# Appendix A - ADS506-01-FA22 - Final Project

Team 1

11/05/2022

### RMarkdown global setup

```
knitr::opts_chunk$set(fig.align = 'center')
```

```
library(AppliedPredictiveModeling)
library(BioStatR)
library(car)
library(caret)
library(class)
library(corrplot)
library(datasets)
library(e1071)
library(Hmisc)
library(mlbench)
library(gridExtra)
library(psych)
library(randomForest)
library(RANN)
library(rpart)
library(rpart.plot)
library(scales)
library(tidyverse)
library(tseries)

set.seed(1699)
```

### Create function to generate boxplots for continuous variables

```
# Define function to produce formatted boxplots
box_comp <- function(xcol = c(), df = NA, rtn_met = TRUE) {
  sig <- 3
  metrics_df01 <- data.frame(metric = c("",
                                        "Total N:",
                                        "Count",
                                        "NA Count",
                                        "Mean",
                                        "Median",
                                        "Standard Deviation",
                                        "Variance",
                                        "Range",
                                        "Min",
```

```
                                        "Max",
                                        "25th Percentile",
                                        "75th Percentile",
                                        "Subset w/o Outliers:",
                                        "Count",
                                        "%",
                                        "Outlier %",
                                        "NA Count",
                                        "Mean",
                                        "Median",
                                        "Standard Deviation",
                                        "Variance",
                                        "Range",
                                        "Min",
                                        "Max"
                                        ))
for (var in xcol) {
  df_s1 <- df[, var]
  df_s1s1 <-data.frame(df_s1)
  df_s1_fit <- preProcess(df_s1s1,
                          method = c("center", "scale"))
  df_s1_trans <- predict(df_s1_fit, df_s1s1)


  # Calculate quartiles
  var_iqr_lim <- IQR(df_s1) * 1.5
  var_q1 <- quantile(df_s1, probs = c(.25))
  var_otlow <- var_q1 - var_iqr_lim
  var_q3 <- quantile(df_s1, probs = c(.75))
  var_othigh <- var_q3 + var_iqr_lim

  # Subset non-outlier data
  var_non_otlr_df01 <- subset(df, (abs(df_s1_trans) <= 3))
  #var_non_otlr_df01 <- subset(df, (df_s1 > var_otlow & df_s1 < var_othigh))
  df_s2 <- var_non_otlr_df01[, var]

  # Begin calculating measures of centrality & dispersion
  var_mean <- mean(df_s1)
  var_non_otlr_df01_trunc_mean <- mean(df_s2)
  var_med <- median(df_s1)
  var_non_otlr_df01_trunc_med <- median(df_s2)
  var_mode <- mode(df_s1)
  var_non_otlr_df01_trunc_mode <- mode(df_s2)
  var_stde <- sd(df_s1)
  var_non_otlr_df01_trunc_stde <- sd(df_s2)
  var_vari <- var(df_s1)
  var_non_otlr_df01_trunc_vari <- var(df_s2)
  var01_min <- min(df[, var])
  var01_max <- max(df[, var])
  var01_range <- var01_max - var01_min
  var02_min <- min(var_non_otlr_df01[, var])
  var02_max <- max(var_non_otlr_df01[, var])
  var02_range <- var02_max - var02_min
```

```
    # Configure y-axis min & max to sync graphs
    plot_min <- min(var01_min, var02_min)
    plot_max <- max(var01_max, var02_max)
    nonoutlier_perc <- round((as.numeric(dim(var_non_otlr_df01)[1] /
↪   as.numeric(dim(df)[1]))) * 100, 1)
    measure_val01 <- c(paste0("Variable: ", var),
                       "",
                       as.character(dim(df)[1]),
                       sum(is.na(df_s1)),
                       round(var_mean, sig),
                       round(var_med, sig),
                       round(var_stde, sig),
                       round(var_vari, sig),
                       round(var01_range, sig),
                       round(var01_min, sig),
                       round(var01_max, sig),
                       round(var_q1, sig),
                       round(var_q3, sig),
                       "",
                       as.character(dim(var_non_otlr_df01)[1]),
                       paste0(nonoutlier_perc, "%"),
                       paste0(round(100 - nonoutlier_perc, 1), "%"),
                       sum(is.na(df_s2)),
                       round(var_non_otlr_df01_trunc_mean, sig),
                       round(var_non_otlr_df01_trunc_med, sig),
                       round(var_non_otlr_df01_trunc_stde, sig),
                       round(var_non_otlr_df01_trunc_vari, sig),
                       round(var02_range, sig),
                       round(var02_min, sig),
                       round(var02_max, sig)
                       )

    var_name <- paste0("Variable: ", var)
    metrics_df01[, ncol(metrics_df01) + 1] <- measure_val01
}
  boxplot(df)
  if(rtn_met == TRUE) {
    return(metrics_df01)
  }
}
```

### Importing Train/Test Datasets

```
#train_x01_df01 <- read.csv("../data/Drinking
↪   Water/analyte_tests_drinking_water_datasd.csv", header = TRUE, sep = ",")
#train_x02_df01 <- read.csv("../data/Campaign
↪   Funds/financial_support_2021_datasd_v1.csv", header = TRUE, sep = ",")
train_x03_df01a <- read.csv("../data/Ocean Water/water_quality_1990_1999_datasd.csv",
↪   header = TRUE, sep = ",")
train_x03_df01b <- read.csv("../data/Ocean Water/water_quality_2000_2010_datasd.csv",
↪   header = TRUE, sep = ",")
```

```r
train_x03_df01c <- read.csv("../data/Ocean Water/water_quality_2011_2019_datasd.csv",
↪  header = TRUE, sep = ",")
train_x03_df01d <- read.csv("../data/Ocean Water/water_quality_2020_2021_datasd.csv",
↪  header = TRUE, sep = ",")

train_x03_df01 <- rbind(train_x03_df01a, train_x03_df01b, train_x03_df01c,
↪  train_x03_df01d)
#train_x01_df01 <- read.csv("../data/FD Incidents/fd_incidents_2022_datasd_v1.csv",
↪  header = TRUE, sep = ",")
#test_x01_df01 <- read.csv("../data/outlier-included/biodeg_test.csv", header = TRUE, sep
↪  = ",")

#train_y01_df01 <- read.csv("../data/outlier-included/response_train.csv", header = TRUE,
↪  sep = ",")
#test_y01_df01 <- read.csv("../data/outlier-included/response_test.csv", header = TRUE,
↪  sep = ",")

#train_y01_vc01 <- train_y01_df01[["x"]]
#test_y01_vc01 <- test_y01_df01[["x"]]

#print(head(train_x01_df01))
#describe(train_x01_df01)

#print(head(train_x02_df01))
#describe(train_x02_df01)

print(head(train_x03_df01))
```

```
##       sample station depth_m date_sample time project   parameter qualifier
## 1 9011158743      C5       9  1990-11-15         PLOO CHLOROPHYLL
## 2 9011158743      C5       9  1990-11-15         PLOO     DENSITY
## 3 9011158743      C5       9  1990-11-15         PLOO          DO
## 4 9011158743      C5       9  1990-11-15         PLOO          PH
## 5 9011158743      C5       9  1990-11-15         PLOO    SALINITY
## 6 9011158743      C5       9  1990-11-15         PLOO        TEMP
##    value   units
## 1  0.870    ug/L
## 2 23.855 sigma-t
## 3  6.550    mg/L
## 4  8.080      pH
## 5 33.617     ppt
## 6 19.430       C
```

```r
describe(train_x03_df01)
```

```
## Warning in FUN(newX[, i], ...): no non-missing arguments to min; returning Inf

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## Warning in FUN(newX[, i], ...): no non-missing arguments to max; returning -Inf

## Warning in FUN(newX[, i], ...): no non-missing arguments to max; returning -Inf

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## Warning in FUN(newX[, i], ...): no non-missing arguments to max; returning -Inf

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## Warning in FUN(newX[, i], ...): no non-missing arguments to max; returning -Inf

## Warning in FUN(newX[, i], ...): no non-missing arguments to max; returning -Inf

## Warning in FUN(newX[, i], ...): no non-missing arguments to max; returning -Inf
##             vars       n   mean      sd min     max   range   se
## sample         1 1236769    NaN      NA Inf    -Inf    -Inf   NA
## station        2 1236769    NaN      NA Inf    -Inf    -Inf   NA
## depth_m        3 1152608  19.38   25.07   1     116     115 0.02
## date_sample    4 1236769    NaN      NA Inf    -Inf    -Inf   NA
## time           5 1236769    NaN      NA Inf    -Inf    -Inf   NA
## project        6 1236769    NaN      NA Inf    -Inf    -Inf   NA
## parameter      7 1236769    NaN      NA Inf    -Inf    -Inf   NA
## qualifier      8 1236769    NaN      NA Inf    -Inf    -Inf   NA
## value          9 1231466 124.24 1785.21 -37 1100000 1100037 1.61
## units         10 1236769    NaN      NA Inf    -Inf    -Inf   NA
```

```
train_x03_df01_ss <- train_x03_df01 %>%
  group_by(station, date_sample) %>%
  summarise(Count = n())
```

```
## `summarise()` has grouped output by 'station'. You can override using the
## `.groups` argument.
```

```
train_x03_df01_ay <- train_x03_df01 %>%
  group_by(parameter) %>%
  summarise(Count = n())

train_x03_df01_date <- train_x03_df01 %>%
  group_by(date_sample) %>%
  summarise(Count = n())

train_x03_df01_full <- train_x03_df01 %>%
  group_by(date_sample, parameter) %>%
  summarise(Total = sum(value))
```

```
## `summarise()` has grouped output by 'date_sample'. You can override using the
## `.groups` argument.
```

```r
print(head(train_x03_df01_ss))
```

```
## # A tibble: 6 x 3
## # Groups:   station [1]
##   station date_sample Count
##   <chr>   <chr>       <int>
## 1 A1      1991-01-02     25
## 2 A1      1991-01-03     25
## 3 A1      1991-01-07     24
## 4 A1      1991-01-09     70
## 5 A1      1991-01-14     25
## 6 A1      1991-01-16     25
```

```r
print(train_x03_df01_ay)
```

```
## # A tibble: 12 x 2
##    parameter    Count
##    <chr>        <int>
##  1 CHLOROPHYLL  88471
##  2 DENSITY      88317
##  3 DO          109542
##  4 ENTERO      144341
##  5 FECAL       137649
##  6 OG            7944
##  7 PH          107818
##  8 SALINITY    109492
##  9 SUSO         27543
## 10 TEMP        139066
## 11 TOTAL       137584
## 12 XMS         139002
```

```r
print(head(train_x03_df01_date))
```

```
## # A tibble: 6 x 2
##   date_sample Count
##   <chr>       <int>
## 1 1990-11-15     14
## 2 1991-01-02    195
## 3 1991-01-03    195
## 4 1991-01-07    190
## 5 1991-01-08    181
## 6 1991-01-09    577
```

```r
print(head(train_x03_df01_full))
```

```
## # A tibble: 6 x 3
## # Groups:   date_sample [1]
##   date_sample parameter   Total
##   <chr>       <chr>       <dbl>
## 1 1990-11-15  CHLOROPHYLL  2.14
## 2 1990-11-15  DENSITY     47.7
## 3 1990-11-15  DO          14.0
## 4 1990-11-15  PH          16.3
## 5 1990-11-15  SALINITY    67.2
## 6 1990-11-15  TEMP        38.7
```

### Run function to create comparative boxplots

```
x01_lst01 <- c()

x01_lst02 <- c("analyte_value")
x02_lst02 <- c("contribution_amount",
               "contribution_annual")
x03_lst02 <- c("value")

x01_lst03 <- c()

x01_lst04 <- c()

x01_lst05 <- c()

x01_lst06 <- c()

x01_lst07 <- c()

x01_lst08 <- c()

x01_lst09 <- c()

x01_lst10 <- c()

x01_lst11 <- c()

x01_lst12 <- c()

x01_lst13 <- c()

x01_lst14 <- c()

x01_lst15 <- c()

x01_lst16 <- c()

#train_x01_df01_cols01 <- colnames(train_x01_df01)
#print(train_x01_df01_cols01)
#train_x01_df01_metrics <- box_comp(xcol = train_x01_df01_cols01, df = train_x01_df01)
#train_x01_df01_metrics
#write.csv(train_x01_df01_metrics, "../outputs/demos.csv", row.names = FALSE)

#train_x01_df03 <- subset(x = train_x01_df01, select = x01_lst02)
#train_x01_df03 <- na.omit(train_x01_df03)
#print(head(train_x01_df03))
#box_comp(xcol = x01_lst02, df = subset(x = train_x01_df03, select = x01_lst02), rtn_met
↪  = TRUE)

#train_x02_df03 <- subset(x = train_x02_df01, select = x02_lst02)
#train_x02_df03 <- na.omit(train_x02_df03)
#print(head(train_x02_df03))
#box_comp(xcol = x02_lst02, df = subset(x = train_x02_df03, select = x02_lst02), rtn_met
↪  = TRUE)
```

```r
train_x03_df03 <- subset(x = train_x03_df01, select = x03_lst02)
train_x03_df03 <- na.omit(train_x03_df03)
print(head(train_x03_df03))
```

```
##    value
## 1  0.870
## 2 23.855
## 3  6.550
## 4  8.080
## 5 33.617
## 6 19.430
```

```r
box_comp(xcol = x03_lst02, df = subset(x = train_x03_df03, select = x03_lst02), rtn_met =
↪  TRUE)
```


```
##                  metric              V2
## 1                        Variable: value
## 2              Total N:
## 3                 Count         1231466
## 4              NA Count               0
## 5                  Mean          124.24
## 6                Median           8.343
## 7    Standard Deviation        1785.206
## 8              Variance     3186959.838
## 9                 Range         1100037
## 10                  Min             -37
## 11                  Max         1100000
## 12      25th Percentile               2
## 13      75th Percentile          33.214
```

```
## 14 Subset w/o Outliers:
## 15                 Count          1223995
## 16                     %            99.4%
## 17             Outlier %             0.6%
## 18              NA Count                0
## 19                  Mean           43.899
## 20                Median            8.298
## 21    Standard Deviation          236.208
## 22              Variance        55794.454
## 23                 Range             5437
## 24                   Min              -37
## 25                   Max             5400
```

```r
print(head(train_x03_df01_full))
```

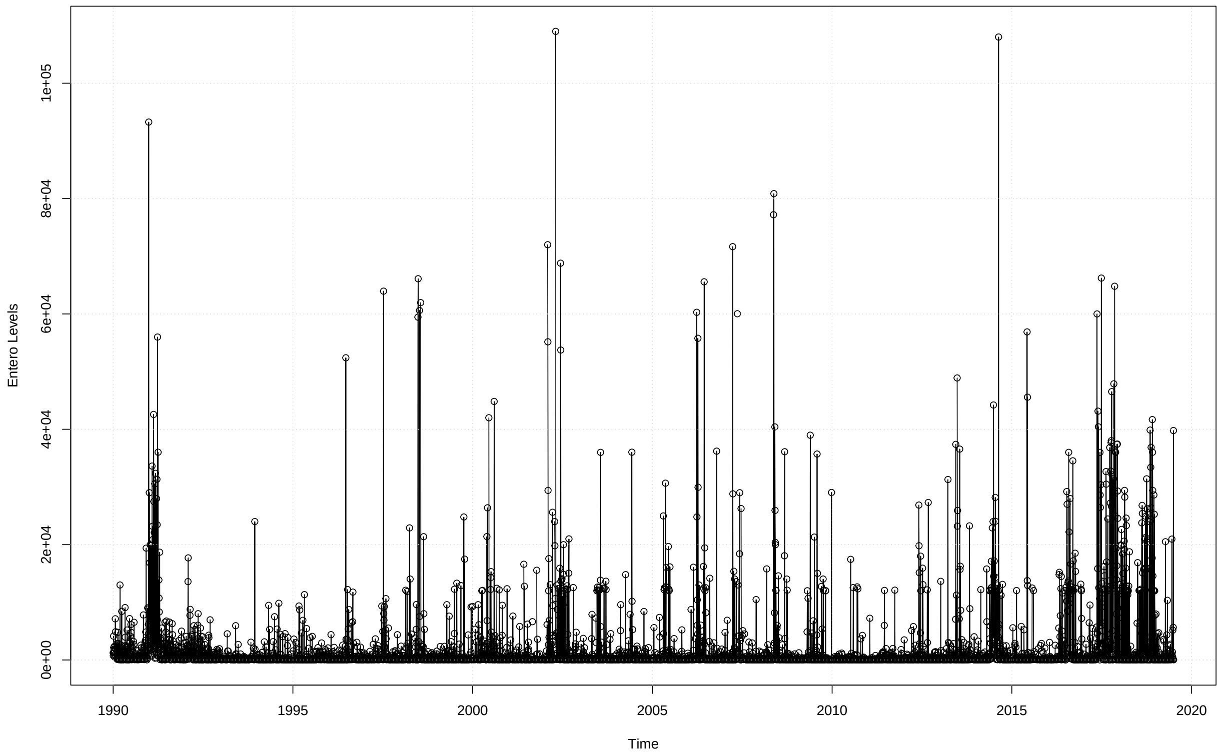
```
## # A tibble: 6 x 3
## # Groups:   date_sample [1]
##   date_sample parameter   Total
##   <chr>       <chr>       <dbl>
## 1 1990-11-15  CHLOROPHYLL  2.14
## 2 1990-11-15  DENSITY     47.7
## 3 1990-11-15  DO          14.0
## 4 1990-11-15  PH          16.3
## 5 1990-11-15  SALINITY    67.2
## 6 1990-11-15  TEMP        38.7
```

```r
print(tail(train_x03_df01_full))
```

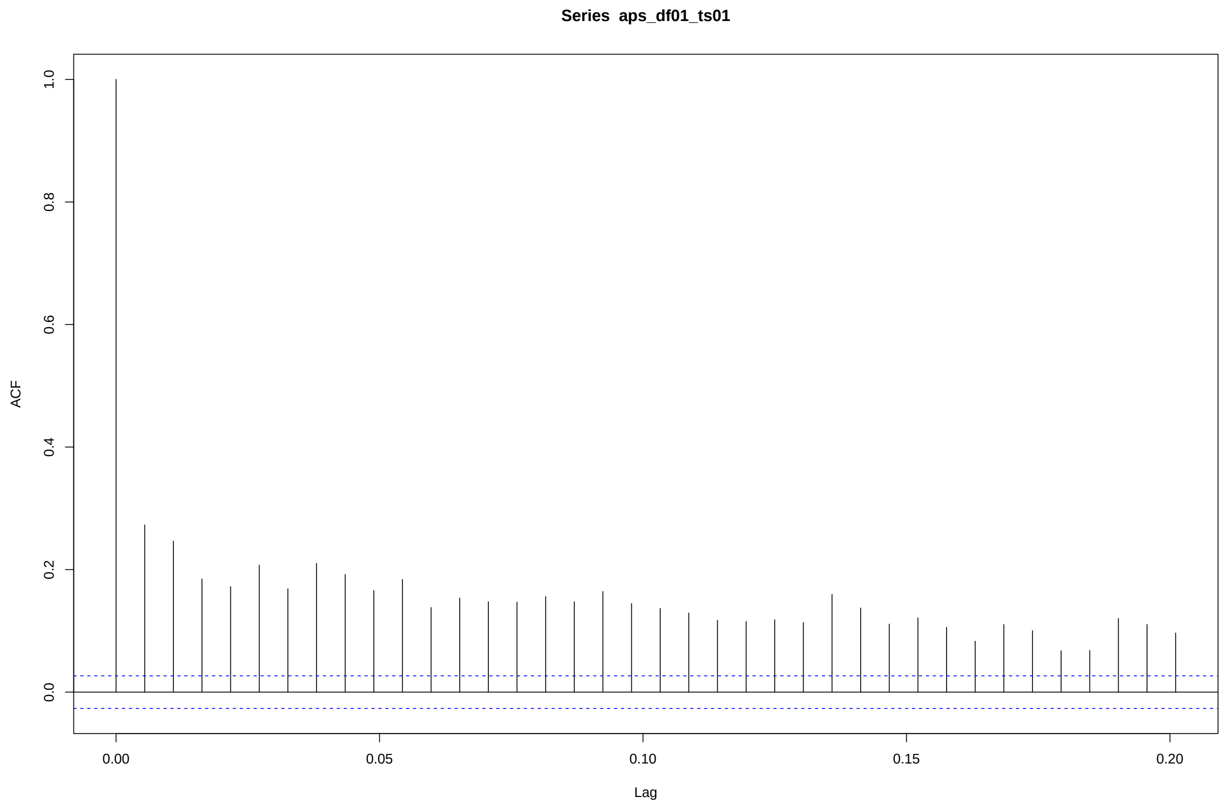
```
## # A tibble: 6 x 3
## # Groups:   date_sample [2]
##   date_sample parameter Total
##   <chr>       <chr>     <dbl>
## 1 2021-12-28  ENTERO    39780
## 2 2021-12-28  FECAL     49256
## 3 2021-12-28  TOTAL     83200
## 4 2021-12-29  ENTERO       36
## 5 2021-12-29  FECAL        40
## 6 2021-12-29  TOTAL       562
```

```r
train_x03_df01_full02 <- train_x03_df01_full[train_x03_df01_full$parameter == "ENTERO", ]
# & train_x03_df01_full$station == "A1"
aps_df01_ts01 <- ts(train_x03_df01_full02$Total, start = c(1990, 1), freq = 184)
#, start = c(2020, 1), freq = 52
#print(aps_df01_ts01)

#ship_fore_avg <- tslm(aps_df01_ts01 ~ trend)
#ship_fore_trnd <- tslm(aps_df01_ts01 ~ trend + I(trend^2))

plot(aps_df01_ts01,
     xlab = "Time",
     ylab = "Entero Levels",
     type = "o",
     main = "Figure 1. Entero Levels Over Five Years")
grid()
```

**Figure 1. Entero Levels Over Five Years**




```
print(acf(aps_df01_ts01, pl=TRUE, na.action = na.pass))
```




```
##
## Autocorrelations of series 'aps_df01_ts01', by lag
##
## 0.00000 0.00543 0.01087 0.01630 0.02174 0.02717 0.03261 0.03804 0.04348 0.04891
##   1.000   0.273   0.246   0.185   0.172   0.207   0.169   0.210   0.192   0.166
## 0.05435 0.05978 0.06522 0.07065 0.07609 0.08152 0.08696 0.09239 0.09783 0.10326
##   0.184   0.138   0.154   0.148   0.147   0.156   0.147   0.164   0.145   0.137
## 0.10870 0.11413 0.11957 0.12500 0.13043 0.13587 0.14130 0.14674 0.15217 0.15761
##   0.129   0.117   0.115   0.118   0.114   0.160   0.137   0.111   0.121   0.106
## 0.16304 0.16848 0.17391 0.17935 0.18478 0.19022 0.19565 0.20109
##   0.083   0.110   0.100   0.068   0.068   0.120   0.110   0.096
```