Assignment_4

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```
library(factoextra)
```

```
## Warning: package 'factoextra' was built under R version 4.1.3

## Loading required package: ggplot2

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

## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
library(ggplot2)
Pharmaanalyst<-read.csv("C:/Users/ravin/Downloads/Pharmaceuticals.csv")
summary(Pharmaanalyst)
```

```
##     Symbol              Name             Market_Cap          Beta
##  Length:21          Length:21          Min.   :  0.41   Min.   :0.1800
##  Class :character   Class :character   1st Qu.:  6.30   1st Qu.:0.3500
##  Mode  :character   Mode  :character   Median : 48.19   Median :0.4600
##                                        Mean   : 57.65   Mean   :0.5257
##                                        3rd Qu.: 73.84   3rd Qu.:0.6500
##                                        Max.   :199.47   Max.   :1.1100
##     PE_Ratio          ROE             ROA        Asset_Turnover    Leverage
##  Min.   : 3.60   Min.   : 3.9   Min.   : 1.40   Min.   :0.3    Min.   :0.0000
##  1st Qu.:18.90   1st Qu.:14.9   1st Qu.: 5.70   1st Qu.:0.6    1st Qu.:0.1600
##  Median :21.50   Median :22.6   Median :11.20   Median :0.6    Median :0.3400
##  Mean   :25.46   Mean   :25.8   Mean   :10.51   Mean   :0.7    Mean   :0.5857
##  3rd Qu.:27.90   3rd Qu.:31.0   3rd Qu.:15.00   3rd Qu.:0.9    3rd Qu.:0.6000
##  Max.   :82.50   Max.   :62.9   Max.   :20.30   Max.   :1.1    Max.   :3.5100
##    Rev_Growth    Net_Profit_Margin Median_Recommendation   Location
##  Min.   :-3.17   Min.   : 2.6      Length:21             Length:21
##  1st Qu.: 6.38   1st Qu.:11.2      Class :character      Class :character
##  Median : 9.37   Median :16.1      Mode  :character      Mode  :character
##  Mean   :13.37   Mean   :15.7
##  3rd Qu.:21.87   3rd Qu.:21.1
##  Max.   :34.21   Max.   :25.5
##    Exchange
##  Length:21
##  Class :character
##  Mode  :character
##
##
##
```

#a)Use only the numerical variables (1 to 9) to cluster the 21 firms. Justify the various choices made in conducting the cluster analysis, such as weights for different variables, the specific clustering algorithm(s) used, the number of clusters formed, and so on. Prior to clustering data, remove the missing data and rescale variables for comparability.

```
x <- na.omit(Pharmaanalyst) #gives the data after removing the incomplete cases.
x
```

```
##    Symbol                                 Name Market_Cap Beta PE_Ratio  ROE  ROA
## 1     ABT                  Abbott Laboratories      68.44 0.32     24.7 26.4 11.8
## 2     AGN                       Allergan, Inc.       7.58 0.41     82.5 12.9  5.5
## 3     AHM                         Amersham plc       6.30 0.46     20.7 14.9  7.8
## 4     AZN                      AstraZeneca PLC      67.63 0.52     21.5 27.4 15.4
## 5     AVE                              Aventis      47.16 0.32     20.1 21.8  7.5
## 6     BAY                             Bayer AG      16.90 1.11     27.9  3.9  1.4
## 7     BMY         Bristol-Myers Squibb Company      51.33 0.50     13.9 34.8 15.1
## 8    CHTT                        Chattem, Inc       0.41 0.85     26.0 24.1  4.3
## 9     ELN             Elan Corporation, plc       0.78 1.08      3.6 15.1  5.1
## 10    LLY              Eli Lilly and Company      73.84 0.18     27.9 31.0 13.5
## 11    GSK                GlaxoSmithKline plc     122.11 0.35     18.0 62.9 20.3
## 12    IVX                   IVAX Corporation       2.60 0.65     19.9 21.4  6.8
## 13    JNJ                  Johnson & Johnson     173.93 0.46     28.4 28.6 16.3
## 14    MRX Medicis Pharmaceutical Corporation       1.20 0.75     28.6 11.2  5.4
## 15    MRK                   Merck & Co., Inc.     132.56 0.46     18.9 40.6 15.0
## 16    NVS                         Novartis AG      96.65 0.19     21.6 17.9 11.2
## 17    PFE                          Pfizer Inc     199.47 0.65     23.6 45.6 19.2
## 18    PHA               Pharmacia Corporation      56.24 0.40     56.5 13.5  5.7
## 19    SGP          Schering-Plough Corporation      34.10 0.51     18.9 22.6 13.3
## 20    WPI        Watson Pharmaceuticals, Inc.       3.26 0.24     18.4 10.2  6.8
## 21    WYE                               Wyeth      48.19 0.63     13.1 54.9 13.4
##    Asset_Turnover Leverage Rev_Growth Net_Profit_Margin Median_Recommendation
## 1             0.7     0.42       7.54              16.1          Moderate Buy
## 2             0.9     0.60       9.16               5.5          Moderate Buy
## 3             0.9     0.27       7.05              11.2            Strong Buy
## 4             0.9     0.00      15.00              18.0         Moderate Sell
## 5             0.6     0.34      26.81              12.9          Moderate Buy
## 6             0.6     0.00      -3.17               2.6                  Hold
## 7             0.9     0.57       2.70              20.6         Moderate Sell
## 8             0.6     3.51       6.38               7.5          Moderate Buy
## 9             0.3     1.07      34.21              13.3         Moderate Sell
## 10            0.6     0.53       6.21              23.4                  Hold
## 11            1.0     0.34      21.87              21.1                  Hold
## 12            0.6     1.45      13.99              11.0                  Hold
## 13            0.9     0.10       9.37              17.9          Moderate Buy
## 14            0.3     0.93      30.37              21.3          Moderate Buy
## 15            1.1     0.28      17.35              14.1                  Hold
## 16            0.5     0.06      -2.69              22.4                  Hold
## 17            0.8     0.16      25.54              25.2          Moderate Buy
## 18            0.6     0.35      15.00               7.3                  Hold
## 19            0.8     0.00       8.56              17.6                  Hold
## 20            0.5     0.20      29.18              15.1         Moderate Sell
## 21            0.6     1.12       0.36              25.5                  Hold
##       Location Exchange
## 1           US     NYSE
```

```
## 2       CANADA     NYSE
## 3           UK     NYSE
## 4           UK     NYSE
## 5       FRANCE     NYSE
## 6      GERMANY     NYSE
## 7           US     NYSE
## 8           US   NASDAQ
## 9      IRELAND     NYSE
## 10          US     NYSE
## 11          UK     NYSE
## 12          US     AMEX
## 13          US     NYSE
## 14          US     NYSE
## 15          US     NYSE
## 16 SWITZERLAND     NYSE
## 17          US     NYSE
## 18          US     NYSE
## 19          US     NYSE
## 20          US     NYSE
## 21          US     NYSE
```

collect only the quantitative variables(1-9) to cluster the 21 firms

```
row.names(x)<- x[,1]
Pharma1<- x[,3:11]
head(Pharma1)
```

```
##     Market_Cap Beta PE_Ratio  ROE  ROA Asset_Turnover Leverage Rev_Growth
## ABT      68.44 0.32     24.7 26.4 11.8            0.7     0.42       7.54
## AGN       7.58 0.41     82.5 12.9  5.5            0.9     0.60       9.16
## AHM       6.30 0.46     20.7 14.9  7.8            0.9     0.27       7.05
## AZN      67.63 0.52     21.5 27.4 15.4            0.9     0.00      15.00
## AVE      47.16 0.32     20.1 21.8  7.5            0.6     0.34      26.81
## BAY      16.90 1.11     27.9  3.9  1.4            0.6     0.00      -3.17
##     Net_Profit_Margin
## ABT              16.1
## AGN               5.5
## AHM              11.2
## AZN              18.0
## AVE              12.9
## BAY               2.6
```

Scale all the quantitative variables in the dataframe

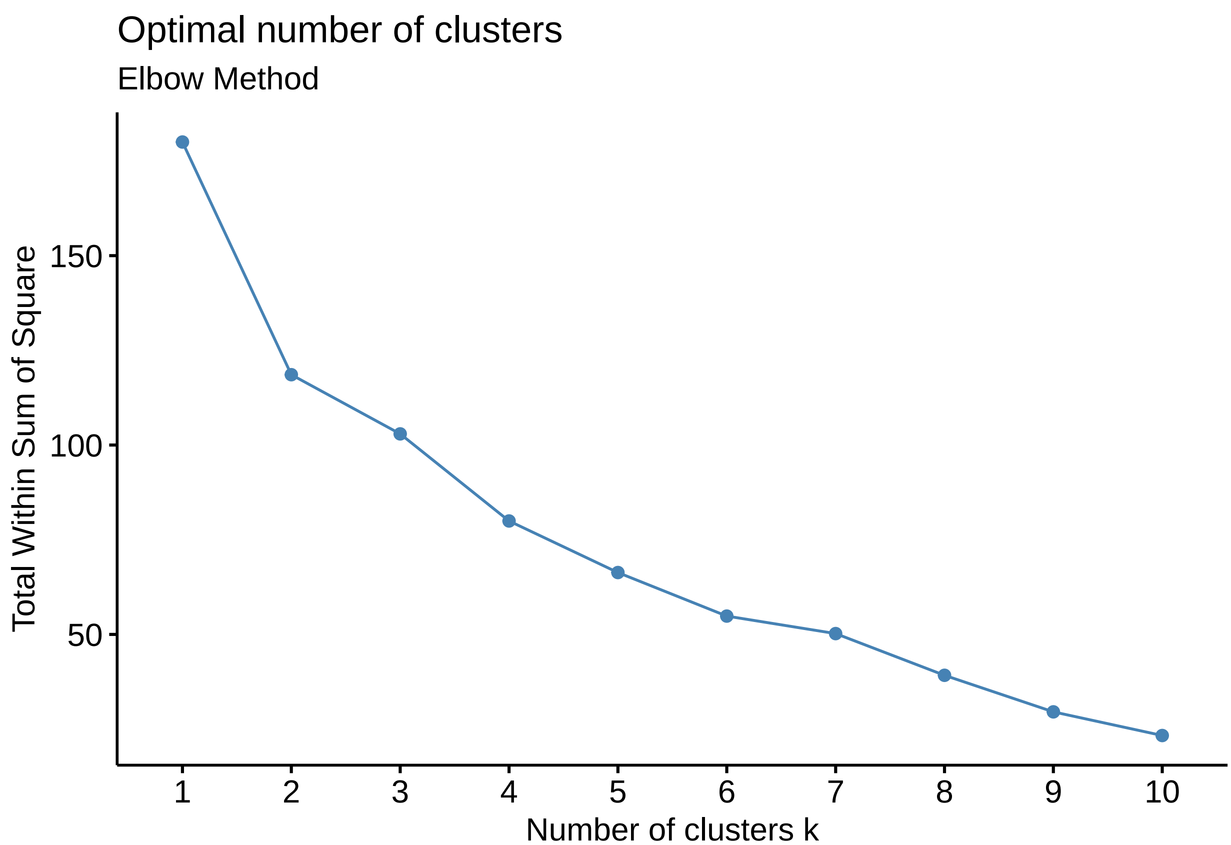
```
Pharma2<-scale(Pharma1)
head(Pharma2)
```

```
##     Market_Cap        Beta    PE_Ratio         ROE        ROA Asset_Turnover
## ABT  0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121      0.0000000
## AGN -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871      0.9225312
## AHM -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700      0.9225312
## AZN  0.1702742 -0.02225704 -0.24290879  0.10638147  0.9181259      0.9225312
## AVE -0.1790256 -0.80125356 -0.32874435 -0.26484883 -0.5664461     -0.4612656
```

```
## BAY -0.6953818  2.27578267  0.14948233 -1.45146000 -1.7127612     -0.4612656
##       Leverage Rev_Growth Net_Profit_Margin
## ABT -0.2120979 -0.5277675        0.06168225
## AGN  0.0182843 -0.3811391       -1.55366706
## AHM -0.4040831 -0.5721181       -0.68503583
## AZN -0.7496565  0.1474473        0.35122600
## AVE -0.3144900  1.2163867       -0.42597037
## BAY -0.7496565 -1.4971443       -1.99560225
```

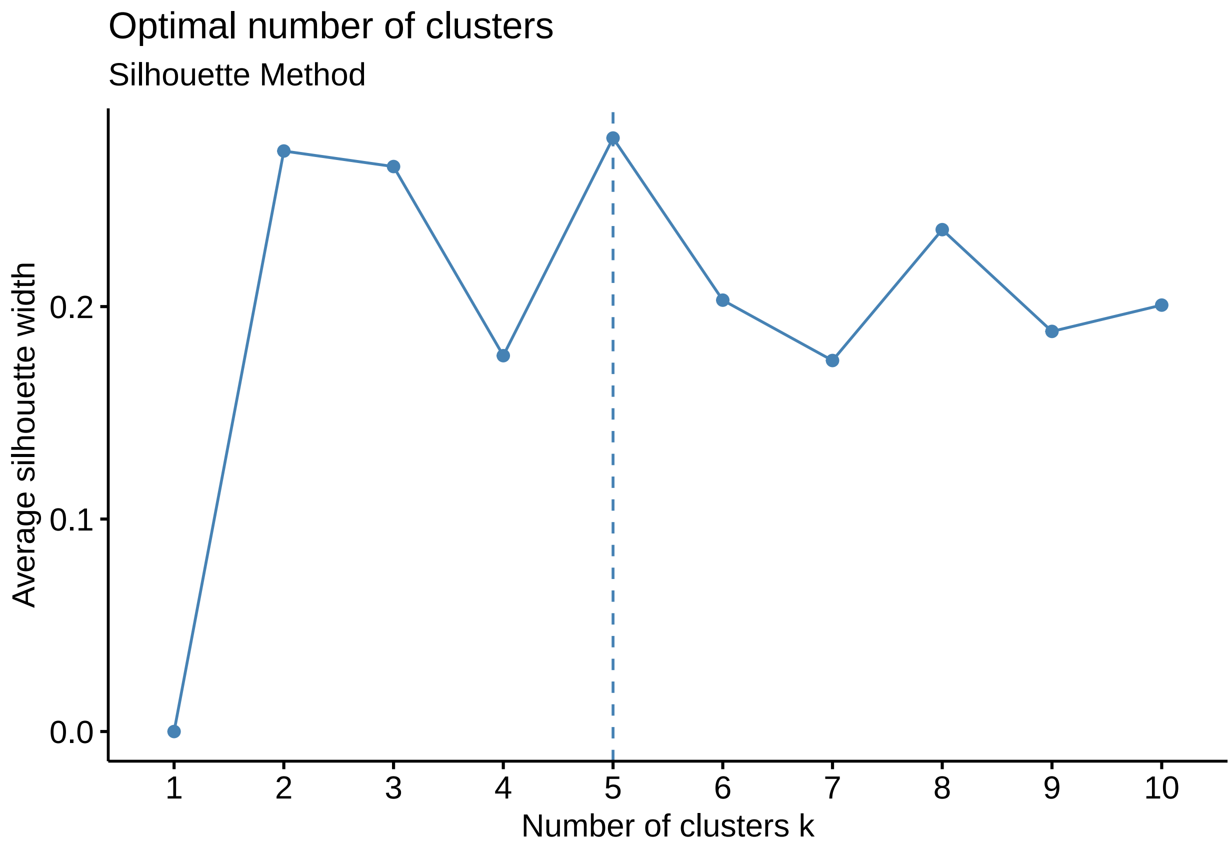
To determine the no of clusters to do the cluster analysis using Elbow Method

```
fviz_nbclust(Pharma2, kmeans, method = "wss") + labs(subtitle = "Elbow Method")
```



Silhouette method for determining no of clusters

```
fviz_nbclust(Pharma2, kmeans, method = "silhouette")+ labs(subtitle = "Silhouette Method")
```

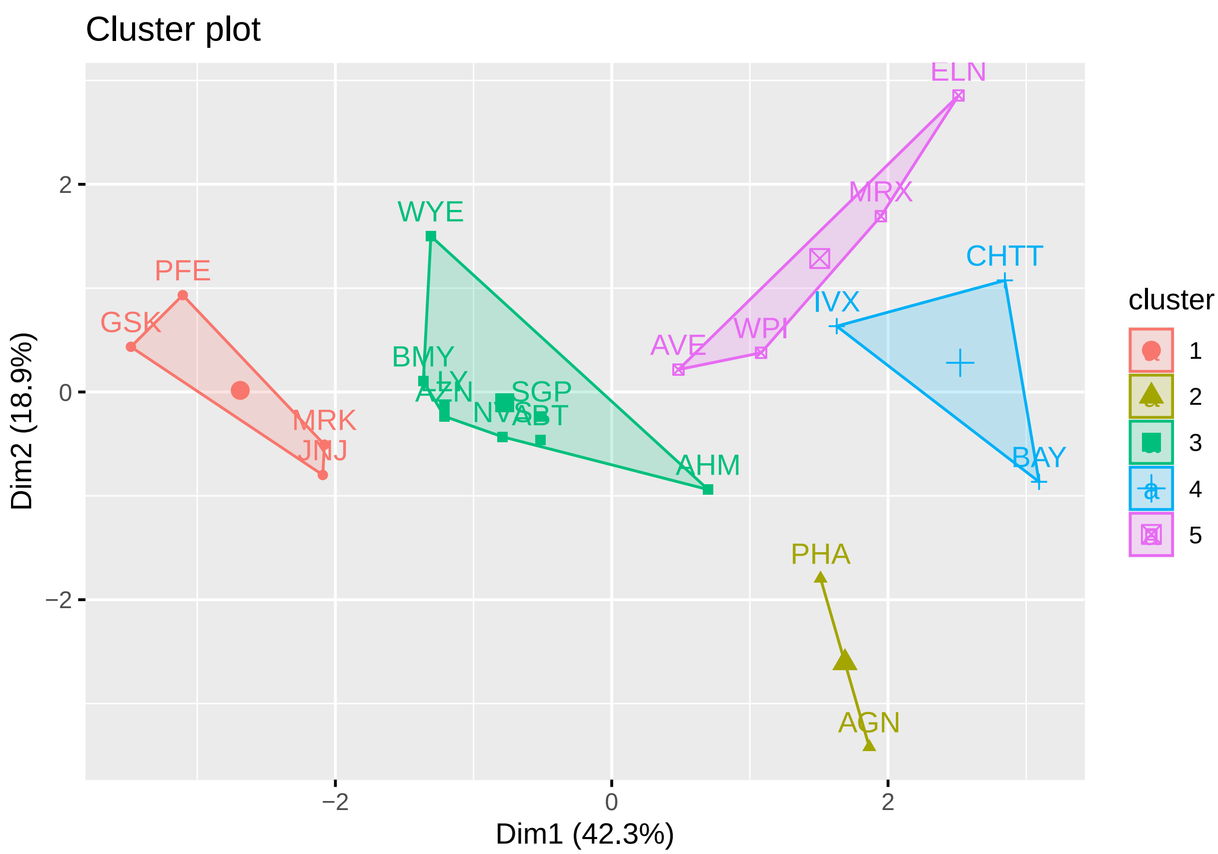


from the above plots, it is clear that the no of clusters are 5 and they are enough to show the variations that are present in the data

```
set.seed(120)
k5<- kmeans(Pharma2,centers=5,nstart = 25)
#Visualize the output
k5$centers  #centroids
```

```
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
## 2 -0.43925134 -0.4701800  2.70002464 -0.8349525 -0.9234951      0.2306328
## 3 -0.03142211 -0.4360989 -0.31724852  0.1950459  0.4083915      0.1729746
## 4 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478     -0.4612656
## 5 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
##      Leverage Rev_Growth Net_Profit_Margin
## 1 -0.46807818  0.4671788       0.591242521
## 2 -0.14170336 -0.1168459      -1.416514761
## 3 -0.27449312 -0.7041516       0.556954446
## 4  1.36644699 -0.6912914      -1.320000179
## 5  0.06308085  1.5180158      -0.006893899
```

```r
fviz_cluster(k5,data = Pharma2) # to Visualize the clusters
```

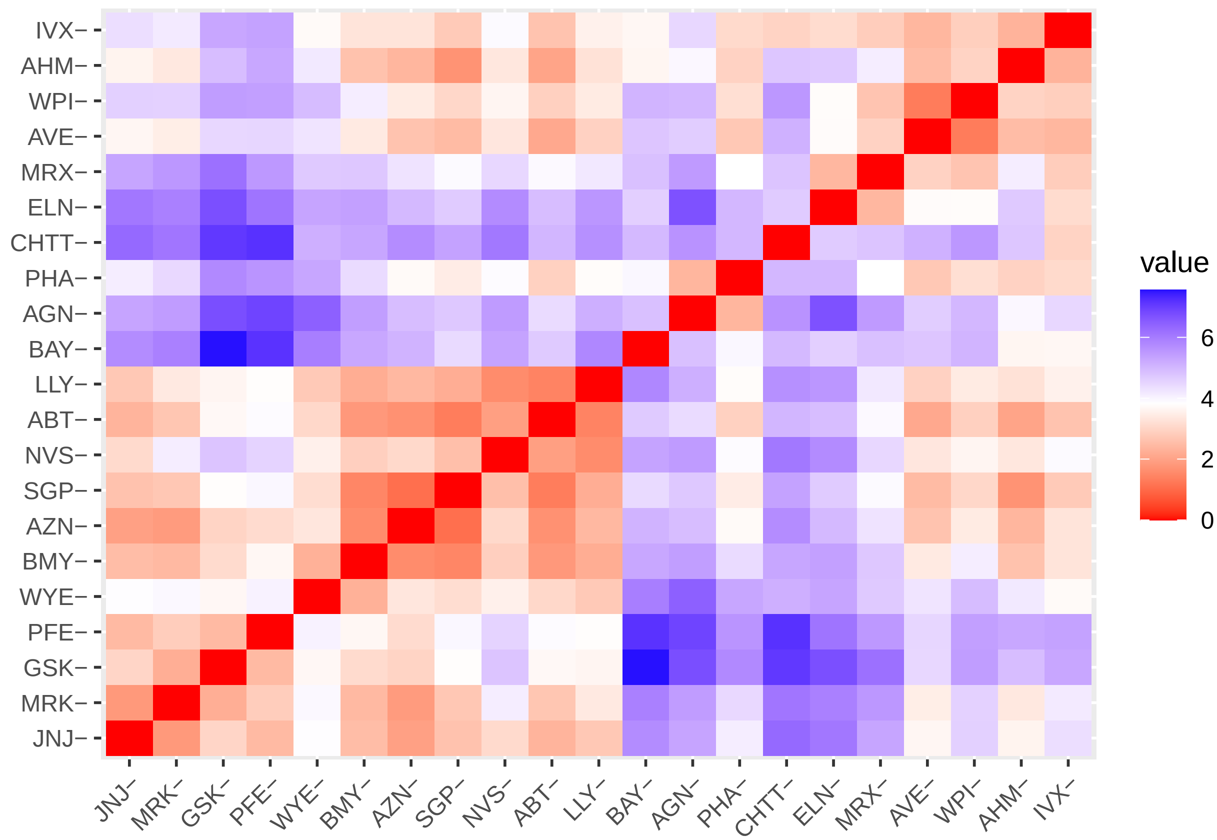



```r
k5
```

```
## K-means clustering with 5 clusters of sizes 4, 2, 8, 3, 4
##
## Cluster means:
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
## 2 -0.43925134 -0.4701800  2.70002464 -0.8349525 -0.9234951      0.2306328
## 3 -0.03142211 -0.4360989 -0.31724852  0.1950459  0.4083915      0.1729746
## 4 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478     -0.4612656
## 5 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
##      Leverage Rev_Growth Net_Profit_Margin
## 1 -0.46807818  0.4671788       0.591242521
## 2 -0.14170336 -0.1168459      -1.416514761
## 3 -0.27449312 -0.7041516       0.556954446
## 4  1.36644699 -0.6912914      -1.320000179
## 5  0.06308085  1.5180158      -0.006893899
##
## Clustering vector:
##  ABT  AGN  AHM  AZN  AVE  BAY  BMY CHTT  ELN  LLY  GSK  IVX  JNJ  MRX  MRK  NVS
##    3    2    3    3    5    4    3    4    5    3    1    4    1    5    1    3
##  PFE  PHA  SGP  WPI  WYE
##    1    2    3    5    3
```

```
##
## Within cluster sum of squares by cluster:
## [1]  9.284424  2.803505 21.879320 15.595925 12.791257
##  (between_SS / total_SS =  65.4 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
distance<- dist(Pharma2, method = "euclidean")
fviz_dist(distance)
```



K-Means Cluster Analysis- Fit the data with 5 clusters

```
fit<-kmeans(Pharma2,5)
```

Finding the mean value of all quantitative variables for each cluster

```
aggregate(Pharma2,by=list(fit$cluster),FUN=mean)
```

```
##   Group.1  Market_Cap       Beta    PE_Ratio        ROE        ROA
## 1       1 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478
## 2       2  0.08926902 -0.4618336 -0.32086149  0.3260892  0.5396003
## 3       3 -0.96686975  1.5162611 -0.57398880 -0.8382671 -0.9892673
```

```
## 4       4  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431
## 5       5 -0.57238455 -0.6220844  0.86927480 -0.7381675 -0.7242993
##   Asset_Turnover   Leverage Rev_Growth Net_Profit_Margin
## 1  -4.612656e-01  1.3664470 -0.6912914        -1.3200002
## 2   6.589509e-02 -0.2559803 -0.7230135         0.7343816
## 3  -1.845062e+00  0.5302448  1.7123890         0.2445520
## 4   1.153164e+00 -0.4680782  0.4671788         0.5912425
## 5   1.776140e-16 -0.2991312  0.3682951        -0.8069490
```

```
Pharma3<-data.frame(Pharma2,fit$cluster)
Pharma3
```

```
##      Market_Cap        Beta    PE_Ratio         ROE        ROA Asset_Turnover
## ABT   0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121      0.0000000
## AGN  -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871      0.9225312
## AHM  -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700      0.9225312
## AZN   0.1702742 -0.02225704 -0.24290879  0.10638147  0.9181259      0.9225312
## AVE  -0.1790256 -0.80125356 -0.32874435 -0.26484883 -0.5664461     -0.4612656
## BAY  -0.6953818  2.27578267  0.14948233 -1.45146000 -1.7127612     -0.4612656
## BMY  -0.1078688 -0.10015669 -0.70887325  0.59693581  0.8617498      0.9225312
## CHTT -0.9767669  1.26308721  0.03299122 -0.11237924 -1.1677918     -0.4612656
## ELN  -0.9704532  2.15893320 -1.34037772 -0.70899938 -1.0174553     -1.8450624
## LLY   0.2762415 -1.34655112  0.14948233  0.34502953  0.5610770     -0.4612656
## GSK   1.0999201 -0.68440408 -0.45749769  2.45971647  1.8389364      1.3837968
## IVX  -0.9393967  0.48409069 -0.34100657 -0.29136529 -0.6979905     -0.4612656
## JNJ   1.9841758 -0.25595600  0.18013789  0.18593083  1.0872544      0.9225312
## MRX  -0.9632863  0.87358895  0.19240011 -0.96753478 -0.9610792     -1.8450624
## MRK   1.2782387 -0.25595600 -0.40231769  0.98142435  0.8429577      1.8450624
## NVS   0.6654710 -1.30760129 -0.23677768 -0.52338423  0.1288598     -0.9225312
## PFE   2.4199899  0.48409069 -0.11415545  1.31287998  1.6322239      0.4612656
## PHA  -0.0240846 -0.48965495  1.90298017 -0.81506519 -0.9047030     -0.4612656
## SGP  -0.4018812 -0.06120687 -0.40231769 -0.21181593  0.5234929      0.4612656
## WPI  -0.9281345 -1.11285216 -0.43297324 -1.03382590 -0.6979905     -0.9225312
## WYE  -0.1614497  0.40619104 -0.75792214  1.92938746  0.5422849     -0.4612656
##         Leverage  Rev_Growth Net_Profit_Margin fit.cluster
## ABT  -0.21209793 -0.52776752        0.06168225           2
## AGN   0.01828430 -0.38113909       -1.55366706           5
## AHM  -0.40408312 -0.57211809       -0.68503583           5
## AZN  -0.74965647  0.14744734        0.35122600           2
## AVE  -0.31449003  1.21638667       -0.42597037           5
## BAY  -0.74965647 -1.49714434       -1.99560225           1
## BMY  -0.02011273 -0.96584257        0.74744375           2
## CHTT  3.74279705 -0.63276071       -1.24888417           1
## ELN   0.61983791  1.88617085       -0.36501379           3
## LLY  -0.07130879 -0.64814764        1.17413980           2
## GSK  -0.31449003  0.76926048        0.82363947           4
## IVX   1.10620040  0.05603085       -0.71551412           1
## JNJ  -0.62166634 -0.36213170        0.33598685           4
## MRX   0.44065173  1.53860717        0.85411776           3
## MRK  -0.39128411  0.36014907       -0.24310064           4
## NVS  -0.67286239 -1.45369888        1.02174835           2
## PFE  -0.54487226  1.10143723        1.44844440           4
## PHA  -0.30169102  0.14744734       -1.27936246           5
## SGP  -0.74965647 -0.43544591        0.29026942           2
```

```
## WPI  -0.49367621  1.43089863       -0.09070919          5
## WYE   0.68383297 -1.17763919        1.49416183          2
```

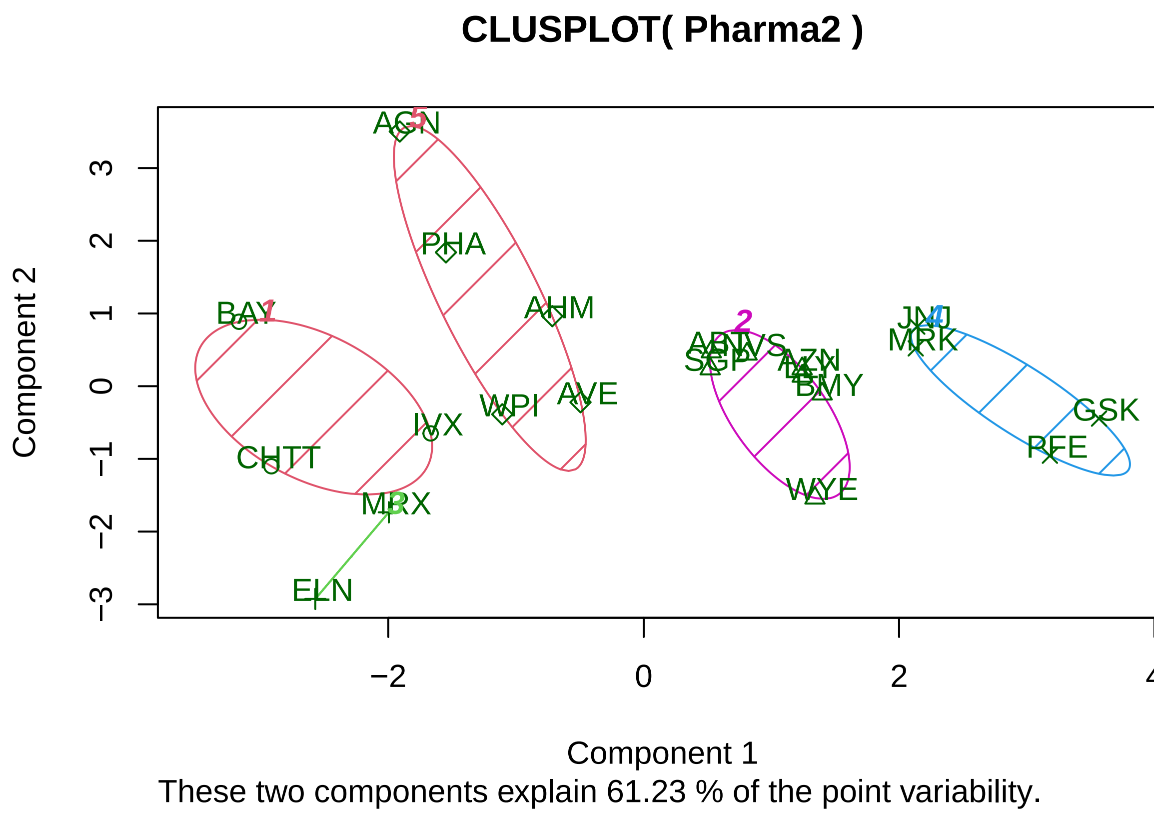
```
View(Pharma3)
```

To view the cluster plot

```
library(cluster)
```

```
## Warning: package 'cluster' was built under R version 4.1.3
```

```
clusplot(Pharma2,fit$cluster,color = TRUE,shade = TRUE,labels = 2,lines = 0)
```



#b)Interpret the clusters with respect to the numerical variables used in forming the clusters.

By observing the mean values of all quantitative variables for each cluster

Cluster 1 - BAY, CHTT, IVX

Cluster 2 - ABT, AZN, BMY, LLY, NVS, SGP,WYE

Cluster 3 - ELN, MRX

Cluster 4 - JNJ, MRK, PFE, GSK

Cluster 5 - AGN, AHM, AVE, PHA, WPI

Cluster 1 has highest Beta , Leverage and lowest Market_Cap, ROE, ROA, Leverage, Rev_Growth, Net_Profit_Margin Cluster 2 has highest Net_Profit_Margin and lowest Beta. Cluster 3 has highest Rev_Growth and lowest PE_Ratio, Asset_Turnover. Cluster 4 has highest Market_Cap, ROE, ROA,Asset_Turnover Cluster 5 has highest PE_Ratio.

#c)Is there a pattern in the clusters with respect to the numerical variables (10 to 12)? (those not used in forming the clusters)

There is a pattern in the clusters with respect to Media recommendation variable.

Cluster 1 with highest Beta, highest Leverage has mostly Moderate Buy Recommendation.

Cluster 2 with highest Net_Profit_Margin has mostly Hold Recommendation

Cluster 3 with lowest PE_Ratio and lowest Asset_Turnover has Hold Recommendation

Cluster 4 with highest Market_Cap, highest ROE, highest ROA, highest Asset_Turnover has equal Hold and Moderate Buy Recommendation

Cluster 5 with highest PE_Ratio has the Strong Buy Recommendation, because high PE_Ratio indicates the company is growing fast.

Could see a pattern among the clusters with respect to variables(10 to 12)

Clusters 1,4 has mostly Moderate Buy Recommendation

Clusters 2,3,4 has Hold Recommendation

#d)Provide an appropriate name for each cluster using any or all of the variables in the dataset.

Cluster1 - high Beta, Leverage cluster (or) Buy Cluster.

Cluster2 - high Net_Profit_Margin cluster (or) high hold cluster.

Cluster3 - Low PE_Ratio, Asset_Turnover cluster (or) hold cluster.

Cluster4 - Moderate Buy cluster

Cluster5 - high PE_Ratio cluster (or) high Buy cluster.