Assignment_4

Ganesh Reddy

2023-11-12

Loading the Required packages

```
library(flexclust)
```

```
## Warning: package 'flexclust' was built under R version 4.3.2

## 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 --
## 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 1.9.3     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)
```

```
## Warning: package 'factoextra' was built under R version 4.3.2

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

```r
library(FactoMineR)
```

```
## Warning: package 'FactoMineR' was built under R version 4.3.2
```

```r
library(ggcorrplot)
```

```
## Warning: package 'ggcorrplot' was built under R version 4.3.2
```

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.

Loading the data

```r
pharma<- read.csv("Pharmaceuticals.csv")

head(pharma)
```

```
##   Symbol                 Name Market_Cap Beta PE_Ratio  ROE  ROA Asset_Turnover
## 1    ABT Abbott Laboratories      68.44 0.32     24.7 26.4 11.8            0.7
## 2    AGN      Allergan, Inc.       7.58 0.41     82.5 12.9  5.5            0.9
## 3    AHM         Amersham plc       6.30 0.46     20.7 14.9  7.8            0.9
## 4    AZN     AstraZeneca PLC      67.63 0.52     21.5 27.4 15.4            0.9
## 5    AVE              Aventis      47.16 0.32     20.1 21.8  7.5            0.6
## 6    BAY             Bayer AG      16.90 1.11     27.9  3.9  1.4            0.6
##   Leverage Rev_Growth Net_Profit_Margin Median_Recommendation Location Exchange
## 1     0.42       7.54              16.1          Moderate Buy       US     NYSE
## 2     0.60       9.16               5.5          Moderate Buy   CANADA     NYSE
## 3     0.27       7.05              11.2            Strong Buy       UK     NYSE
## 4     0.00      15.00              18.0         Moderate Sell       UK     NYSE
## 5     0.34      26.81              12.9          Moderate Buy   FRANCE     NYSE
## 6     0.00      -3.17               2.6                  Hold  GERMANY     NYSE
```

Choosing columns 3 to 11 now, and putting the information in variable Info 1

```r
pharma1 <- pharma[3:11]

head(pharma1)
```

```
##   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
```

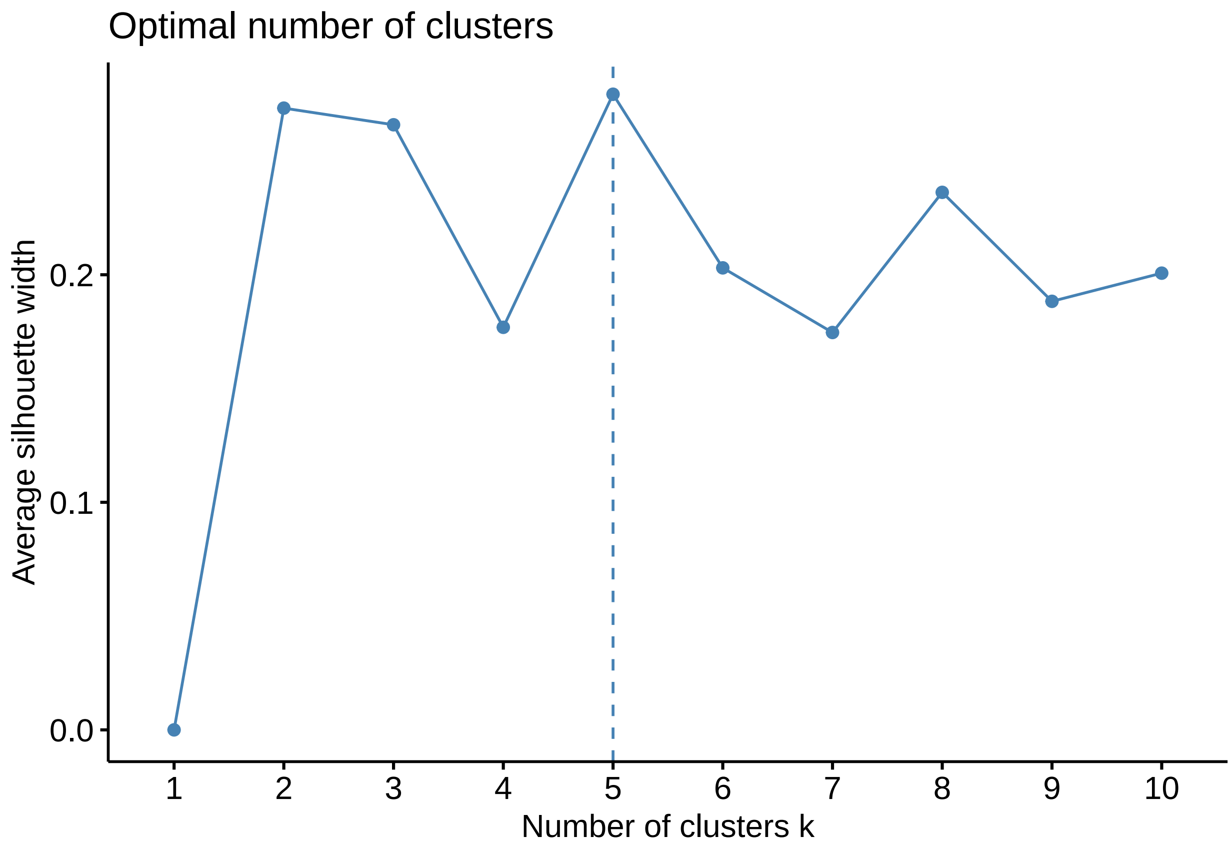
```
##   Net_Profit_Margin
## 1              16.1
## 2               5.5
## 3              11.2
## 4              18.0
## 5              12.9
## 6               2.6
```

```
summary(pharma1)
```

```
##    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
```

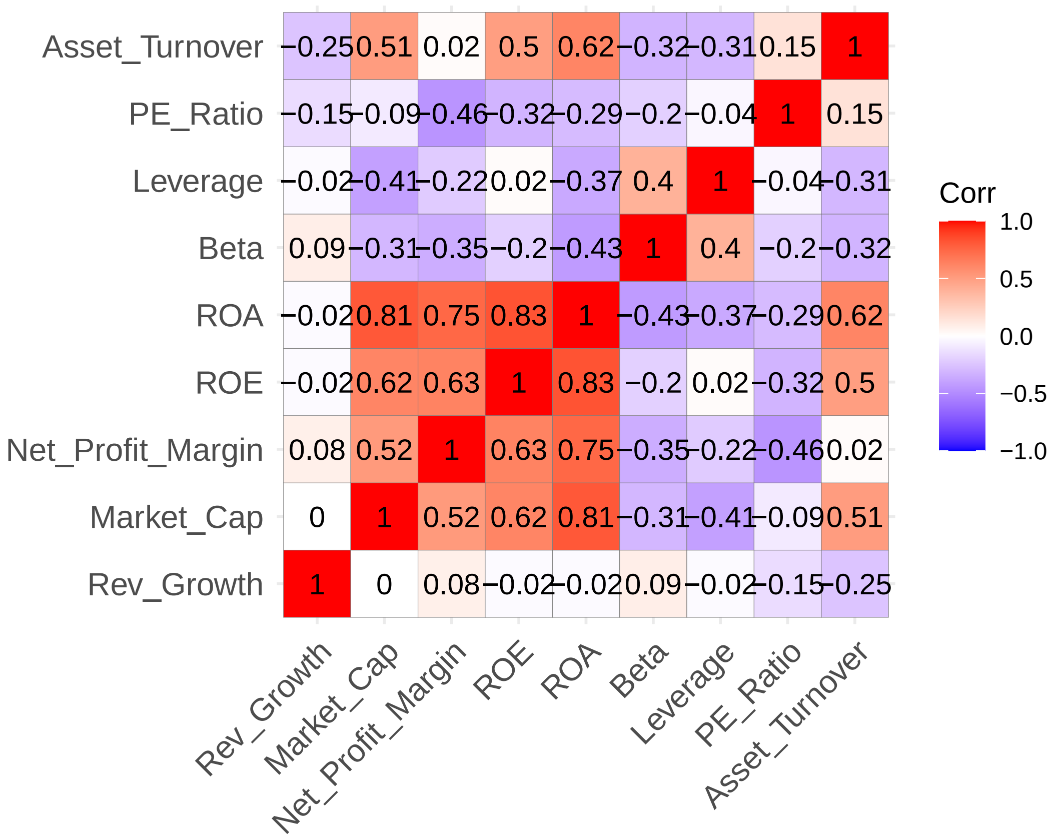
The data in pharma1 and the pharma updated dataframe will be scaled according to the varying weights assigned to each variable along the rows. using the factoextra package's get dist and fviz dist functions to measure the distance between data rows and visualize the distance matrix

```
norm_data <- scale(pharma1)
row.names(norm_data) <- pharma[,1]
distance <- get_dist(norm_data)
corr <- cor(norm_data)
fviz_nbclust(norm_data,kmeans,method = "silhouette")
```



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

```
corr <- cor(norm_data)
ggcorrplot(corr, outline.color = "grey50", lab = TRUE, hc.order = TRUE, type = "full")
```

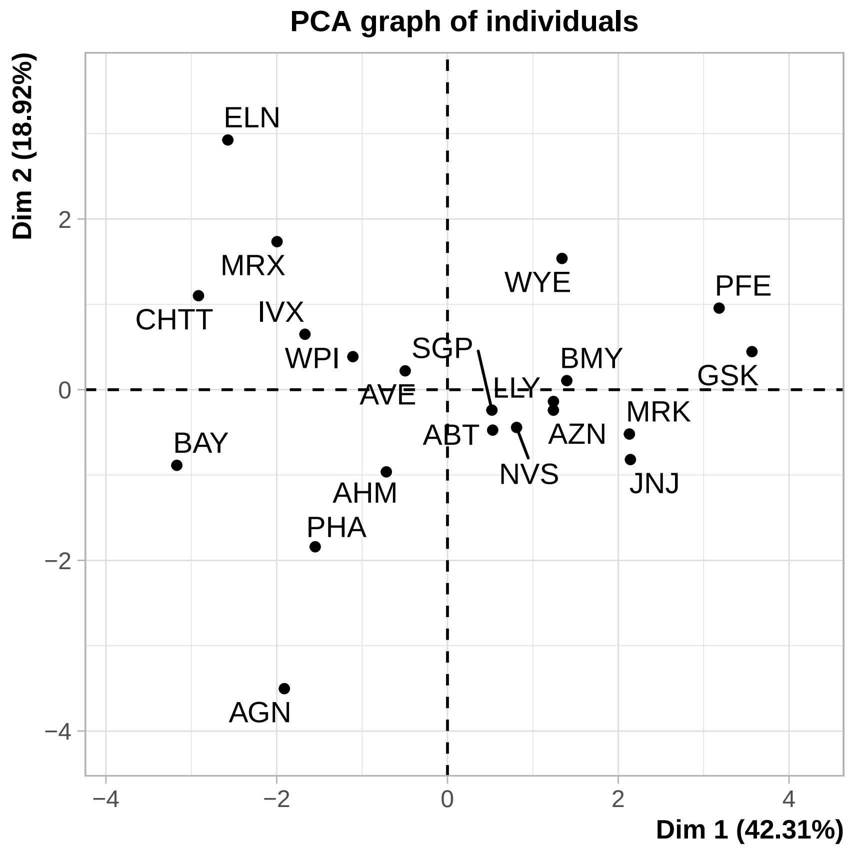


The ROA, ROE, Net Profit Margin, and Market Cap are all high, according to the Correlation Matrix

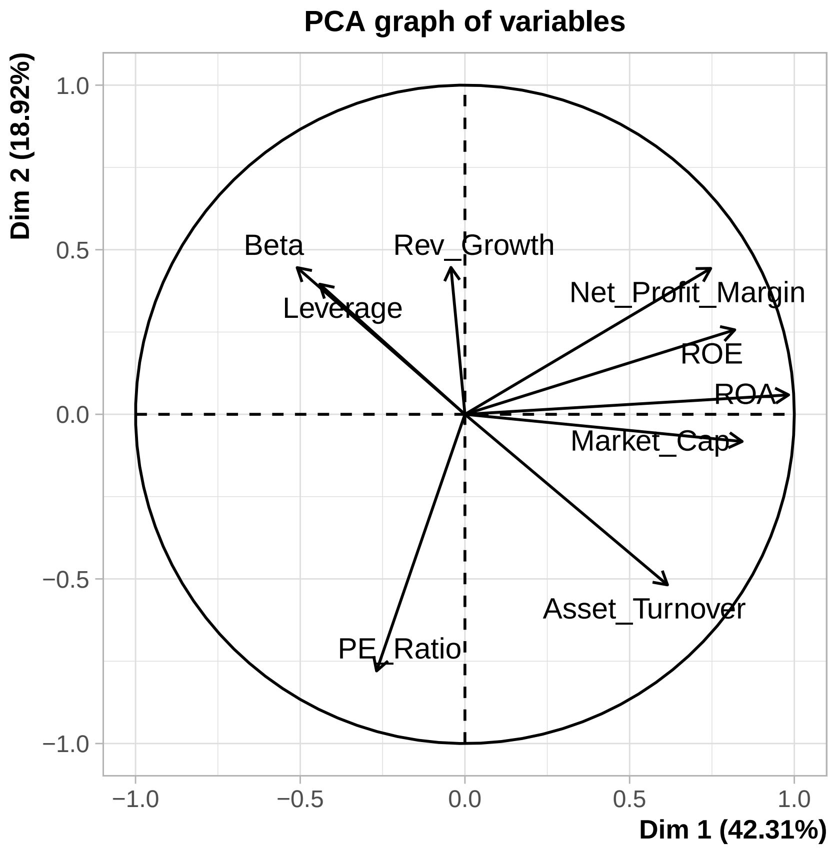
Finding out the relative importance of the primary variables in the data set will be done using principal component analysis.

`assuming the optimal cluster size is 5`

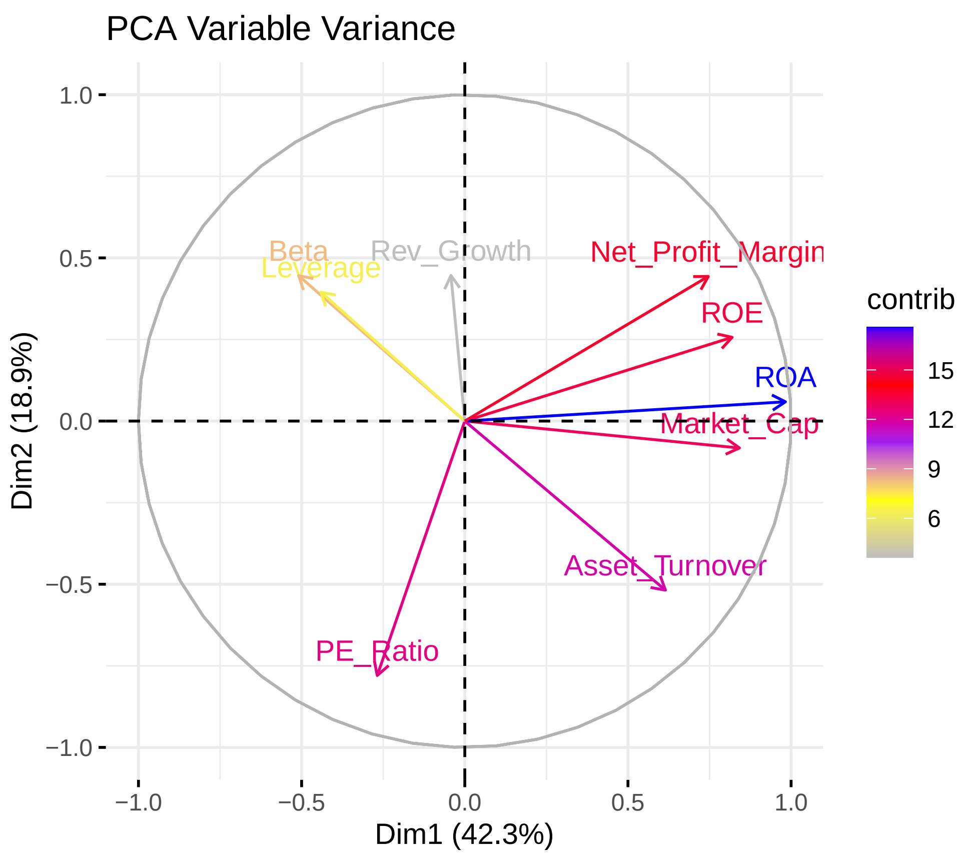
```
pca <- PCA(norm_data)
```



PCA graph of individuals
Dim 2 (18.92%)
Dim 1 (42.31%)
ELN
MRX
CHTT
IVX
WPI
WYE
PFE
SGP
BMY
GSK
AVE
LLY
MRK
ABT
AZN
BAY
NVS
JNJ
AHM
PHA
AGN
2
0
−2
−4
4



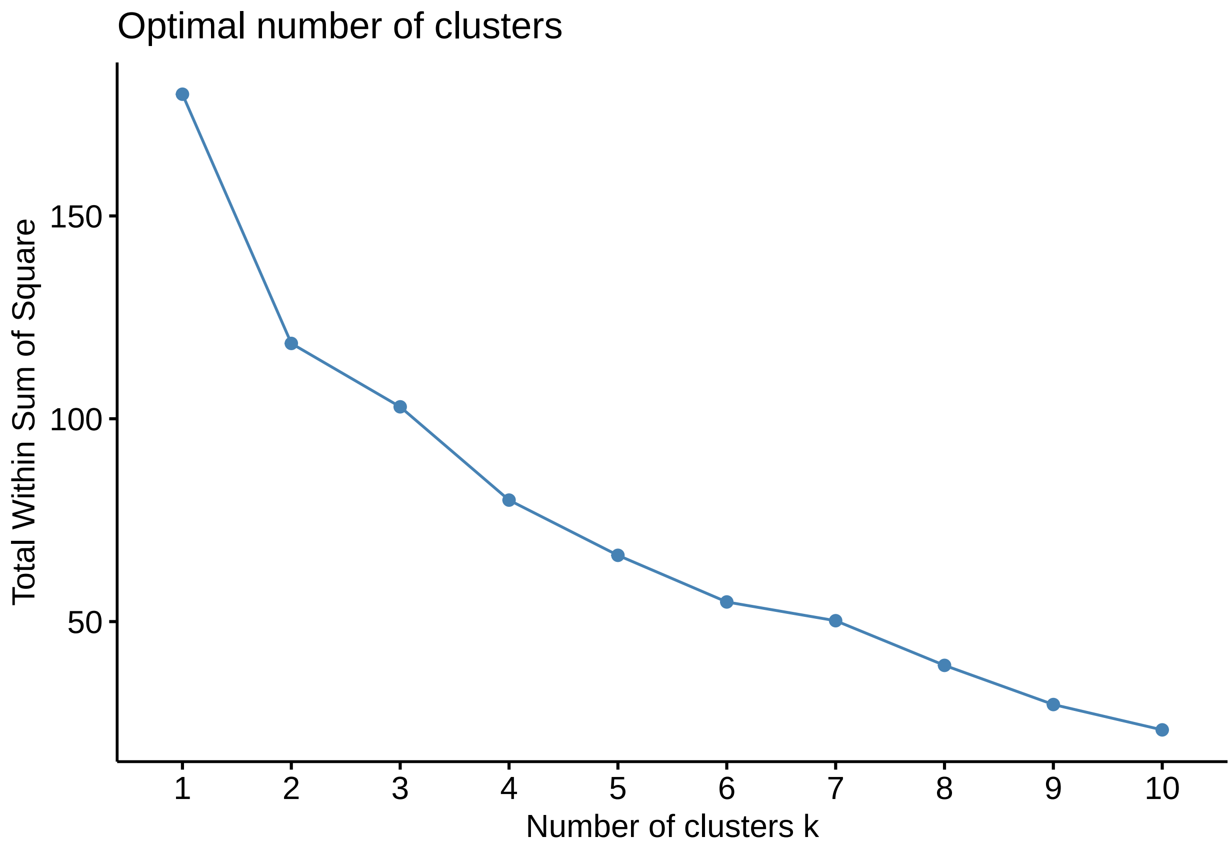

```
var <- get_pca_var(pca)
fviz_pca_var(pca, col.var="contrib",
             gradient.cols = c("grey","yellow","purple","red","blue"),ggrepel = TRUE ) + labs( title =
```



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.seed(10)

wss <- vector()
for(i in 1:10) wss[i] <- sum(kmeans(norm_data,i)$withinss)
fviz_nbclust(norm_data, kmeans, method = "wss")
```




```
wss
```

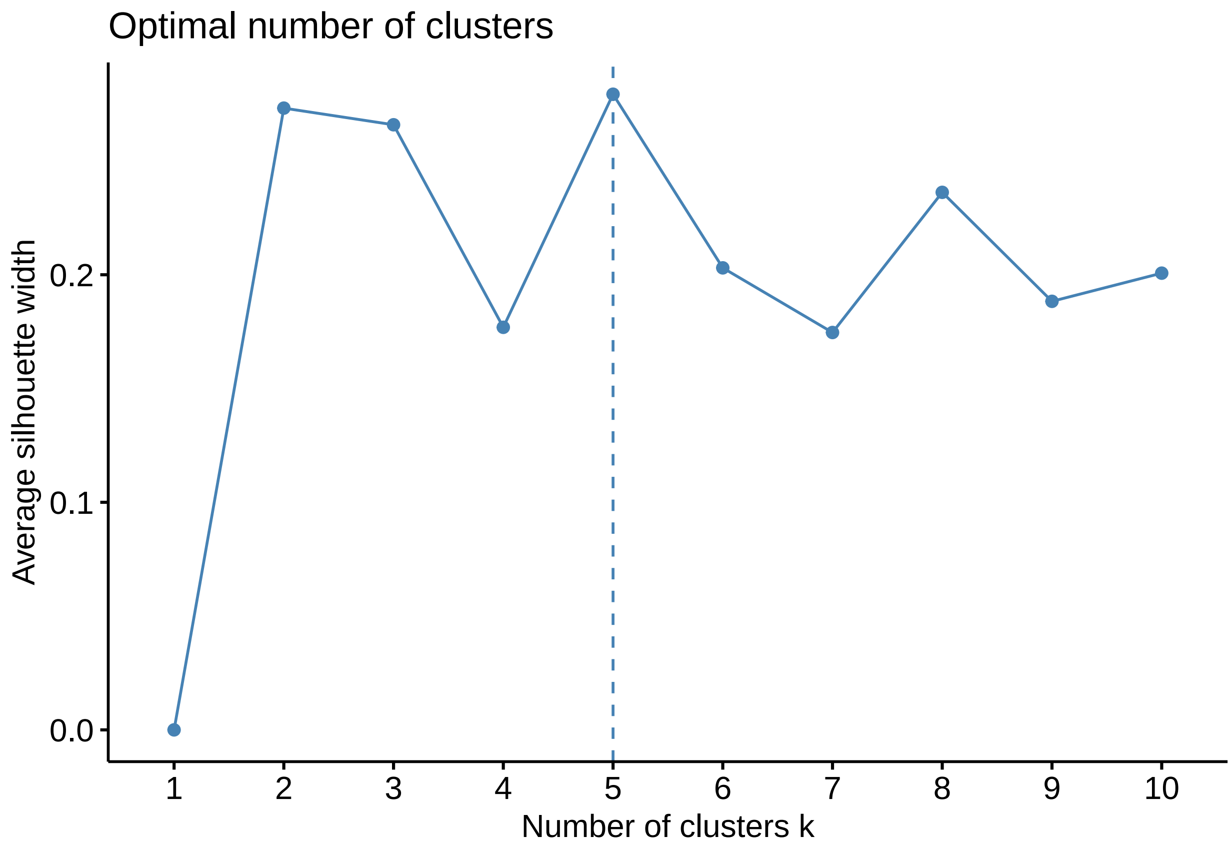
```
##  [1] 180.00000 118.56934  95.99420  79.21748  65.61035  52.67476  47.66961
##  [8]  41.12605  31.81763  31.57252
```

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

Determining the optimal cluster size.

Silhouette*

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



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

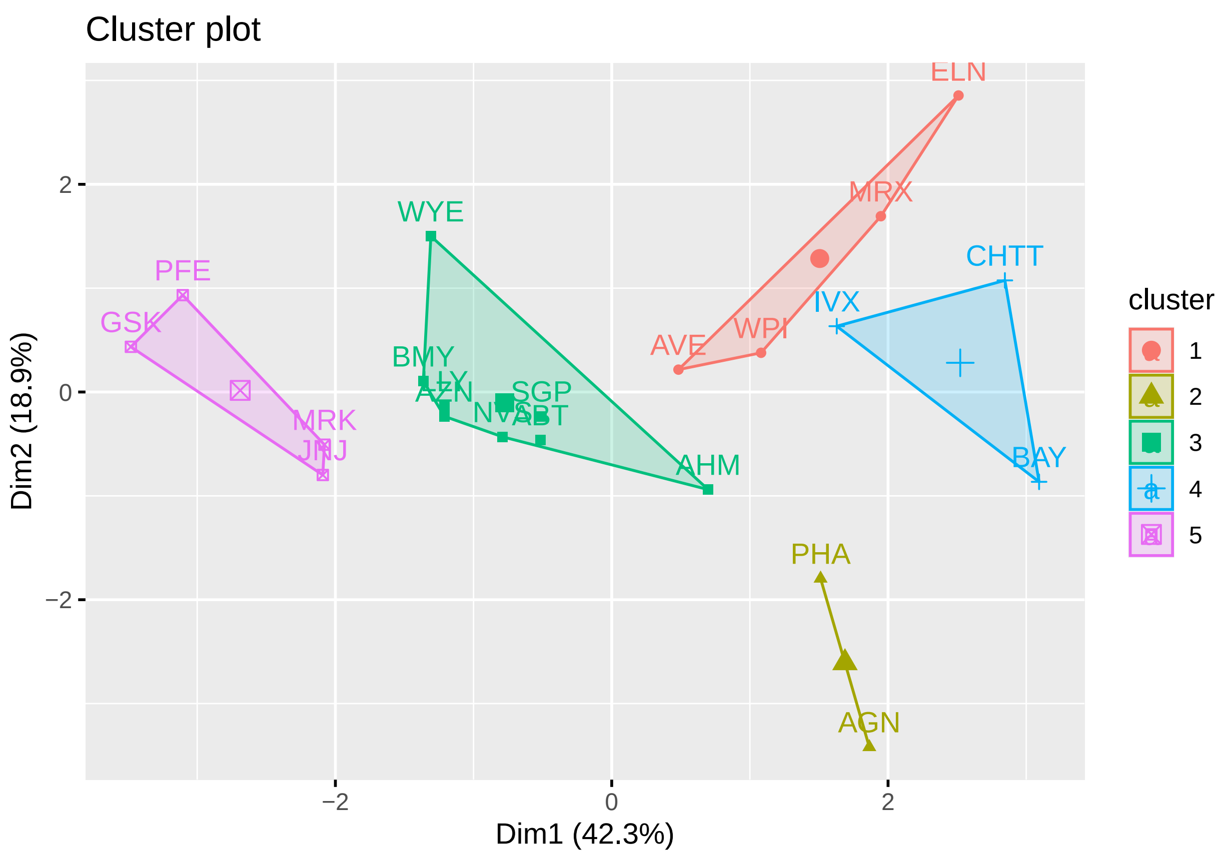
```r
set.seed(1)
k5 <- kmeans(norm_data, centers = 5, nstart = 31) # k = 5, number of restarts = 31
k5$centers
```

```
##    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
```

```r
k5$size
```

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

```r
fviz_cluster(k5, data = norm_data)
```




```r
set.seed(15)
k51 = kcca(norm_data, k=5, kccaFamily("kmedians"))
k51
```

Manhattan Distance when using Kmeans Clustering.

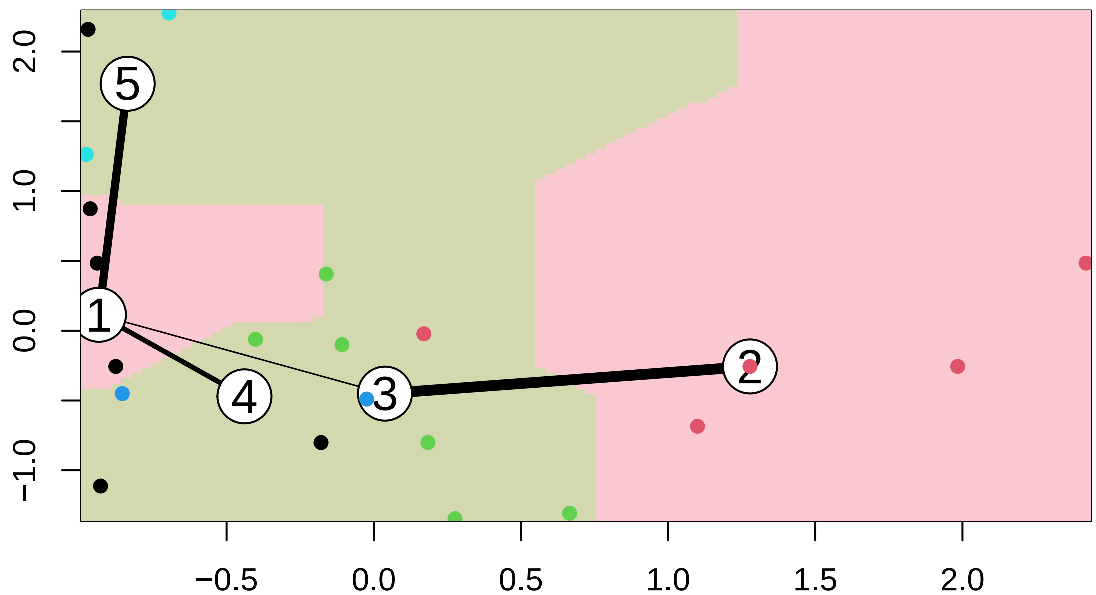
```
## kcca object of family 'kmedians'
##
## call:
## kcca(x = norm_data, k = 5, family = kccaFamily("kmedians"))
##
## cluster sizes:
##
## 1 2 3 4 5
## 6 5 6 2 2
```

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

Using predict function.

```
##          1        2        3        4
## 2 3.945545
## 3 3.168054 2.377053
## 4 3.724526 4.795056 4.301987
## 5 3.578425 5.494529 4.448919 4.043870
```

```
image(k51)
points(norm_data, col=clusters_index, pch=19, cex=0.9)
```



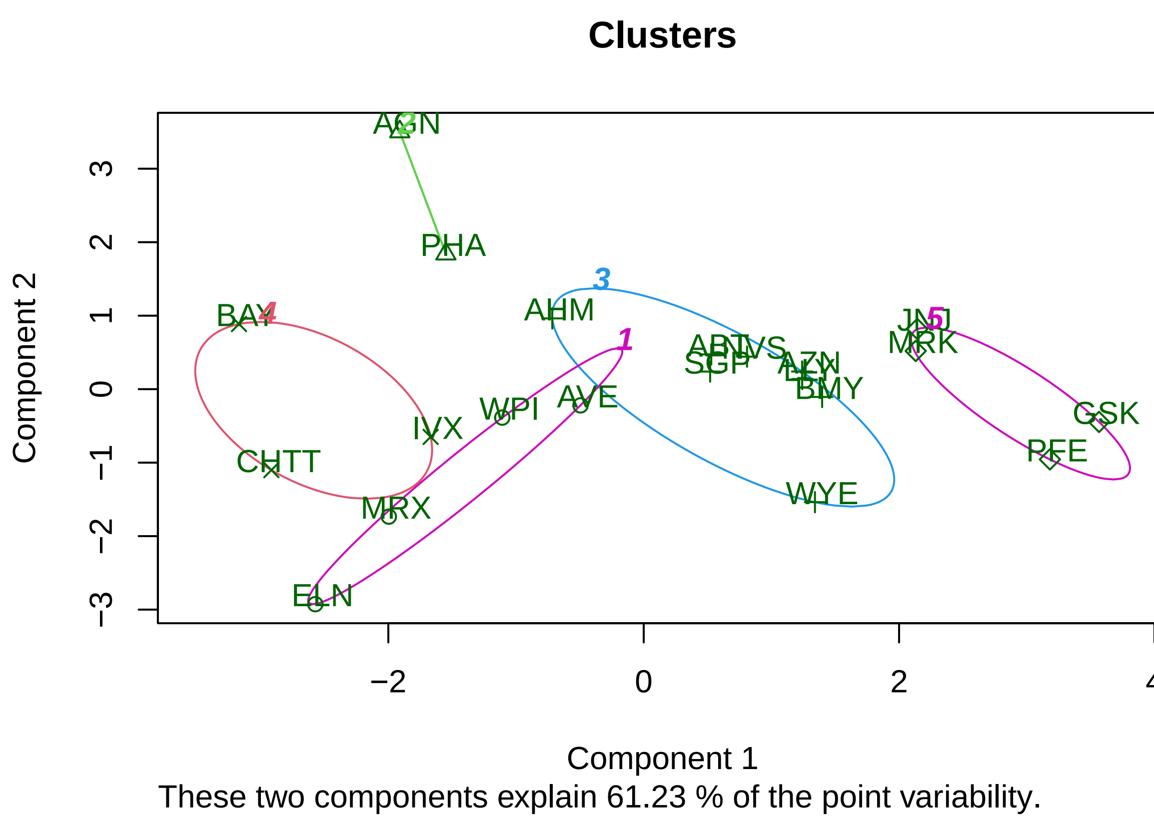
2.Interpret the clusters with respect to the numerical variables used in forming the clusters Using Kmeans method to calculate Mean.

```
pharma1%>% mutate(Cluster = k5$cluster) %>% group_by(Cluster) %>% summarise_all("mean")
```

```
## # A tibble: 5 x 10
##   Cluster Market_Cap  Beta PE_Ratio   ROE   ROA Asset_Turnover Leverage
##     <int>      <dbl> <dbl>    <dbl> <dbl> <dbl>          <dbl>    <dbl>
## 1       1      13.1  0.598     17.7  14.6  6.2           0.425    0.635
## 2       2      31.9  0.405     69.5  13.2  5.6           0.75     0.475
## 3       3      55.8  0.414     20.3  28.7 12.7           0.738    0.371
## 4       4       6.64 0.87      24.6  16.5  4.17          0.6      1.65
```

```
## 5       5      157.    0.48       22.2  44.4 17.7           0.95     0.22
## # i 2 more variables: Rev_Growth <dbl>, Net_Profit_Margin <dbl>
```

```
clusplot(norm_data,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 obtain as follow:

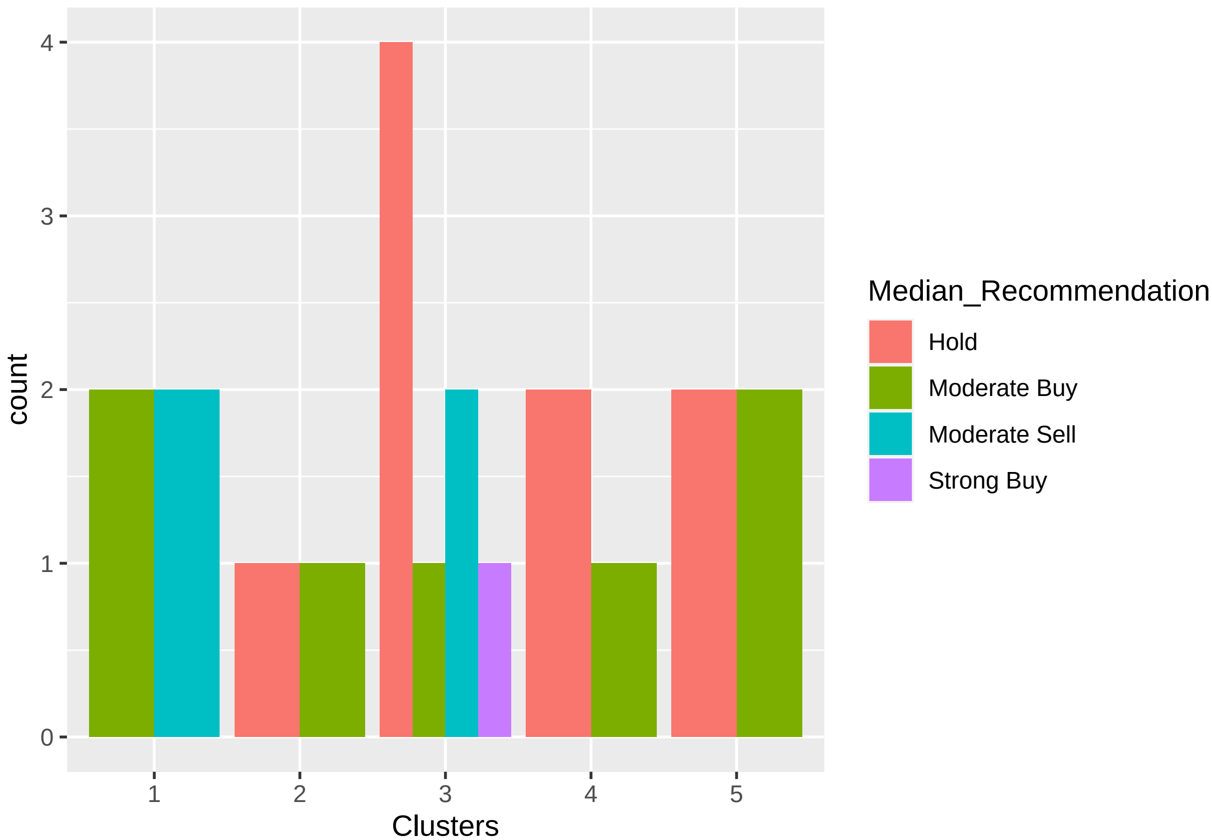
- Cluster 1 has the best Net Profit Margin, the lowest PE ratio, and the fastest sales growth. It can be bought or kept on hand as a reserve.+
- Cluster 2 PE ratio is very high.+
- Cluster 3 has a medium risk.+
- Cluster 4 Despite having an excellent PE ratio, it is incredibly risky to own due to its 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.+

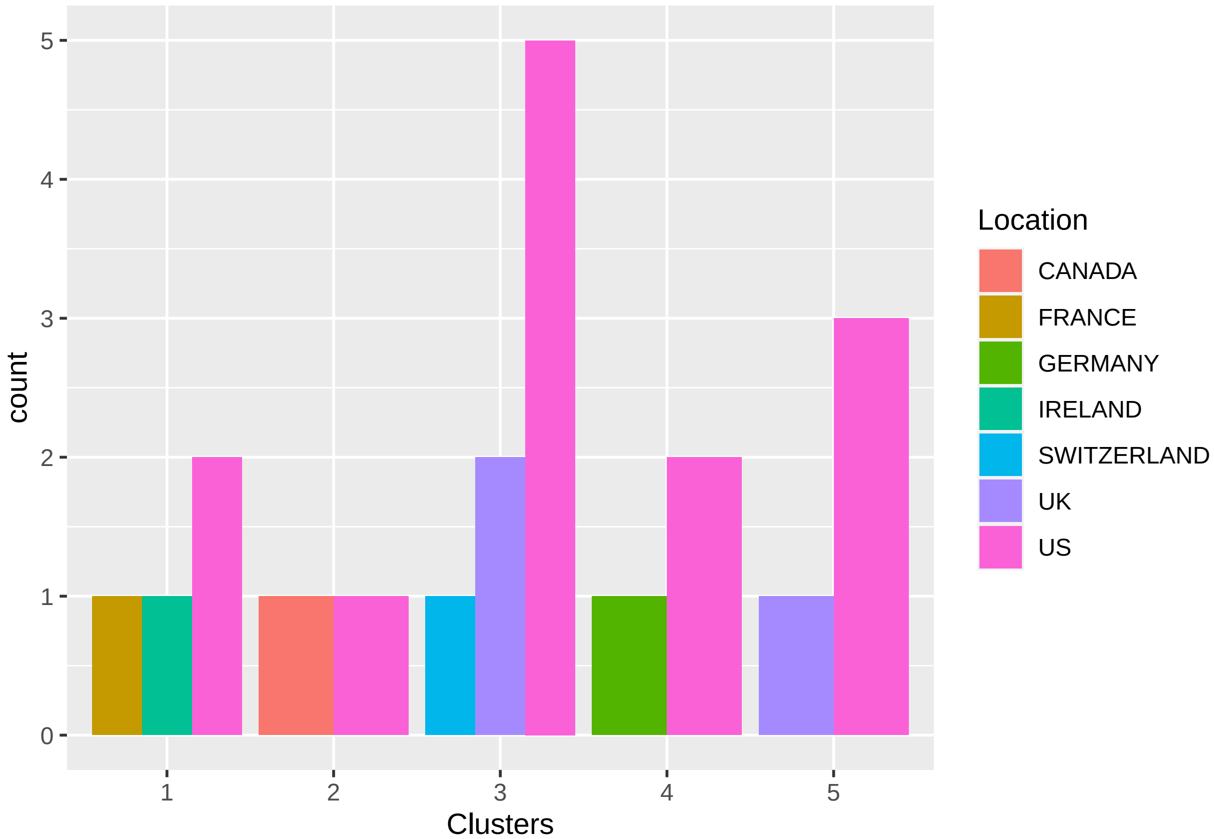
2B Is there a pattern in the clusters with respect to the numerical variables (10 to 12)?

```
We can examining patterns by visualizing clusters against the variables
```

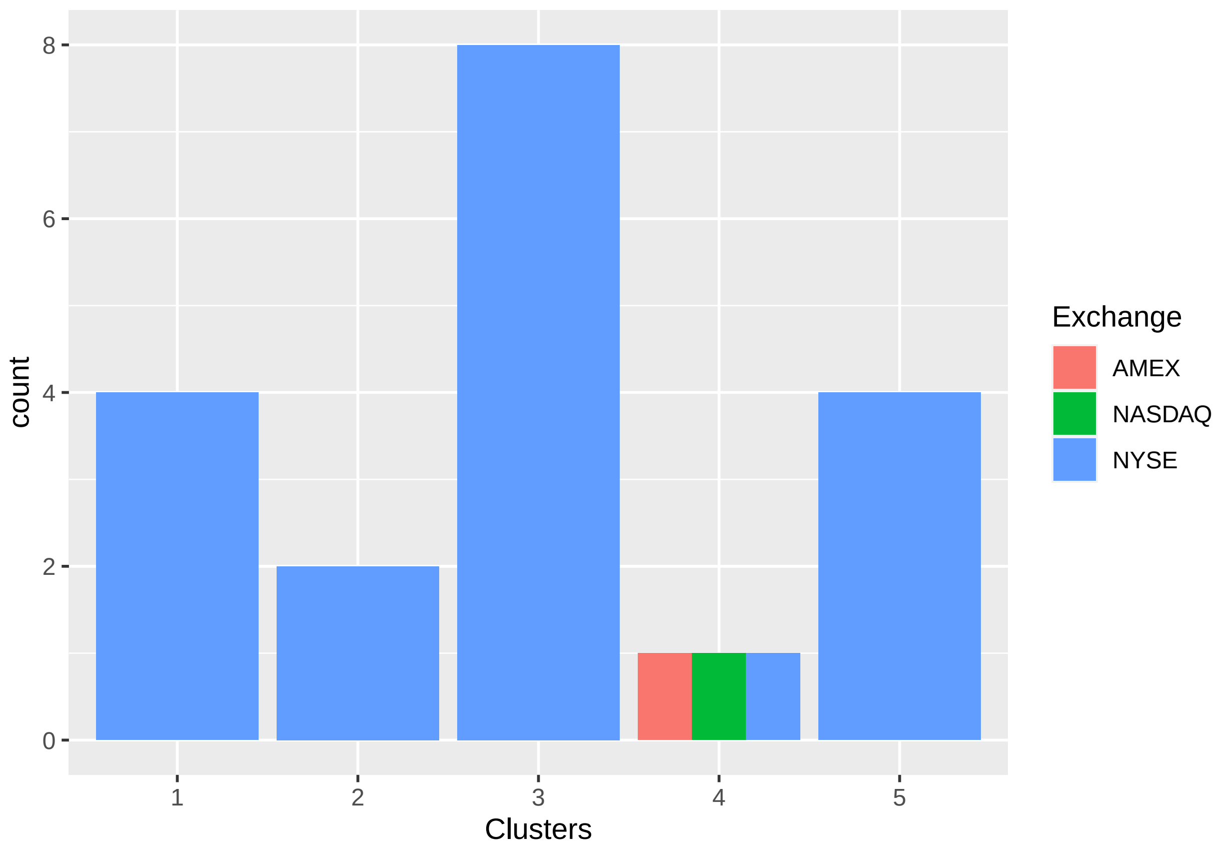
```r
Info_2 <- pharma[12:14] %>% mutate(Clusters=k5$cluster)
ggplot(Info_2, mapping = aes(factor(Clusters), fill =Median_Recommendation))+geom_bar(position='dodge')+
```




```r
ggplot(Info_2, mapping = aes(factor(Clusters),fill = Location))+geom_bar(position = 'dodge')+labs(x ='Cl
```




```
ggplot(Info_2, mapping = aes(factor(Clusters),fill = Exchange))+geom_bar(position = 'dodge')+labs(x ='Cl
```




```
The variable in 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
```

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

```
To Name for the clusters, Here I have consider Market_Cap, Beta, PE_Ratio, ROE, ROA, Asset_Turnover. and
```

Cluster 1: Profitable Giants

- Identified by substantial Market Cap, low Beta, low PE Ratio, high ROE, ROA, and Asset Turnover. These entities represent formidable, profitable giants in the market.+

Cluster 2: High Beta, High Risk Players

- Marked by elevated Beta and PE Ratio, Cluster 2 signifies entities with higher risk levels. Investors should exercise caution due to increased market sensitivity and potential overvaluation.+

Cluster 3: Balanced Performers

- Cluster 3 strikes a balance across Market Cap, Beta, and PE Ratio, representing entities in a moderate-risk category. These balanced performers exhibit stability and potential.+

Cluster 4: High Risk, Low Efficiency

- Despite a strong PE Ratio, entities in Cluster 4 face exceptionally high risk, with low efficiency indicated by poor ROE, ROA, and Asset Turnover. This cluster is deemed high-risk and less efficient.+

Cluster 5: Efficient Powerhouses

- Cluster 5 showcases entities with strong efficiency metrics, including high ROE, ROA, and Asset Turnover, paired with a moderately valued PE Ratio. These efficient powerhouses are attractive for both purchase and retention.+