

# Assignment-4

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2023-10-28

```
Pharmaceuticals <- read.csv("C:/Users/msrin/Downloads/Pharmaceuticals.csv")
```

```
#Reading the required libraries
```

```
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  1.9.2      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
```

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

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

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

```
#Task-1-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.
```

```
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	BMJ	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
```

*#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 numerical 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
```

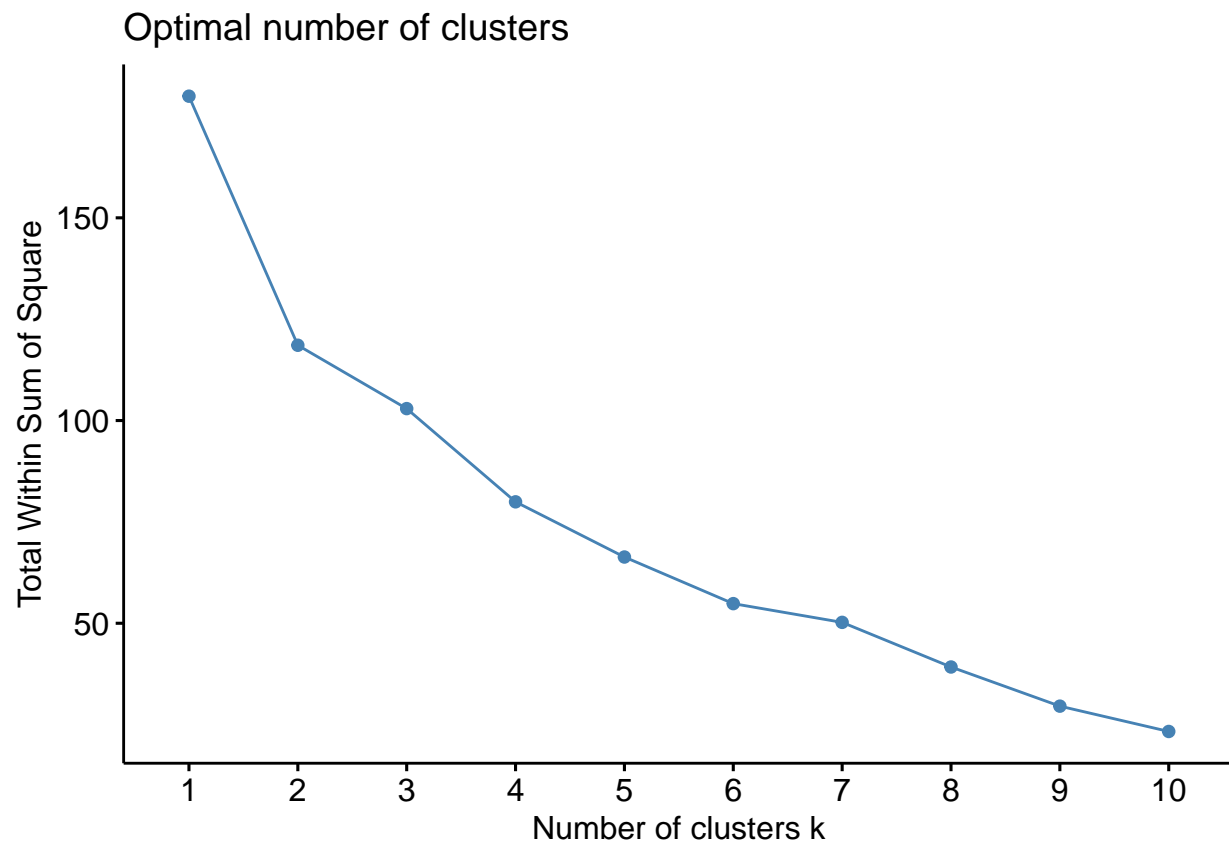
*#Normalizing the data frame with scale method*

```
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
```

*#To determine the number of clusters to do the cluster analysis using Elbow Method*

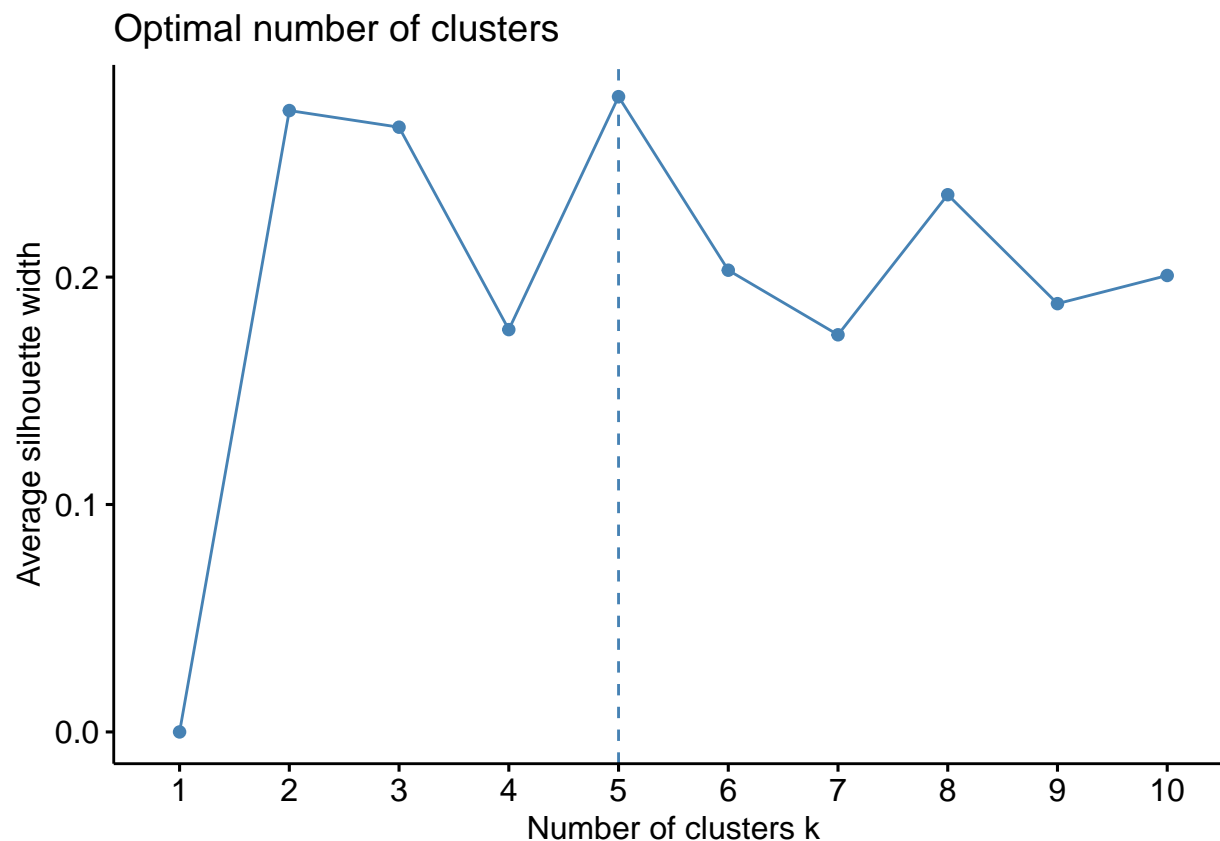
```
fviz_nbclust(Pharma_data2, kmeans, method = "wss")
```



*##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")
```



```
##By seeing the graph from silhouette method, I can see sharp rise at k=5.
#So, considering the silhouette method.
```

```
#Applying K-means
```

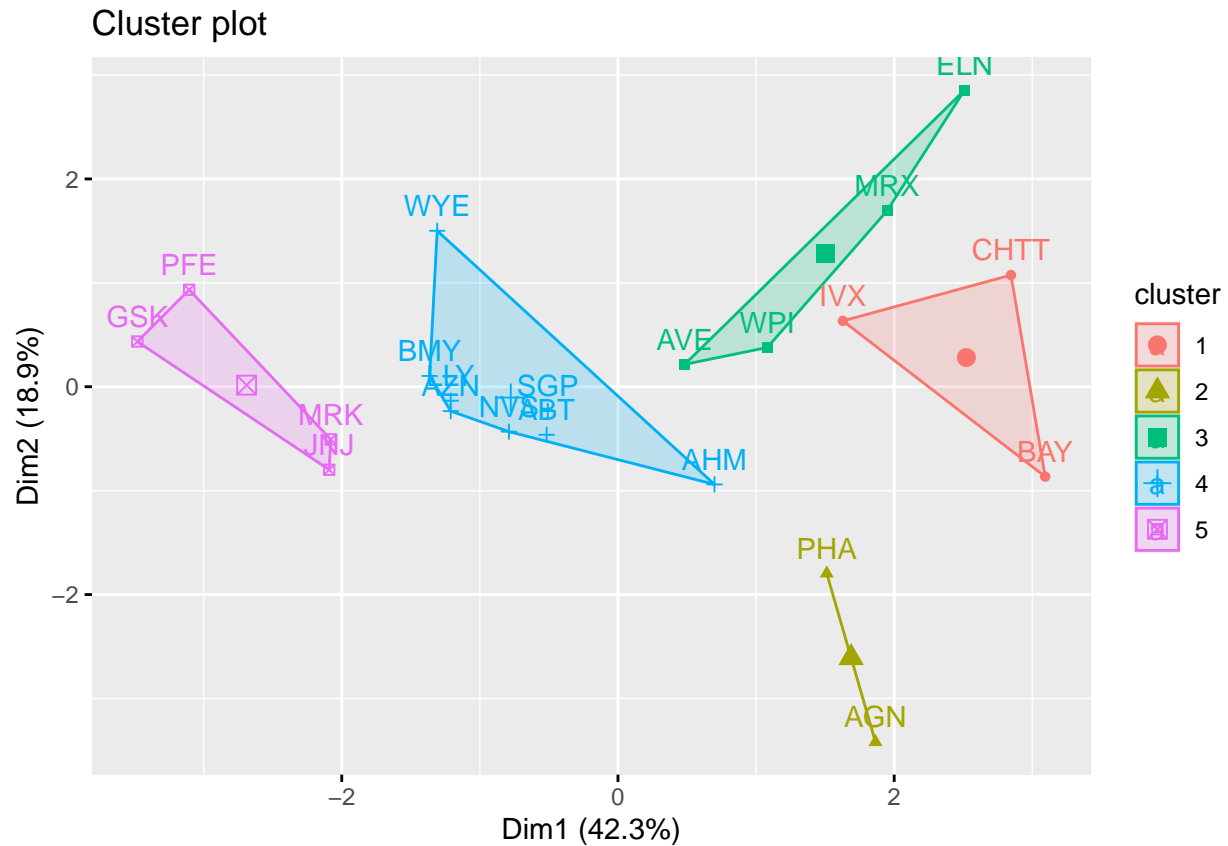
```
set.seed(64060)
k_5<- kmeans(Pharma_data2,centers=5,nstart = 25)
```

```
#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
```



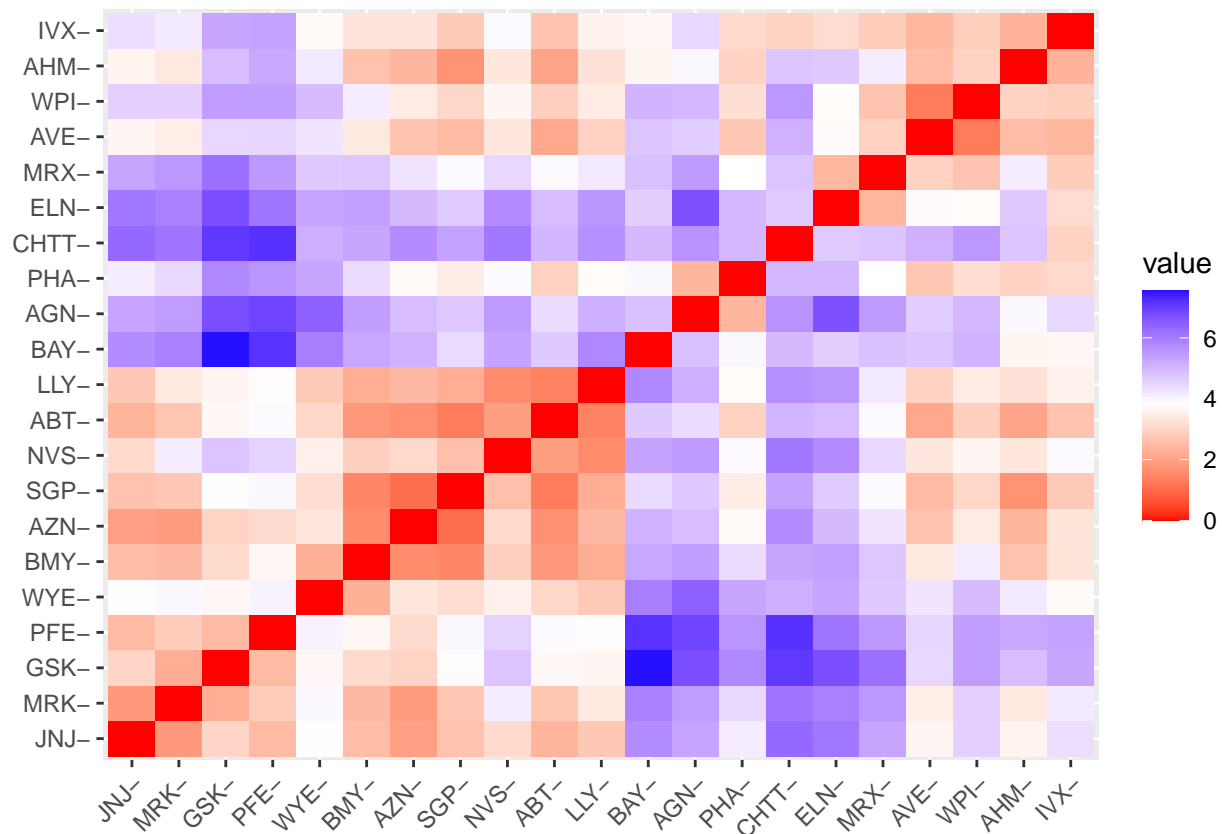
k\_5

```
## 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
```

```
Pharma_data3<-data.frame(Pharma_data2,fit$cluster)
Pharma_data3
```

```
##      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
```

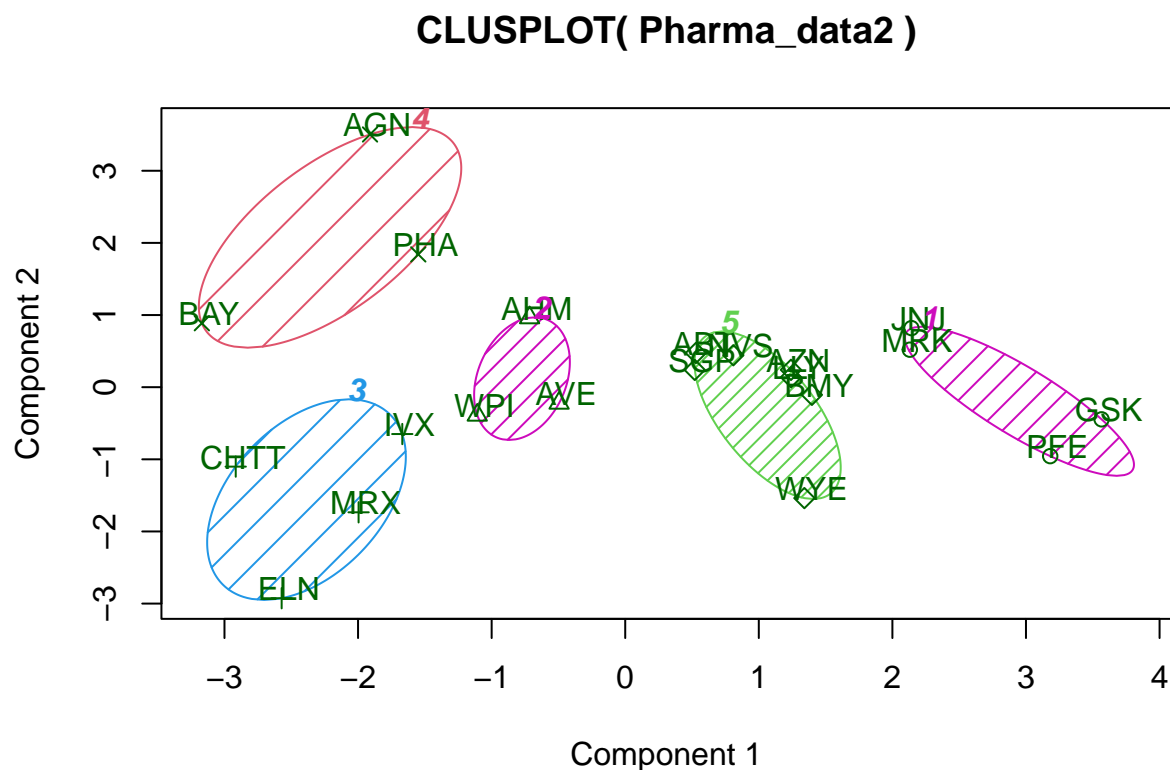


```
## PFE -0.54487226 1.10143723 1.44844440 1
## PHA -0.30169102 0.14744734 -1.27936246 4
## SGP -0.74965647 -0.43544591 0.29026942 5
## WPI -0.49367621 1.43089863 -0.09070919 2
## WYE 0.68383297 -1.17763919 1.49416183 5
```

```
View(Pharma_data3)
```

```
#To view the cluster plot
```

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



These two components explain 61.23 % of the point variability.

```
#Task 2 Interpret the clusters with respect to the numerical variables used in forming the clusters.
```

```
#By noticing the mean values of all quantitative variables for each cluster
```

```
#Cluster_1 - AGN, PHA, BAY - These have the highest PE_Ratio. ROE value is not good.
```

```
#Cluster_2 - JNJ, MRK, GSK, PFE - They have the highest market_Cap and has Good Leverage value.
```

```
#Cluster_3 - AHM, AVE, WPI - They have lowest asset_turnover, and lowest beta.
```

```
#Cluster_4 - IVX, MRX, ELN, CHTT - They have the lowest market capitalization, Leverage and Beta # are good. It has highest revenue growth.
```

*#Cluster\_5 - ABT, NVS, AZN, LLY, BMY, WYE, SGP - They have lowest revenue growth, highest assets turnover and highest net profit margin.*

*#Task 3: Is there a pattern in the clusters with respect to the numerical variables (10 to 12)?  
#(those not used in forming the clusters)*

*#For cluster 1: It has the highest PE\_Ratio and needs to be held as per the media recommendations.  
#For cluster 2: It has the highest market\_Cap and has Good Leverage value. And they can be moderately recommended.  
#For cluster 3: It has lowest asset\_turnover, and lowest beta. But media recommendations are highly positive.  
#For cluster 4: The leverage ratio is high, they are moderately recommended.  
#For Cluster 5: They have lowest revenue growth, highest asset turnover and highest net profit margin.*

*#Task 4: Provide an appropriate name for each cluster using any or all of the variables in the dataset.*

*#Cluster 1: Hold cluster -They have decent numbers.  
#Cluster 2: Moderate Buy (or) Hold cluster.  
#Cluster 3: Buy or Sell Cluster  
#Cluster 4: Buy Cluster - It has good stability.  
#Cluster 5: High Hold cluster*