# Assignment 4

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```
setwd("C:/Users/Hanish Bhogadi/Documents/64060_hbhogadi/Assignment 4")
```

Loading the required libraries

```
library(factoextra)
```

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

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

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

Loading the data

```
Pharma_Data <- read.csv("Pharmaceuticals.csv")
View(Pharma_Data)
summary(Pharma_Data)
```

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

Removing the missing data

```
Pharma_Data_NA <- na.omit(Pharma_Data)
View(Pharma_Data_NA)
```

Separating the columns 1-9 for initial analysis with numerical columns

```
row.names(Pharma_Data_NA) <- Pharma_Data_NA[,1]
Pharma_Data1 <- Pharma_Data_NA[,3:11]
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
```

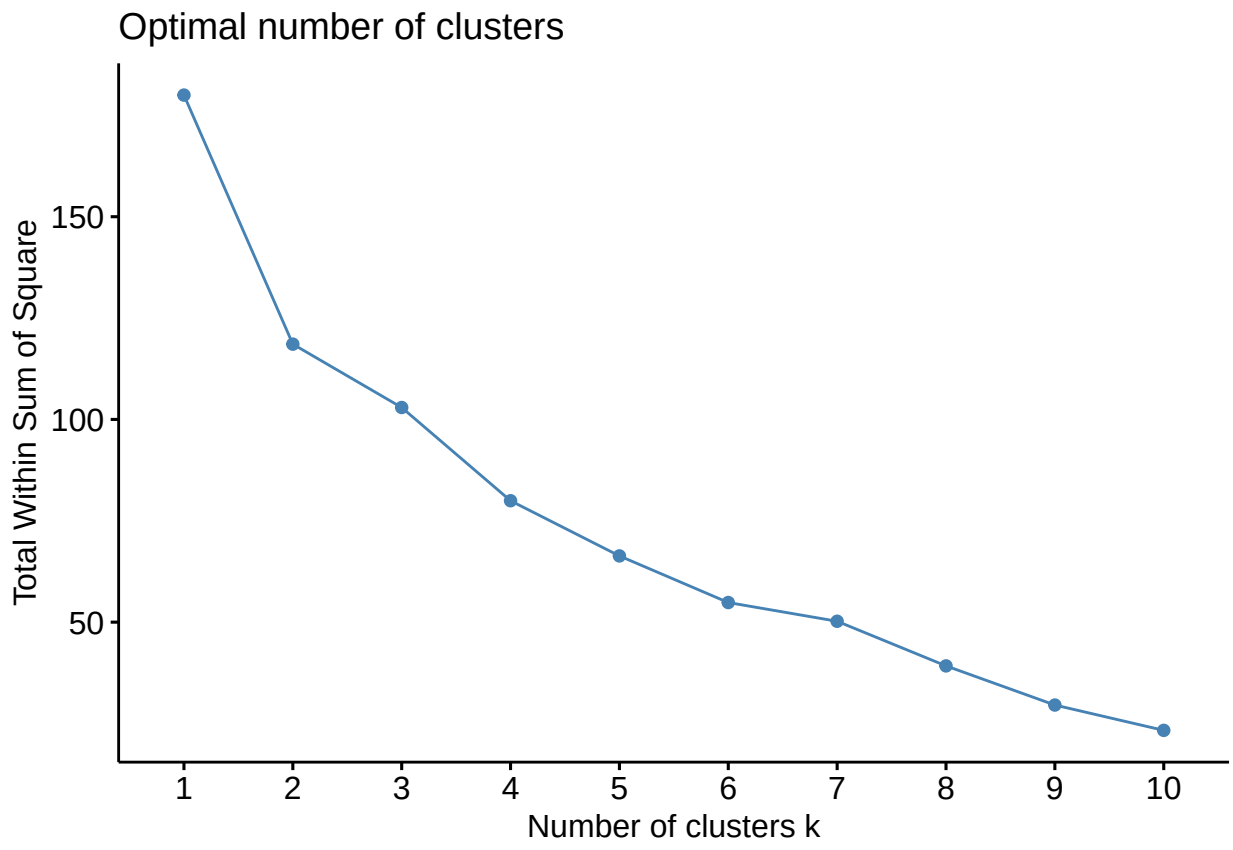
Scaling the data to bring the quantity data to reduce the distance between them

```
Pharma_scale <- scale(Pharma_Data1)
head(Pharma_scale)
```

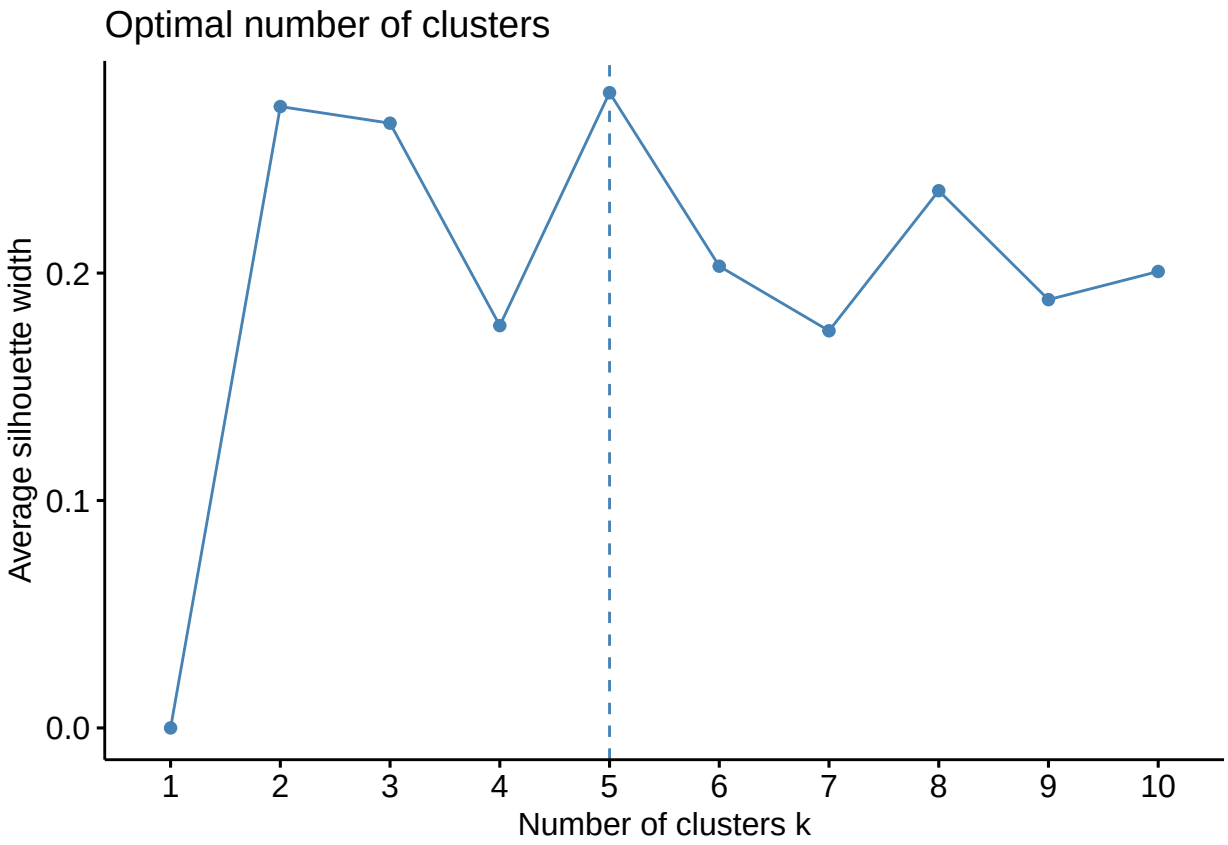
```
##     Market_Cap        Beta    PE_Ratio         ROE        ROA Asset_Turnover
## ABT  0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121      0.0000000
## AGN -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871      0.9225312
## AHM -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700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

Determining the number of clusters using Elbow method and sillhouette Method

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




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

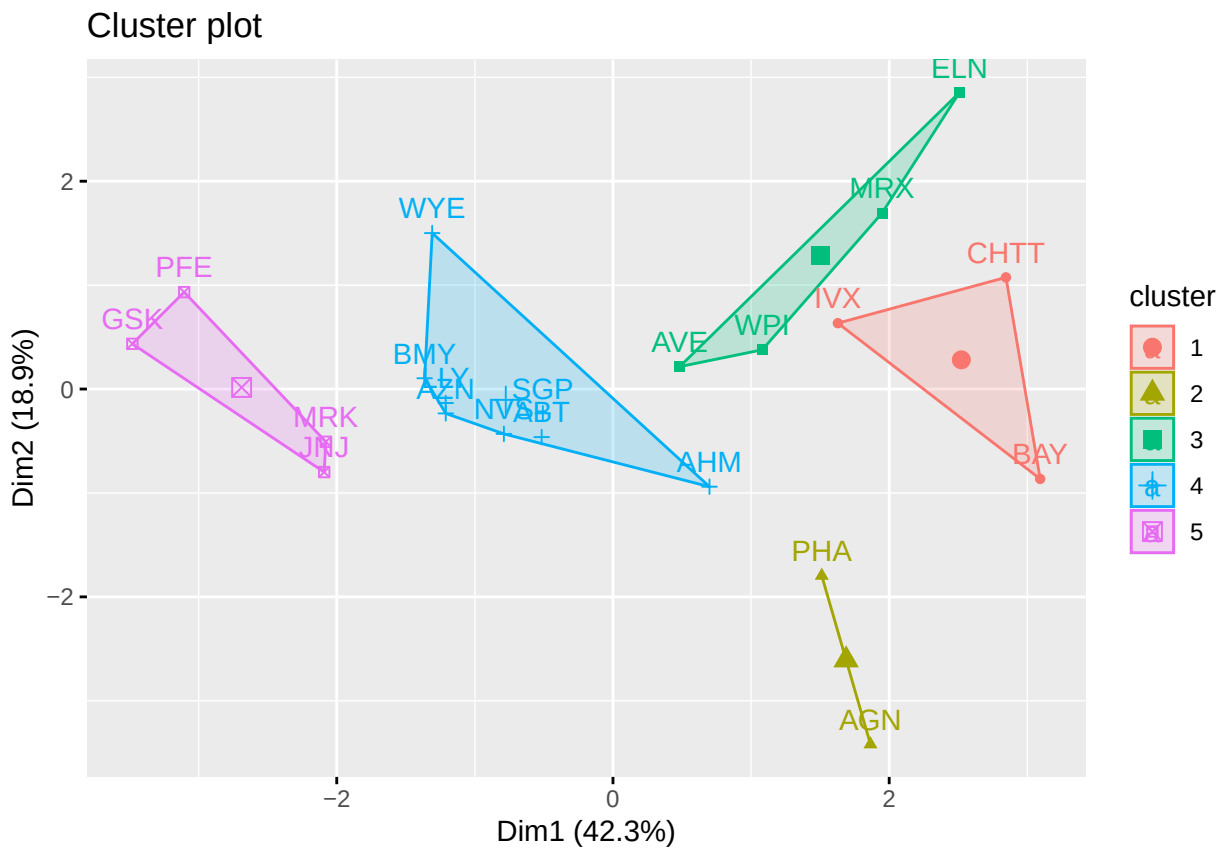



I used Elbow and Silhouette methods to find the optimal number of clusters. As Silhouette analysis is considered better than elbow method, I wanted to go with Silhouette method.

```
set.seed(64060)
five_clusters <- kmeans(Pharma_scale, centers = 5, nstart = 25)
five_clusters$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(five_clusters, data = Pharma_scale)
```




#As per the clusters formed above the sizes are 8, 2, 4, 4, 3

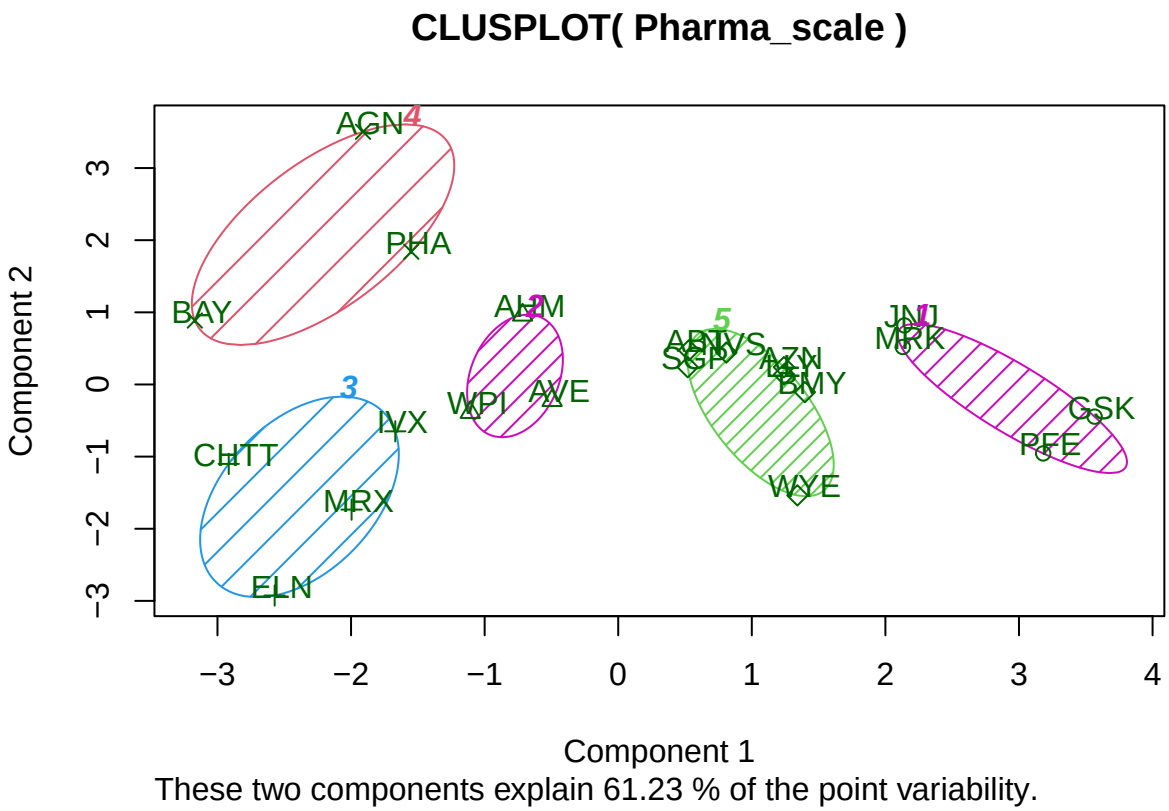
```
fit <- kmeans(Pharma_scale, 5)
```

```
Pharma2 <- data.frame(Pharma_scale, fit$cluster)
Pharma2
```

```
##      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
```

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




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

By observing the mean values of all quantitative variables for each cluster

```
aggregate(Pharma_scale, 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
```

Cluster_1 - JNJ, MRK, GSK, PFE - They have the highest market cap and the the companies are managing their operations by financing their operations fairly well (leverage below 0.47)

Cluster_2 - AHM, AVE, WPI - They have lowest asset turnover, lowest beta meaning the company stocks are performing lower than the current market performance index.

Cluster_3 - IVX, MRX, ELN, CHTT - They have the lowest market capitalization, the company is not using its debt to fund its operations, they all have highest revenue growth. These company stocks are also giving good returns since their beta value is more than 1.

Cluster_4 - AGN, PHA, BAY - These have the highest price to earning ratio making them less lucrative. Their Return on equity is also in below 1 proving that investment in these stocks will not be as fruitful as other stocks.

Cluster_5 - ABT, NVS, AZN, LLY, BMY, WYE, SGP - They have highest asset turnover, lowest revenue growth, and highest net profit margin. These companies are lucrative as they are growing companies.

#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)

We have manually filter each cluster to identify the patterns with respect to media recommendations, location and exchange.

For cluster 1: The stocks are moderate in nature meaning, they are neither weak stocks nor stocks with good returns in the recent past.

For cluster 2: The stocks are diversified in terms of their location. Their fundamentals are technically good and media recommendations are highly positive

For cluster 3: Their leverage ratio is high, they are moderately recommended because of their financial stability

For cluster 4: hese are the stocks that needs to be held as per the media recommendations since they will eventually turn into good stocks

For Cluster 5: The cluster has stocks that are recommended to be held for longer time since they have high net profit margin.

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

Cluster 1: Growth Cluster - Since these are stable stocks Cluster 2: Multi bagger cluster - Through their beta is low, market recommendations are very positive Cluster 3: Fundamental Cluster - Stocks with good stability in terms of their finances and other fundamentals Cluster 4: Hold cluster - These are the stocks they have decent numbers. Cluster 5: Long term Cluster - High net profit margin means good business and hence the stocks are highly recommended to be held in the portofolio