Assignment-4

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```r
Pharmaceuticals <- read.csv("D:/Pharmaceuticals.csv")
```

```r
library(tidyverse)# For Data manipulation
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.3     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.3     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.0
## v purrr     1.0.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```r
library(factoextra)# Used for clustering algorithms and visualization
```

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

```r
library(dplyr)
library(ggplot2)
library(cluster)
```

```r
Pharma_data <- na.omit(Pharmaceuticals)
#Provides the data after removing the incomplete cases.
Pharma_data
```

```
##    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
```

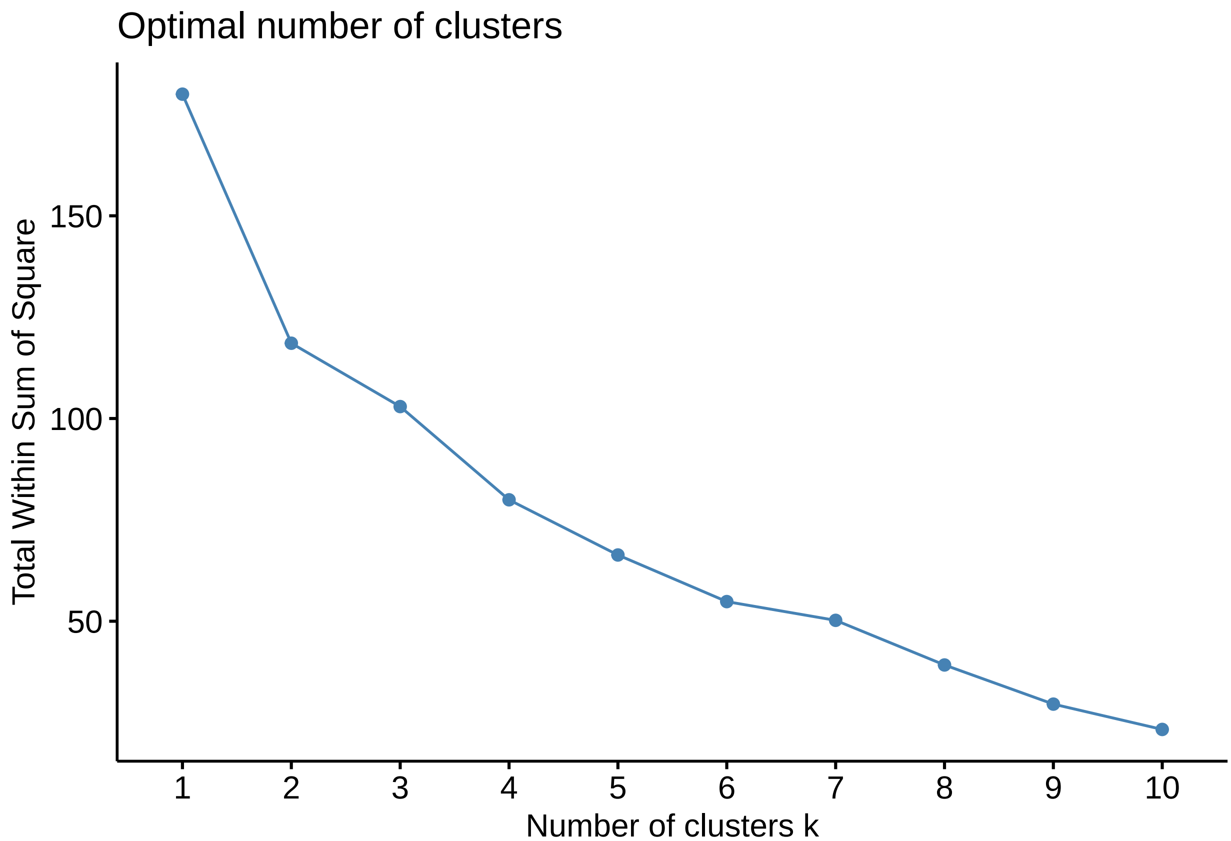
```r
#Taking the quantitative variables(1-9) to cluster the 21 firms
row.names(Pharma_data)<- Pharma_data[,1]
Pharma_data1<- Pharma_data[,3:11]
# Considering only numercial values i.e., 3-11 columns from csv file
head(Pharma_data1)
```

```
##     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
```

```r
#Normalizing the data frame with scale method
Pharma_data2<-scale(Pharma_data1)
head(Pharma_data2)
```

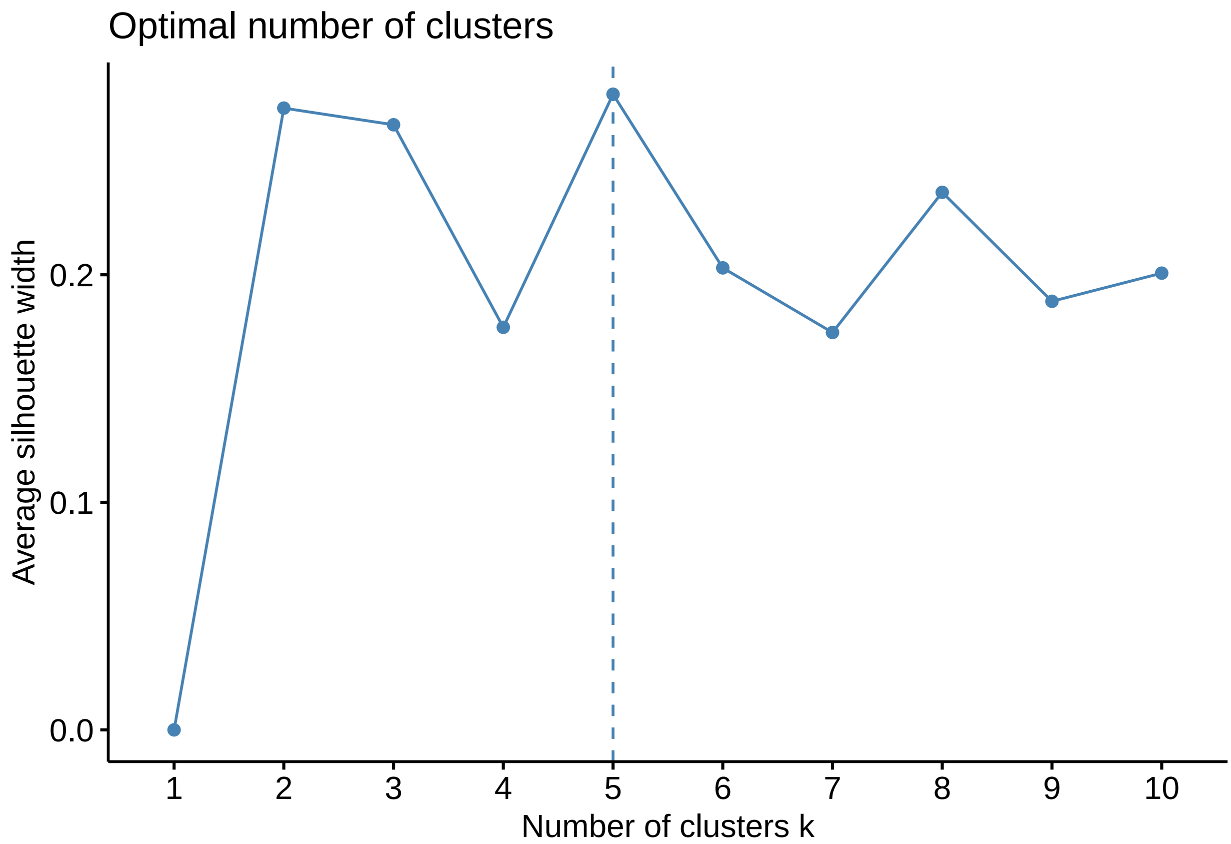
```
##     Market_Cap        Beta    PE_Ratio         ROE        ROA Asset_Turnover
## ABT  0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121      0.0000000
## AGN -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871      0.9225312
## AHM -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700      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
```

```r
#To determine the number of clusters to do the cluster analysis using Elbow Method
fviz_nbclust(Pharma_data2, kmeans, method = "wss")
```




```
##By seeing the above graph from Elbow method, Graph is not
#clear to choose k=2 or 3 or 4 or 5.
#Silhouette method for determining no of clusters


fviz_nbclust(Pharma_data2, kmeans, method = "silhouette")
```

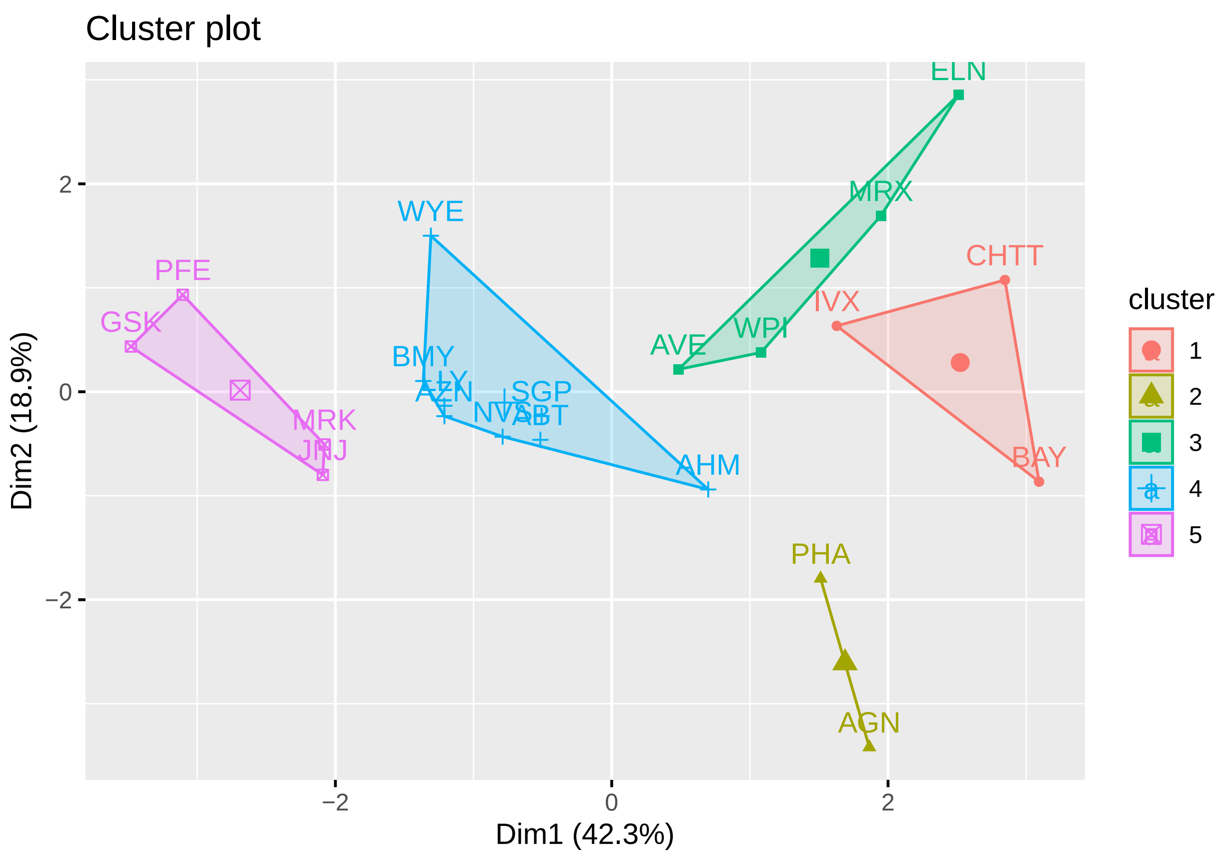



```
#Applying K-means
set.seed(64060)
k_5<- kmeans(Pharma_data2,centers=5,nstart = 25)
```

```
#Visualizing the output
#centroids
k_5$centers
```

```
##    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
```

```
fviz_cluster(k_5,data = Pharma_data2) # to Visualize the clusters
```

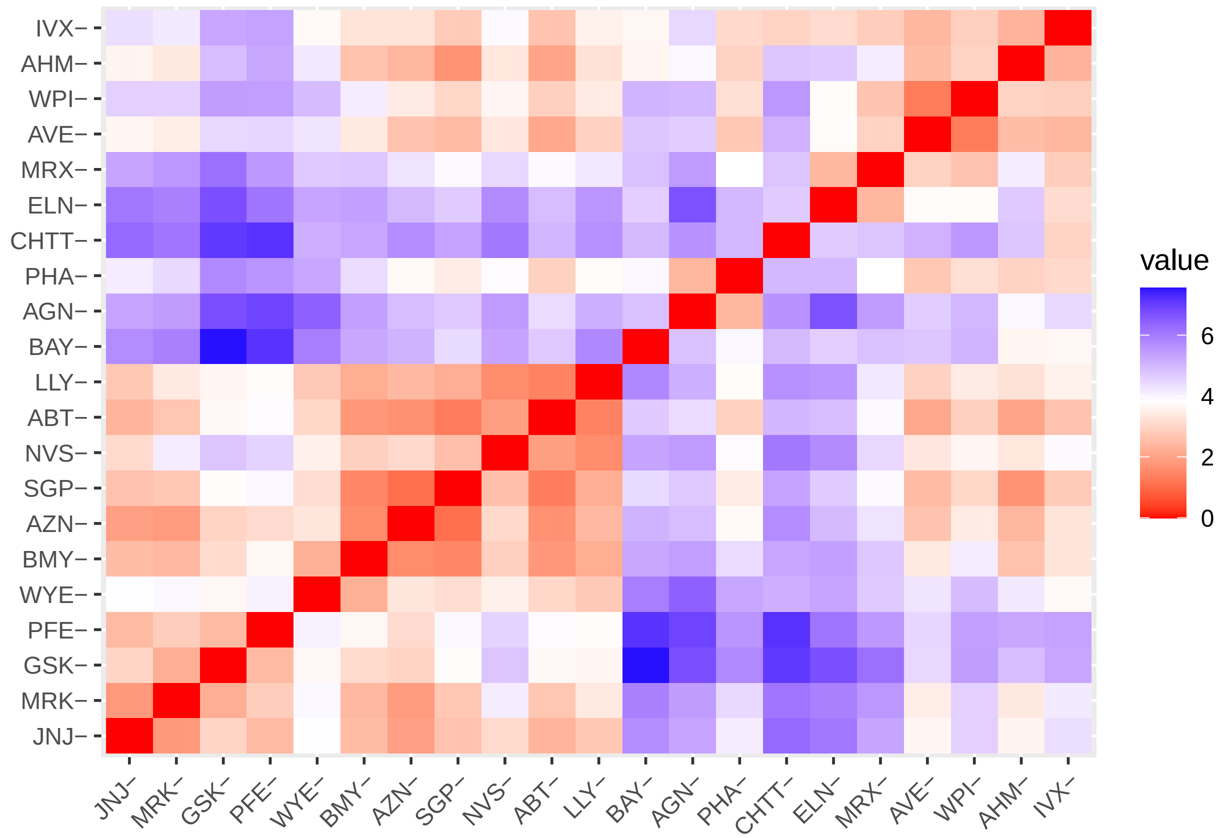



```
k_5
```

```
## 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_data2, method = "euclidean")
fviz_dist(distance)
```




```
## I can see there are 5 clusters and the center is defined after 25 restarts
#which is determined in kmeans.
#K - Means Cluster Analysis- Fit the data with 5 clusters
fit<-kmeans(Pharma_data2,5)
```

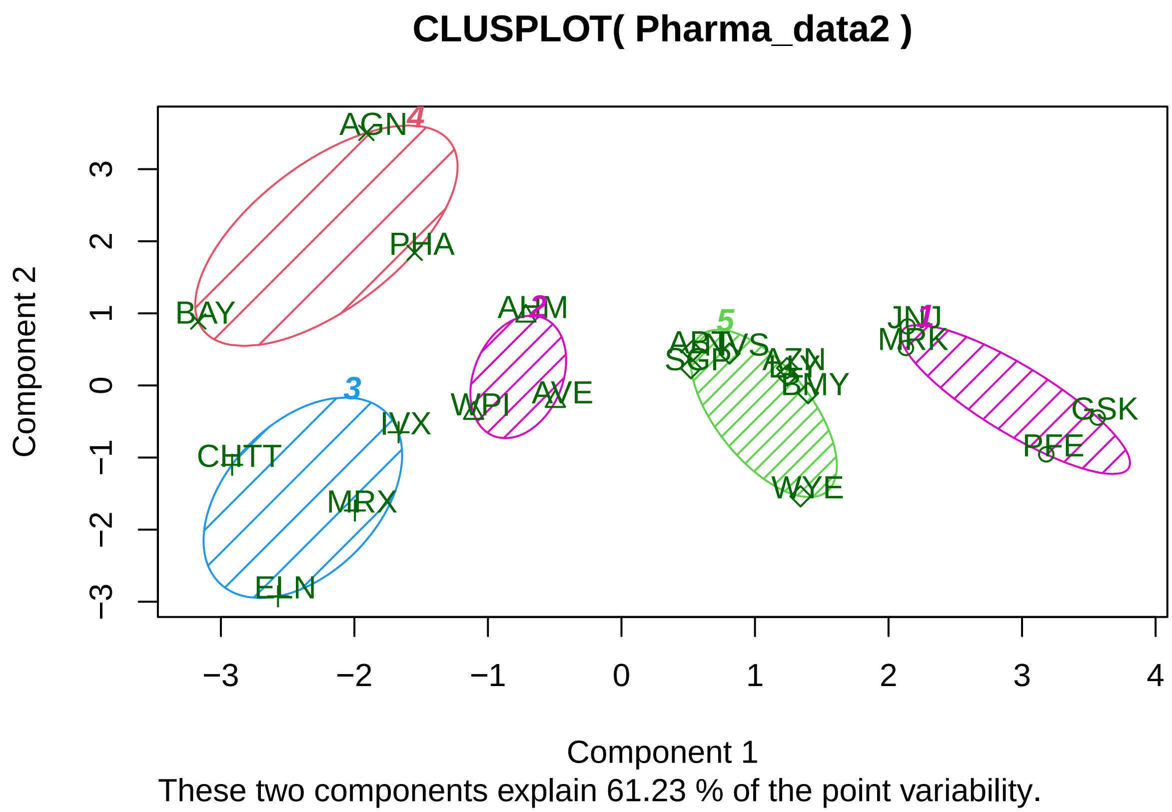
```
#Finding the mean value of all quantitative variables for each cluster
aggregate(Pharma_data2,by=list(fit$cluster),FUN=mean)
```

```
##   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
```

```r
##To view the cluster plot

clusplot(Pharma_data2,fit$cluster,color =
           TRUE,shade = TRUE,labels = 2,lines = 0)
```



#Task 2: Examine the clusters in light of the numerical variables that were utilised to create them. #Cluster_1 - AGN, PHA, BAY - These have the highest PE_Ratio. #By observing the mean values of all quantitative variables for each cluster. The ROE value is poor. #JNJ, MRK, GSK, and PFE are in #Cluster_2 and have the biggest market capitalization and good leverage value. #AHM, AVE, and WPI are in #Cluster_3; they have the lowest beta and asset turnover. #Cluster_4: The lowest market capitalization, leverage, and beta are exhibited by IVX, MRX, ELN, and CHTT. #They're good. Its revenue growth is the highest. #Cluster_5: ABT, NVS, AZN, LLY, BMY, WYE, SGP - These companies have the largest net profit margin, the biggest asset turnover, and the lowest sales growth.

#Task 3: Do the clusters exhibit any patterns in relation to the numerical variables (10–12)? #(those not utilised in cluster formation) #For cluster 1: It should be held in accordance with media recommendations as it has the highest PE Ratio. #For cluster 2: It has a good leverage value and the largest market capitalization. Additionally, they can be rather violent#For cluster 3: Its beta and asset turnover are the lowest. However, media endorsements are very positive.#For cluster 4: They come with a modest recommendation despite the high leverage ratio. #For Cluster 5: They have the largest net profit margin, the highest asset turnover, and the lowest revenue growth.

#Task 4: Using any or all of the variables in the dataset, give each cluster a suitable name. #Cluster 1: Hold cluster – Their numbers are respectable. #4 Cluster 2: Mild Purchase or Hold a cluster. #Cluster 3: To Purchase or To Sell #Cluster 4: Purchase Cluster; it is fairly stable. #High Hold Cluster is Cluster # 5.