# DATA SCIENCE LABORATORY

## LAB MANUAL

| | | |
|---|---|---|
| **Year** | **:** | **2018 - 2019** |
| **Course Code** | **:** | **BCS101** |
| **Regulations** | **:** | **IARE - R18** |
| **Semester** | **:** | **I** |
| **Branch** | **:** | **COMPUTER SCIENCE AND ENGINEERING** |


Prepared By

**Mr. C Raghavendra, Assistant Professor**


# INSTITUTE OF AERONAUTICAL ENGINEERING

**(AUTONOMOUS)**

**Dundigal – 500 043, Hyderabad**

# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

DUNDIGAL – 500 043, HYDERABAD

## COMPUTER SCIENCE AND ENGINEERING

## 1. PROGRAM OUTCOMES:

| M.TECH-PROGRAM OUTCOMES (POS) | |
|---|---|
| PO1 | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering |
| PO2 | **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| PO3 | **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental |
| PO4 | **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| PO6 | **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| PO7 | **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| PO9 | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO12 | **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

## 2. PROGRAM SPECIFIC OUTCOMES:

| PROGRAM SPECIFIC OUTCOMES(PSO's) | |
|---|---|
| POS1 | **Professional Skills**: An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems |
| POS2 | **Problem-solving skills**: An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions. |
| POS3 | **Successful career and Entrepreneurship**: An understanding of social-awareness & environmental wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur. |

## OBJECTIVES OF THE DEPARTMENT

### Program Educational Objectives (PEOs)

A Post Graduate of the Computer Science and Engineering Program should:

| | |
|---|---|
| **PEO – I** | Students will establish themselves as effective professionals by solving real problems through the use of computer science knowledge and with attention to team work, effective communication, critical thinking and problem solving skills. |
| **PEO–II** | Students will develop professional skills that prepare them for immediate employment and for life-long learning in advanced areas of computer science and related fields. |
| **PEO– III** | Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies. |
| **PEO– IV** | Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career. |

### Program Specific Outcomes (PSO's)

| | |
|---|---|
| **PSO – I** | **Professional Skills:** The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity. |
| **PSO – II** | **Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success. |
| **PSO – III** | **Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies. |

## INDEX

## Week 1 - R AS CALCULATOR APPLICATION

**a. Using without R objects on console**

```
> 2587+2149
```

Output:-

```
[1] 4736
```

```
> 287954-135479
```

Output:-

```
[1] 152475
> 257*52
[1] 13364
```

```
> 257/21
```

Output:-

```
[1] 12.2381
```

**Using with R objects on console:**

```
>A=1000
>B=2000
>C=A+B
>C
```

Output:-

```
[1] 3000
```

**b. Using mathematical functions on console**

```
>a=100

>class(a)

[1] "numeric"

>b=500

>c=a-b

>class(b)

[1] "numeric"

>sum<a-b
```

```
[1] FALSE
>sum
[1] -400
```

c. **Write an R script, to create R objects for calculator application and save in a specified location in disk.**

```
getwd()
[1] "C:/Users/Administrator/Documents"
>write.csv(a,'a.csv')
>write.csv(a,'C:\\Users\\Administrator\\Documents')
```

**Week 2 - DESCRIPTIVE STATISTICS IN R**

a. Write an R script to find basic descriptive statistics using summary, str, quartile function on mtcars& cars datasets.

```
>mtcars
mpgcyldisphp drat    wtqsec vs am gear carb
Mazda RX4            21.0    6  160.0  110  3.90  2.620  16.46   0   1     4
4
Mazda RX4 Wag        21.0    6  160.0  110  3.90  2.875  17.02   0   1     4
4
Datsun 710           22.8    4  108.0   93  3.85  2.320  18.61   1   1     4
1
Hornet 4 Drive       21.4    6  258.0  110  3.08  3.215  19.44   1   0     3
1
Hornet Sportabout   18.7    8  360.0  175  3.15  3.440  17.02   0   0     3
2
Valiant              18.1    6  225.0  105  2.76  3.460  20.22   1   0     3
1
Duster 360           14.3    8  360.0  245  3.21  3.570  15.84   0   0     3
4
Merc 240D            24.4    4  146.7   62  3.69  3.190  20.00   1   0     4
2
Merc 230             22.8    4  140.8   95  3.92  3.150  22.90   1   0     4
2
Merc 280             19.2    6  167.6  123  3.92  3.440  18.30   1   0     4
4
Merc 280C            17.8    6  167.6  123  3.92  3.440  18.90   1   0     4
4
Merc 450SE           16.4    8  275.8  180  3.07  4.070  17.40   0   0     3
3
Merc 450SL           17.3    8  275.8  180  3.07  3.730  17.60   0   0     3
3
Merc 450SLC          15.2    8  275.8  180  3.07  3.780  18.00   0   0     3
3
Cadillac Fleetwood  10.4    8  472.0  205  2.93  5.250  17.98   0   0     3
4
Lincoln Continental 10.4    8  460.0  215  3.00  5.424  17.82   0   0     3
4
Chrysler Imperial   14.7    8  440.0  230  3.23  5.345  17.42   0   0     3
4
Fiat 128             32.4    4   78.7   66  4.08  2.200  19.47   1   1     4
1
Honda Civic          30.4    4   75.7   52  4.93  1.615  18.52   1   1     4
2
Toyota Corolla      33.9    4   71.1   65  4.22  1.835  19.90   1   1     4
1
Toyota Corona       21.5    4  120.1   97  3.70  2.465  20.01   1   0     3
1
Dodge Challenger    15.5    8  318.0  150  2.76  3.520  16.87   0   0     3
2
AMC Javelin          15.2    8  304.0  150  3.15  3.435  17.30   0   0     3
```

```
2
Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3
4
Pontiac Firebird    19.2   8 400.0 175 3.08 3.845 17.05  0  0    3
2
Fiat X1-9           27.3   4  79.0  66 4.08 1.935 18.90  1  1    4
1
Porsche 914-2       26.0   4 120.3  91 4.43 2.140 16.70  0  1    5
2
Lotus Europa        30.4   4  95.1 113 3.77 1.513 16.90  1  1    5
2
Ford Pantera L      15.8   8 351.0 264 4.22 3.170 14.50  0  1    5
4
Ferrari Dino        19.7   6 145.0 175 3.62 2.770 15.50  0  1    5
6
Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5
8
Volvo 142E          21.4   4 121.0 109 4.11 2.780 18.60  1  1    4
2
```

```
>summary(mtcars)
```

```
mpgcyldisphp             drat
Min.:10.40   Min.   :4.000   Min.   : 71.1   Min.: 52.0   Min.:2.760
 1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5   1st
Qu.:3.080
Median :19.20   Median :6.000   Median :196.3   Median :123.0   Median
:3.695
 Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7   Mean
:3.597
 3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0   3rd
Qu.:3.920
 Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0   Max.
:4.930
wtqsec            vs               am               gear
Min.:1.513   Min.   :14.50   Min.   :0.0000   Min.   :0.0000   Min.
:3.000
 1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000   1st Qu.:0.0000   1st
Qu.:3.000
Median  :3.325    Median  :17.71    Median  :0.0000    Median  :0.0000
Median :4.000
 Mean    :3.217    Mean    :17.85    Mean    :0.4375    Mean    :0.4062
Mean   :3.688
 3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000   3rd Qu.:1.0000   3rd
Qu.:4.000
 Max.    :5.424    Max.    :22.90    Max.    :1.0000    Max.    :1.0000
Max.   :5.000
carb
Min.:1.000
 1st Qu.:2.000
Median :2.000
 Mean   :2.812
 3rd Qu.:4.000
 Max.   :8.000
```

```
>str(mtcars)
```

```
'data.frame': 32 obs. of  11 variables:
$ mpg :num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
 $ cyl :num  6 6 4 6 8 6 8 4 4 6 ...
 $ disp: num  160 160 108 258 360 ...
 $ hp  :num  110 110 93 110 175 105 245 62 95 123 ...
 $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
 $ wt  :num  2.62 2.88 2.32 3.21 3.44 ...
 $ qsec: num  16.5 17 18.6 19.4 17 ...
 $ vs  :num  0 0 1 1 0 1 0 1 1 1 ...
 $ am  :num  1 1 1 0 0 0 0 0 0 0 ...
 $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
 $ carb: num  4 4 1 1 2 1 4 2 2 4 ...

>quantile(mtcars$mpg)

    0%    25%    50%    75%   100%
10.400 15.425 19.200 22.800 33.900

>cars

speeddist
1      4    2
2      4   10
3      7    4
4      7   22
5      8   16
6      9   10
7     10   18
8     10   26
9     10   34
10    11   17
11    11   28
12    12   14
13    12   20
14    12   24
15    12   28
16    13   26
17    13   34
18    13   34
19    13   46
20    14   26
21    14   36
22    14   60
23    14   80
24    15   20
25    15   26
26    15   54
27    16   32
28    16   40
29    17   32
30    17   40
31    17   50
32    18   42
33    18   56
34    18   76
35    18   84
36    19   36
```

```
37    19   46
38    19   68
39    20   32
40    20   48
41    20   52
42    20   56
43    20   64
44    22   66
45    23   54
46    24   70
47    24   92
48    24   93
49    24  120
50    25   85
```

```
>summary(cars)

speeddist
Min.: 4.0   Min.   :  2.00
 1st Qu.:12.0   1st Qu.: 26.00
Median :15.0   Median : 36.00
 Mean   :15.4   Mean   : 42.98
 3rd Qu.:19.0   3rd Qu.: 56.00
 Max.   :25.0   Max.   :120.00

>class(cars)
[1] "data.frame"

>dim(cars)

[1] 50  2

>str(cars)

'data.frame': 50 obs. of  2 variables:
 $ speed: num  4 4 7 7 8 9 10 10 10 11 ...
 $ dist :num  2 10 4 22 16 10 18 26 34 17 ...
```

>quantile(cars$speed)

```
  0%  25%  50%  75% 100%
   4   12   15   19   25
```

b. Write an R script to find subset of dataset by using subset (), aggregate () functions on iris dataset.

>aggregate(. ~ Species, data = iris, mean)

**Output:**

```
Species Sepal.LengthSepal.WidthPetal.LengthPetal.Width
1     setosa        5.006       3.428        1.462       0.246
2 versicolor        5.936       2.770        4.260       1.326
3  virginica        6.588       2.974        5.552       2.026
```

>subset(iris,iris$Sepal.Length==5.0)

**Output:**

```
Sepal.LengthSepal.WidthPetal.LengthPetal.WidthSpecies
5              5          3.6          1.4          0.2     setosa
8              5          3.4          1.5          0.2     setosa
26             5          3.0          1.6          0.2     setosa
27             5          3.4          1.6          0.4     setosa
36             5          3.2          1.2          0.2     setosa
41             5          3.5          1.3          0.3     setosa
44             5          3.5          1.6          0.6     setosa
50             5          3.3          1.4          0.2     setosa
61             5          2.0          3.5          1.0 versicolor
94             5          2.3          3.3          1.0 versicolor
```

## Week 3 - READING AND WRITING DIFFERENT TYPES OF DATASETS

a. Reading different types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location.

```
library(utils)
data<- read.csv("input.csv")
data
```

**Output :-**

```
id,   name,    salary,   start_date,    dept
1      1    Rick     623.30    2012-01-01      IT
2      2    Dan      515.20    2013-09-23      Operations
3      3    Michelle 611.00    2014-11-15      IT
4      4    Ryan     729.00    2014-05-11      HR
5     NA    Gary     843.25    2015-03-27      Finance
6      6    Nina     578.00    2013-05-21      IT
7      7    Simon    632.80    2013-07-30      Operations
8      8    Guru     722.50    2014-06-17      Finance
```

```
data<- read.csv("input.csv")

print(is.data.frame(data))
print(ncol(data))
print(nrow(data))
```

**Output:-**

```
[1] TRUE
[1] 5
[1] 8
```

```
# Create a data frame.
data<- read.csv("input.csv")

# Get the max salary from data frame.
sal<- max(data$salary)
sal
```

**Output:-**

```
[1] 843.25
```

```
# Create a data frame.
```

```
data<- read.csv("input.csv")


# Get the max salary from data frame.
sal<- max(data$salary)

# Get the person detail having max salary.
retval<- subset(data, salary == max(salary))
retval
```

**Output:-**

```
id    name  salary  start_datedept
5     NA    Gary  843.25  2015-03-27    Finance
```

Get all the people working in IT department

```
# Create a data frame.
data<- read.csv("input.csv")

retval<- subset( data, dept == "IT")
retval
```

**Output:-**

```
id   name      salary   start_datedept
1      1    Rick      623.3    2012-01-01   IT
3      3    Michelle  611.0    2014-11-15   IT
6      6    Nina      578.0    2013-05-21   IT
```

```
#Create a data frame.

data<- read.csv("input.csv")
retval<- subset(data, as.Date(start_date) >as.Date("2014-01-01"))

# Write filtered data into a new file.

write.csv(retval,"output.csv")
newdata<- read.csv("output.csv")
newdata
```

**Output:-**

```
  X      id   name      salary   start_datedept
1 3      3    Michelle  611.00   2014-11-15    IT
2 4      4    Ryan      729.00   2014-05-11    HR
```

```
3 5     NA    Gary      843.25   2015-03-27    Finance
4 8      8    Guru      722.50   2014-06-17    Finance
```

**b. Reading Excel data sheet in R.**

```
install.packages("xlsx")
library("xlsx")
data<- read.xlsx("input.xlsx", sheetIndex = 1)
data
```

**Output:-**

```
id,   name,    salary,   start_date,     dept
1      1    Rick     623.30    2012-01-01      IT
2      2    Dan      515.20    2013-09-23      Operations
3      3    Michelle 611.00    2014-11-15      IT
4      4    Ryan     729.00    2014-05-11      HR
5     NA    Gary     843.25    2015-03-27      Finance
6      6    Nina     578.00    2013-05-21      IT
7      7    Simon    632.80    2013-07-30      Operations
8      8    Guru     722.50    2014-06-17      Finance
```

c. Reading XML dataset in R.

```
install.packages("XML")
library("XML")
library("methods")
result<- xmlParse(file = "input.xml")
result
```

**Output:-**

```
1
   Rick
   623.3
   1/1/2012
   IT


   2
   Dan
   515.2
   9/23/2013
   Operations
```

3
Michelle
611
11/15/2014
IT

4
Ryan
729
5/11/2014
HR

5
Gary
843.25
3/27/2015
Finance

6
Nina
578
5/21/2013
IT

7
Simon
632.8
7/30/2013
Operations

8
Guru
722.5
6/17/2014
Finance

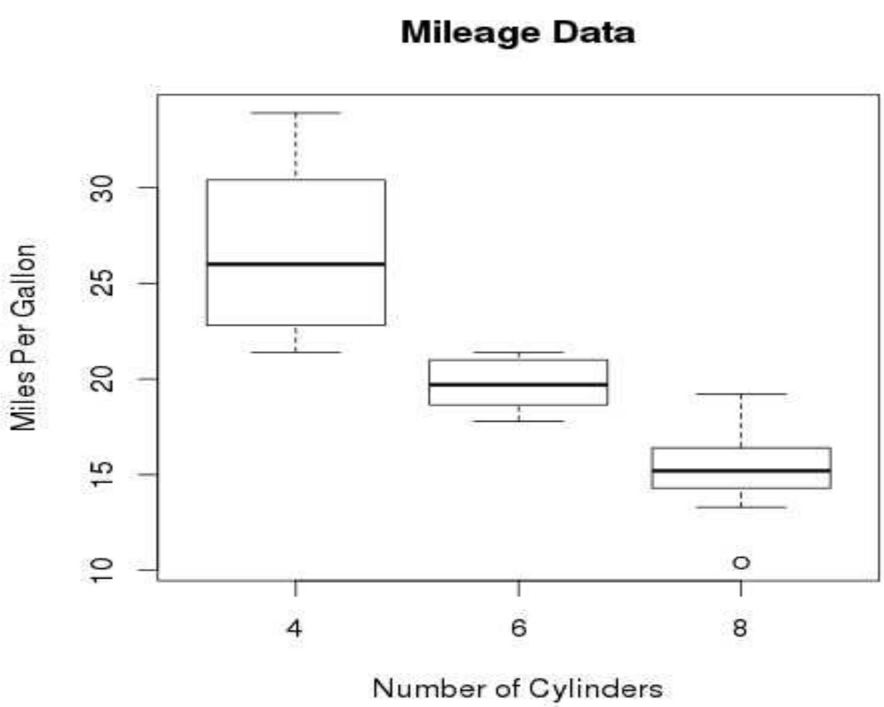
## Week 4 – VISUALIZATIONS

**a. Find the data distributions using box and scatter plot.**

```
Install.packages("ggplot2")
Library(ggplot2)
Input <- mtcars[,c('mpg','cyl')]
input

Boxplot(mpg ~ cyl, data = mtcars, xlab = "number of cylinders",
ylab = "miles per gallon", main = "mileage data")

Dev.off()
```

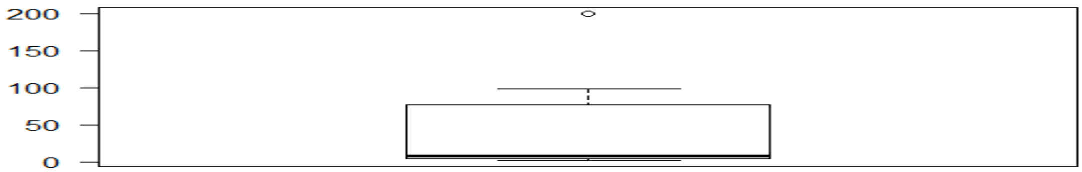
**Output :-**

```
mpg  cyl
Mazda rx4         21.0   6
Mazda rx4 wag     21.0   6
Datsun 710        22.8   4
Hornet 4 drive    21.4   6
Hornet sportabout 18.7   8
Valiant           18.1   6
```



**b.** **Find the outliers using plot.**

```
v=c(50,75,100,125,150,175,200)
boxplot(v)
```

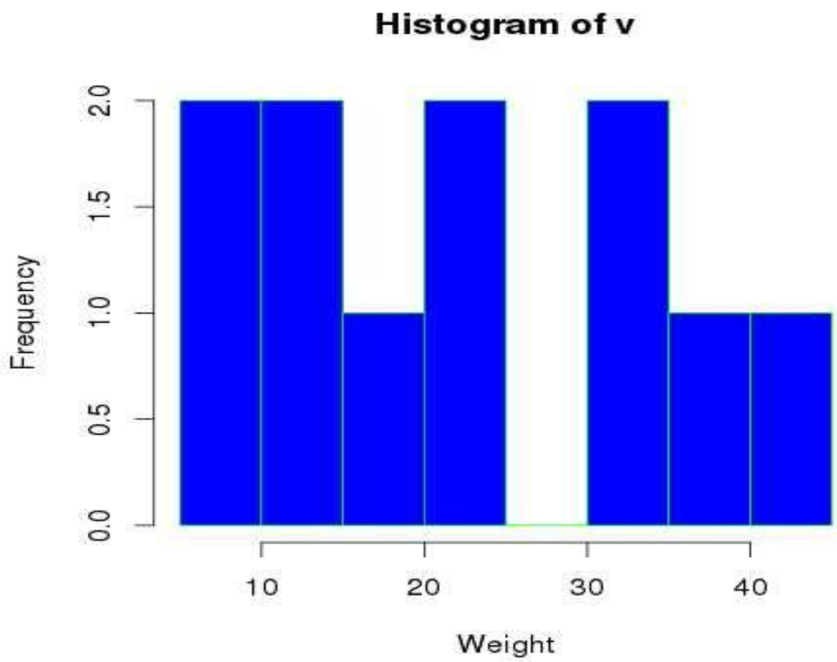



**c.** **Plot the histogram, bar chart and pie chart on sample data.**

**<u>Histogram</u>**

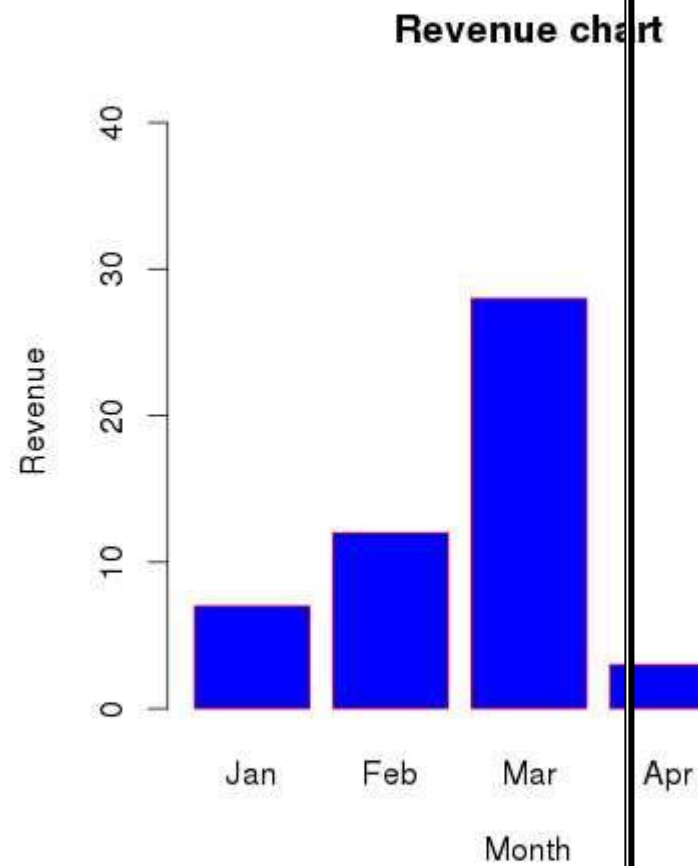
```
library(graphics)
v <-  c(9,13,21,8,36,22,12,41,31,33,19)

# Create the histogram.
hist(v,xlab = "Weight",col = "blue",border = "green")
dev.off()
```

**Output:-**



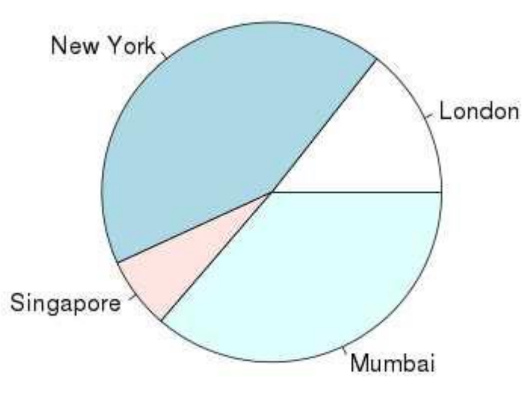

**<u>Bar chart</u>**

```
library(graphics)
H <- c(7,12,28,3,41)
M <- c("Jan","Feb","Mar","Apr","May")
# Plot the bar chart.
barplot(H,names.arg = M,xlab = "Month",ylab = "Revenue",col = "blue",main = "Revenue chart",border
= "red")
dev.off()
```




**Pie Chart**

```
library(graphics)
x <- c(21, 62, 10, 53)
labels<-    c("London",    "NewYork",
"Singapore", "Mumbai")
# Plot the Pie chart.
pie(x,labels)
dev.off()
```



**WEEK5:**

**PROBLEM DEFINATION**:

**a)How to find a corelation matrix and plot the correlation on iris data set**

**SOURCE CODE:**

```
d<-data.frame(x1=rnorm(!0),x2=rnorm(10),x3=rnorm(10))
cor(d)
m<-cor(d)  #get correlations
library('corrplot')
corrplot(m,method="square")
x<-matrix(rnorm(2),,nrow=5,ncol=4)
y<-matrix(rnorm(15),nrow=5,ncol=3)
COR<-cor(x,y)
COR
```

**PROBLEM DEFINATION:**

b) Plot the correlation plot on dataset and visualize giving an overview of relationships among data on iris data.

**SOURCE CODE:**

```
Image(x=seq(dim(x)[2])
```

```
Y<-seq(dim(y)[2])
Z=COR,xlab="xcolumn",ylab="y column")
Library(gtlcharts)
Data(iris)
Iris$species<-NULL
Iplotcorr(iris,reoder=TRUE
```

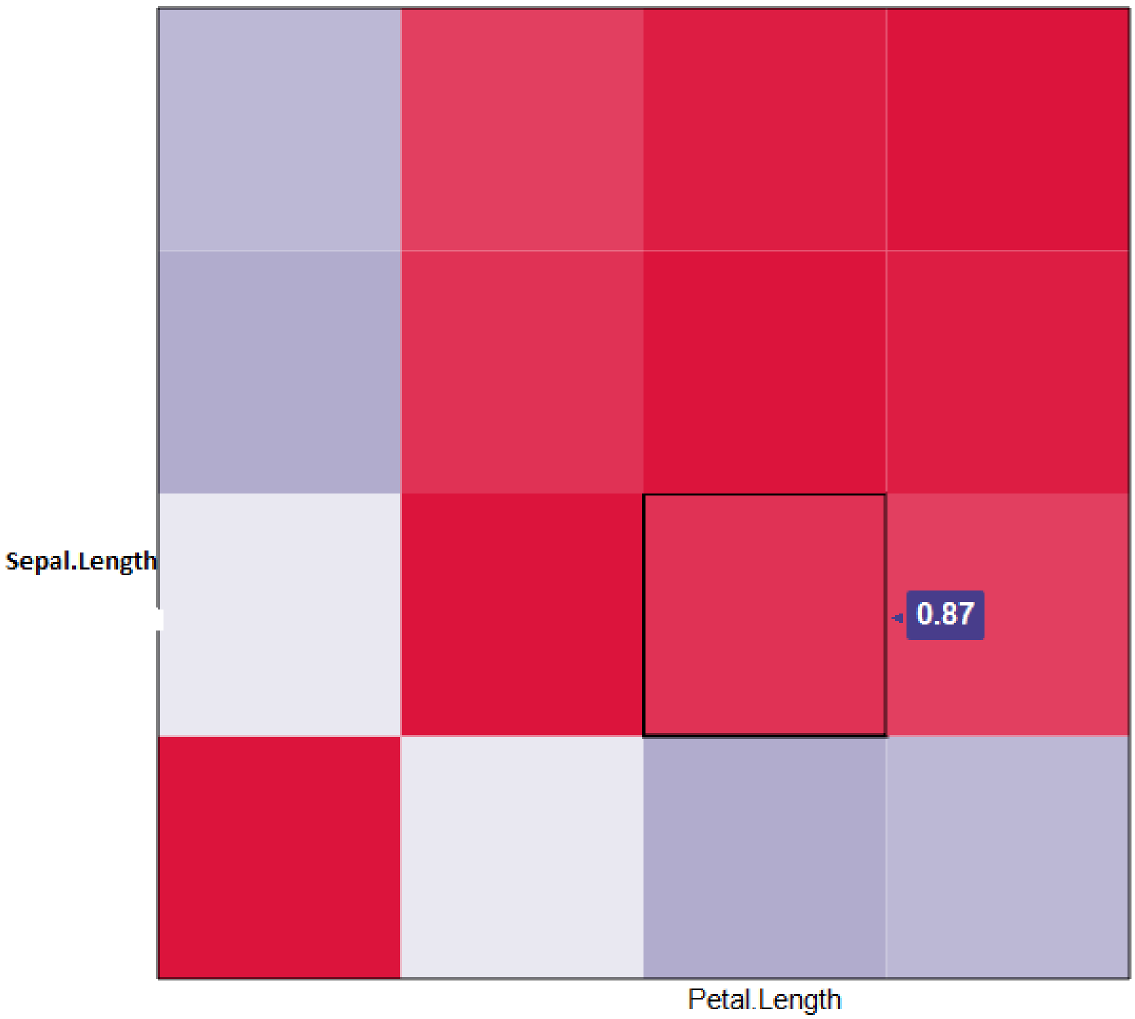
**PROBLEM DEFINATION**:

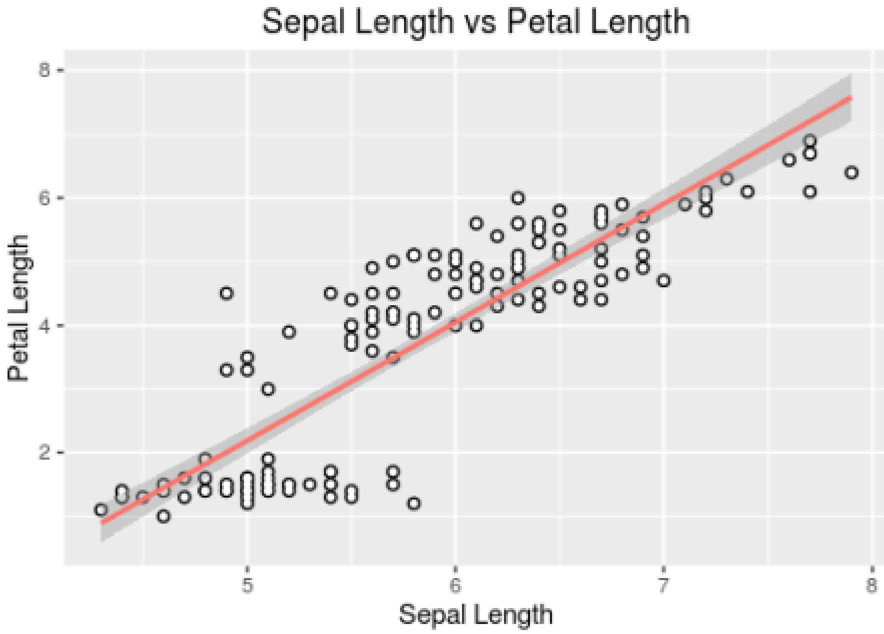
**c) Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.**

**SOURCE CODE**:

```
library(ggplot2)
data(iris)
str(iris)
ggplot(data=iris,aes(x=sepal.length,y=petal.length))+geom_point(size=2,colour="black")+geom_point(size=1,colour="white")+geom_smooth(aes(colour="black"),method="lm')+ggtitle("sepal.lengthvspetal.length")+xlab("sepal.length")+ylab("petal.length")+these(legend.position="none")
```

**OUTPUT**:


Sepal.Length
0.87
Petal.Length



Sepal Length vs Petal Length
Petal Length
Sepal Length
8
6
4
2
5
6
7
8

## WEEK 6

**PROBLEM DEFINATION:**

**REGRESSION MODEL:** Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in a institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS)

**SOURCE CODE:**

mydata<-read.csv(http://www.ats.ucla.edu/stat/data/binary.csv”)
Head(my data)

**OUTPUT:**

```
>
> mydata <- read.csv("http://www.ats.ucla.edu/stat/data/binary.csv")
> head(mydata)
  admit gre  gpa rank
1     0 380 3.61    3
2     1 660 3.67    3
3     1 800 4.00    1
4     1 640 3.19    4
5     0 520 2.93    4
6     1 760 3.00    2
```

**WEEK 7 :CLASSIFICATION MODEL**

**PROBLEM DEFINATION**:
Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.
**SOURCE CODE:**
>mydata$rank<-factor(mydata$rank)
>mylogit<-glm(admit~gre+gpa+rank,data=mydata,family="binomial")
>summary(mylogit)
**OUTPUT:**

```
> mydata$rank <- factor(mydata$rank)
> mylogit <- glm(admit ~ gre + gpa + rank, data = mydata, family = "binomial")
> summary(mylogit)

Call:
glm(formula = admit ~ gre + gpa + rank, family = "binomial",
    data = mydata)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.6268  -0.8662  -0.6388   1.1490   2.0790

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -3.989979   1.139951  -3.500 0.000465 ***
gre          0.002264   0.001094   2.070 0.038465 *
gpa          0.804038   0.331819   2.423 0.015388 *
rank2       -0.675443   0.316490  -2.134 0.032829 *
rank3       -1.340204   0.345306  -3.881 0.000104 ***
rank4       -1.551464   0.417832  -3.713 0.000205 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 499.98  on 399  degrees of freedom
Residual deviance: 458.52  on 394  degrees of freedom
AIC: 470.52

Number of Fisher Scoring iterations: 4
```

1

**Week 8 - REGRESSION MODEL FOR PREDICTION**

Apply regression Model techniques to predict the data on above dataset.

```
># make sure R knows region is categorical
>str(states.data$region)
 Factor w/ 4 levels "West","N. East",..: 3 1 1 3 1 1 2 3 NA 3 ...
>states.data$region<- factor(states.data$region)
> #Add region to the model
>sat.region<- lm(csat ~ region,
+                 data=states.data)
> #Show the results
>coef(summary(sat.region)) # show regression coefficients table
```

**Out put:**

```
              Estimate Std. Error t value Pr(>|t|)
(Intercept)      946.3       14.8  63.958 1.35e-46
regionN. East    -56.8       23.1  -2.453 1.80e-02
regionSouth      -16.3       19.9  -0.819 4.17e-01
regionMidwest     63.8       21.4   2.986 4.51e-03
>anova(sat.region) # show ANOVA table
Analysis of Variance Table

Response: csat
Df Sum Sq Mean Sq F value   Pr(>F)
region     3  82049   27350    9.61 0.000049
Residuals 46 130912    2846
>
```

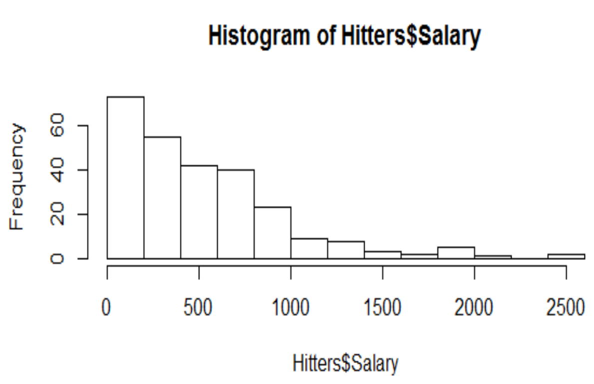
**WEEK 9 :CLASSIFICATION MODEL**

**PROBLEM DEFINATION**:
d. Install relevant package for classification.

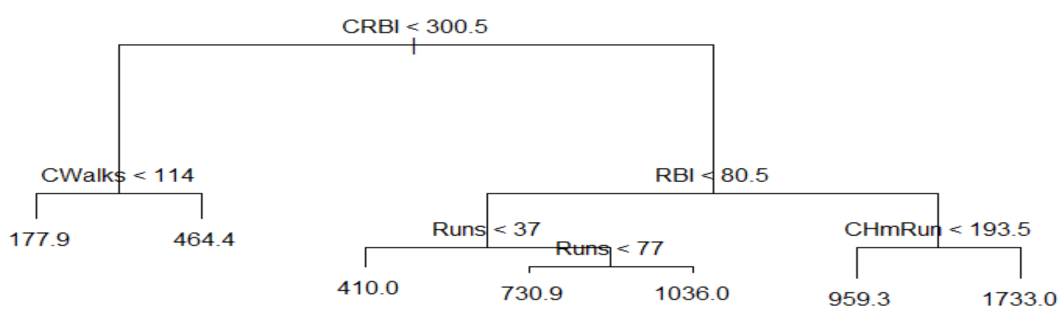
**SOURCE CODE:**
```
install.packages("rpart.plot")
install.packages("tree")
install.packages("ISLR")
install.packages("rattle")

library(tree)
library(ISLR)
library(rpart.plot)
library(rattle)
```

**PROBLEM DEFINATION:**
e. Choose classifier for classification problem.
Evaluate the performance of classifier**.**
**SOURCE CODE:**
```
attach(Hitters)
View(Hitters)
# Remove NA data
Hitters<-na.omit(Hitters)

# log transform Salary to make it a bit more normally distributed
hist(Hitters$Salary)

Hitters$Salary <- log(Hitters$Salary)
hist(Hitters$Salary)
```

output:

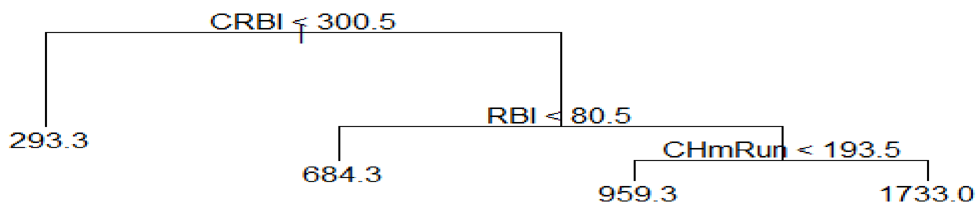


**SOURCE CODE:**
```
> tree.fit <- tree(Salary~Hits+Years, data=Hitters)
> summary(tree.fit)


Regression tree:
tree(formula = Salary ~ Hits + Years, data = Hitters)
Number of terminal nodes:  8
Residual mean deviance:  101200 = 25820000 / 255
Distribution of residuals:
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-1238.00  -157.50   -38.84     0.00    76.83  1511.00

plot(tree.fit, uniform=TRUE,margin=0.2)
text(tree.fit, use.n=TRUE, all=TRUE, cex=.8)
#plot(tree.fit)
>split <- createDataPartition(y=Hitters$Salary, p=0.5, list=FALSE)
> train <- Hitters[split,]
> test <- Hitters[-split,]
#Create tree model
> trees <- tree(Salary~., train)
> plot(trees)
> text(trees, pretty=0)

# Cross validate to see whether pruning the tree will improve
  Performance
```
**OUTPUT:**




**SOURCE CODE:**
```
#Cross validate to see whether pruning the tree will improve performance
> cv.trees <- cv.tree(trees)
> plot(cv.trees)
> prune.trees <- prune.tree(trees, best=4)
> plot(prune.trees)
> text(prune.trees, pretty=0)
```

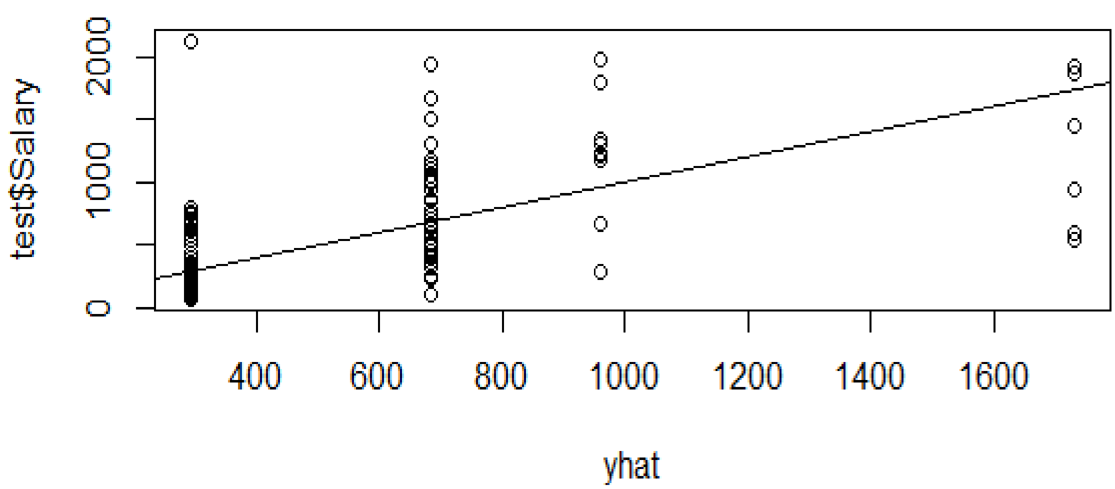
**OUTPUT:**




**SOURCE CODE:**

> yhat <- predict(prune.trees, test)
> plot(yhat, test$Salary)
> abline(0,1
[1] 150179.7
> mean((yhat - test$Salary)^2)
[1] 150179.7

**OUTPUT:**




> mean((yhat - test$Salary)^2)
[1] 150179.7

**WEEK 10**

**PROBLEM DEFINATION:**

CLUSTERING MODEL

c. Clustering algorithms for unsupervised classification.

Plot the cluster data using R visualizations

**SOURCE CODE:**

1. Clustering algorithms for unsupervised classification.

```
library(cluster)

> set.seed(20)
> irisCluster <- kmeans(iris[, 3:4], 3, nstart = 20)
# nstart = 20. This means that R will try 20 different random starting assignments and then select the one with the lowest within cluster variation.
> irisCluster
```

**OUTPUT:**

```
  Petal.Length Petal.Width
1     1.462000    0.246000
2     4.269231    1.342308
3     5.595833    2.037500
```

**Clustering vector:**

```
  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 [42] 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 3 2 2 2 2
 [83] 2 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 2 3 3 3 3 3 3 3 3 3 3 3 3 2 3 3 3
[124] 3 3 3 2 3 3 3 3 3 3 3 3 3 3 3 2 3 3 3 3 3 3 3 3 3 3 3
```

**Within cluster sum of squares by cluster**:

```
[1]  2.02200 13.05769 16.29167
 (between_SS / total_SS =  94.3 %)
```

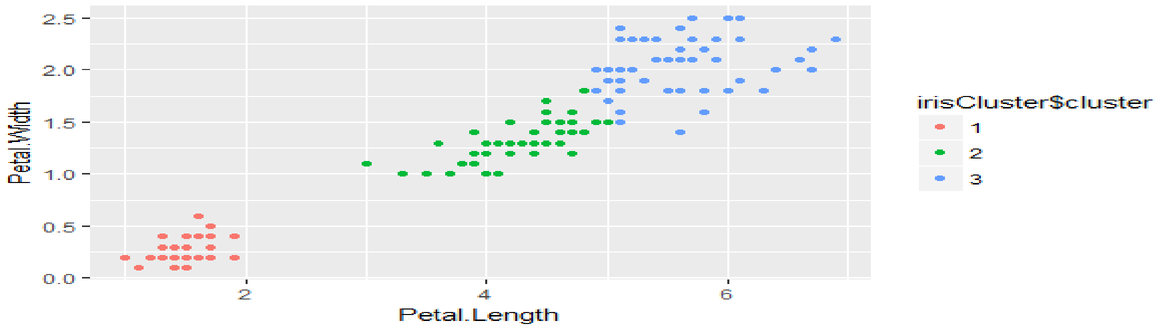
**Available components:**

```
[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"

[6] "betweenss"    "size"         "iter"         "ifault"
```

**SOURCE CODE:**

```
> irisCluster$cluster <- as.factor(irisCluster$cluster)
> ggplot(iris, aes(Petal.Length, Petal.Width, color = irisCluster$cluster)) + geom_point()
```

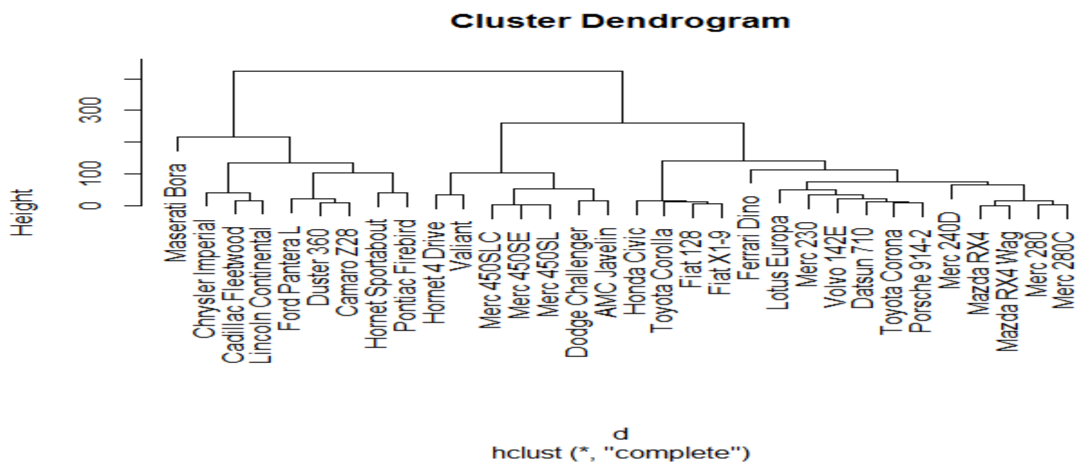
**OUTPUT:**




**SOURCE CODE:**

```
> d <- dist(as.matrix(mtcars))   # find distance matrix
> hc <- hclust(d)                # apply hirarchical clustering
> plot(hc)                       # plot the dendrogram
```

**OUTPUT:**

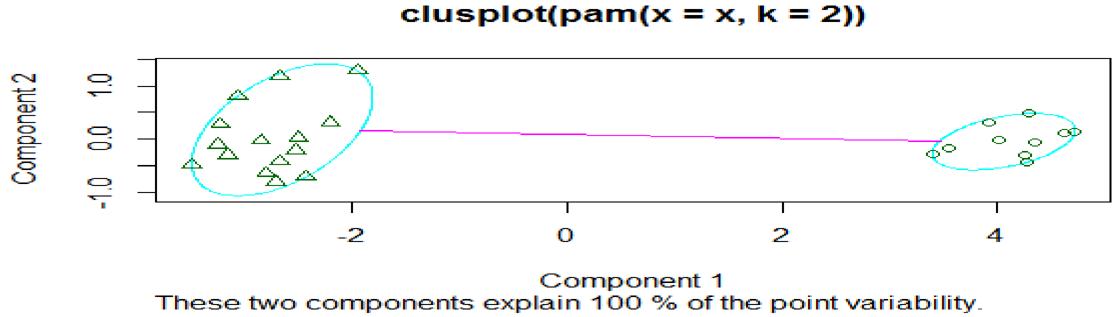



**2. Plot the cluster data using R visualizations.**

**SOURCE CODE**:

```
## generate 25 objects, divided into 2 clusters.
x <- rbind(cbind(rnorm(10,0,0.5), rnorm(10,0,0.5)),
 cbind(rnorm(15,5,0.5), rnorm(15,5,0.5)))
clusplot(pam(x, 2))
```

**OUTPUT:**




**SOURCE CODE:**

```
## add noise, and try again :
x4 <- cbind(x, rnorm(25), rnorm(25))
clusplot(pam(x4, 2))
```

**OUTPUT:**