Fundamentals Of Machine Learning- Assignment-4

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```r
data_1 <- read.csv("~/Desktop/Pharmaceuticals.csv")
```

```r
library(factoextra)
```

```
## Loading required package: ggplot2

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

```r
library(ggplot2)
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --

## v tibble  3.1.8      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.2      v forcats 0.5.2
## v purrr   0.3.4
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```r
library(ISLR)
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.

P<- na.omit(data_1)
summary(P)
```

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

```
row.names(P) <- P[,1]
P_1 <- P[,3:11]
head(P_1)
```

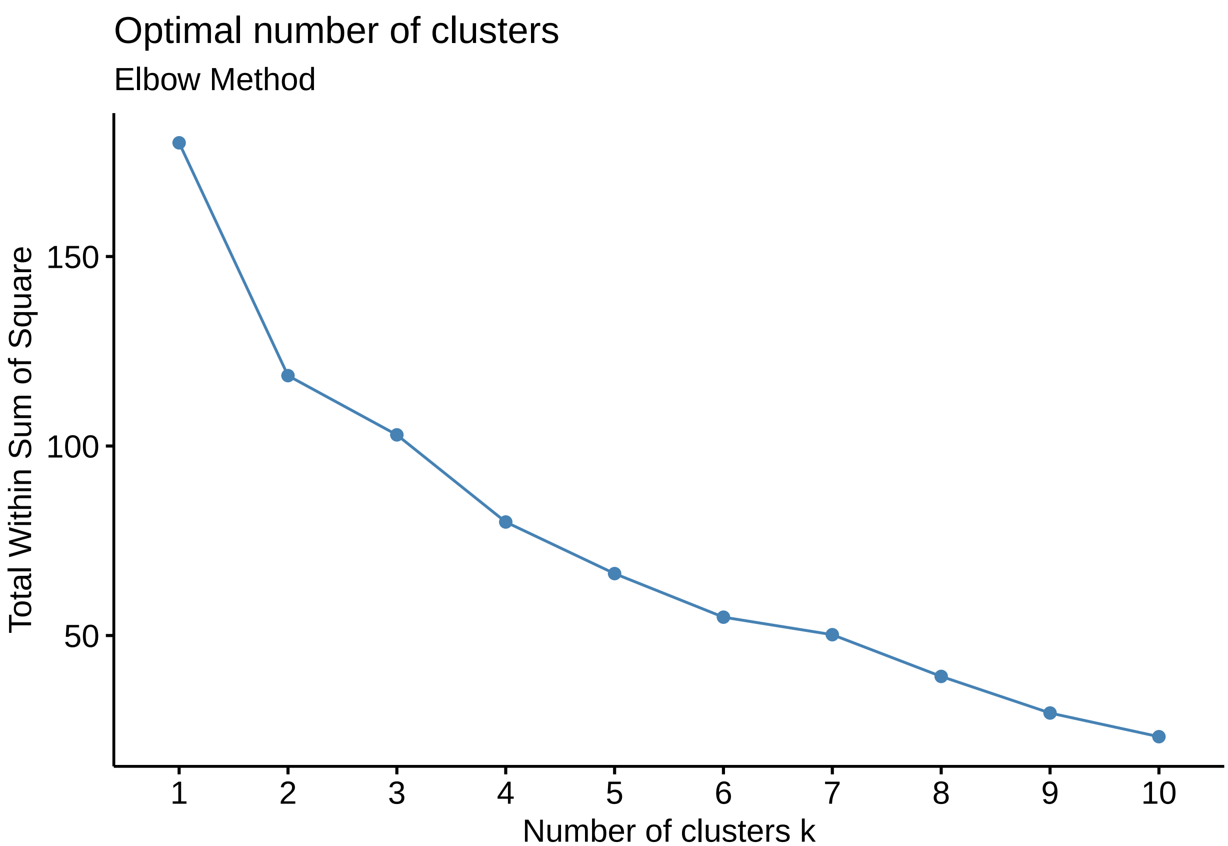
```
##     Market_Cap Beta PE_Ratio  ROE  ROA Asset_Turnover Leverage Rev_Growth
## ABT      68.44 0.32     24.7 26.4 11.8            0.7     0.42       7.54
## AGN       7.58 0.41     82.5 12.9  5.5            0.9     0.60       9.16
## AHM       6.30 0.46     20.7 14.9  7.8            0.9     0.27       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
```

```
P_2 <- scale(P_1)
head(P_2)
```

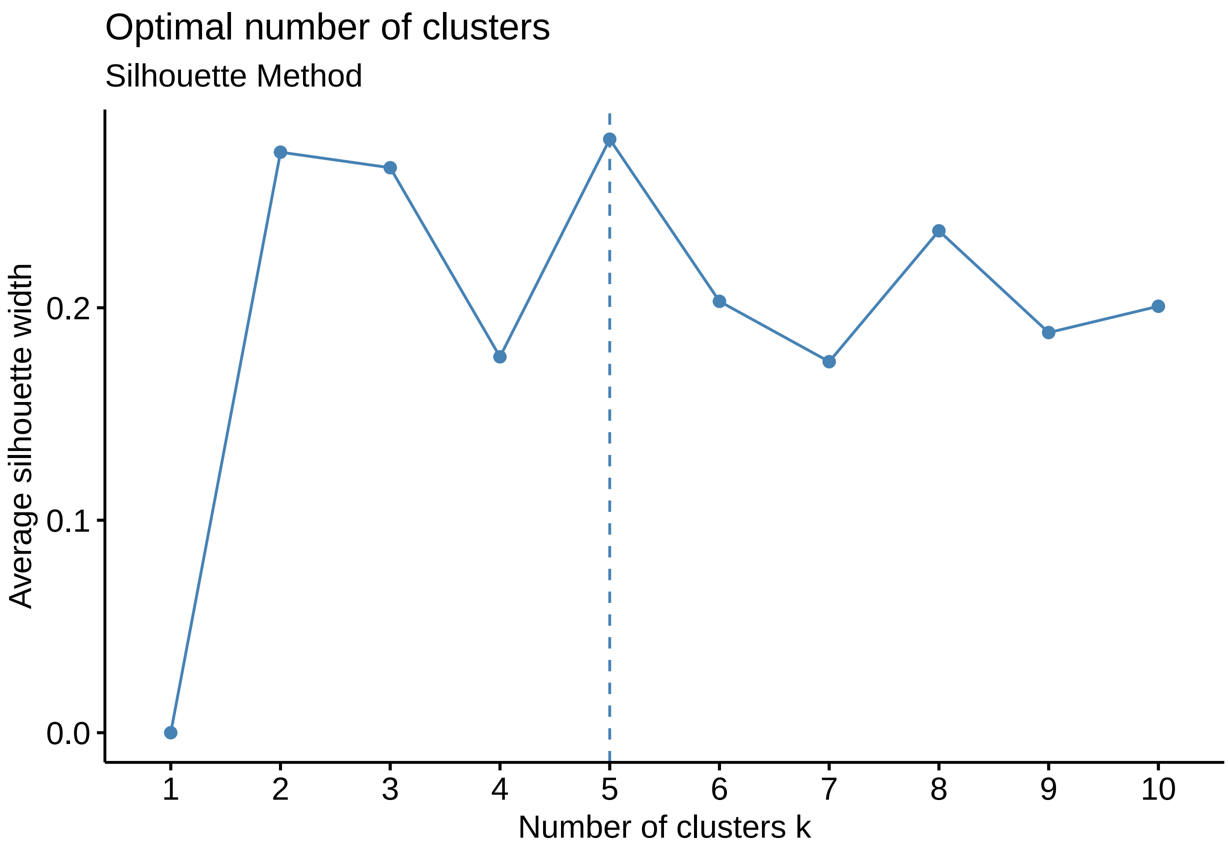
```
##     Market_Cap        Beta    PE_Ratio         ROE        ROA Asset_Turnover
## ABT  0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121      0.0000000
## AGN -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871      0.9225312
## AHM -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700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

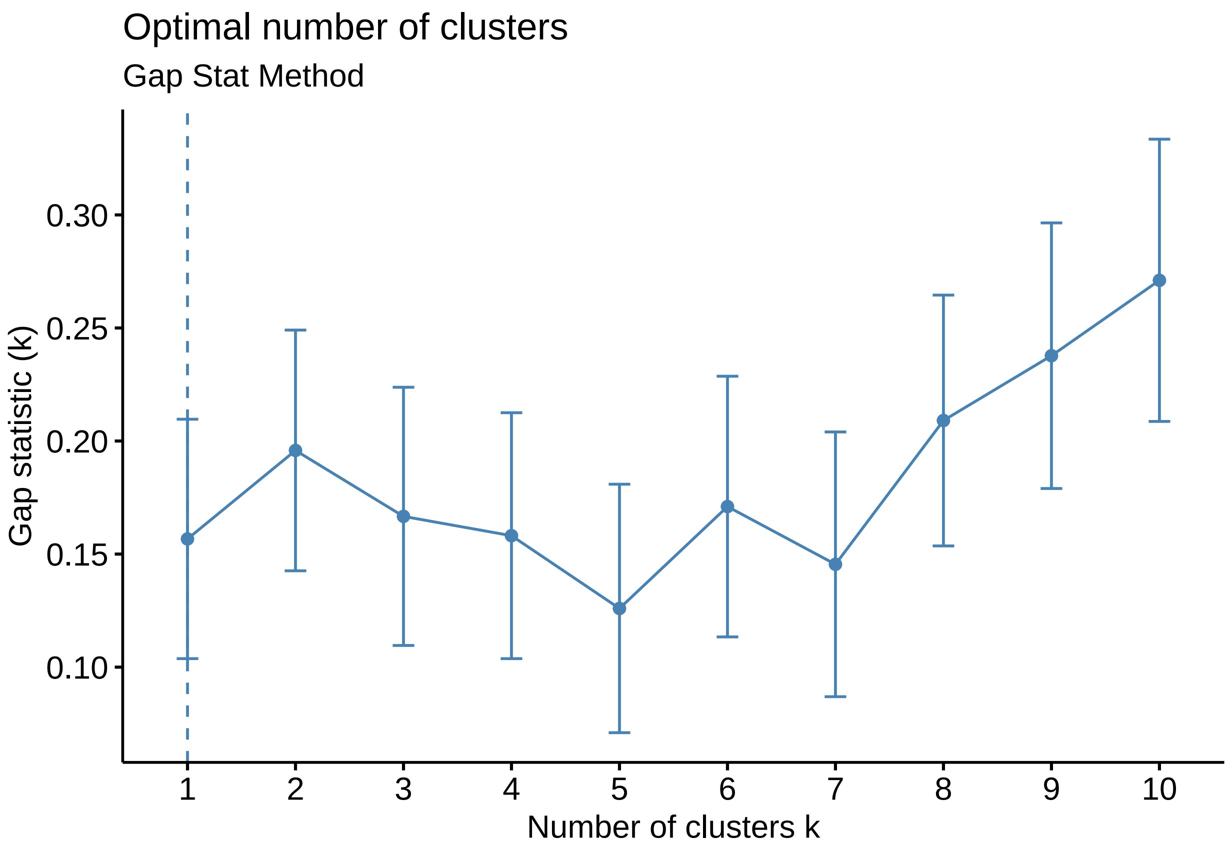
```r
fviz_nbclust(P_2, kmeans, method = "wss") + labs(subtitle = "Elbow Method")
```




```r
fviz_nbclust(P_2, kmeans, method = "silhouette") + labs(subtitle = "Silhouette Method")
```



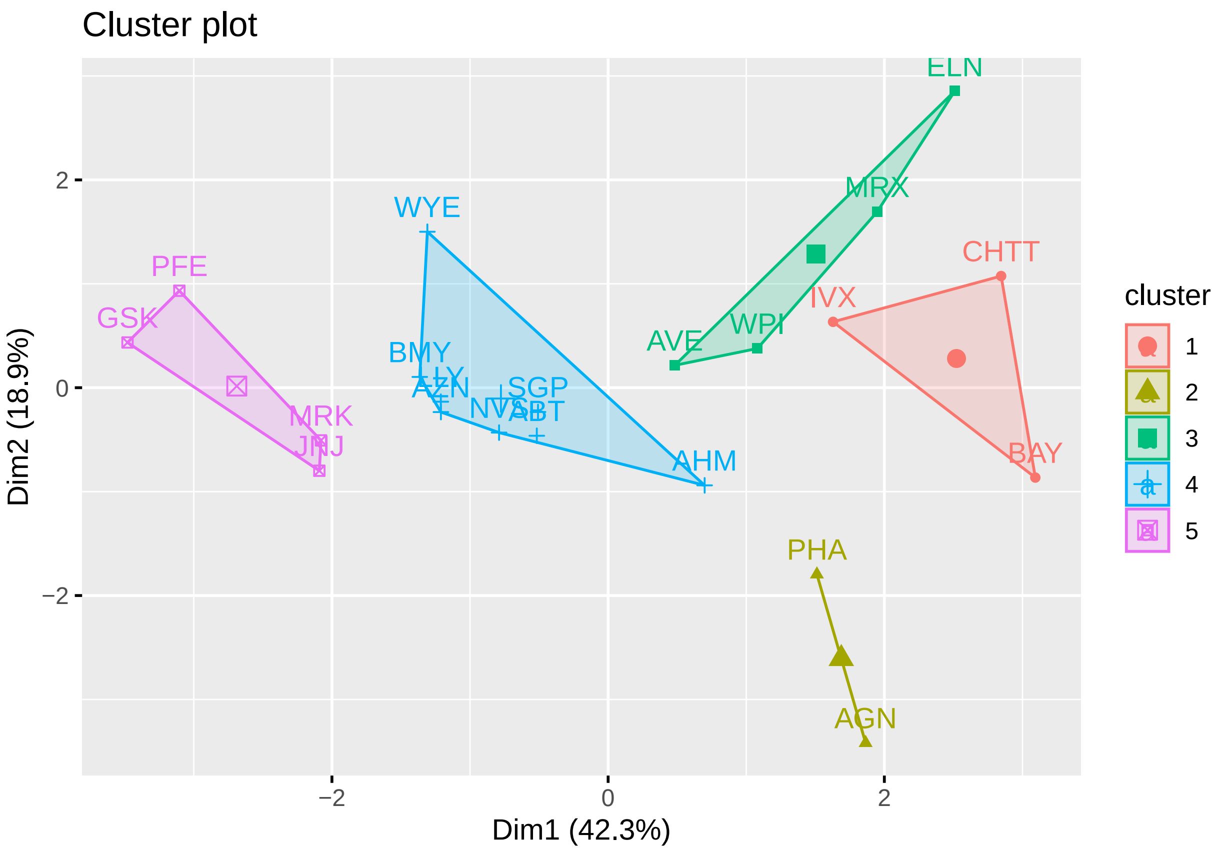

```
fviz_nbclust(P_2, kmeans, method = "gap_stat") + labs(subtitle = "Gap Stat Method")
```



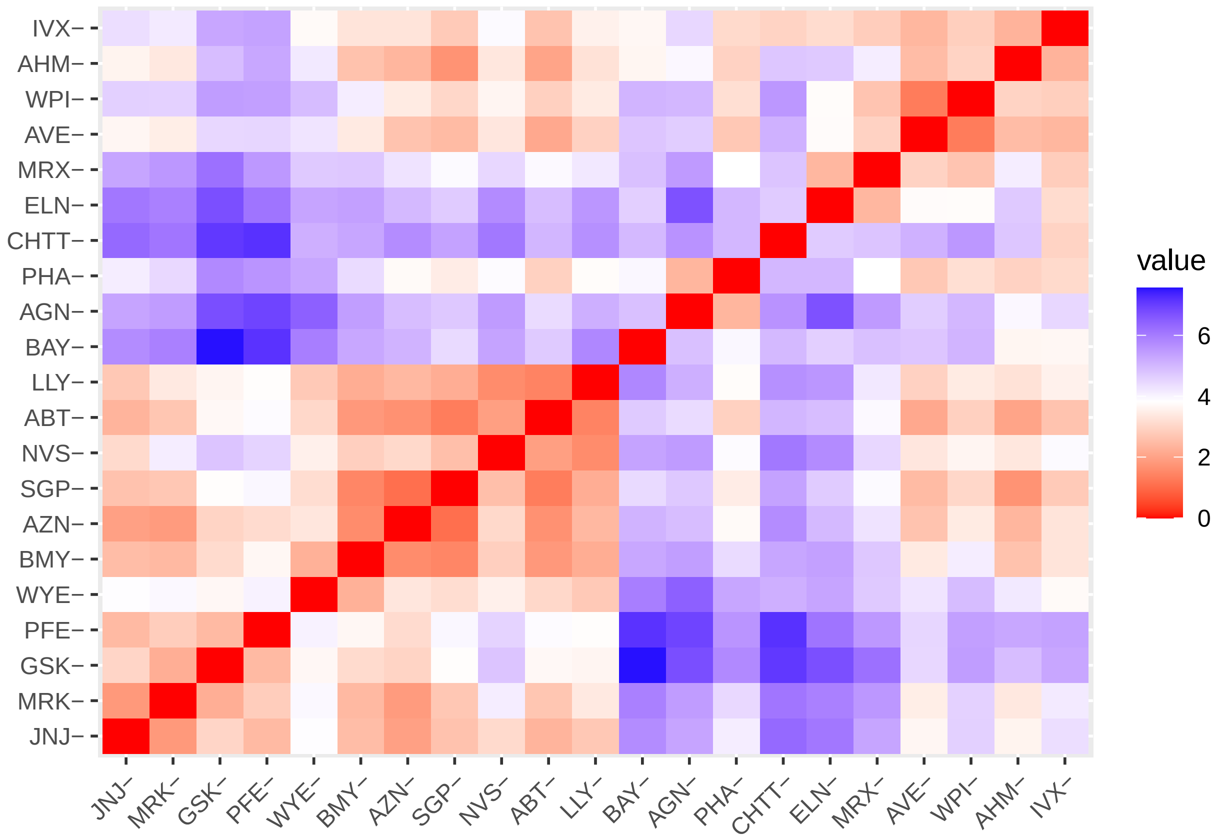

```
set.seed(64060)
k_value_5 <- kmeans(P_2, centers = 5, nstart = 25)
k_value_5$centers
```

```
##    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_value_5, data = P_2)
```




```
distance_1 <- dist(P_2, method = "euclidean")
fviz_dist(distance_1)
```




```
fit_1 <- kmeans(P_2, 5)
aggregate(P_2, by=list(fit_1$cluster), FUN=mean)
```

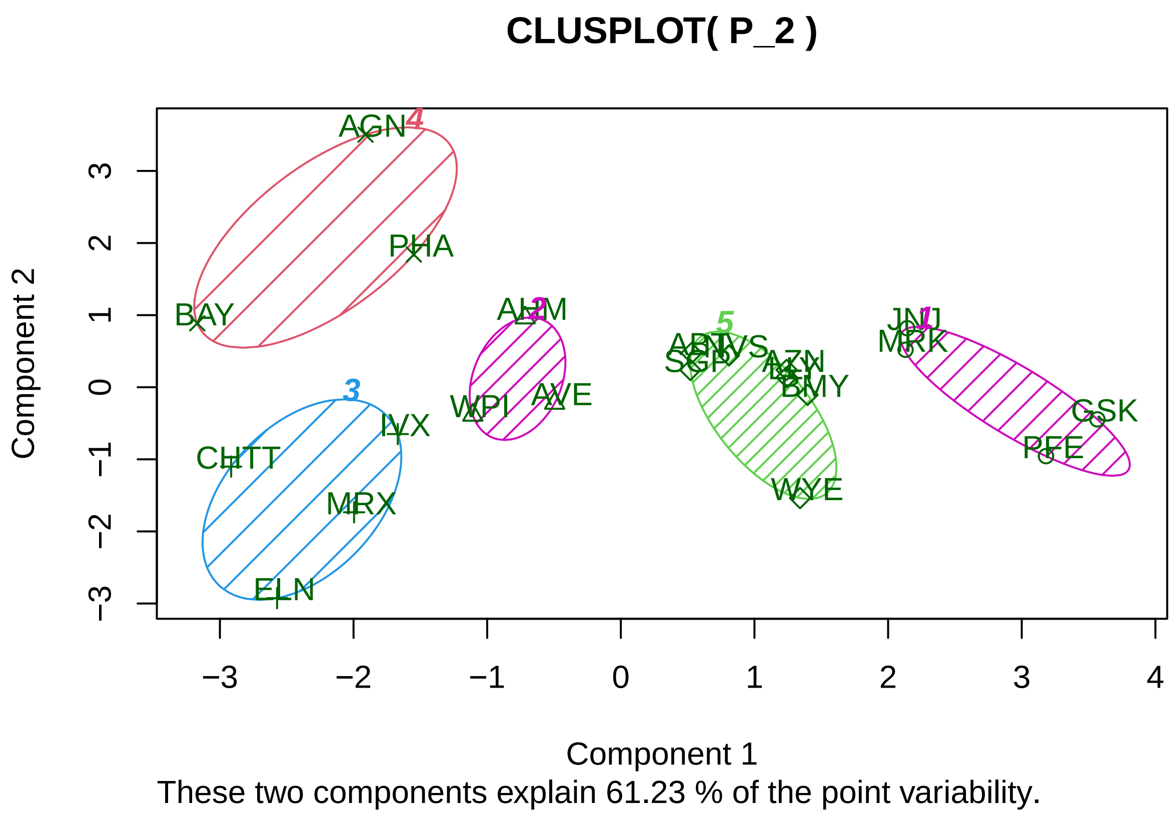
```
##   Group.1  Market_Cap       Beta   PE_Ratio        ROE        ROA
## 1       1  1.69558112 -0.1780563 -0.1984582  1.2349879  1.3503431
## 2       2 -0.66114002 -0.7233539 -0.3512251 -0.6736441 -0.5915022
## 3       3 -0.96247577  1.1949250 -0.3639982 -0.5200697 -0.9610792
## 4       4 -0.52462814  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
```

```
P_3 <- data.frame(P_2, fit_1$cluster)
P_3
```

```
##     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_1.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
```

```r
clusplot(P_2, fit_1$cluster, color = TRUE, shade = TRUE,
         labels = 2, lines = 0)
```



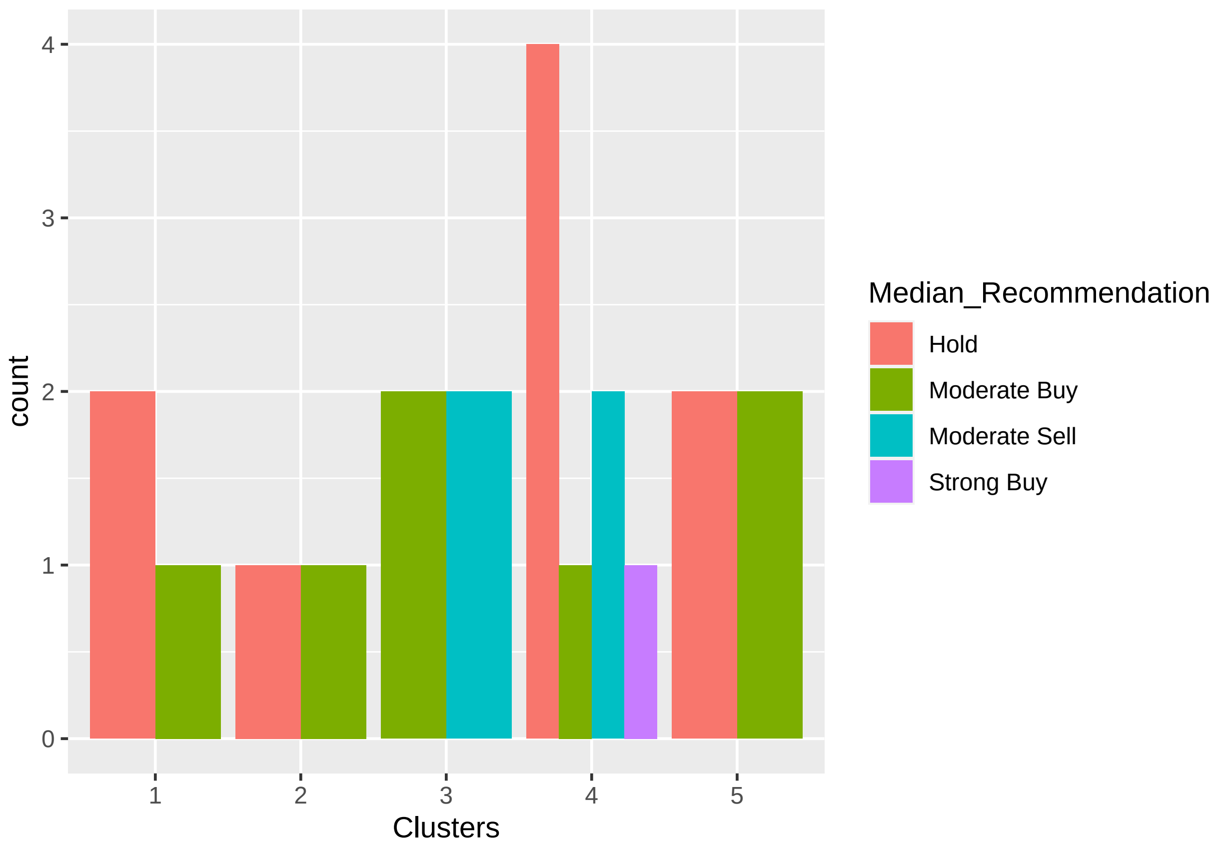

```r
#Task 2

#Interpret the clusters with respect to the
#numerical variables used in forming the clusters.
P_4 <- data.frame(P_2,k_value_5$cluster)
P_4
```

```
##       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
```

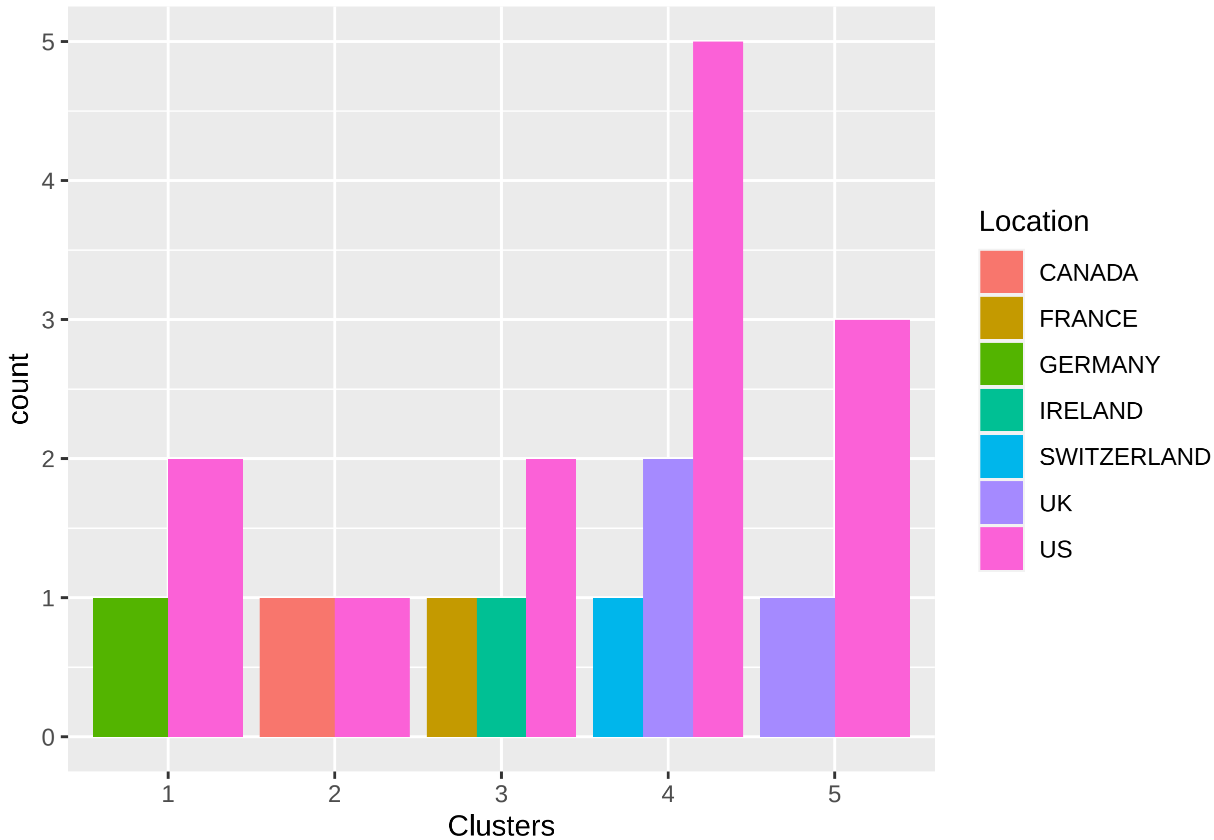
```
## WYE  -0.1614497  0.40619104 -0.75792214  1.92938746  0.5422849     -0.4612656
##         Leverage  Rev_Growth Net_Profit_Margin k_value_5.cluster
## ABT  -0.21209793 -0.52776752        0.06168225                 4
## AGN   0.01828430 -0.38113909       -1.55366706                 2
## AHM  -0.40408312 -0.57211809       -0.68503583                 4
## AZN  -0.74965647  0.14744734        0.35122600                 4
## AVE  -0.31449003  1.21638667       -0.42597037                 3
## BAY  -0.74965647 -1.49714434       -1.99560225                 1
## BMY  -0.02011273 -0.96584257        0.74744375                 4
## CHTT  3.74279705 -0.63276071       -1.24888417                 1
## ELN   0.61983791  1.88617085       -0.36501379                 3
## LLY  -0.07130879 -0.64814764        1.17413980                 4
## GSK  -0.31449003  0.76926048        0.82363947                 5
## IVX   1.10620040  0.05603085       -0.71551412                 1
## JNJ  -0.62166634 -0.36213170        0.33598685                 5
## MRX   0.44065173  1.53860717        0.85411776                 3
## MRK  -0.39128411  0.36014907       -0.24310064                 5
## NVS  -0.67286239 -1.45369888        1.02174835                 4
## PFE  -0.54487226  1.10143723        1.44844440                 5
## PHA  -0.30169102  0.14744734       -1.27936246                 2
## SGP  -0.74965647 -0.43544591        0.29026942                 4
## WPI  -0.49367621  1.43089863       -0.09070919                 3
## WYE   0.68383297 -1.17763919        1.49416183                 4
```

```
#Cluster-1
#JNJ,MRK,PFE,GSK belongs to this cluster.
#They have the highest Market Capitalization and the lowest Beta & Price/earnings ratio.

#Cluster 2
#AHM,WPI,AVE belongs to this cluster.
#They have the highest Estimated revenue growth
#and the lowest Price/earnings ratio & Asset Turnover ratio.

#Cluster 3
#CHTT,MRX,IVX,ELN belongs to this cluster.
#They have the highest Beta, Leverage & Asset turnover
#ratio and the lowest Net profit margin & Price/earnings ratio.

#Cluster 4
#AGN,BAY,PHA belongs to this cluster.
#They have the highest Profit/earnings ratio ad lowest
#Asset turnover ratio.

#Cluster 5
#ABT,SGP,NVS,AZN,BMY,WYE, LLY belongs to this cluster.
#They have the highest Net profit margin and lowest is
#the Leverage.





#Task 3
```

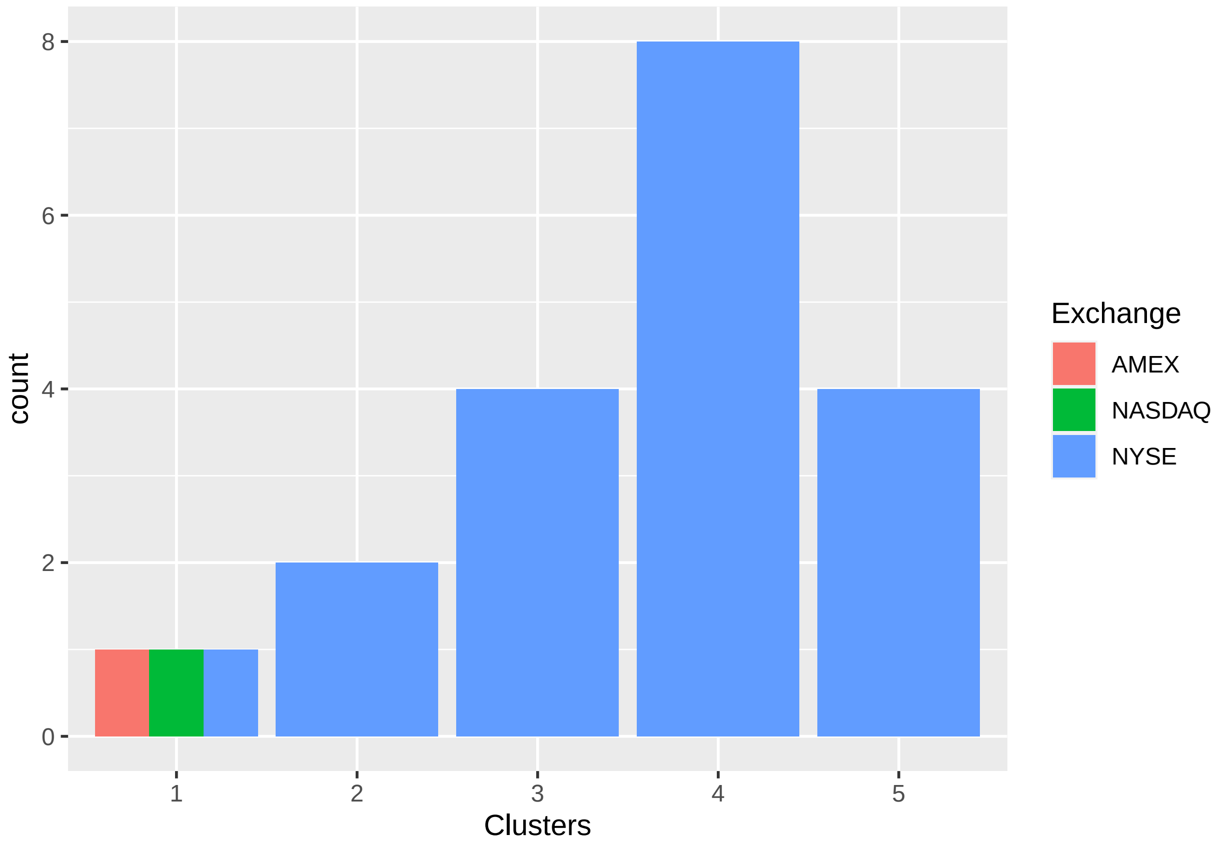
```r
#Is there a pattern in the clusters with respect
#to the numerical variables (10 to 12)? #(those not
#used in forming the clusters)

pharm <- data_1[12:14] %>%
  mutate(Clusters=k_value_5$cluster)
ggplot(pharm, mapping =
          aes(factor(Clusters), fill =Median_Recommendation)) +
  geom_bar(position='dodge')+labs(x ='Clusters')
```




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




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




```
#From the plotted graphs, a pattern has been
#observed among the clusters. The following statements
#are based on these observations:

#Cluster 1

#The companies are uniformly distributed throughout
#AMEX, NASDAQ, and NYSE while the Hold and Moderate
#Buy medians in cluster 1 are different from those in the
#US and Germany, respectively.

#Cluster 2
#This cluster is exclusively listed on the NYSE with
#an equal split between the US and Canada and it also has
#equal hold and moderate buy medians.

#Cluster 3
#Here the cluster has medians for moderate buys and sales
#that are equal, and the counts from those of France and Ireland
#are same while for the US it is different, and NYSE listing
#entirely covers this cluster.

#Cluster 4
#The Hold median in Cluster 4 is the highest, followed by
#Moderate Sell and then having Moderate Buy and Strong buy on
#the same level. They're from countries US, UK and Switzerland
#and they are listed in NYSE.
```

```
#Cluster 5
#This Cluster has the same hold and moderate buy medians
#and is distributed among the countries US and UK and also
#NYSE is listed here.





#Task 4

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

#Cluster 1- Highest Market Capitalization Cluster.
#Cluster 2- Highest Estimated Growth Cluster.
#Cluster 3- Highest Beta Cluster
#Cluster 4- Highest Profit/earnings ratio Cluster.
#Cluster 5- Highest Net profit margin Cluster.
```