MD2201 Data Science
Home Assignment
AY:2021-22 SEM II

S.No	Div	Batch No	Group No	Roll No	Gr.No	Name of Student
1	D	3	3	80	12120172	PATIL MANASI
2				89	12120061	SONAWANE HARSHAL
3				79	12120057	PATIL CHAITANYA
4				81	12120128	PATIL SHASHANK
5				91	12120087	THAKUR UMA
6				78	12120056	PATIL BHAVIN

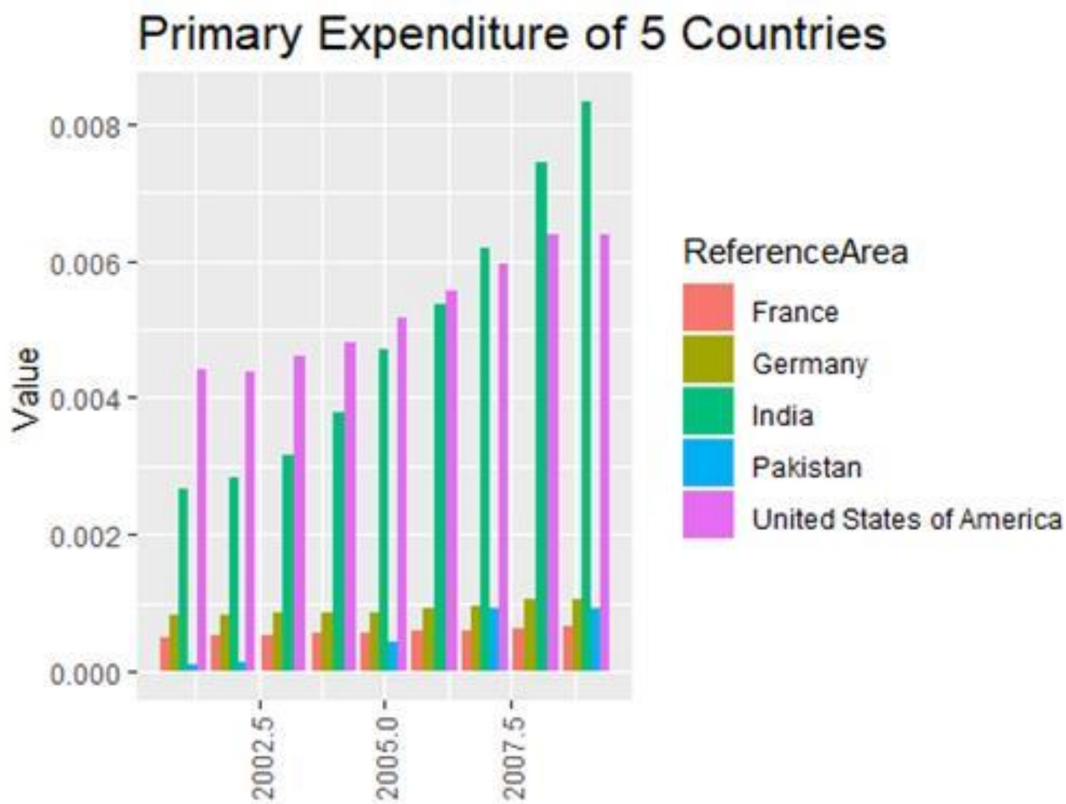
1. Data Visualization:

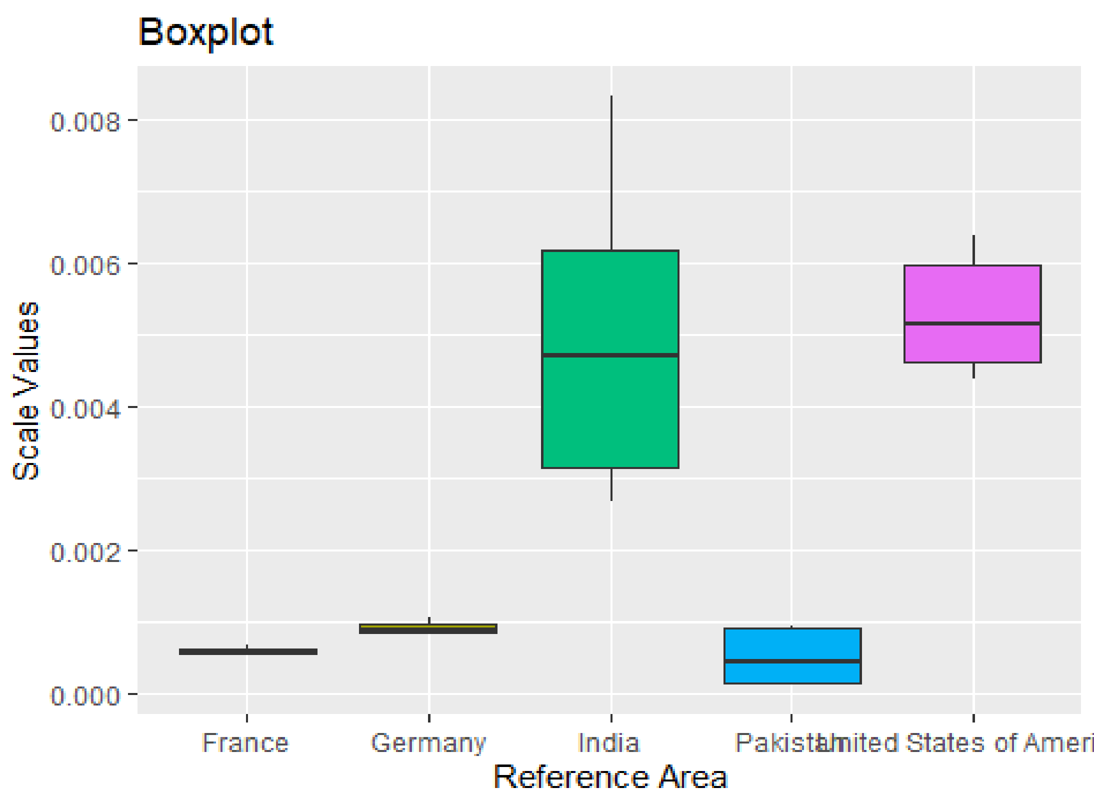
i. **Statement:** Use minimum two different appropriate visualization tools for visualizing/comparing the data

ii. **Code**:

```
Bar Plot: ggplot(train, aes(fill=ReferenceArea, y=Scale, x=TimePeriod))+geom_bar(position="dodge", stat="identity")+theme(axis.text.x=element_text(angle=90,vjust=0.5),plot.title=element_text(color="black",size=16,face="italic"))+labs(x="",y="Value",title="Primary Expenditure of 5 Countries")

Box Plot: ggplot(train,aes(ReferenceArea, Scale,fill=ReferenceArea))+geom_boxplot(outlier.color="red",outlier.shape=4,outlier.size = 4)+theme(legend.position = "dodge")+ggtitle("Boxplot")+xlab("Reference Area")+ylab("Scale Values")
```

iii. Plot:


Primary Expenditure of 5 Countries
Value
0.008
0.006
0.004
0.002
0.000
2002.5
2005.0
2007.5
ReferenceArea
France
Germany
India
Pakistan
United States of America


Boxplot
Scale Values
0.008
0.006
0.004
0.002
0.000
France
Germany
India
Pakistan
United States of Ameri
Reference Area

iv. Conclusion:

1. **Bar Plot:** Plotted a Bar Plot for Primary Expenditure of 5 Countries. Showing Scaler values in Y axis and Time period on X axis. Using ggplot function along with aesthetics function to specify graphing elements.

2. **Box Plot:** For Box plot, the same function is used with geom_boxplot function instead of geom_bar function. On X axis the Reference area name are given and on Y axis it is showing the scaler values.

2. Details of Meta Data:

Name of Data Set	**Link**
Gross domestic expenditure on R & D	https://data.un.org/

```
str(train)

## 'data.frame':    41 obs. of  4 variables:
##  $ ReferenceArea   : chr  "India" "India" "India" "India" ...
##  $ TimePeriod      : int  2001 2002 2003 2004 2005 2006 2007 2008 2009 2001
...
##  $ ObservationValue: num  1.70e+11 1.81e+11 2.01e+11 2.41e+11 2.99e+11 ...
##  $ Scale           : num  0.00267 0.00284 0.00315 0.00378 0.0047 ...

summary(train)

##  ReferenceArea        TimePeriod   ObservationValue        Scale
##  Length:41          Min.   :2001   Min.   :7.018e+09   Min.   :0.0001101
##  Class :character   1st Qu.:2003   1st Qu.:4.107e+10   1st Qu.:0.0006443
##  Mode  :character   Median :2005   Median :6.148e+10   Median :0.0009647
##                     Mean   :2005   Mean   :1.681e+11   Mean   :0.0026370
##                     3rd Qu.:2007   3rd Qu.:2.993e+11   3rd Qu.:0.0046965
##                     Max.   :2009   Max.   :5.304e+11   Max.   :0.0083223
```

Reference Area	Class: Character Mode : Character Length : 41	contains the name of different countries.
Time Period	Class: Integer Mode: Numeric	Year in which government, consumer and business investment has spent.
Observation Value	Class: Numeric Mode: Numeric	Sum of all final goods and services in economic in that particular year.
Scale	Class: Numeric Mode: Numeric	Normalized value for observation values.

3. Data Preprocessing:

i. Details of Techniques used for Data cleaning

First, we have separated the columns with same objects from the given dataset we have removed the Sex, Age.group and Units.of.measurement columns. Using the combine function created a df dataset which only contains operational columns. From caret package preProcessing function is used to convert the observation values into scaler values. Lastly, we have taken the 5 primary countries as our training dataset.

ii. Code:

```
head(df)

##   Reference.Area Time.Period            Sex      Age.group
Units.of.measurement
## 1        Albania        2007 Not applicable Not applicable
Number
## 2        Albania        2008 Not applicable Not applicable
Number
## 3        Algeria        2001 Not applicable Not applicable
Number
## 4        Algeria        2002 Not applicable Not applicable
Number
## 5        Algeria        2003 Not applicable Not applicable
Number
## 6        Algeria        2004 Not applicable Not applicable
Number
##   Observation.Value
## 1         845500000
## 2        1665500000
## 3        9734253000
## 4       16571247000
## 5       10306455000
## 6       10058086000

keeps <- c("Reference.Area", "Time.Period","Observation.Value")
df <- df[keeps]
head(df)

##   Reference.Area Time.Period Observation.Value
## 1        Albania        2007         845500000
## 2        Albania        2008        1665500000
## 3        Algeria        2001        9734253000
## 4        Algeria        2002       16571247000
## 5        Algeria        2003       10306455000
## 6        Algeria        2004       10058086000

sum(is.null(df))

## [1] 0
```

Normalizing the observation values.

```
library(caret)

## Warning: package 'caret' was built under R version 4.1.3

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 4.1.3

## Loading required package: lattice

process <- preProcess(as.data.frame(df$Observation.Value), method =
c("range"))
scale <- predict(process, as.data.frame(df$Observation.Value))
df <- cbind(df, scale)
colnames(df) <- c("ReferenceArea", "TimePeriod", "ObservationValue",
"Scale")
head(df)

##   ReferenceArea TimePeriod ObservationValue        Scale
## 1       Albania       2007         845500000 1.325951e-05
## 2       Albania       2008        1665500000 2.612545e-05
## 3       Algeria       2001        9734253000 1.527257e-04
## 4       Algeria       2002       16571247000 2.599993e-04
## 5       Algeria       2003       10306455000 1.617036e-04
## 6       Algeria       2004       10058086000 1.578067e-04
```

Data Splitting

```
library(dplyr)

## Warning: package 'dplyr' was built under R version 4.1.3

##
## 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

df %>% filter(ReferenceArea == "India" ) -> a1
df %>% filter(ReferenceArea == "France" ) -> a2
df %>% filter(ReferenceArea == "Germany" ) -> a3
df %>% filter(ReferenceArea == "Pakistan" ) -> a4
df %>% filter(ReferenceArea == "United States of America" ) -> a5

train <- rbind(a1, a2, a3, a4, a5)
train %>% filter(TimePeriod > 2000 & TimePeriod < 2010) -> train
```

4. Hypothesis Testing:

i. **Statement:** Hypothesis testing for 5 Countries who have spending in year 2010.

ii. **Code:**

```
stdDev <- sd(df$ObservationValue)
cat("\nStandard Deviation of Population Data: ", stdDev)

Samean <- mean(Hypotrain$ObservationValue)
cat("Mean of Sample Data: ",Samean)

Pval<- pnorm(Samean,meanObs,stdDev)


if(Pval < 0.05){
  cat("\n\nReject null Hypothesis for 0.05")
}else{
  cat("\n\nDo not Reject null Hypothesis for 0.05")
}

if(Pval < 0.01){
  cat("\n\nReject null Hypothesis for 0.01")
}else{
  cat("\n\nDo not Reject null Hypothesis for 0.01")
}
```

iii. **Output:**

```
Standard Deviation of Population Data:  4.279967e+12

Mean of Sample Data:  893658701821

P-Value:  0.5179612

Do not Reject null Hypothesis for 0.05

Do not Reject null Hypothesis for 0.01
```

iv. **Conclusion:** In the given dataset there was not a normal population distribution, so we have used the Central Limit Theorem to assume the distribution to be nearly normal from which we have calculated the P-value and performed the hypothesis testing.

5. Principal Component Analysis:

i. **Statement:** Find the principal components. How many principal components are required to describe 90% of total variance? (Hint: Use prcomp command).

ii. **Code:**

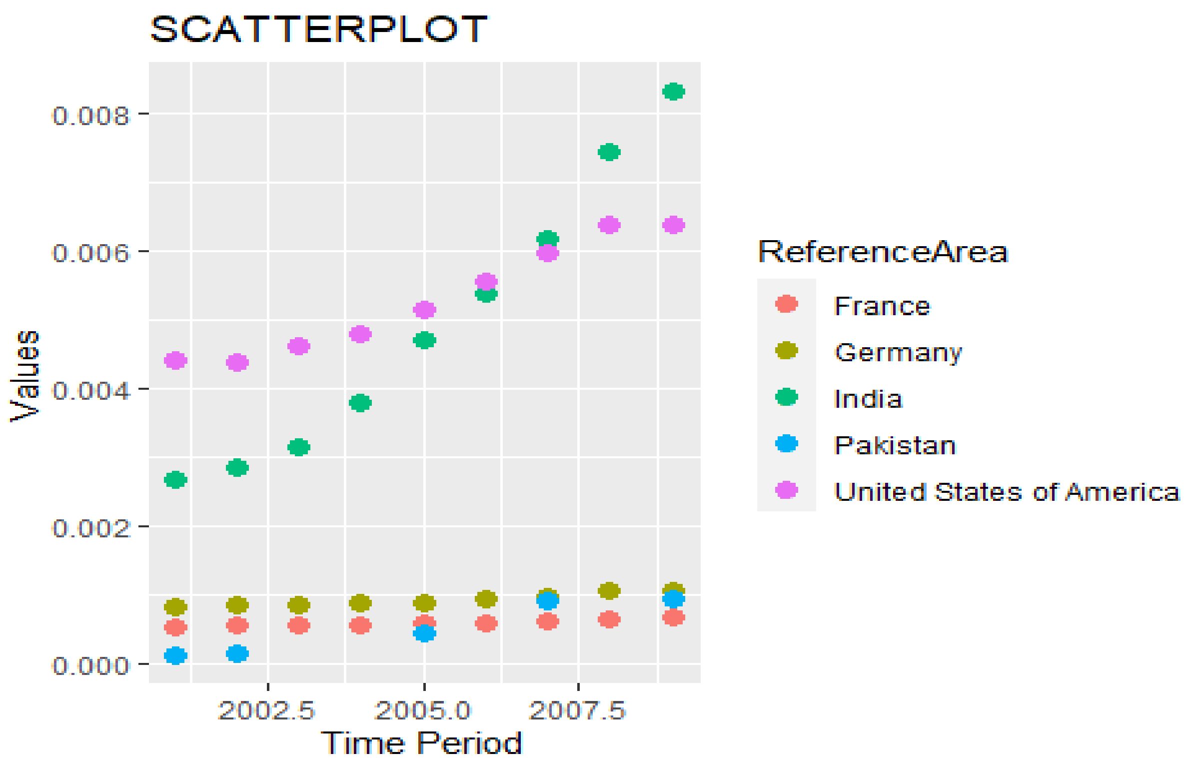
```
head(train)

##   ReferenceArea TimePeriod ObservationValue       Scale
## 1         India       2001     170381500000 0.002673310
## 2         India       2002     180881600000 0.002838059
## 3         India       2003     200863400000 0.003151577
## 4         India       2004     241172400000 0.003784032
## 5         India       2005     299325800000 0.004696470
## 6         India       2006     342383900000 0.005372059

preordain <- train[, 2:3]

head(prcomtrain)

##   TimePeriod ObservationValue
## 1       2001     170381500000
## 2       2002     180881600000
## 3       2003     200863400000
## 4       2004     241172400000
## 5       2005     299325800000
## 6       2006     342383900000

prcom <- prcomp(prcomtrain, scale. = TRUE)
summary(prcom)

## Importance of components:
##                           PC1    PC2
## Standard deviation     1.1292 0.8514
## Proportion of Variance 0.6376 0.3624
## Cumulative Proportion  0.6376 1.0000
```

iii. **Conclusion:** The given dataset is not sufficient to calculate principal component still we have calculated the principal component for Time Period and Observation Values with the prcomp function and the cumulative proportion value for PC2 has passed the 0.90 value so we can say that the 2 principal components required to pass the 90% of total variance.

6. Correlation:

i. Statement: Check whether any two or more variables are correlated. Find the degree of correlation. Also plot the scatter plot for the same.

ii. Plots:




```
cor(train$TimePeriod, train$Scale)

## [1] 0.2751963

Indi <- cor(a1$TimePeriod, a1$Scale)
Frn <- cor(a2$TimePeriod, a2$Scale)
Usa <- cor(a5$TimePeriod, a5$Scale)
Ger <- cor(a3$TimePeriod, a3$Scale)
Pak <- cor(a4$TimePeriod, a4$Scale)

fdata <- data.frame(C_name = rep(c('India', 'France', 'Germany',
'Pakistan', 'USA')),
                    Cor_Val = rep(c(Indi, Frn, Ger, Pak, Usa)))
fdata

##     C_name   Cor_Val
## 1    India 0.9465078
## 2   France 0.9958850
## 3  Germany 0.9845807
## 4 Pakistan 0.9594195
## 5      USA 0.9931212
```

iii. **Conclusion:** Scatterplot showing the correlation between Time Period and Observation Values for each selected countries. Also, a table showing the correlation values for each countries.

7. Regression:

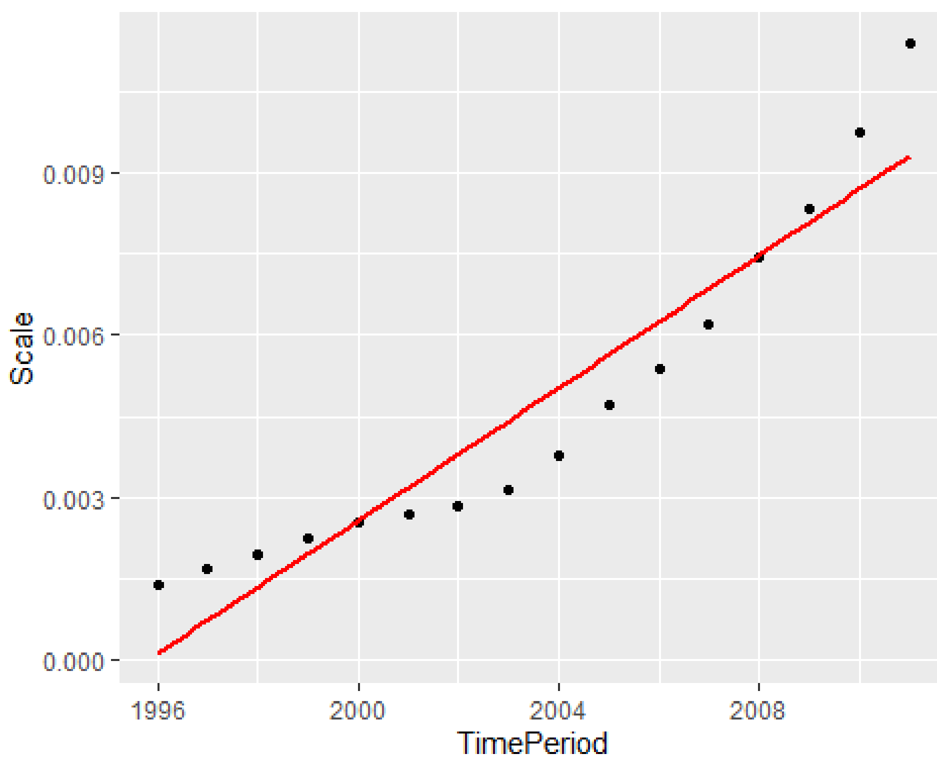
i. **Statement :** Apply regression to predict the future value of one/more variables if applicable. (If not applicable, justify):

ii. **Code:**

```
l1 <- lm(Scale~TimePeriod, a1)
summary(l1)

##
## Call:
## lm(formula = Scale ~ TimePeriod, data = a1)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -1.255e-03 -8.884e-04 -3.359e-05  6.942e-04  2.086e-03
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.223e+00  1.118e-01  -10.93 3.06e-08 ***
## TimePeriod   6.127e-04  5.583e-05   10.97 2.92e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.001029 on 14 degrees of freedom
## Multiple R-squared:  0.8959, Adjusted R-squared:  0.8884
## F-statistic: 120.5 on 1 and 14 DF,  p-value: 2.916e-08

#Predicted Values
prd <- predict(l1)
prd

##            1            2            3            4            5
6
## 0.0025684612 0.0031811719 0.0037938827 0.0044065935 0.0050193042
0.0056320150
##            7            8            9           10           11
12
## 0.0062447257 0.0068574365 0.0074701472 0.0080828580 0.0086955688
0.0093082795
##           13           14           15           16
## 0.0001176182 0.0007303289 0.0013430397 0.0019557504
```

```
#Error Values
er <- a1$Scale - prd
er

##             1             2             3             4             
5
## -2.684977e-05 -5.078619e-04 -9.558241e-04 -1.255017e-03 -1.235272e-
03
##             6             7             8             9            
10
## -9.355454e-04 -8.726668e-04 -6.695838e-04 -4.032260e-05  2.394116e-
04
##            11            12            13            14            
15
##  1.040727e-03  2.085993e-03  1.280937e-03  9.346030e-04  6.140168e-
04
##            16
##  3.032557e-04

ggplot(a1, aes(TimePeriod, Scale))+geom_point()+geom_smooth(method = 
"lm", formula = y~x, col="red", se=F)
```

iii. Plot:



iv. Conclusion: As regression we have taken the Country India and predicted values for it and checked the values matches with the actual values and with error values, we have confirmed that the normalized values and predicted values are nearly same. Also plotted the scatterplot for India showing the regression line.

8. Classification:

i. **Statement:** Apply a suitable classifier to classify the given data into one/two classes if applicable. (If not applicable, justify).

ii. **Conclusion:** In the given dataset we cannot perform the classification techniques as there is not any categorical variable from which can classify the class of any object of sample dataset.