Assignment 4

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#Loading the Required packages

```
library(flexclust)
```

```
## Loading required package: grid
```

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

```
## Loading required package: modeltools
```

```
## Loading required package: stats4
```

```
library(cluster)
library(tidyverse)
```

```
## ── Attaching core tidyverse packages ──────────────────────── tidyverse
2.0.0 ──
## ✓ dplyr     1.1.0     ✓ readr     2.1.4
## ✓ forcats   1.0.0     ✓ stringr   1.5.0
## ✓ ggplot2   3.4.1     ✓ tibble    3.1.8
## ✓ lubridate 1.9.2     ✓ tidyr     1.3.0
## ✓ purrr     1.0.1
```

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

```
library(factoextra)
```

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

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

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.

Loading the data

```
# Set working directory to where the file is stored
setwd("C:/Users/vamsh/Downloads")

# Read in the CSV file using read.csv
Info <- read.csv("C:/Users/vamsh/Downloads/Pharmaceuticals.csv")

# Choose columns 3 to 11 and store the resulting data frame in Info1
Info1 <- Info[3:11]

# Display the top six rows of Info1 using the head function
head(Info1)
```

```
##   Market_Cap Beta PE_Ratio  ROE  ROA Asset_Turnover Leverage Rev_Growth
## 1      68.44 0.32     24.7 26.4 11.8            0.7     0.42       7.54
## 2       7.58 0.41     82.5 12.9  5.5            0.9     0.60       9.16
## 3       6.30 0.46     20.7 14.9  7.8            0.9     0.27       7.05
## 4      67.63 0.52     21.5 27.4 15.4            0.9     0.00      15.00
## 5      47.16 0.32     20.1 21.8  7.5            0.6     0.34      26.81
## 6      16.90 1.11     27.9  3.9  1.4            0.6     0.00      -3.17
##   Net_Profit_Margin
## 1              16.1
## 2               5.5
## 3              11.2
## 4              18.0
## 5              12.9
## 6               2.6
```

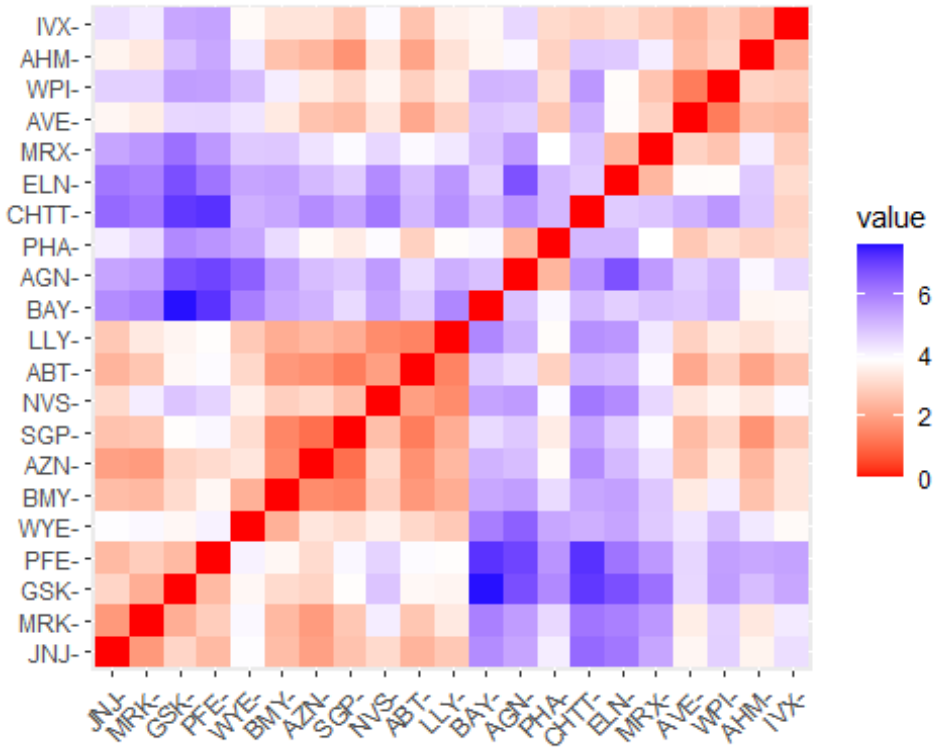
```
# Print summary statistics for Info1
summary(Info1)
```

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

```
##  3rd Qu.:21.1
##  Max.   :25.5
```

##The data in Info1 and the Info updated dataframe will be scaled according to the varying weights assigned to each variable along the rows. using the factoextra package's get dist and fviz dist functions to measure the distance between data rows and visualize the distance matrix

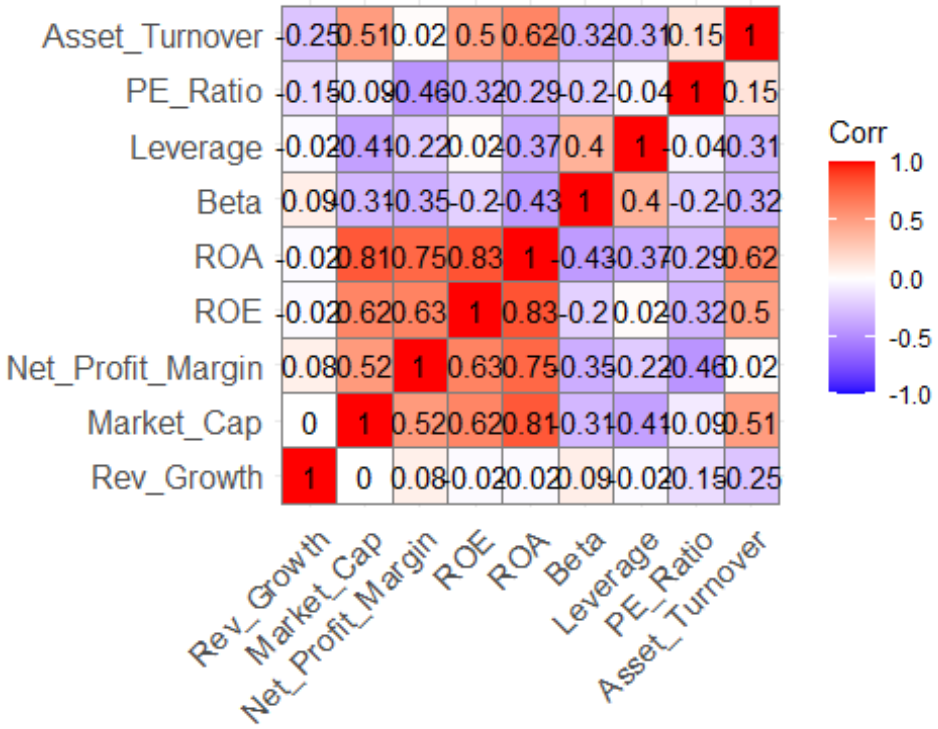
```
library(factoextra)

# Scale the Info1 data
Infoupdated <- scale(Info1)

# Set row names to match the first column of the original Info data
row.names(Infoupdated) <- Info[,1]

# Calculate the distance matrix using get_dist
distance <- get_dist(Infoupdated)

# Visualize the distance matrix using fviz_dist
fviz_dist(distance)
```



#To check the correlation between key variables, create a correlation matrix and print it.

```
library(ggcorrplot)

# Calculate the correlation matrix for Infoupdated using the cor function
```

```
corr <- cor(Infoupdated)

# Visualize the correlation matrix using ggcorrplot
ggcorrplot(corr, outline.color = "grey50", lab = TRUE, hc.order = TRUE, type
= "full")
```

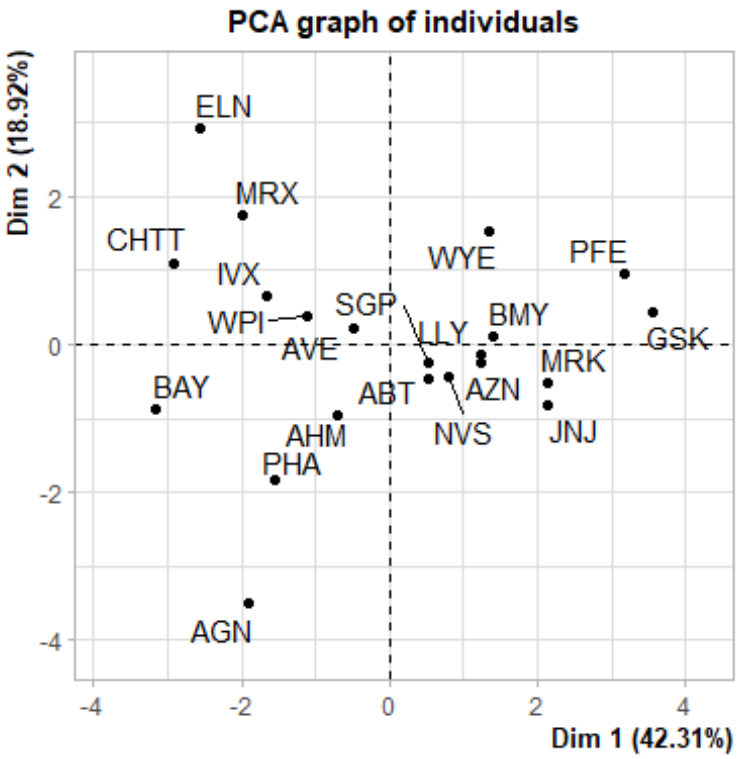


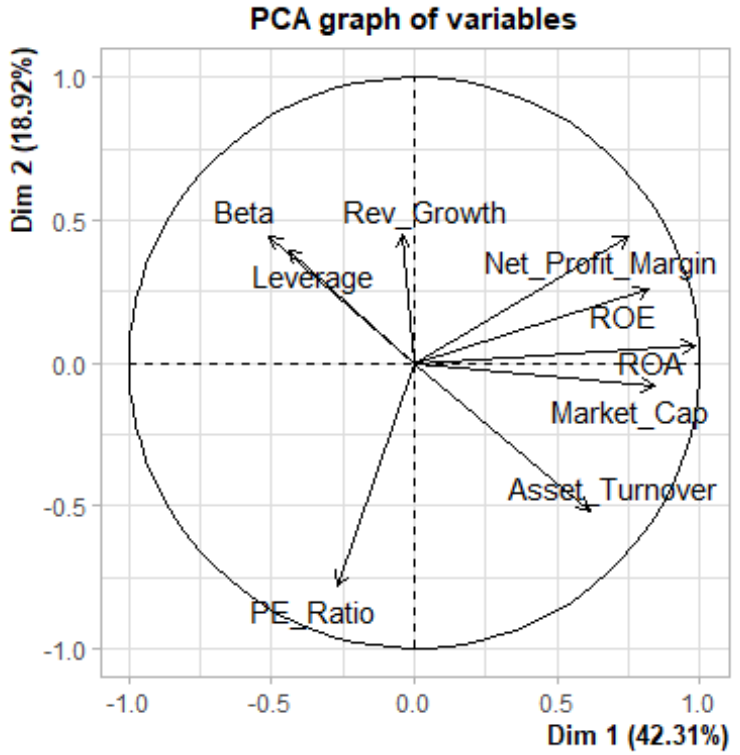
##The ROA, ROE, Net Profit Margin, and Market Cap are all high, according to the Correlation Matrix..

Finding out the relative importance of the primary variables in the data set will be done using principal component analysis.

assuming the optimal cluster size is 5.

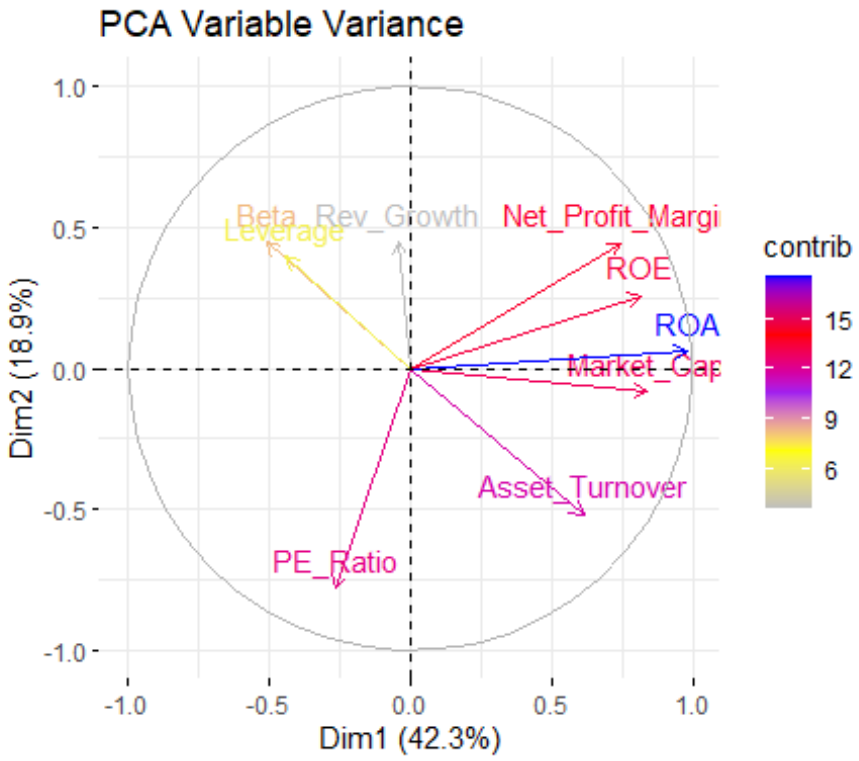
```
library(factoextra)

# Perform PCA on Infoupdated using the PCA function
pca <- PCA(Infoupdated)
```





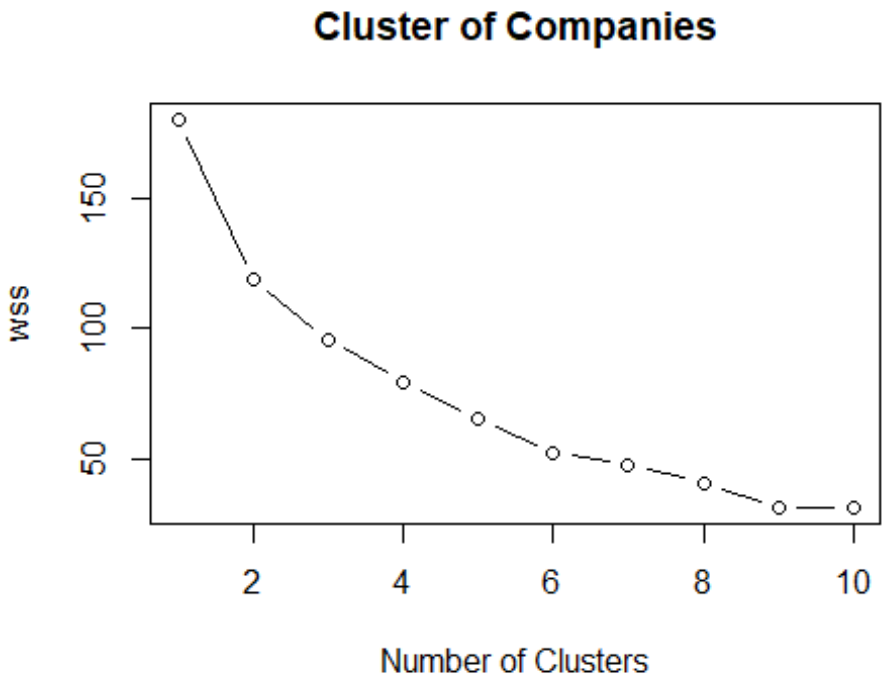

```
# Get the variable contributions using the get_pca_var function
var <- get_pca_var(pca)

# Visualize the variable contributions using fviz_pca_var
```

```
fviz_pca_var(pca, col.var="contrib",
             gradient.cols = c("grey","yellow","purple","red","blue"),ggrepel
= TRUE ) + labs( title = "PCA Variable Variance")
```



Using the elbow technique to discover the ideal number of customers, we can infer from PCA Variable Variance that ROA, ROE, Net Profit Margin, Market Cap, and Asset Turnover contribute over 61% to the two PCA components/dimensions Variables.

```
# Set the random seed for reproducibility
set.seed(10)

# Use a for loop to calculate the within-cluster sum of squares (wss) for 1
to 10 clusters
wss <- vector()
for(i in 1:10) wss[i] <- sum(kmeans(Infoupdated,i)$withinss)

# Visualize the wss values using a line plot
plot(1:10, wss , type = "b" , main = paste('Cluster of Companies') , xlab =
"Number of Clusters", ylab="wss")
```




```
# Print the wss values for each number of clusters
wss
```

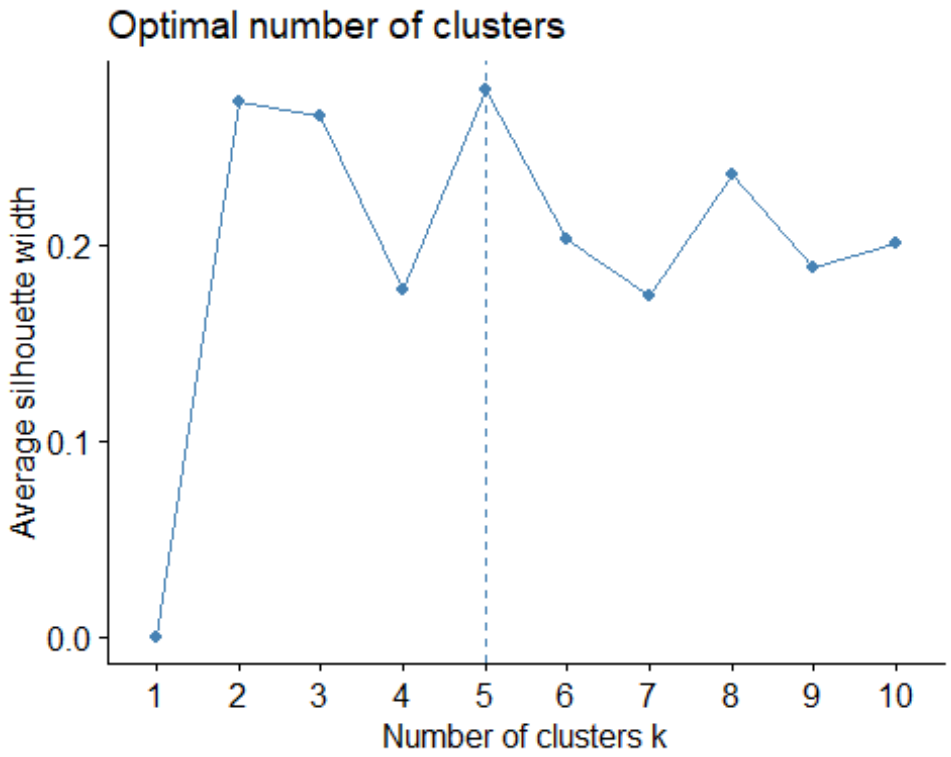
```
##  [1] 180.00000 118.56934  95.99420  79.21748  65.61035  52.67476  47.66961
##  [8]  41.12605  31.81763  31.57252
```

Exactly as predicted, the ideal cluster is at number 5.

Silhouette Approach

determining the optimal cluster size.

```
# Use the fviz_nbclust function to determine the optimal number of clusters
using the silhouette method
fviz_nbclust(Infoupdated, kmeans, method = "silhouette")
```



This demonstrates that five clusters are the optimum number. Using the k-means method to create a 5 cluster.

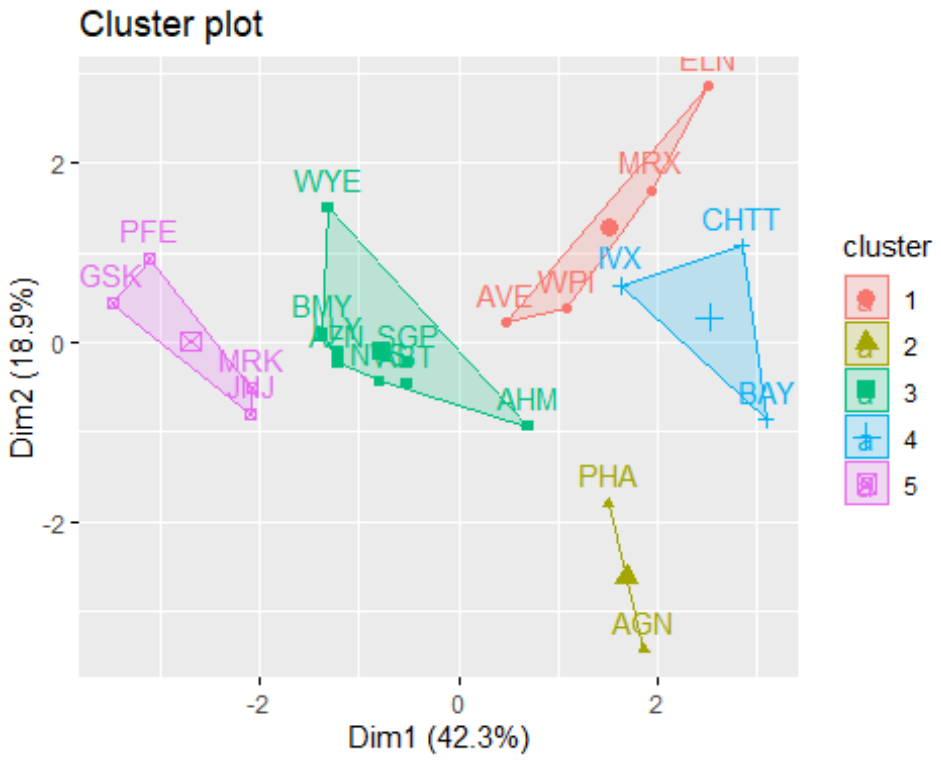
```
# Use the kmeans function to create 5 clusters and visualize the results
using the fviz_cluster function
set.seed(1)
k5 <- kmeans(Infoupdated, centers = 5, nstart = 25) # k = 5, number of
restarts = 25
k5$centers
```

```
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
## 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  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
##      Leverage Rev_Growth Net_Profit_Margin
## 1  0.06308085  1.5180158      -0.006893899
## 2 -0.14170336 -0.1168459      -1.416514761
## 3 -0.27449312 -0.7041516       0.556954446
## 4  1.36644699 -0.6912914      -1.320000179
## 5 -0.46807818  0.4671788       0.591242521
```

```
k5$size
```

```
## [1] 4 2 8 3 4
```

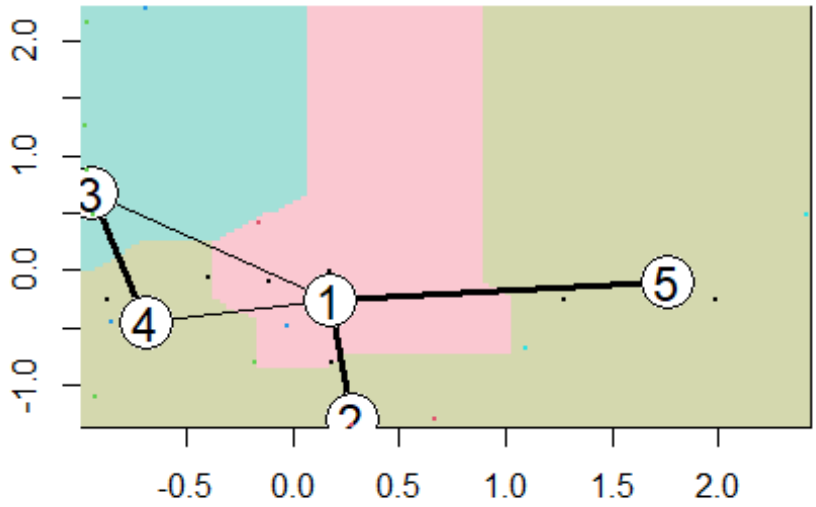
```
fviz_cluster(k5, data = Infoupdated)
```



Manhattan Distance when using Kmeans Clustering.

```
# Use kcca function to create 5 clusters with Manhattan distance and k-
medians algorithm
set.seed(1)
k51 <- kcca(Infoupdated, k = 5, kccaFamily("kmedians"))

# Print the results and visualize the clusters
k51

## kcca object of family 'kmedians'
##
## call:
## kcca(x = Infoupdated, k = 5, family = kccaFamily("kmedians"))
##
## cluster sizes:
##
## 1 2 3 4 5
## 7 3 6 3 2

clusters_index <- predict(k51)
dist(k51@centers)

##          1        2        3        4
## 2 2.150651
## 3 3.513242 4.146567
## 4 3.878726 4.246051 3.388339
## 5 3.018500 3.737739 5.124420 6.043691
```

```
image(k51)
points(Infoupdated, col = clusters_index, pch = 19, cex = 0.3)
```



b.Interpret the clusters with respect to the numerical variables used in forming the clusters Using Kmeans method to calculate Mean.

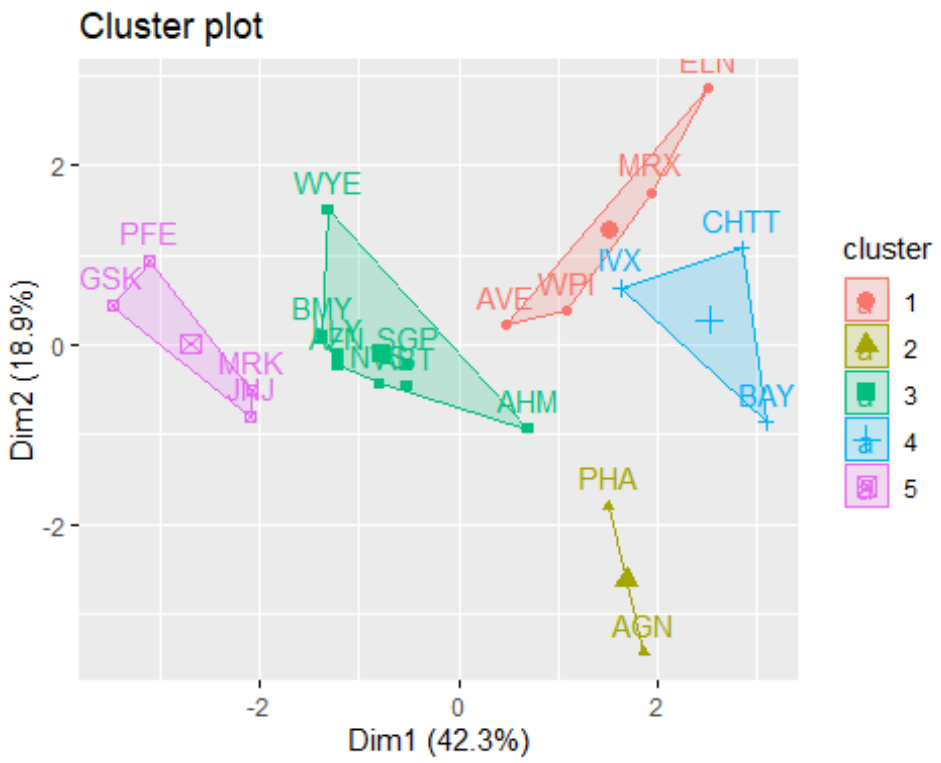
```
set.seed(1)
k5 <- kmeans(Infoupdated, centers = 5, nstart = 25) # k = 5, number of
restarts = 25
k5$centers
```

```
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
## 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  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
##      Leverage Rev_Growth Net_Profit_Margin
## 1  0.06308085  1.5180158      -0.006893899
## 2 -0.14170336 -0.1168459      -1.416514761
## 3 -0.27449312 -0.7041516       0.556954446
## 4  1.36644699 -0.6912914      -1.320000179
## 5 -0.46807818  0.4671788       0.591242521
```

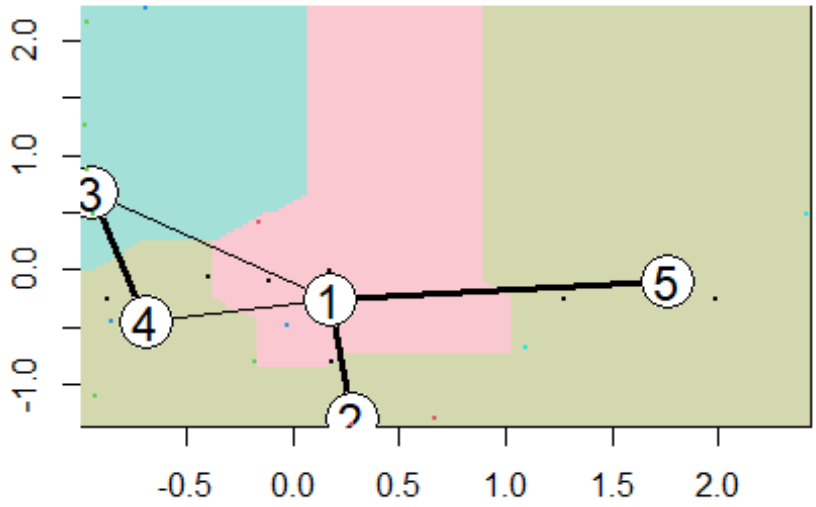
```
k5$size
```

```
## [1] 4 2 8 3 4
```

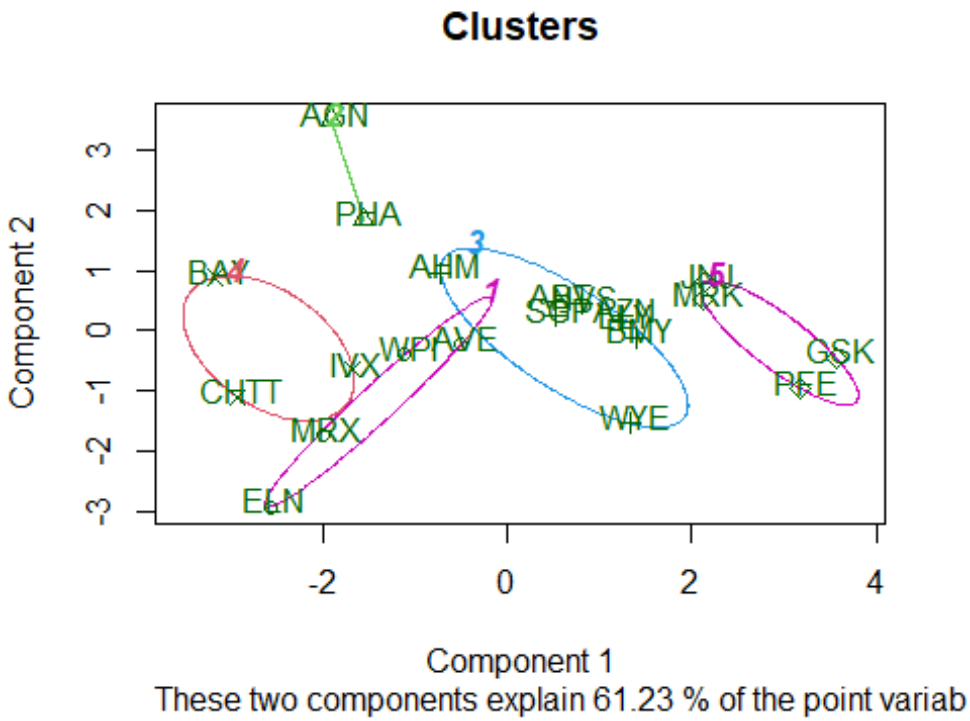
```
fviz_cluster(k5, data = Infoupdated)
```




```
set.seed(1)
k51 = kcca(Infoupdated, k=5, kccaFamily("kmedians"))
k51

## kcca object of family 'kmedians'
##
## call:
## kcca(x = Infoupdated, k = 5, family = kccaFamily("kmedians"))
##
## cluster sizes:
##
## 1 2 3 4 5
## 7 3 6 3 2

#Using predict function.
clusters_index <- predict(k51)
dist(k51@centers)

##          1        2        3        4
## 2 2.150651
## 3 3.513242 4.146567
## 4 3.878726 4.246051 3.388339
## 5 3.018500 3.737739 5.124420 6.043691

image(k51)
points(Infoupdated, col=clusters_index, pch=19, cex=0.3)
```




```
Info1 %>% mutate(Cluster = k5$cluster) %>% group_by(Cluster) %>%
summarise_all("mean")

## # A tibble: 5 × 10
##   Cluster Market_Cap  Beta PE_Ratio   ROE   ROA Asset_…¹ Lever…² Rev_G…³
Net_P…⁴
##     <int>      <dbl> <dbl>    <dbl> <dbl> <dbl>    <dbl>   <dbl>   <dbl>
<dbl>
## 1       1      13.1  0.598     17.7  14.6  6.2     0.425   0.635   30.1
15.6
## 2       2      31.9  0.405     69.5  13.2  5.6     0.75    0.475   12.1
6.4
## 3       3      55.8  0.414     20.3  28.7 12.7     0.738   0.371    5.59
19.4
## 4       4       6.64 0.87      24.6  16.5  4.17    0.6     1.65     5.73
7.03
## 5       5     157.   0.48      22.2  44.4 17.7     0.95    0.22    18.5
19.6
## # … with abbreviated variable names ¹Asset_Turnover, ²Leverage, ³
Rev_Growth,
## #   ⁴Net_Profit_Margin

clusplot(Infoupdated,k5$cluster, main="Clusters",color = TRUE, labels =
2,lines = 0)
```



Companies are categorized into different clusters as follows:

Cluster 1: ELN, MRX, WPI and AVE Cluster 2: AGN and PHA Cluster 3: AHM,WYE,BMY,AZN, LLY, ABT, NVS and SGP Cluster 4: BAY, CHTT and IVX Cluster 5: JNJ, MRK, PFE and GSK

From the means of the cluster variables, it can be derived as follow:

Cluster 1has the best Net Profit Margin, the lowest PE ratio, and the fastest sales growth. It can be bought or kept on hand as a reserve.

Cluster 2 PE ratio is very high

Cluster 3 has a medium risk

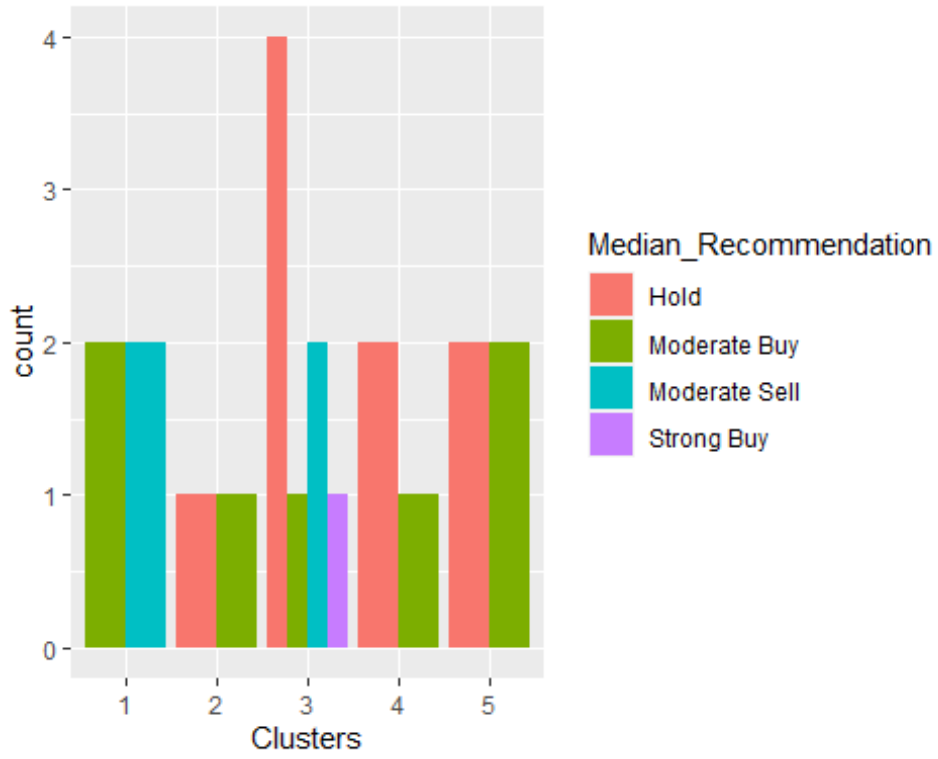
Cluster 4 Despite having an excellent PE ratio, it is incredibly risky to own due to its extremely high risk, extremely high leverage, and poor Net Profit margin. Also very low is revenue growth.

Cluster 5 has strong market capitalization, ROI, ROA, ROA on assets, ROA on turnover of assets, and ROA on net profit margin. A low PE ratio indicates that the stock price is moderately valued and may thus be bought and kept. Revenue growth of 18.5% is also favorable.

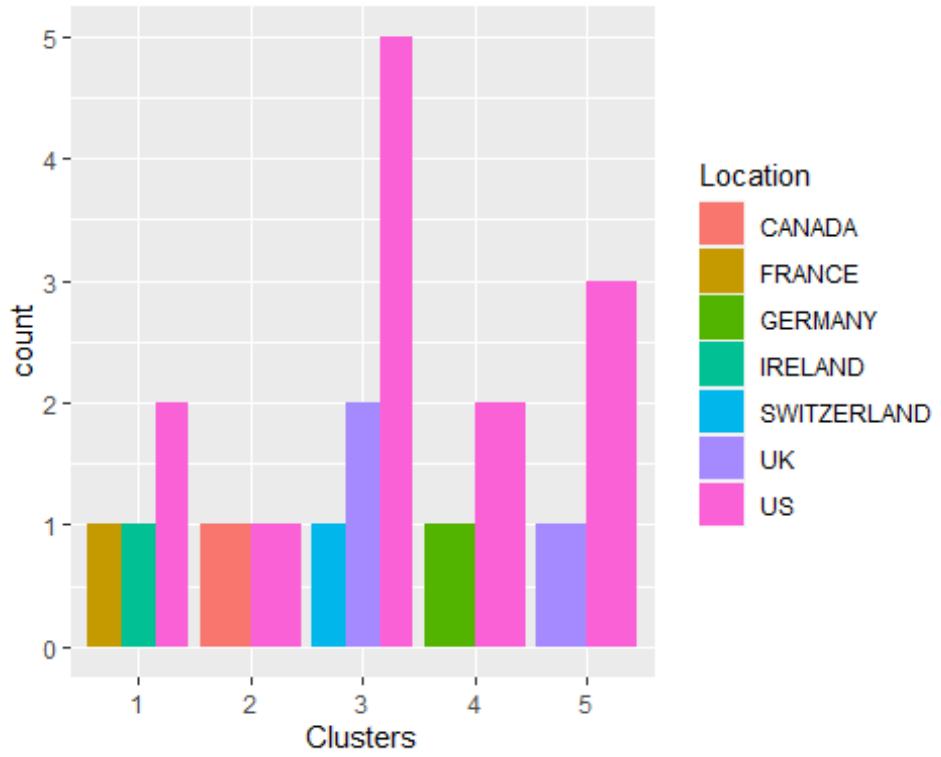
c.Is there a pattern in the clusters with respect to the numerical variables (10 to 12)? (those not used informing the clusters)

examining patterns by visualizing clusters against the variables

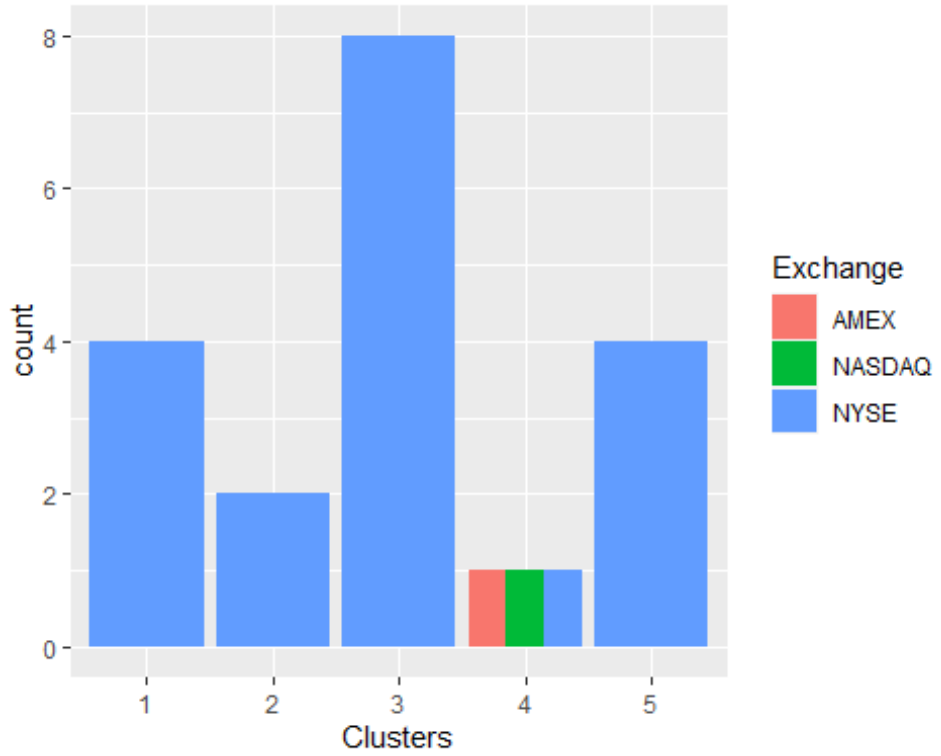
```
Info3 <- Info[12:14] %>% mutate(Clusters=k5$cluster)
ggplot(Info3, mapping = aes(factor(Clusters), fill =Median_Recommendation)) +
  geom_bar(position='dodge') + labs(x ='Clusters')
```




```
ggplot(Info3, mapping = aes(factor(Clusters),fill = Location)) +
  geom_bar(position = 'dodge') + labs(x ='Clusters')
```




```
ggplot(Info3, mapping = aes(factor(Clusters),fill = Exchange)) +
  geom_bar(position = 'dodge') + labs(x ='Clusters')
```



The variable and clusters There is a trend in the median recommendations.

There doesn't seem to be any discernable pattern among the clusters, locations, or exchanges other than the fact that the majority of the clusters/companies are listed on the NYSE and situated in the United States.

d.Provide an appropriate name for each cluster using any or all of the variables in the data set.

Cluster 1: Top Buying Cluster 2: Significant Risk Cluster 3: Attempt it Cluster 4: Very Dangerous or Runaway Cluster 5: A Perfect Asset