ASSIGNMENT 4 FML

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```
Pharmaceuticals <- read.csv("C://Users//heere//Downloads//ASSIGNMENT 4 FML//Pharmaceuticals (2).csv")

summary(Pharmaceuticals)
```

```
##     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  
##                    
##                    
## 
```

```
library(factoextra) # clustering algorithms & visualization
```

```
## Warning: package 'factoextra' was built under R version 4.2.2
```

```
## Loading required package: ggplot2
```

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

```r
library(ISLR)
library(caret)
```

```
## Loading required package: lattice
```

```r
#Task-a. Use only the numerical variables (1 to 9) to cluster the 21 firms. Justify the various choices

#Remove missing data and rescale variables for comparability before clustering data.

Pharma<- na.omit(Pharmaceuticals) #gives the data after removing the missing values.
Pharma
```

```
##    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
```

```
#To cluster the 21 firms, just the quantitative variables (1-9) need be collected.


row.names(Pharma)<- Pharma[,1]
Pharma_1<- Pharma[,3:11]
head(Pharma_1)
```

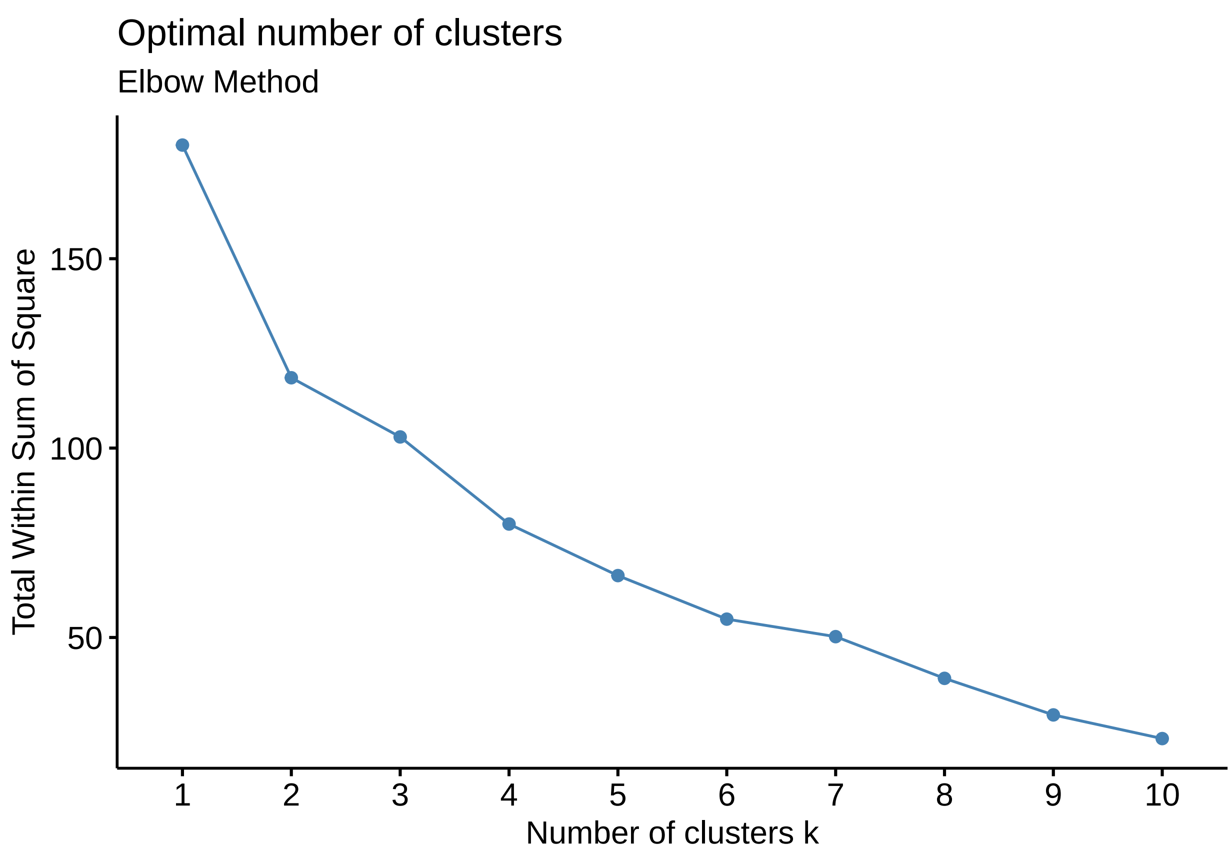
```
##     Market_Cap Beta PE_Ratio  ROE  ROA Asset_Turnover Leverage Rev_Growth
## ABT      68.44 0.32     24.7 26.4 11.8            0.7     0.42       7.54
## AGN       7.58 0.41     82.5 12.9  5.5            0.9     0.60       9.16
## AHM       6.30 0.46     20.7 14.9  7.8            0.9     0.27       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 dataframe's quantitative variables

Pharma_2<-scale(Pharma_1)
head(Pharma_2)
```

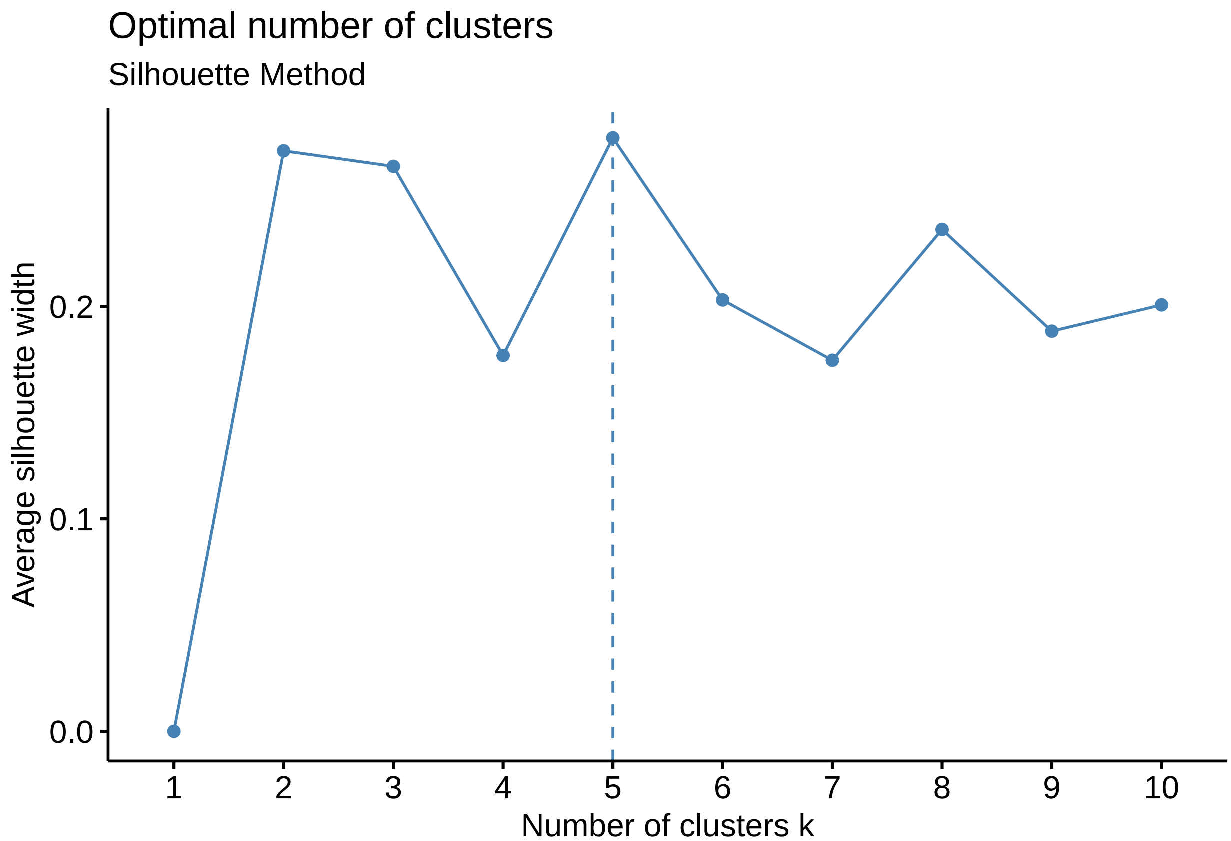
```
##     Market_Cap        Beta    PE_Ratio         ROE         ROA Asset_Turnover
```

```
## 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
```

```
#Determining the no of clusters to do the cluster analysis using Elbow Method

fviz_nbclust(Pharma_2, kmeans, method = "wss") + labs(subtitle = "Elbow Method")
```



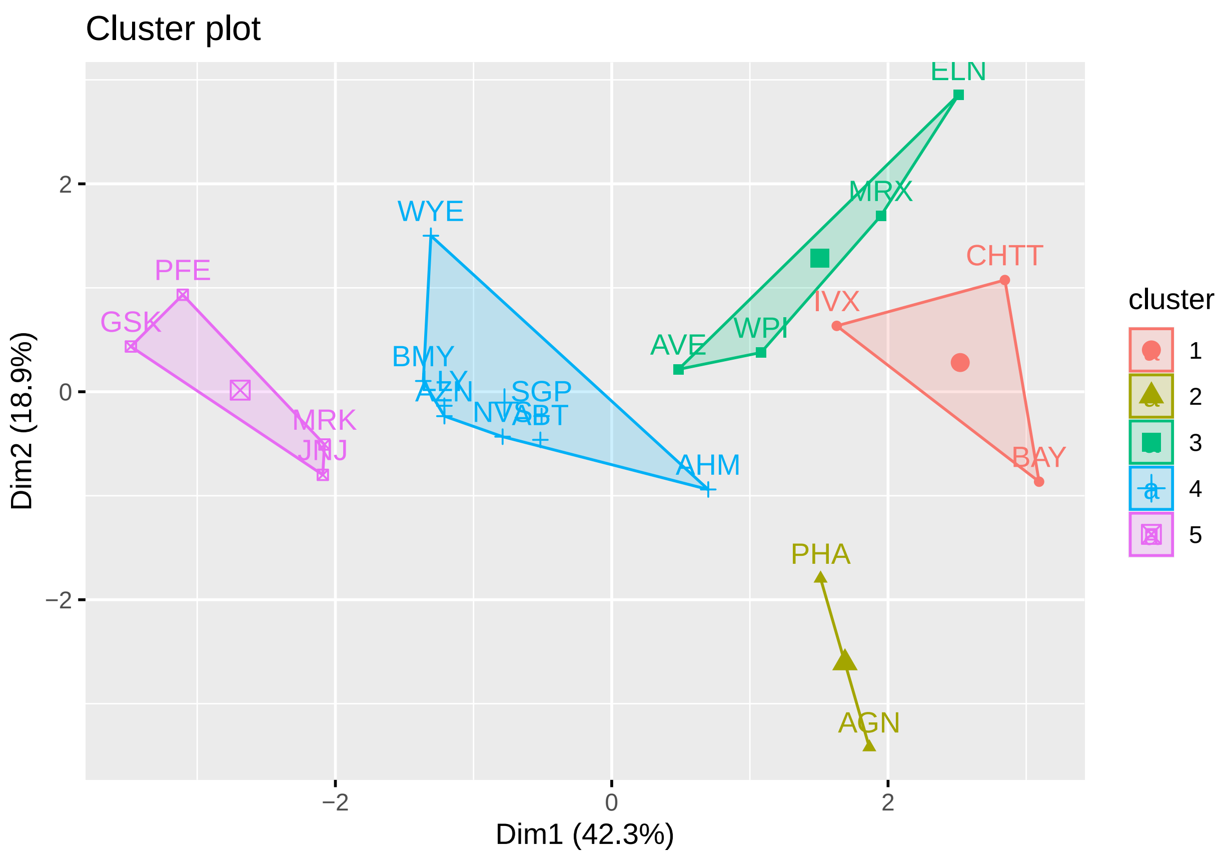

```
#Using Silhouette method for determining no of clusters

fviz_nbclust(Pharma_2, kmeans, method = "silhouette")+ labs(subtitle = "Silhouette Method")
```




```r
#The number of clusters is 5 in the above plots, which is sufficient to display the data variations.

set.seed(64060)
k5<- kmeans(Pharma_2,centers=5,nstart = 25)

#Visualizing the output

k5$centers  #for centroids
```

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

```r
fviz_cluster(k5,data = Pharma_2) # to Visualize the clusters
```

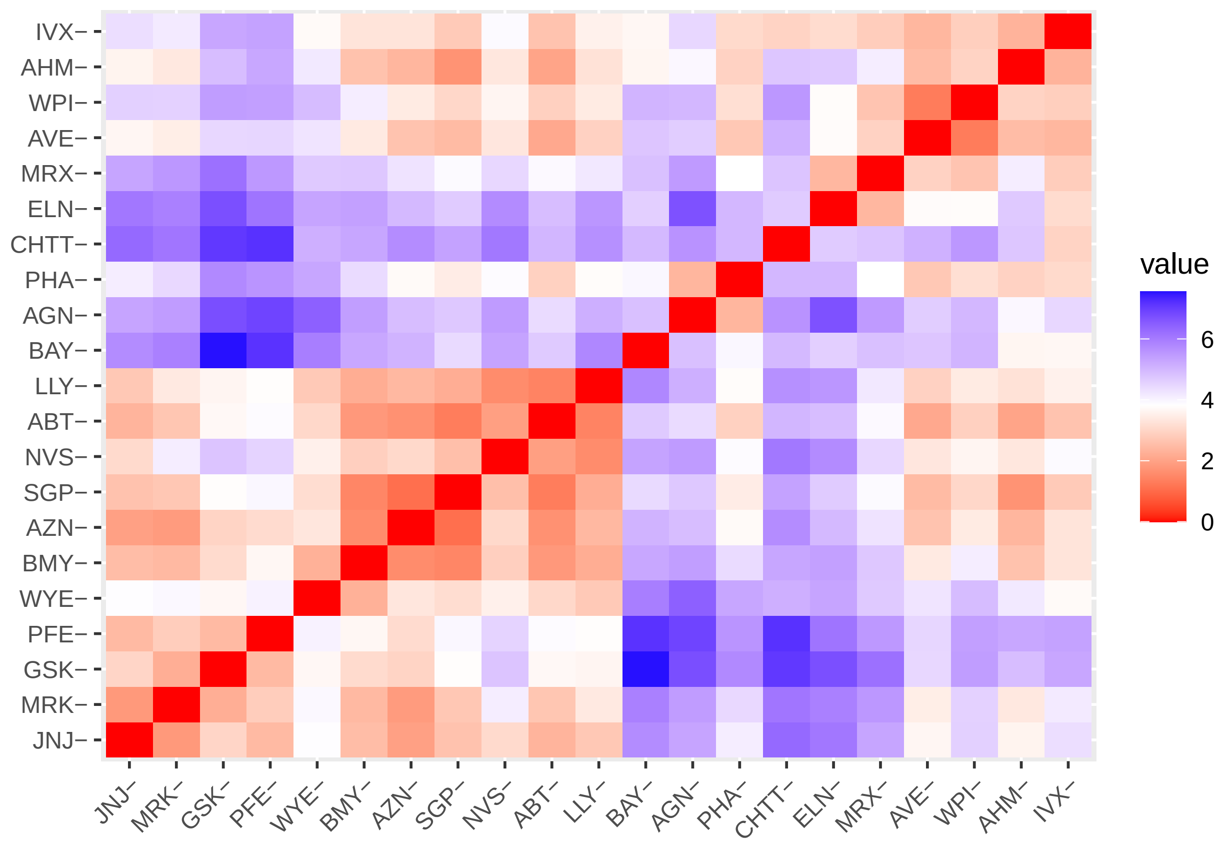



```
k5
```

```
## K-means clustering with 5 clusters of sizes 3, 2, 4, 8, 4
##
## Cluster means:
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478     -0.4612656
## 2 -0.43925134 -0.4701800  2.70002464 -0.8349525 -0.9234951      0.2306328
## 3 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
## 4 -0.03142211 -0.4360989 -0.31724852  0.1950459  0.4083915      0.1729746
## 5  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
##      Leverage Rev_Growth Net_Profit_Margin
## 1  1.36644699 -0.6912914      -1.320000179
## 2 -0.14170336 -0.1168459      -1.416514761
## 3  0.06308085  1.5180158      -0.006893899
## 4 -0.27449312 -0.7041516       0.556954446
## 5 -0.46807818  0.4671788       0.591242521
##
## Clustering vector:
##  ABT  AGN  AHM  AZN  AVE  BAY  BMY CHTT  ELN  LLY  GSK  IVX  JNJ  MRX  MRK  NVS
##    4    2    4    4    3    1    4    1    3    4    5    1    5    3    5    4
##  PFE  PHA  SGP  WPI  WYE
##    5    2    4    3    4
##
## Within cluster sum of squares by cluster:
## [1] 15.595925  2.803505 12.791257 21.879320  9.284424
```

```
##   (between_SS / total_SS =  65.4 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
distance<- dist(Pharma_2, method = "euclidean")
fviz_dist(distance)
```




```
#Using K-Means Cluster Analysis-  to Fit the data with 5 clusters

fit<-kmeans(Pharma_2,5)

#calculating the mean of all quantitative variables in each cluster

aggregate(Pharma_2,by=list(fit$cluster),FUN=mean)
```

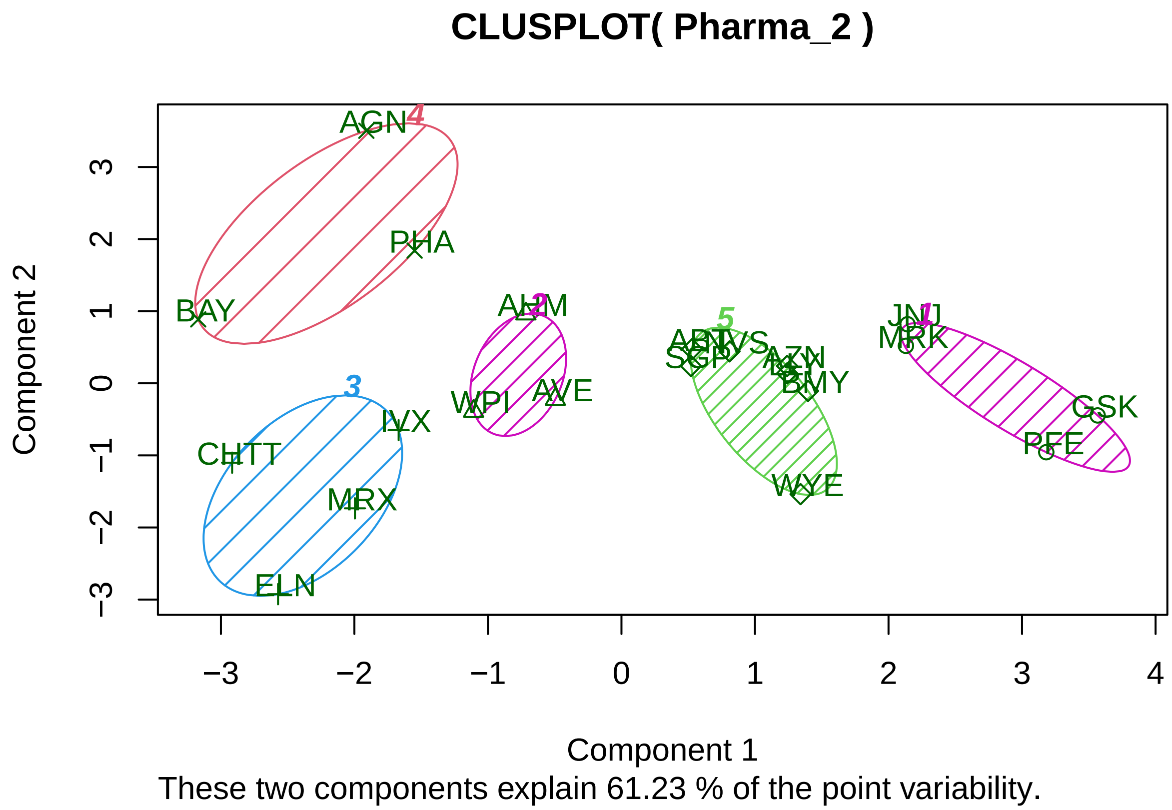
```
##   Group.1  Market_Cap       Beta   PE_Ratio        ROE        ROA
## 1       1  1.69558112 -0.1780563 -0.1984582  1.2349879  1.3503431
## 2       2 -0.66114002 -0.7233539 -0.3512251 -0.6736441 -0.5915022
## 3       3 -0.96247577  1.1949250 -0.3639982 -0.5200697 -0.9610792
## 4       4 -0.52462814  0.4451409  1.8498439 -1.0404550 -1.1865838
## 5       5  0.08926902 -0.4618336 -0.3208615  0.3260892  0.5396003
##   Asset_Turnover   Leverage Rev_Growth Net_Profit_Margin
```

```
## 1   1.153164e+00 -0.4680782  0.4671788         0.5912425
## 2  -1.537552e-01 -0.4040831  0.6917224        -0.4005718
## 3  -1.153164e+00  1.4773718  0.7120120        -0.3688236
## 4   1.480297e-16 -0.3443544 -0.5769454        -1.6095439
## 5   6.589509e-02 -0.2559803 -0.7230135         0.7343816
```

```
Pharma_3<-data.frame(Pharma_2,fit$cluster)
Pharma_3
```

```
##       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           5
## AGN   0.01828430 -0.38113909       -1.55366706           4
## AHM  -0.40408312 -0.57211809       -0.68503583           2
## AZN  -0.74965647  0.14744734        0.35122600           5
## AVE  -0.31449003  1.21638667       -0.42597037           2
## BAY  -0.74965647 -1.49714434       -1.99560225           4
## BMY  -0.02011273 -0.96584257        0.74744375           5
## CHTT  3.74279705 -0.63276071       -1.24888417           3
## ELN   0.61983791  1.88617085       -0.36501379           3
## LLY  -0.07130879 -0.64814764        1.17413980           5
## GSK  -0.31449003  0.76926048        0.82363947           1
## IVX   1.10620040  0.05603085       -0.71551412           3
## JNJ  -0.62166634 -0.36213170        0.33598685           1
## MRX   0.44065173  1.53860717        0.85411776           3
## MRK  -0.39128411  0.36014907       -0.24310064           1
## NVS  -0.67286239 -1.45369888        1.02174835           5
## PFE  -0.54487226  1.10143723        1.44844440           1
## PHA  -0.30169102  0.14744734       -1.27936246           4
## SGP  -0.74965647 -0.43544591        0.29026942           5
## WPI  -0.49367621  1.43089863       -0.09070919           2
## WYE   0.68383297 -1.17763919        1.49416183           5
```

```
View(Pharma_3)


#view of the cluster plot

library(cluster)
clusplot(Pharma_2,fit$cluster,color = TRUE,shade = TRUE,labels = 2,lines = 0)
```




```
#Task-b. Interpret the clusters with respect to the numerical variables used in forming the clusters.
#By looking at the mean values of all quantitative variables in each cluster.

#Cluster 1 - JNJ, MRK, PFE, GSK

#Cluster 2 - AHM,WPI,AVE

#Cluster 3 - CHTT,ELN,MRX,IVX

#Cluster 4 - BAY,PHA,AGN

#Cluster 5 - AZN,ABT,NVS,BMY,WYE,SGP,LLY

#Cluster 1 has highest Market_cap,ROA,ROE,Asset_Turnover and lowest is Beta,PE_Ratio.

#Cluster 2 has highest Rev_Growth and lowest PE_Ratio, Asset_Turnover.
```

```
#Cluster 3 has highest Beta, Leverage and lowest Market_Cap, ROE, ROA, Leverage, Rev_Growth, Net_Profit

#Cluster 4 has highest PE_Ratio and lowest Leverage, Asset_Turnover.

#Cluster 5 has highest Net_Profit_Margin and lowest leverage,Beta.

#Task-c. Is there a pattern in the clusters with respect to the numerical variables (10 to 12)? (those
#forming the clusters)

#With respect to the Media recommendation variable, there is a pattern in the clusters.

#Cluster 1 with highest ROA, highest Asset_Turnover , highest Market_cap, highest ROE has equal Hold an

#Cluster 2 with lowest Asset_Turnover and lowest PE_Ratio we considered as  undervalued stock but moder

#Cluster-3 with highest Leverage, highest Beta has mostly too risky nature  it is less Recommendation t

#Cluster 4 with highest PE_Ratio that means all stocks in this cluster are overvalued so it advisible t

#Cluster 5 with highest Net_Profit_Margin has mostly Hold Recommendation.

#In terms of variables, I have seen a pattern among the clusters (10 to 12)

#Clusters 1,3 has mostly Moderate Buy Recommendation

#Clusters 1,2,4,5 has Hold Recommendation

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

#Cluster-1 - strong Buy Recommendation (less risky nature)..

#Cluster-2 - Moderately Hold cluster

#Cluster-3 - high sell Recommendation cluster (high risky nature)

#Cluster-4 - low sell Recommendation cluster

#Cluster-5 - strong Hold cluster.
```