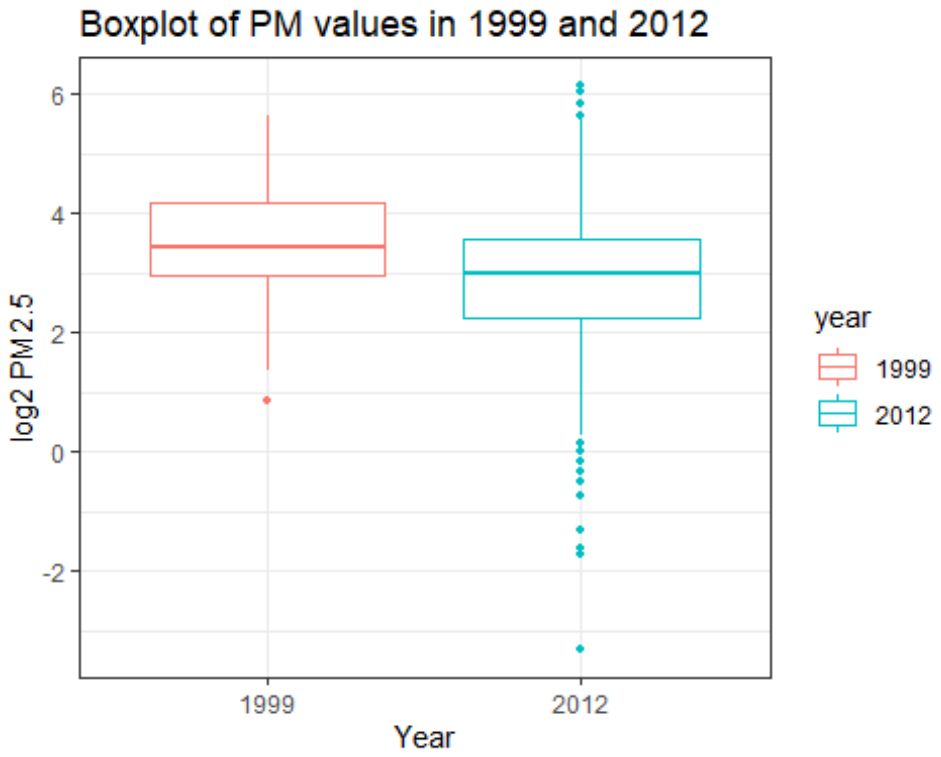
```r
### ASSIGNMENT 2 ###

## Please find all the answers summarized in the word file "Answers to AS2 -
Daniele Melotti" ##

### 1) Import and Preprocess Data

## a) Import the datasets.
#install.packages("data.table", dependencies = T)
#install.packages('plyr', repos = "http://cran.us.r-project.org")
options(repos = list(CRAN="http://cran.rstudio.com/"))
require(plyr)

## Loading required package: plyr

## Warning: package 'plyr' was built under R version 4.0.5

require(data.table)

## Loading required package: data.table

## Warning: package 'data.table' was built under R version 4.0.5

require(dplyr)

## Loading required package: dplyr

## Warning: package 'dplyr' was built under R version 4.0.5

## Registered S3 methods overwritten by 'tibble':
##   method     from
##   format.tbl pillar
##   print.tbl  pillar

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:data.table':
##
##     between, first, last

## The following objects are masked from 'package:plyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize

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

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

```r
d1 <- fread("https://bit.ly/3c4AHbL", colClasses = list(character = 1:5,
numeric = 6:12))
d2 <- fread("https://bit.ly/3nZicL2", colClasses = list(character = 1:5,
numeric = 6:12))

## b) Take a look at the 1999 data.
# Print the dimensions:
dim(d1)

## [1] 117421     12

# Print the first 3 rows.
head(d1, 3)

##    X..RD Action.Code State.Code County.Code Site.ID Parameter POC
## 1:    RD           I         01         027    0001     88101   1
## 2:    RD           I         01         027    0001     88101   1
## 3:    RD           I         01         027    0001     88101   1
##    Sample.Duration Unit Method     Date Sample.Value
## 1:               7  105    120 19990103           NA
## 2:               7  105    120 19990106           NA
## 3:               7  105    120 19990109           NA

## c) Using the 1999 data, print the summary statistics of the variable with
summary().
summary(d1$Sample.Value)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    0.00    7.20   11.50   13.74   17.90  157.10   13217

# (i) Compute the number of NAs using table() and is.na(), then divide the
numbers by the total number of observations.
table(is.na(d1$Sample.Value))

##
##  FALSE   TRUE
## 104204  13217

table(is.na(d1$Sample.Value))/sum(table(is.na(d1$Sample.Value)))

##
##     FALSE      TRUE
## 0.8874392 0.1125608

# (ii) What is the percentage of the PM2.5 observations that are missing
(round up to 3 decimal places)?
paste(round(sum(is.na(d1$Sample.Value) ==
T)/sum(table(is.na(d1$Sample.Value)))*100, 3), "%")

## [1] "11.256 %"
```

```r
## d) Bind the 1999 data and 2012 data and assign the aggregated data to an
object called 'pm'. Then, subset the years from the Date variable and convert
it into a factor variable called 'year'.
pm <- rbind(d1, d2)

# I did not just model the Date variable and rename it because it will be
useful later (around 2j)), so I simply created a new variable year:
pm$year <- substr(pm$Date, 1, 4)
pm$year <- as.factor(pm$year)

## e) Rename the Sample.Value variable to PM.
pm <- pm %>%
  rename(PM = Sample.Value)

### 2) Data Exploration with Visualization using ggplot2

## a) Set the seed at 2021 and draw 1,000 randomly selected samples from the
data (i.e., pm) using the sampling function in dplyr package.
set.seed(2021)
sample <- sample_n(pm, 1000,na.rm = T)

## b) Create boxplots of all monitor values in 1999 and 2012 using the
randomly selected sampled data.
# Taking the log of the PM values (with base 2):
sample$PM <- log(sample$PM, 2)

## Warning: NaNs produced

# Creating the box plots:
require(ggplot2)

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 4.0.5

box <- ggplot(subset(sample), aes(x = year, y = PM, col = year))

box +
  geom_boxplot(outlier.size = 1) +
  labs(title = "Boxplot of PM values in 1999 and 2012",
      x = "Year",
      y = "log2 PM2.5") +
  theme_bw()

## Warning: Removed 89 rows containing non-finite values (stat_boxplot).
```




```
## c) Describe what you observe in terms of the means and variances of the
observations in 1999 and 2012?
# If the distribution was normal, we would be able to say that the median
shown on the boxplots is equal to the mean (and the mode as well). However,
the PM data is probably not normally distributed, so we may only discuss
about the median. If we look at the median value of the boxplots, we can see
that PM air pollution in the US was a little higher in 1999 than in 2012, on
average. The difference is more visible when we compare the two upper
quartiles, as we see that the one for the 1999 data is well above the one for
2012 data. The same is true in the case of the lower quartile. However, we
can also see that there are way more outliers for the 2012 data; moreover,
the whiskers are a little longer when compared to those of the 1999 data.
These features can be taken as a sign that the variance is higher in the case
of 2012 data.

## d) Identify a monitor in New York State that has data in 1999 and 2012.
# Subsetting the data to include only the observations from New York and only
including the County.Code and the Site.ID using filter(), select() and
unique():
ny <- pm %>%
  filter(State.Code == 36) %>%
  select(County.Code, Site.ID, year) %>%
  unique()

## e) Create a new variable called Site.Code that combines the county code
and the site ID into a single string by using paste() with "." as the
separator.
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ny$Site.Code <- paste(ny$County.Code, ny$Site.ID, sep = ".")

## f) Find the intersection of the sites in between 1999 and 2012 which gives us the list of monitors in NY operated both in 1999 and 2012 using split() and intersect().
monitor <- split(ny$Site.Code, ny$year)
inter <- intersect(monitor$"1999", monitor$"2012")

## g) Write a block of code to identify the monitor in NY state that had the most data using mutate(), filter(), group_by(), summarize() and arrange().
pm %>%
  mutate(Site.Code = paste(County.Code, Site.ID, sep = "." )) %>%
  filter(Site.Code %in% inter) %>%
  group_by(Site.Code) %>%
  summarize(n = n()) %>%
  arrange(desc(n))
```
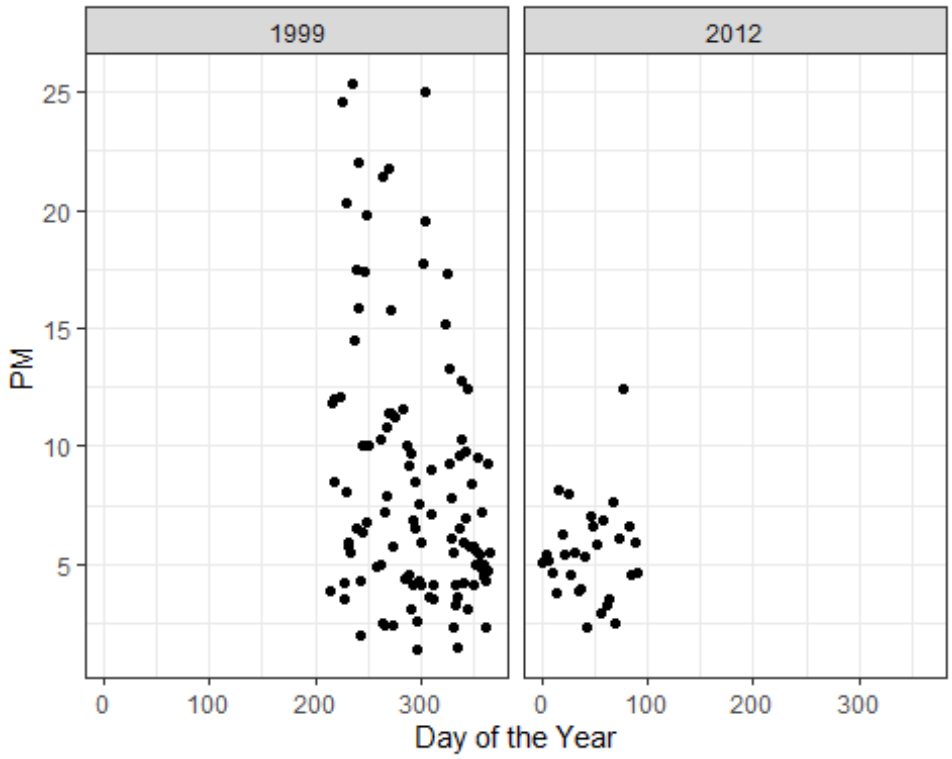

```
## Warning: `...` is not empty.
##
## We detected these problematic arguments:
## * `needs_dots`
##
## These dots only exist to allow future extensions and should be empty.
## Did you misspecify an argument?
```

```
## # A tibble: 10 x 2
##    Site.Code     n
##    <chr>     <int>
##  1 101.0003    527
##  2 013.0011    213
##  3 031.0003    198
##  4 001.0005    186
##  5 067.1015    153
##  6 063.2008    152
##  7 029.0005     94
##  8 001.0012     92
##  9 005.0080     92
## 10 085.0055     38
```

```r
## h) Subset the data (i.e. pm) that contains observations from the monitor we just identified (State.Code = 36 & County.Code = 101 & Site.ID = 0003) and assign the subset data to an object called pmsub.
pmsub <- subset(pm, State.Code == "36" & County.Code == "101" & Site.ID == "0003")

## i) Using the lubridate package, convert the Date variable into a date object and create a variable called yday containing info on day of the year using yday().
require(lubridate)
```

```
## Loading required package: lubridate

## Warning: package 'lubridate' was built under R version 4.0.5

##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:data.table':
##
##     hour, isoweek, mday, minute, month, quarter, second, wday, week,
##     yday, year

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

pmsub$Date <- as.character(pmsub$Date)
pmsub$Date <- as_date(pmsub$Date, format = "%Y%m%d")

pmsub$yday <- yday(pmsub$Date)

## j) Draw a scatter plot by mapping the year-day variable on the x-axis,
PM2.5 level on the y-axis separately for 1999 and 2012. Make sure to label
the x-axis, separate the plots using the facet function and use the base
white theme.
sct <- ggplot(pmsub, aes(x = yday, y = PM))

sct +
  geom_point() +
  labs(x = "Day of the Year", y = "PM") +
  facet_wrap(~ year, ncol = 2) +
  theme_bw()

## Warning: Removed 45 rows containing missing values (geom_point).
```


1999
2012
PM
25
20
15
10
5
0
100
200
300
Day of the Year