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Roll No: 380
Class: TYBSC CS A
Subject: Data Science Practical
No :7

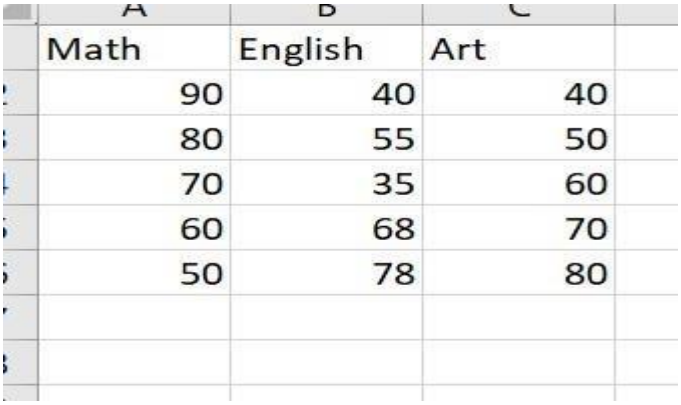
Aim: Demonstration of Principal Component Analysis.

Steps:

Step1: click on packages and set cran mirror(click on other and select USA IN)
Step2: click on packages and select install packages and install package FactoMineR. **install.packages("FactoMine**

R") library(FactoMineR)

Step3: Create Excel Sheet.



	A	B	C	
	Math	English	Art	
2	90	40	40	
3	80	55	50	
4	70	35	60	
5	60	68	70	
6	50	78	80	
7				
8				

Code:

x=read.csv("C:/Users/Akki/OneDrive/Desktop/JEENAL/students.csv") x

```
> x=read.csv("C:/Users/Akki/OneDrive/Desktop/JEENAL/students.csv")
> x
  Math English Art
1   90      40  40
2   80      55  50
3   70      35  60
4   60      68  70
5   50      78  80
```

cov_mat=cov(x)
cov_mat

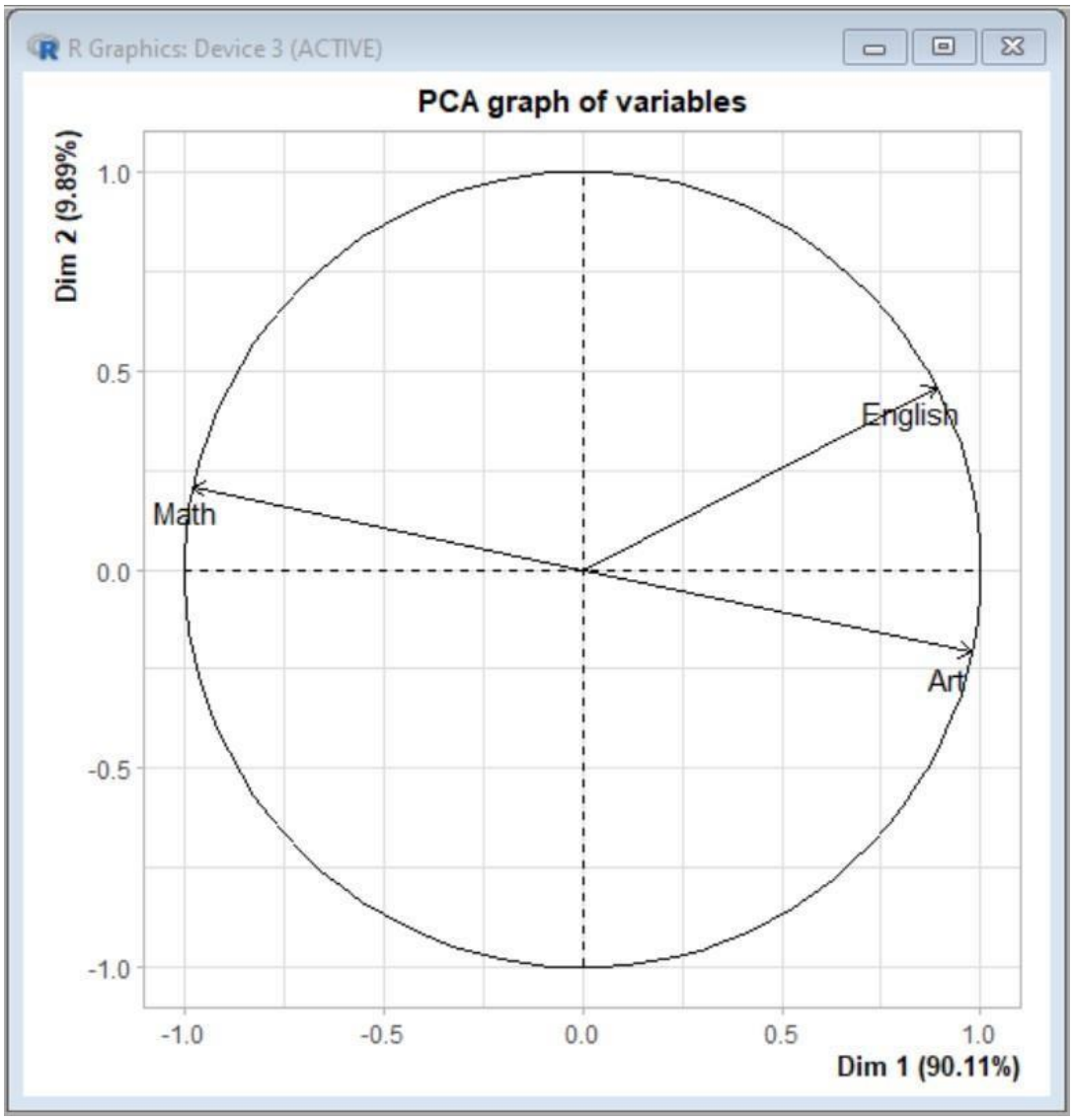
```
> cov_mat=cov(x)
> cov_mat
          Math English    Art
Math     250.0  -222.5 -250.0
English -222.5   330.7  222.5
Art     -250.0   222.5  250.0
```

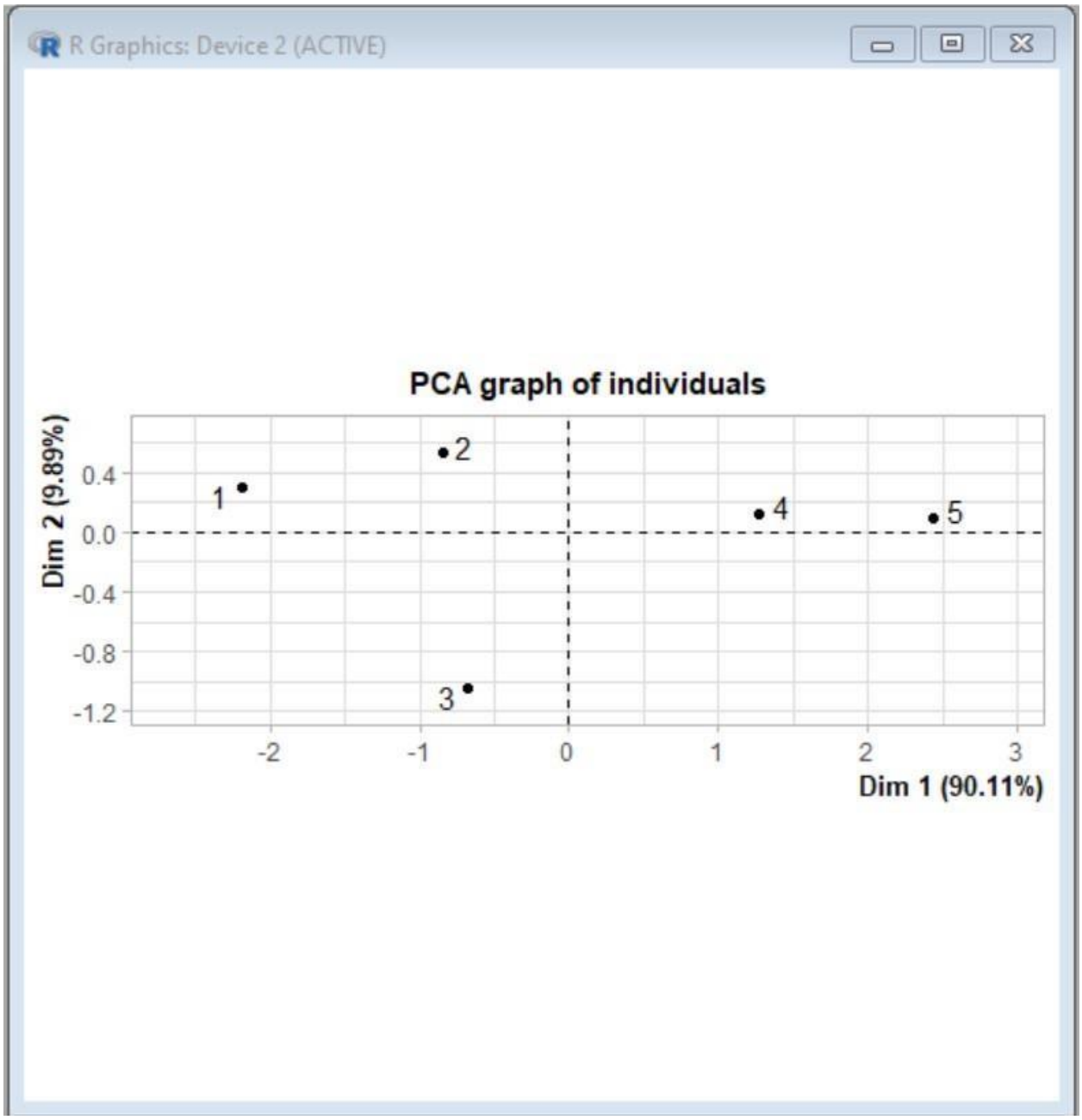
ex=eigen(cov_mat)

ex

```
> ex=eigen(cov_mat)
> ex
eigen() decomposition
$values
[1] 7.411998e+02 8.950015e+01 2.991369e-14

$vectors
           [,1]       [,2]         [,3]
[1,]  0.5612001 -0.4301795 7.071068e-01
[2,] -0.6083657 -0.7936568 2.220446e-16
[3,] -0.5612001  0.4301795 7.071068e-01

> datapca=PCA(x,ncp=3,graph=TRUE)
```

datapca=PCA(x,ncp=3,graph=TRUE)


R Graphics: Device 3 (ACTIVE)
PCA graph of variables
Dim 2 (9.89%)
1.0
0.5
0.0
-0.5
-1.0
English
Math
Art
-1.0
-0.5
0.0
0.5
1.0
Dim 1 (90.11%)



datapca$eig

```
> datapca$eig
       eigenvalue percentage of variance cumulative percentage of variance
comp 1  2.7031671              90.105571                           90.10557
comp 2  0.2968329               9.894429                          100.00000
comp 3  0.0000000               0.000000                          100.00000
```

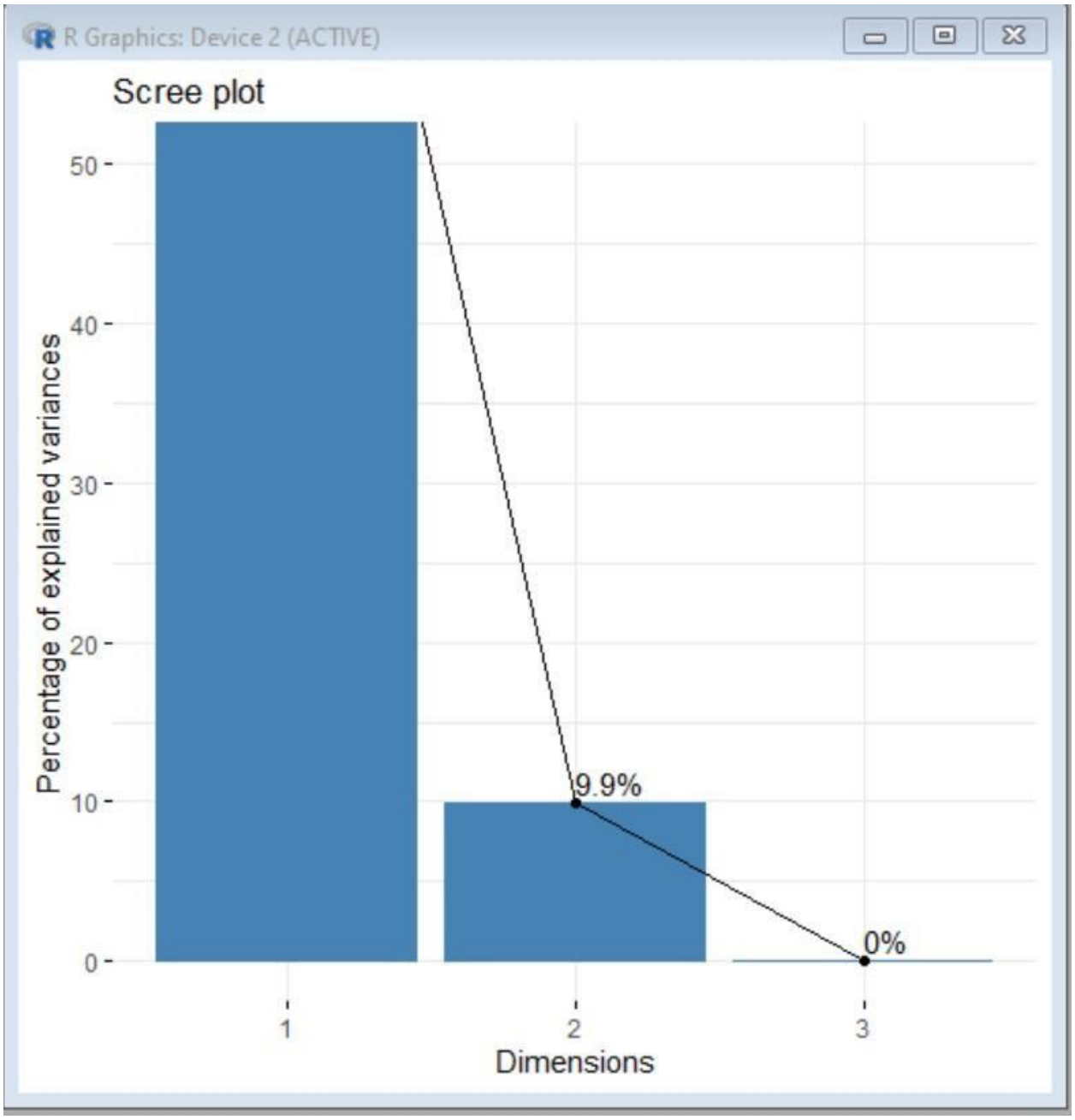
datapca$var

```
> datapca$var
$coord
             Dim.1       Dim.2 Dim.3
Math    -0.9780749  0.2082535     0
English  0.8887667  0.4583599     0
Art      0.9780749 -0.2082535     0

$cor
             Dim.1       Dim.2 Dim.3
Math    -0.9780749  0.2082535     0
English  0.8887667  0.4583599     0
Art      0.9780749 -0.2082535     0

$cos2
            Dim.1       Dim.2 Dim.3
Math    0.9566305 0.04336952     0
English 0.7899062 0.21009384     0
Art     0.9566305 0.04336952     0

$contrib
           Dim.1    Dim.2 Dim.3
Math    35.38925 14.61075   NaN
English 29.22151 70.77849   NaN
Art     35.38925 14.61075   NaN
```

datapcavarcoord

```
> datapca$var$coord
             Dim.1       Dim.2 Dim.3
Math    -0.9780749  0.2082535     0
English  0.8887667  0.4583599     0
Art      0.9780749 -0.2082535     0
> |
```

fviz_screeplot(datapca,addlabels=TRUE,ylim=c(0,50))


R Graphics: Device 2 (ACTIVE)
Scree plot
Percentage of explained variances
50
40
30
20
10
0
9.9%
0%
1
2
3
Dimensions

```
> install.packages('factoextra',repos="http://cran.us.r-project.org")
Installing package into 'C:/Users/Akki/AppData/Local/R/win-library/4.2'
(as 'lib' is unspecified)
also installing the dependencies 'corrplot', 'viridis', 'ggsci', 'cowplot', 'gg$

trying URL 'http://cran.us.r-project.org/bin/windows/contrib/4.2/corrplot_0.92.$
Content type 'application/zip' length 3844780 bytes (3.7 MB)
downloaded 3.7 MB

trying URL 'http://cran.us.r-project.org/bin/windows/contrib/4.2/viridis_0.6.2.$
Content type 'application/zip' length 2999945 bytes (2.9 MB)
downloaded 2.9 MB

trying URL 'http://cran.us.r-project.org/bin/windows/contrib/4.2/ggsci_2.9.zip'
Content type 'application/zip' length 2978453 bytes (2.8 MB)
downloaded 2.8 MB

trying URL 'http://cran.us.r-project.org/bin/windows/contrib/4.2/cowplot_1.1.1.$
```

install.packages('factoextra',repos="http://cran.us.r-project.org") library("factoextra")
fviz_screeplot(datapca,addlabels=TRUE,ylim=c(0,50)) head(iris)
x=iris[,-5]

```
> library("factoextra")
Loading required package: ggplot2
Learn more about the underlying theory at https://ggplot2-book.org/
Welcome! Want to learn more? See two factoextra-related books at https://go
> fviz_screeplot(datapca,addlabels=TRUE,ylim=c(0,50))
> head(iris)
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species
1          5.1         3.5          1.4         0.2  setosa
2          4.9         3.0          1.4         0.2  setosa
3          4.7         3.2          1.3         0.2  setosa
4          4.6         3.1          1.5         0.2  setosa
5          5.0         3.6          1.4         0.2  setosa
6          5.4         3.9          1.7         0.4  setosa
> xiri[,-5]
Error: object 'xiri' not found
> x=iris[,-5]
```

x=iris[,-5]

x

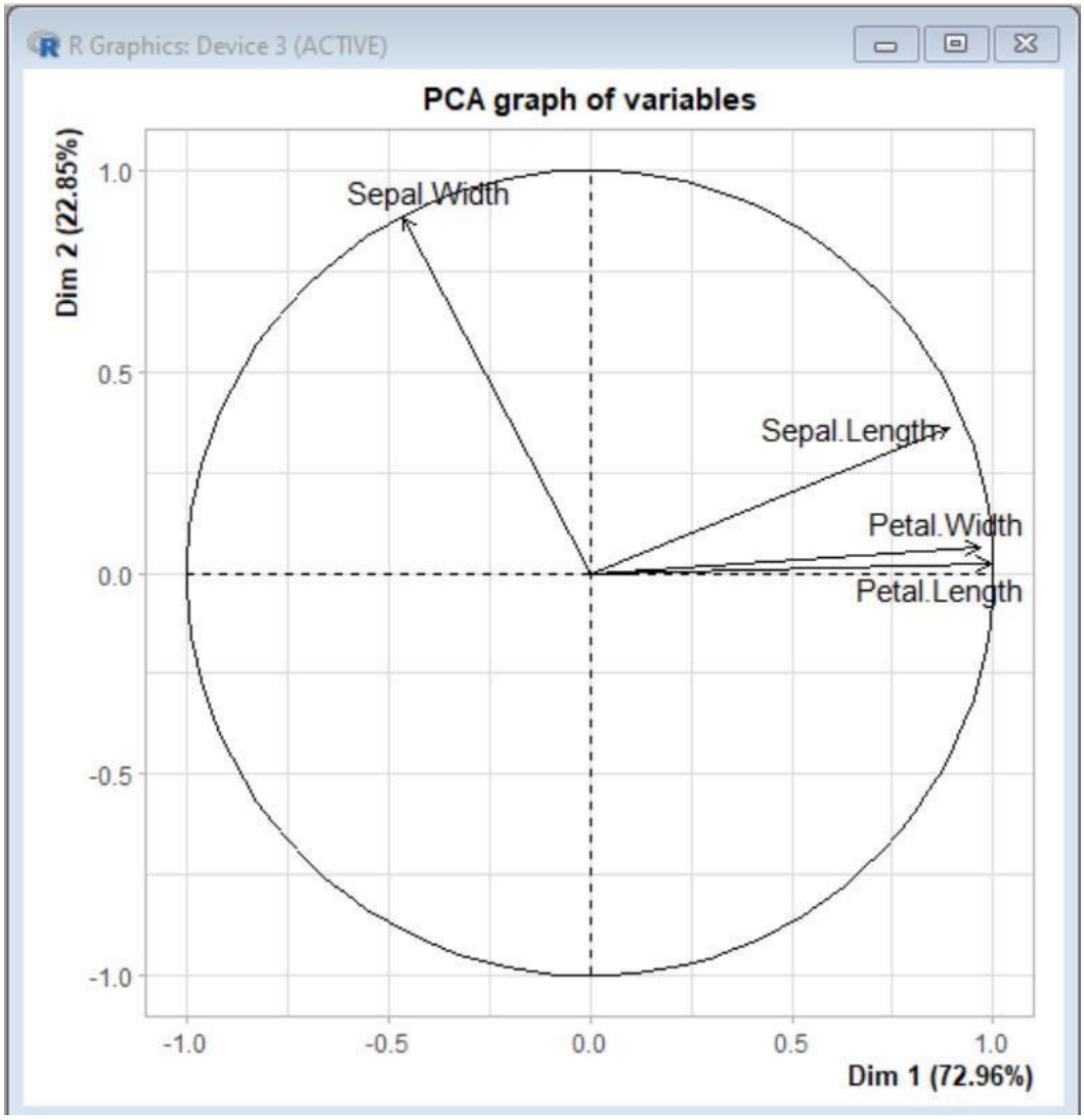
```
> x=iris[,-5]
> x
    Sepal.Length Sepal.Width Petal.Length Petal.Width
1            5.1         3.5          1.4         0.2
2            4.9         3.0          1.4         0.2
3            4.7         3.2          1.3         0.2
4            4.6         3.1          1.5         0.2
5            5.0         3.6          1.4         0.2
6            5.4         3.9          1.7         0.4
7            4.6         3.4          1.4         0.3
8            5.0         3.4          1.5         0.2
9            4.4         2.9          1.4         0.2
10           4.9         3.1          1.5         0.1
11           5.4         3.7          1.5         0.2
12           4.8         3.4          1.6         0.2
13           4.8         3.0          1.4         0.1
14           4.3         3.0          1.1         0.1
15           5.8         4.0          1.2         0.2
```

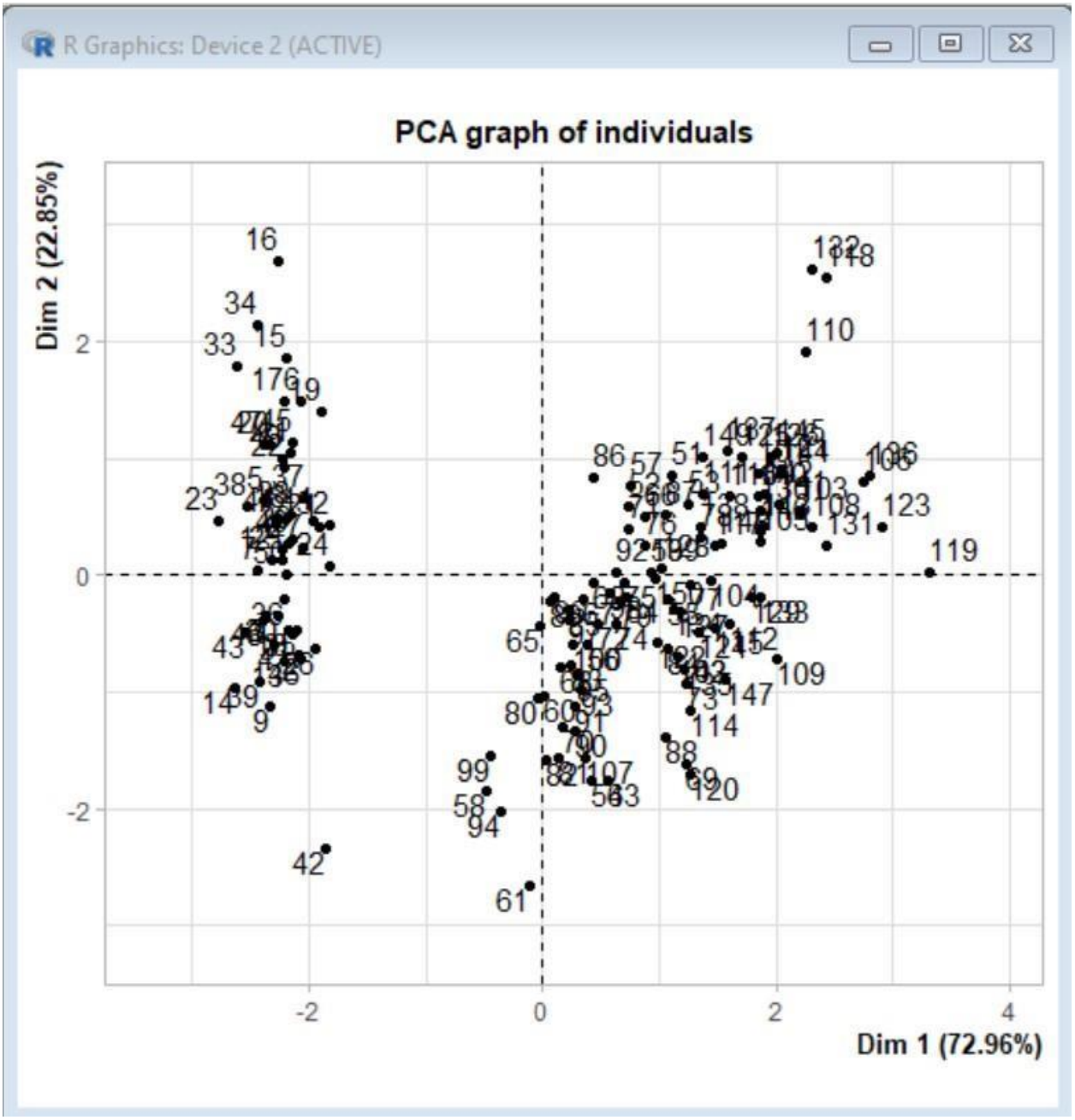
cov_iris=cov(x)

cov_iris

```
> cov_iris=cov(x)
> cov_iris
             Sepal.Length Sepal.Width Petal.Length Petal.Width
Sepal.Length    0.6856935  -0.0424340    1.2743154   0.5162707
Sepal.Width    -0.0424340   0.1899794   -0.3296564  -0.1216394
Petal.Length    1.2743154  -0.3296564    3.1162779   1.2956094
Petal.Width     0.5162707  -0.1216394    1.2956094   0.5810063
> irispca=PCA(x,ncp=3,graph=TRUE)
```

> irispca=PCA(x,ncp=3,graph=TRUE)


R Graphics: Device 3 (ACTIVE)
PCA graph of variables
Dim 2 (22.85%)
1.0
0.5
0.0
-0.5
-1.0
Sepal.Width
Sepal.Length
Petal.Width
Petal.Length
-1.0
-0.5
0.0
0.5
1.0
Dim 1 (72.96%)


R Graphics: Device 2 (ACTIVE)
PCA graph of individuals
Dim 2 (22.85%)
Dim 1 (72.96%)
2
0
-2
-2
0
2
4

irispca

```
> irispca
**Results for the Principal Component Analysis (PCA)**
The analysis was performed on 150 individuals, described by 4 variables
*The results are available in the following objects:

   name               description
1  "$eig"             "eigenvalues"
2  "$var"             "results for the variables"
3  "$var$coord"       "coord. for the variables"
4  "$var$cor"         "correlations variables - dimensions"
5  "$var$cos2"        "cos2 for the variables"
6  "$var$contrib"     "contributions of the variables"
7  "$ind"             "results for the individuals"
8  "$ind$coord"       "coord. for the individuals"
9  "$ind$cos2"        "cos2 for the individuals"
10 "$ind$contrib"     "contributions of the individuals"
11 "$call"            "summary statistics"
12 "$call$centre"     "mean of the variables"
13 "$call$ecart.type" "standard error of the variables"
14 "$call$row.w"      "weights for the individuals"
15 "$call$col.w"      "weights for the variables"
>
```

summary(irispca)

```
> summary(irispca)

Call:
PCA(X = x, ncp = 3, graph = TRUE)


Eigenvalues
                       Dim.1   Dim.2   Dim.3   Dim.4
Variance               2.918   0.914   0.147   0.021
% of var.             72.962  22.851   3.669   0.518
Cumulative % of var.  72.962  95.813  99.482 100.000

Individuals (the 10 first)
                  Dist    Dim.1    ctr   cos2    Dim.2    ctr   cos2    Dim.3
1              |  2.319 | -2.265  1.172  0.954 |  0.480  0.168  0.043 | -0.128
2              |  2.202 | -2.081  0.989  0.893 | -0.674  0.331  0.094 | -0.235
3              |  2.389 | -2.364  1.277  0.979 | -0.342  0.085  0.020 |  0.044
4              |  2.378 | -2.299  1.208  0.935 | -0.597  0.260  0.063 |  0.091
5              |  2.476 | -2.390  1.305  0.932 |  0.647  0.305  0.068 |  0.016
6              |  2.555 | -2.076  0.984  0.660 |  1.489  1.617  0.340 |  0.027
7              |  2.468 | -2.444  1.364  0.981 |  0.048  0.002  0.000 |  0.335
8              |  2.246 | -2.233  1.139  0.988 |  0.223  0.036  0.010 | -0.089
9              |  2.592 | -2.335  1.245  0.812 | -1.115  0.907  0.185 |  0.145
```

Conclusion: Hence, we successfully implemented Principal component analysis.