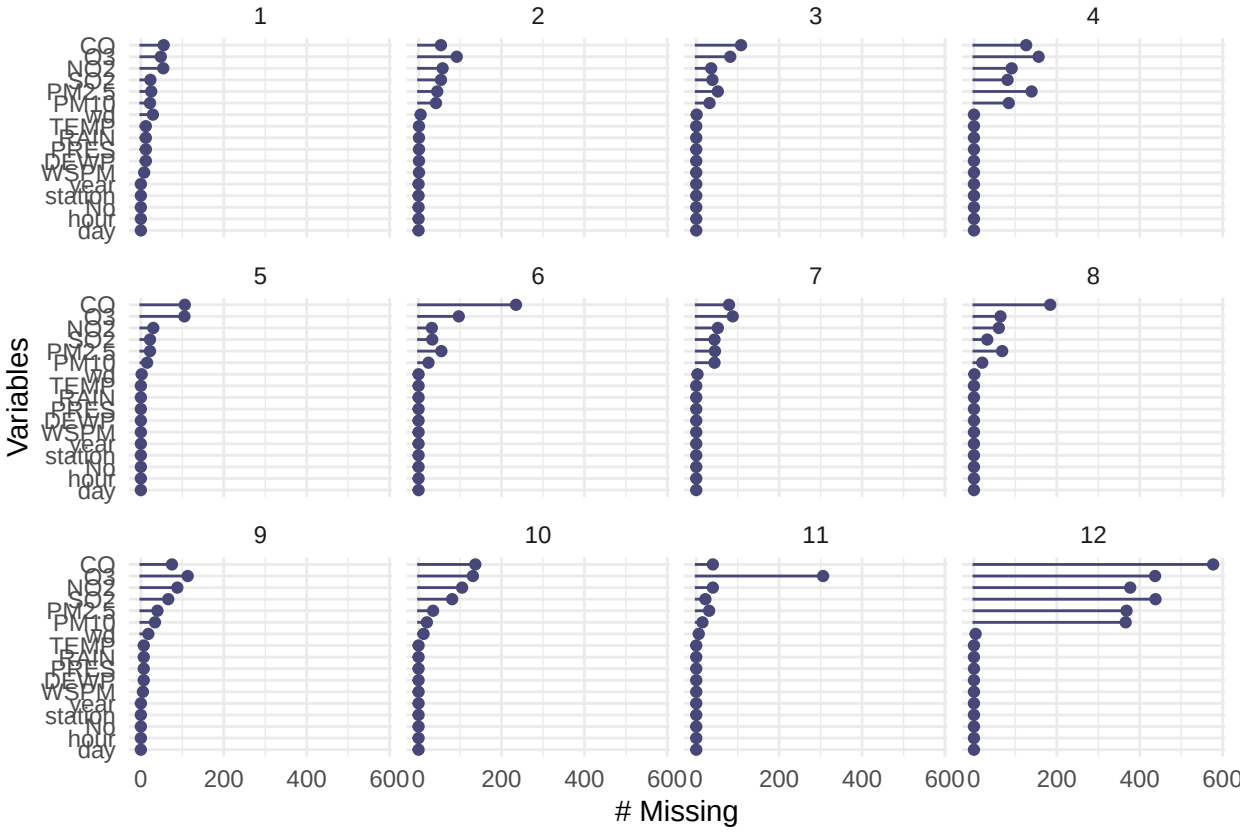
Apartir da análise mencionada anteriormente foi identificada que as varáveis “PM2.5”, “PM10”, “SO2”, “NO2”, “CO”, “O3”, “TEMP”, “PRES”, “DEWP”, “RAIN”, “wd”, “WSPM” possuem missing values.

Em seguida foi uma análise e foi verificado que as variáveis “TEMP”, “PRES”, “DEWP”, “RAIN” esta a

faltar no mesmo dia atravez do gráfico:

```
#check missing values
#df %>% select(RAIN, TEMP, PRES, wd, WSPM) %>% filter_any_na()
gg_miss_var(df, facet = month)
```

```
## Warning: `cols` is now required.
## Please use `cols = c(data)`
```



Data Analisys

```
head(df, 20)
```

```
##    No year month day hour PM2.5 PM10 SO2 NO2  CO O3 TEMP   PRES  DEWP RAIN
## 1   1 2013     3   1    0     4    4   4   7 300 77 -0.7 1023.0 -18.8    0
## 2   2 2013     3   1    1     8    8   4   7 300 77 -1.1 1023.2 -18.2    0
## 3   3 2013     3   1    2     7    7   5  10 300 73 -1.1 1023.5 -18.2    0
## 4   4 2013     3   1    3     6    6  11  11 300 72 -1.4 1024.5 -19.4    0
## 5   5 2013     3   1    4     3    3  12  12 300 72 -2.0 1025.2 -19.5    0
## 6   6 2013     3   1    5     5    5  18  18 400 66 -2.2 1025.6 -19.6    0
## 7   7 2013     3   1    6     3    3  18  32 500 50 -2.6 1026.5 -19.1    0
## 8   8 2013     3   1    7     3    6  19  41 500 43 -1.6 1027.4 -19.1    0
## 9   9 2013     3   1    8     3    6  16  43 500 45  0.1 1028.3 -19.2    0
## 10 10 2013     3   1    9     3    8  12  28 400 59  1.2 1028.5 -19.3    0
## 11 11 2013     3   1   10     3    6   9  12 400 72  1.9 1028.2 -19.4    0
## 12 12 2013     3   1   11     3    6   9  14 400 71  2.9 1028.2 -20.5    0
## 13 13 2013     3   1   12     3    6   7  13 300 74  3.9 1027.3 -19.7    0
## 14 14 2013     3   1   13     3    6   7  12 400 76  5.3 1026.2 -19.3    0
```

```
## 15 15 2013     3   1   14     6    9   7  11 400 77  6.0 1025.9 -19.6    0
## 16 16 2013     3   1   15     8   15   7  14 400 76  6.2 1025.7 -18.6    0
## 17 17 2013     3   1   16     9   19   9  13 400 76  5.9 1025.6 -18.1    0
## 18 18 2013     3   1   17    10   23  11  15 400 74  4.3 1026.3 -18.7    0
## 19 19 2013     3   1   18    11   20   8  20 500 70  3.1 1027.4 -18.4    0
## 20 20 2013     3   1   19     8   14  12  30 500 60  2.3 1028.3 -18.4    0
##     wd WSPM      station
## 1  NNW  4.4 Aotizhongxin
## 2    N  4.7 Aotizhongxin
## 3  NNW  5.6 Aotizhongxin
## 4   NW  3.1 Aotizhongxin
## 5    N  2.0 Aotizhongxin
## 6    N  3.7 Aotizhongxin
## 7  NNE  2.5 Aotizhongxin
## 8  NNW  3.8 Aotizhongxin
## 9  NNW  4.1 Aotizhongxin
## 10   N  2.6 Aotizhongxin
## 11 NNW  3.6 Aotizhongxin
## 12   N  3.7 Aotizhongxin
## 13 NNW  5.1 Aotizhongxin
## 14  NW  4.3 Aotizhongxin
## 15  NW  4.4 Aotizhongxin
## 16 NNE  2.8 Aotizhongxin
## 17 NNW  3.9 Aotizhongxin
## 18 NNE  2.8 Aotizhongxin
## 19 NNE  2.1 Aotizhongxin
## 20   N  2.8 Aotizhongxin
```

```
summary(df)
```

```
##        No              year          month              day
##  Min.   :    1   Min.   :2013   Min.   : 1.000   Min.   : 1.00
##  1st Qu.: 8767   1st Qu.:2014   1st Qu.: 4.000   1st Qu.: 8.00
##  Median :17532   Median :2015   Median : 7.000   Median :16.00
##  Mean   :17532   Mean   :2015   Mean   : 6.523   Mean   :15.73
##  3rd Qu.:26298   3rd Qu.:2016   3rd Qu.:10.000   3rd Qu.:23.00
##  Max.   :35064   Max.   :2017   Max.   :12.000   Max.   :31.00
##
##       hour           PM2.5             PM10            SO2
##  Min.   : 0.00   Min.   :  3.00   Min.   :  2.0   Min.   :  0.2856
##  1st Qu.: 5.75   1st Qu.: 22.00   1st Qu.: 38.0   1st Qu.:  3.0000
##  Median :11.50   Median : 58.00   Median : 87.0   Median :  9.0000
##  Mean   :11.50   Mean   : 82.77   Mean   :110.1   Mean   : 17.3759
##  3rd Qu.:17.25   3rd Qu.:114.00   3rd Qu.:155.0   3rd Qu.: 21.0000
##  Max.   :23.00   Max.   :898.00   Max.   :984.0   Max.   :341.0000
##                  NA's   :925      NA's   :718     NA's   :935
##       NO2               CO              O3               TEMP
##  Min.   :  2.00   Min.   :  100   Min.   :  0.2142   Min.   :-16.80
##  1st Qu.: 30.00   1st Qu.:  500   1st Qu.:  8.0000   1st Qu.:  3.10
##  Median : 53.00   Median :  900   Median : 42.0000   Median : 14.50
##  Mean   : 59.31   Mean   : 1263   Mean   : 56.3534   Mean   : 13.58
##  3rd Qu.: 82.00   3rd Qu.: 1500   3rd Qu.: 82.0000   3rd Qu.: 23.30
##  Max.   :290.00   Max.   :10000   Max.   :423.0000   Max.   : 40.50
##  NA's   :1023     NA's   :1776    NA's   :1719       NA's   :20
##       PRES             DEWP             RAIN               wd
```

```
##  Min.   : 985.9   Min.   :-35.300   Min.   : 0.00000   NE     : 5140
##  1st Qu.:1003.3   1st Qu.: -8.100   1st Qu.: 0.00000   ENE    : 3950
##  Median :1011.4   Median :  3.800   Median : 0.00000   SW     : 3359
##  Mean   :1011.8   Mean   :  3.123   Mean   : 0.06742   E      : 2608
##  3rd Qu.:1020.1   3rd Qu.: 15.600   3rd Qu.: 0.00000   NNE    : 2445
##  Max.   :1042.0   Max.   : 28.500   Max.   :72.50000   (Other):17481
##  NA's   :20       NA's   :20        NA's   :20         NA's   :   81
##       WSPM                station
##  Min.   : 0.000   Aotizhongxin:35064
##  1st Qu.: 0.900
##  Median : 1.400
##  Mean   : 1.708
##  3rd Qu.: 2.200
##  Max.   :11.200
##  NA's   :14
```

```
dim(df)
```

```
## [1] 35064    18
```

Check Outliers

Verificamos para cada uma das colunas se existem valores outliers Para isso plotamos os dados utilizando o boxplot ....

```
#df %>% group_by(month) %>% ggplot(aes(group = month, y = TEMP)) + geom_boxplot()
#temp_out <- boxplot(TEMP~month+year , data=df)$out
#temp_out <- boxplot(df$TEMP~month)$out

#ed_exp1 <- df[c(10:21),c(2,6:7)]

#df_new <- df[-which(df$TEMP %in% temp_out),]
#boxplot(TEMP~month+year , data=df_new)

#boxplot(df.NEW_TEMP$TEMP)
#boxplot(df$TEMP)
```

Missing Values

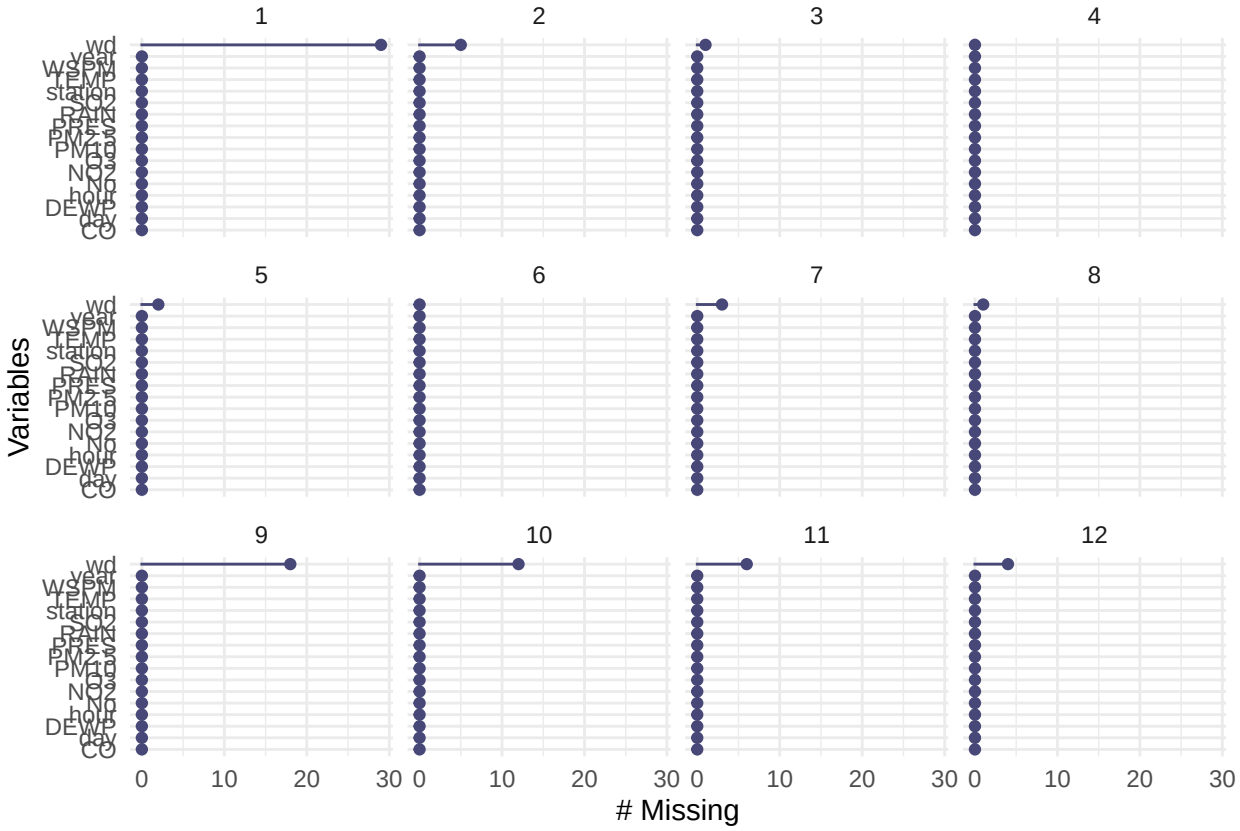
```
#function interpolation
interpolation_df <- function(df, col_names ){
  for(col in col_names){
    df[col] <- na.approx(df[col], rule=2)
  }
  return(df)
}

head(df)
```

```
##   No year month day hour PM2.5 PM10 SO2 NO2  CO O3 TEMP   PRES  DEWP RAIN
## 1  1 2013     3   1    0     4    4   4   7 300 77 -0.7 1023.0 -18.8    0
## 2  2 2013     3   1    1     8    8   4   7 300 77 -1.1 1023.2 -18.2    0
## 3  3 2013     3   1    2     7    7   5  10 300 73 -1.1 1023.5 -18.2    0
## 4  4 2013     3   1    3     6    6  11  11 300 72 -1.4 1024.5 -19.4    0
## 5  5 2013     3   1    4     3    3  12  12 300 72 -2.0 1025.2 -19.5    0
```

```
## 6  6 2013     3   1    5     5    5  18  18 400 66 -2.2 1025.6 -19.6    0
##    wd WSPM      station
## 1 NNW  4.4 Aotizhongxin
## 2   N  4.7 Aotizhongxin
## 3 NNW  5.6 Aotizhongxin
## 4  NW  3.1 Aotizhongxin
## 5   N  2.0 Aotizhongxin
## 6   N  3.7 Aotizhongxin
```

```
col_names = c("PM2.5", "PM10", "SO2", "NO2", "CO", "O3", "TEMP", "PRES", "DEWP", "RAIN", "WSPM")
df <- interpolation_df(df, col_names)
gg_miss_var(df, facet = month)
```

```
## Warning: `cols` is now required.
## Please use `cols = c(data)`
```




```
#falta remover os missing values da coluna wd
#sum(is.na(df$wd))
```

Calc a class variable

```
df$aqi<-NA
df[, "aqi"] <- apply(df[, 6:11], 1, max)

head(df)
```

```
##   No year month day hour PM2.5 PM10 SO2 NO2  CO O3 TEMP   PRES  DEWP RAIN
## 1  1 2013     3   1    0     4    4   4   7 300 77 -0.7 1023.0 -18.8    0
## 2  2 2013     3   1    1     8    8   4   7 300 77 -1.1 1023.2 -18.2    0
```

```
## 3  3 2013     3   1    2     7    7   5  10 300 73 -1.1 1023.5 -18.2    0
## 4  4 2013     3   1    3     6    6  11  11 300 72 -1.4 1024.5 -19.4    0
## 5  5 2013     3   1    4     3    3  12  12 300 72 -2.0 1025.2 -19.5    0
## 6  6 2013     3   1    5     5    5  18  18 400 66 -2.2 1025.6 -19.6    0
##    wd WSPM      station aqi
## 1 NNW  4.4 Aotizhongxin 300
## 2   N  4.7 Aotizhongxin 300
## 3 NNW  5.6 Aotizhongxin 300
## 4  NW  3.1 Aotizhongxin 300
## 5   N  2.0 Aotizhongxin 300
## 6   N  3.7 Aotizhongxin 400
```

Data exploratory analysis

Predictive modelling