Assignment 4 FML

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#Importing the Dataset

```
Pharmaceuticals <- read.csv("C:/Users/ADMIN/Downloads/Pharmaceuticals.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
##
##
##
```

```
str(Pharmaceuticals)
```

```
## 'data.frame':    21 obs. of  14 variables:
##  $ Symbol               : chr  "ABT" "AGN" "AHM" "AZN" ...
##  $ Name                 : chr  "Abbott Laboratories" "Allergan, Inc." "Amersham plc" "Astr
aZeneca PLC" ...
##  $ Market_Cap           : num  68.44 7.58 6.3 67.63 47.16 ...
##  $ Beta                 : num  0.32 0.41 0.46 0.52 0.32 1.11 0.5 0.85 1.08 0.18 ...
##  $ PE_Ratio             : num  24.7 82.5 20.7 21.5 20.1 27.9 13.9 26 3.6 27.9 ...
##  $ ROE                  : num  26.4 12.9 14.9 27.4 21.8 3.9 34.8 24.1 15.1 31 ...
##  $ ROA                  : num  11.8 5.5 7.8 15.4 7.5 1.4 15.1 4.3 5.1 13.5 ...
##  $ Asset_Turnover       : num  0.7 0.9 0.9 0.9 0.6 0.6 0.9 0.6 0.3 0.6 ...
##  $ Leverage             : num  0.42 0.6 0.27 0 0.34 0 0.57 3.51 1.07 0.53 ...
##  $ Rev_Growth           : num  7.54 9.16 7.05 15 26.81 ...
##  $ Net_Profit_Margin    : num  16.1 5.5 11.2 18 12.9 2.6 20.6 7.5 13.3 23.4 ...
##  $ Median_Recommendation: chr  "Moderate Buy" "Moderate Buy" "Strong Buy" "Moderate Sell"
...
##  $ Location             : chr  "US" "CANADA" "UK" "UK" ...
##  $ Exchange             : chr  "NYSE" "NYSE" "NYSE" "NYSE" ...
```

```
library(readr)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(caret)
```

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

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

```
library(tidyverse)
```

```
## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
## ✔ forcats   1.0.0     ✔ stringr   1.5.0
## ✔ lubridate 1.9.2     ✔ tibble    3.1.8
## ✔ purrr     1.0.1     ✔ tidyr     1.3.0
```

```
## ── Conflicts ──────────────────────────────────────────── tidyverse_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
## ✖ purrr::lift()   masks caret::lift()
## ℹ Use the  ]8;;http://conflicted.r-lib.org/ conflicted package ]8;;  to force all conflict
s to become errors
```

```
library(cluster)
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'
##
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(ggrepel)
library(factoextra)
```

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

```
library(flexclust)
```

```
## Loading required package: grid
## Loading required package: modeltools
## Loading required package: stats4
```

```
library(ggcorrplot)
library(FactoMineR)
```

#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.

#Removing the Null Values in the dataset and selecting the Numercial variables.

```
colSums(is.na(Pharmaceuticals))
```

```
##                Symbol                  Name            Market_Cap
##                     0                     0                     0
##                  Beta              PE_Ratio                   ROE
##                     0                     0                     0
##                   ROA        Asset_Turnover              Leverage
##                     0                     0                     0
##            Rev_Growth     Net_Profit_Margin Median_Recommendation
##                     0                     0                     0
##              Location              Exchange
##                     0                     0
```

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

```
##     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
```

Scaling and Normalisation the dataset.

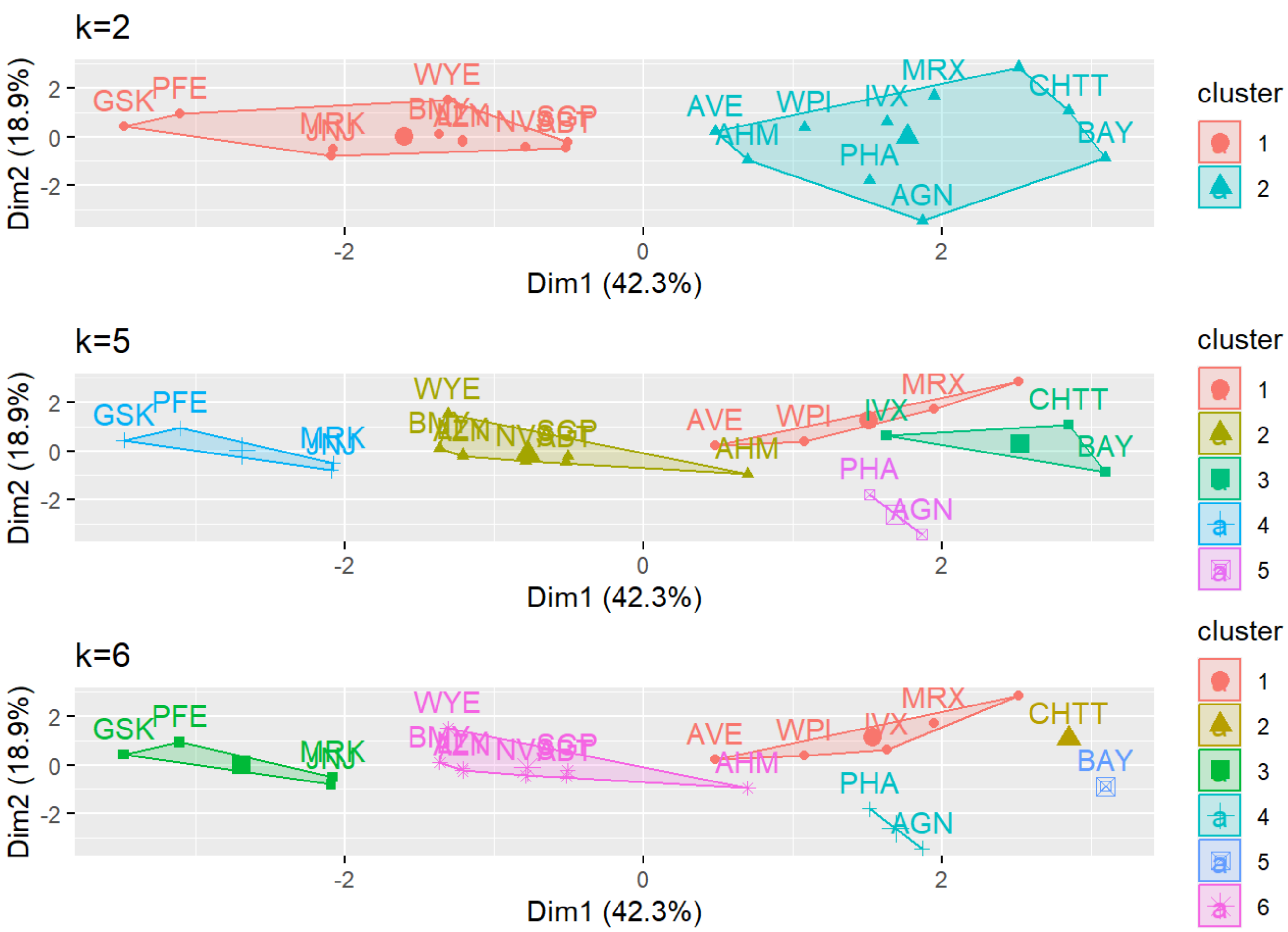
```
Pharmaceuticals_scale <- scale(Pharmaceuticals_data_num)
head(Pharmaceuticals_scale)
```

```
##     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
```

```
normal_data <- as.data.frame(scale(Pharmaceuticals_data_num))
```

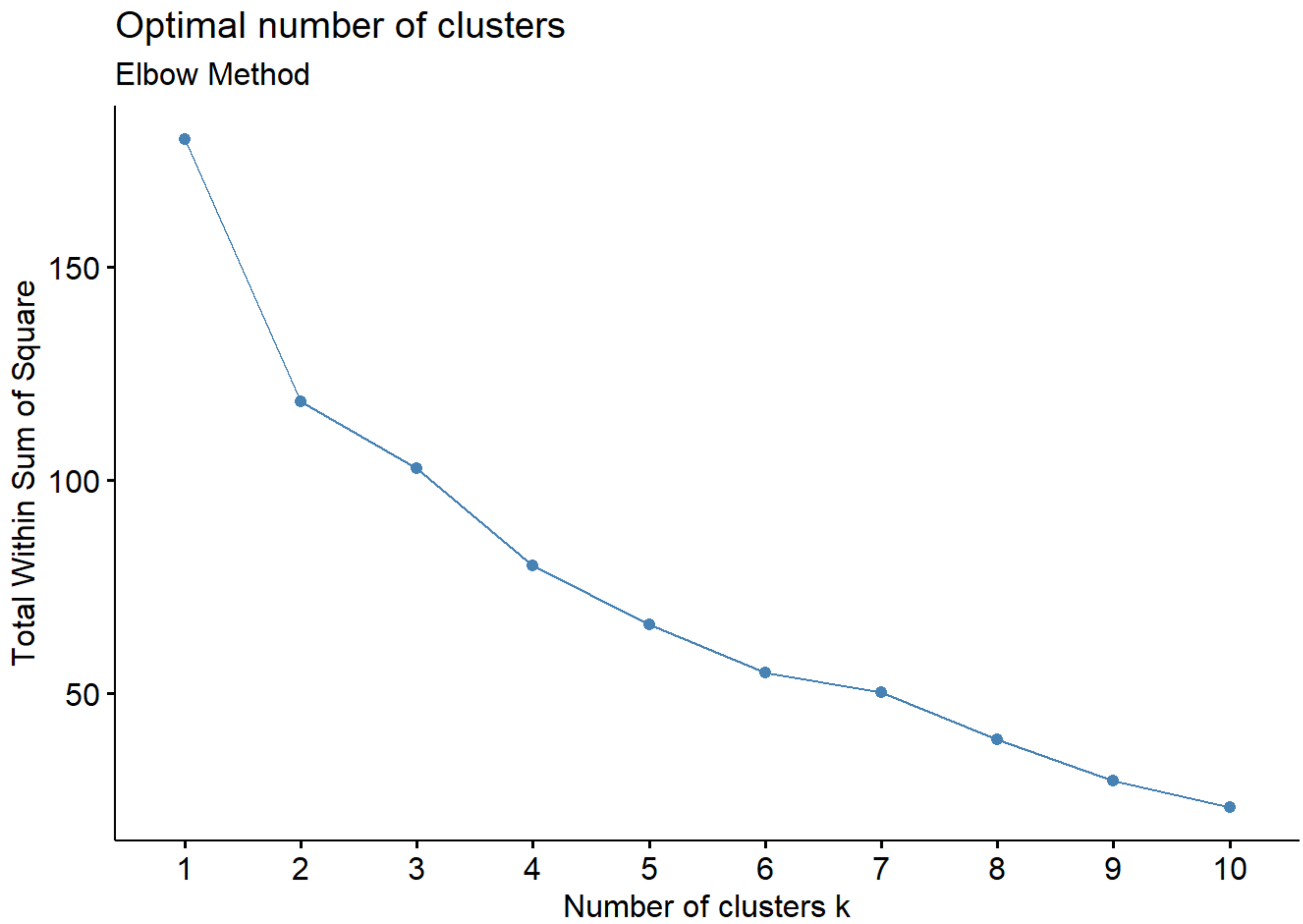
Computing K-means clustering for different centers and Using multiple values of K and examine the differences in results

```
kmeans_1 <- kmeans(Pharmaceuticals_scale, centers = 2, nstart = 30)
kmeans_2<- kmeans(Pharmaceuticals_scale, centers = 5, nstart = 30)
kmeans_3<- kmeans(Pharmaceuticals_scale, centers = 6, nstart = 30)
Plot_1<-fviz_cluster(kmeans_1, data = Pharmaceuticals_scale)+ggtitle("k=2")
plot_2<-fviz_cluster(kmeans_2, data = Pharmaceuticals_scale)+ggtitle("k=5")
plot_3<-fviz_cluster(kmeans_3, data = Pharmaceuticals_scale)+ggtitle("k=6")
grid.arrange(Plot_1,plot_2,plot_3, nrow = 3)
```



#so the recommanded number of clusters is k=2 i.e plot2 # Estimating the number of clusters

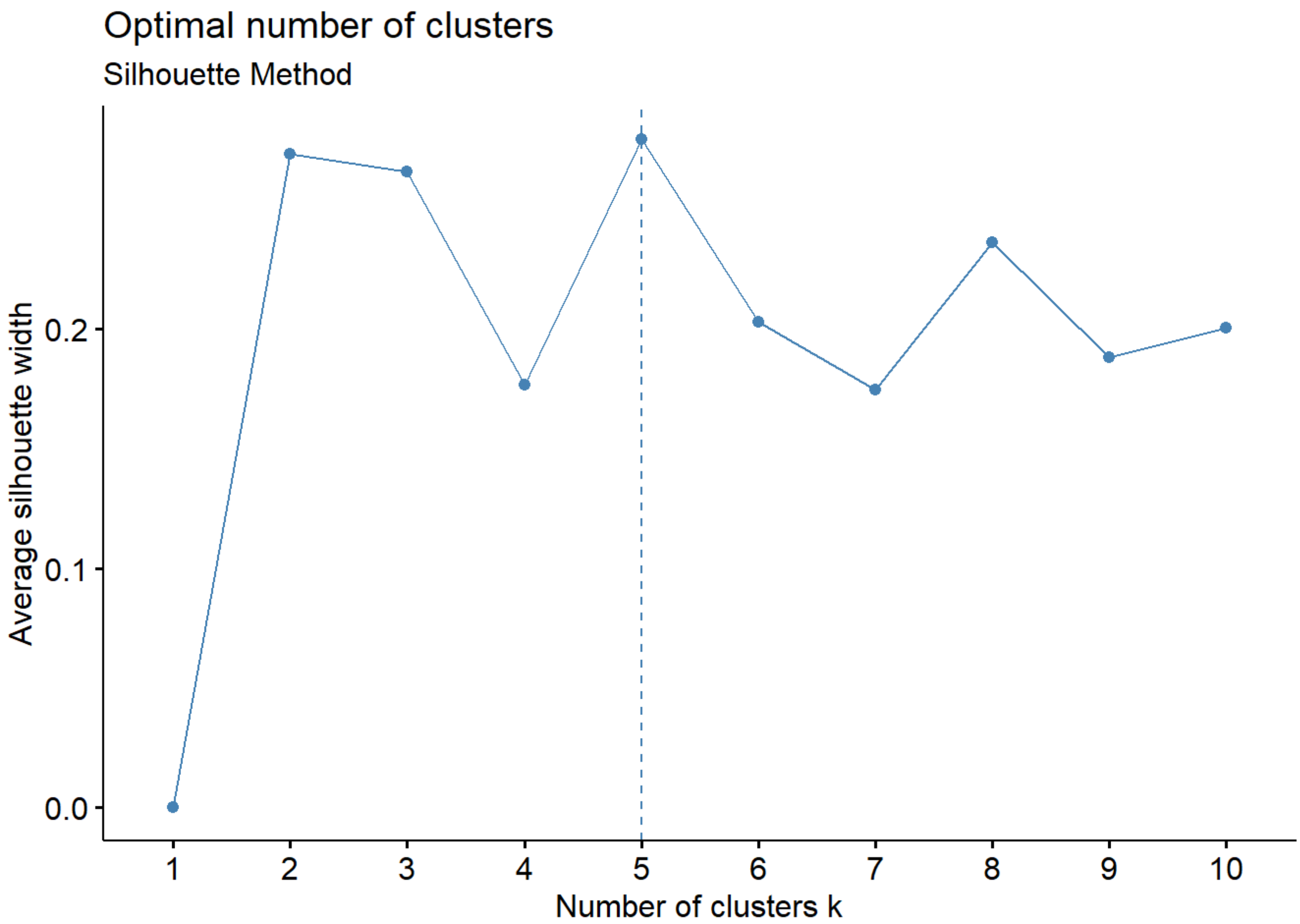
```
fviz_nbclust(normal_data, FUNcluster = kmeans, method = "wss") + labs(subtitle = "Elbow Metho
d")
```



#

Silhouette Method is used in scaling the data to determine the number of clusters

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



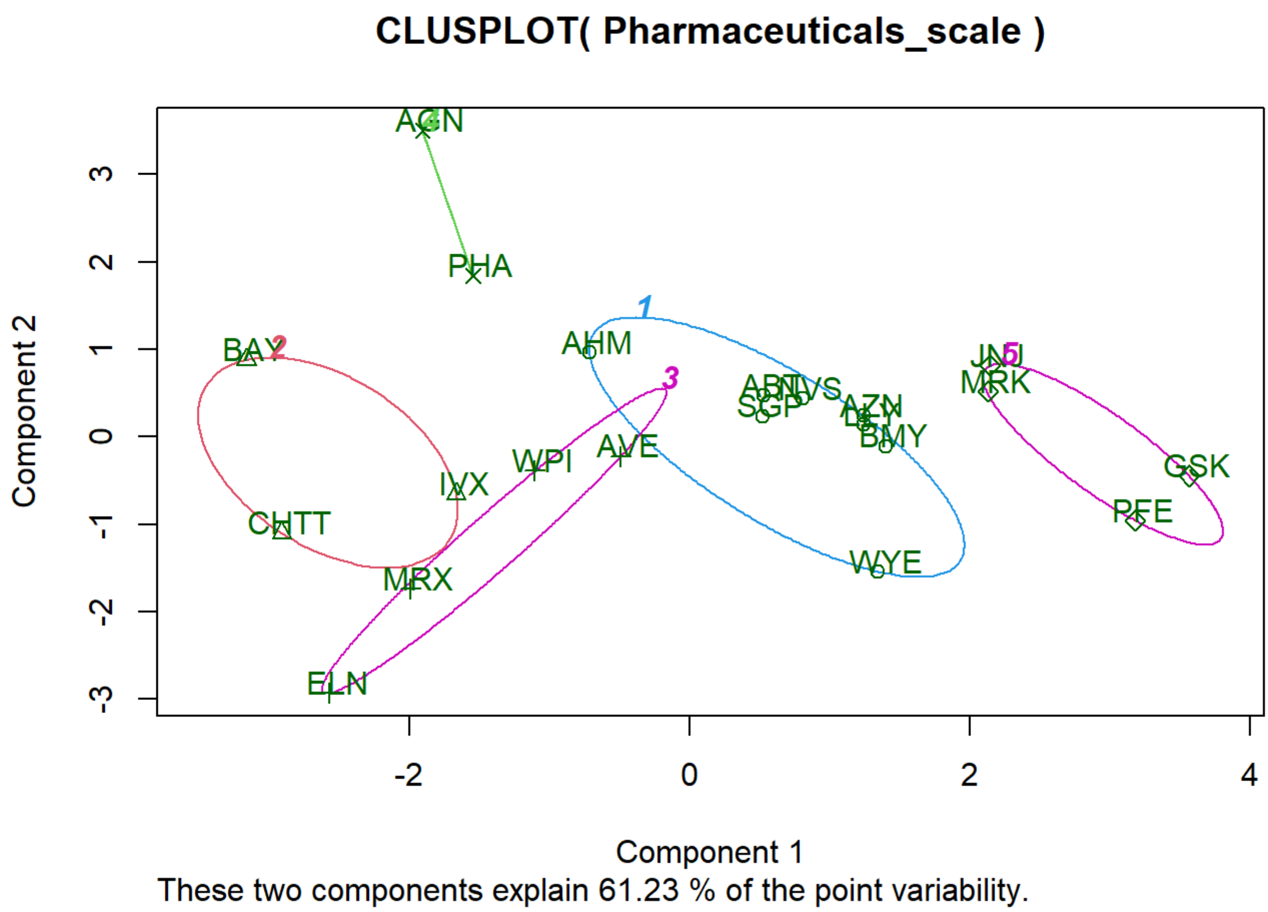
#

Final analysis and Extracting results using 5 clusters and Visualize the results

```
set.seed(300)
final_Cluster<- kmeans(Pharmaceuticals_scale, 5, nstart = 25)
print(final_Cluster)
```

```
## K-means clustering with 5 clusters of sizes 8, 3, 4, 2, 4
##
## Cluster means:
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1 -0.03142211 -0.4360989 -0.31724852  0.1950459  0.4083915      0.1729746
## 2 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478     -0.4612656
## 3 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
## 4 -0.43925134 -0.4701800  2.70002464 -0.8349525 -0.9234951      0.2306328
## 5  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
##      Leverage Rev_Growth Net_Profit_Margin
## 1 -0.27449312 -0.7041516       0.556954446
## 2  1.36644699 -0.6912914      -1.320000179
## 3  0.06308085  1.5180158      -0.006893899
## 4 -0.14170336 -0.1168459      -1.416514761
## 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
##    1    4    1    1    3    2    1    2    3    1    5    2    5    3    5    1
##  PFE  PHA  SGP  WPI  WYE
##    5    4    1    3    1
##
## Within cluster sum of squares by cluster:
## [1] 21.879320 15.595925 12.791257  2.803505  9.284424
##  (between_SS / total_SS =  65.4 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
clusplot(Pharmaceuticals_scale,final_Cluster$cluster, color = TRUE, labels = 2,lines = 0)
```



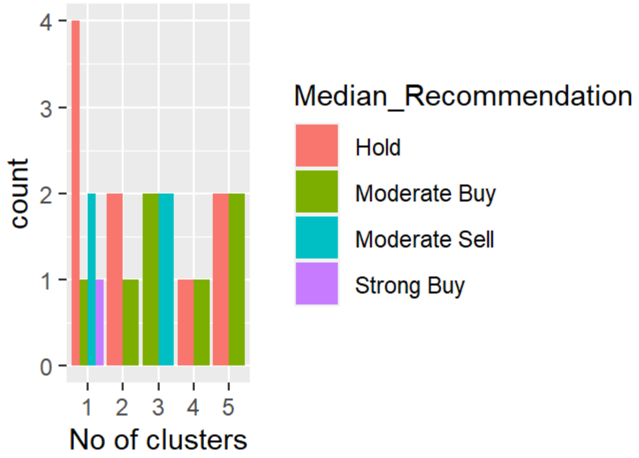
#B Interpret the clusters with respect to the numerical variables used in forming the clusters. #Cluster 1 - AHM,SGP,WYE,BMY,AZN, ABT, NVS, LLY (lowest Market_Cap,lowest Beta,lowest PE_Ratio,highest Leverage,highest Rev_Growth.) #Cluster 2 - BAY, CHTT, IVX (lowest Rev_Growth,highest Beta and levearge,lowest Net_Profit_Margin) #Cluster 3 - WPI, MRX,ELN,AVE (lowest PE_Ratio,highest ROE,lowest ROA,lowest Net_Profit_Margin, highest Rev_Growth) #Cluster 4 - AGN, PHA (lowest Beta,lowest Asset_Turnover, Highest PE Ratio) #Cluster 5 - JNJ, MRK, PFE,GSK (Highest Market_Cap,ROE, ROA,Asset_Turnover Ratio and lowest Beta/PE Ratio)

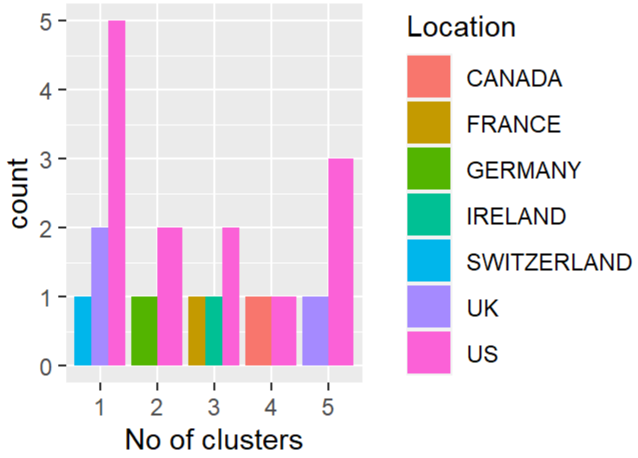
```
Pharmaceuticals_Cluster <- Pharmaceuticals[,c(12,13,14)]%>% mutate(clusters = final_Cluster$c
luster)%>% arrange(clusters, ascending = TRUE)
Pharmaceuticals_Cluster
```

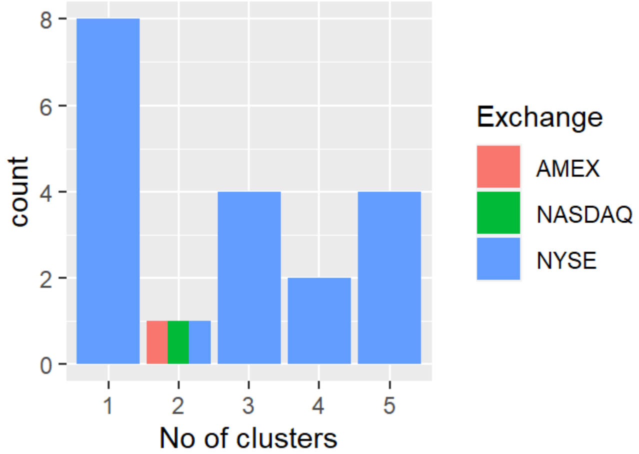
```
##      Median_Recommendation    Location Exchange clusters
## ABT           Moderate Buy          US     NYSE        1
## AHM             Strong Buy          UK     NYSE        1
## AZN          Moderate Sell          UK     NYSE        1
## BMY          Moderate Sell          US     NYSE        1
## LLY                   Hold          US     NYSE        1
## NVS                   Hold SWITZERLAND     NYSE        1
## SGP                   Hold          US     NYSE        1
## WYE                   Hold          US     NYSE        1
## BAY                   Hold     GERMANY     NYSE        2
## CHTT          Moderate Buy          US   NASDAQ        2
## IVX                   Hold          US     AMEX        2
## AVE           Moderate Buy      FRANCE     NYSE        3
## ELN          Moderate Sell     IRELAND     NYSE        3
## MRX           Moderate Buy          US     NYSE        3
## WPI          Moderate Sell          US     NYSE        3
## AGN           Moderate Buy      CANADA     NYSE        4
## PHA                   Hold          US     NYSE        4
## GSK                   Hold          UK     NYSE        5
## JNJ           Moderate Buy          US     NYSE        5
## MRK                   Hold          US     NYSE        5
## PFE           Moderate Buy          US     NYSE        5
```

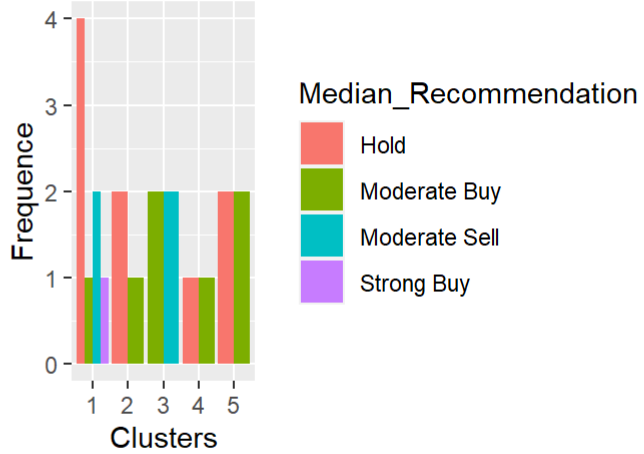
#C Is there a pattern in the clusters with respect to the numerical variables (10 to 12)?

```
plot1<-ggplot(Pharmaceuticals_Cluster, mapping = aes(factor(clusters), fill=Median_Recommenda
tion))+geom_bar(position = 'dodge')+labs(x ='No of clusters')
plot2<- ggplot(Pharmaceuticals_Cluster, mapping = aes(factor(clusters),fill = Location))+geom
_bar(position = 'dodge')+labs(x ='No of clusters')
plot3<- ggplot(Pharmaceuticals_Cluster, mapping = aes(factor(clusters),fill = Exchange))+geom
_bar(position = 'dodge')+labs(x ='No of clusters')
plot4<- ggplot(Pharmaceuticals_Cluster, mapping = aes(factor(clusters), fill=Median_Recommend
ation)) + geom_bar(position = 'dodge') + labs(x='Clusters', y='Frequence')
grid.arrange(plot1, plot2, plot3,plot4)
```









#AS per the graph

#Cluster 1 :The Hold median is the highest in this cluster , which also contains separate Hold, Moderate Buy, Moderate Sell, and Strong Buy medians. They are listed on the NYSE and come from the US, UK, and Switzerland.

#Cluster 2: Although the firms are evenly divided throughout AMEX, NASDAQ, and NYSE, has a distinct Hold and Moderate Buy median, as well as a different count between the US and Germany.

#Cluster 3: listed on the NYSE, has separate counts for France, Ireland, and the US, and has equal moderate buy and sell medians.

#Cluster 4: dispersed throughout the US and UK, as well as being listed in, has the identical hold and moderate buy medians

#Cluster 5: #solely listed on the NYSE, equally dispersed in the US and Canada, with Hold and Moderate Buy medians.