FML Assignment4

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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)
```

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

```
library(ggcorrplot)
```

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

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

Importing the dataset

```
Pharmaceuticals <- read.csv("C:\\Users\\priya\\OneDrive\\Desktop\\FML\\Assignment 4\\Pharmaceuticals.csv
head(Pharmaceuticals)
```

```
##   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
```

Choose columns 3 to 11 and store the resulting data frame in Pharma1

```
Pharma <- na.omit(Pharmaceuticals)
Pharma
```

```
##    Symbol                              Name Market_Cap Beta PE_Ratio  ROE  ROA
## 1     ABT             Abbott Laboratories      68.44 0.32     24.7 26.4 11.8
## 2     AGN                  Allergan, Inc.       7.58 0.41     82.5 12.9  5.5
## 3     AHM                   Amersham plc       6.30 0.46     20.7 14.9  7.8
## 4     AZN                 AstraZeneca PLC      67.63 0.52     21.5 27.4 15.4
## 5     AVE                        Aventis      47.16 0.32     20.1 21.8  7.5
## 6     BAY                      Bayer AG      16.90 1.11     27.9  3.9  1.4
## 7     BMY     Bristol-Myers Squibb Company      51.33 0.50     13.9 34.8 15.1
## 8    CHTT                   Chattem, Inc       0.41 0.85     26.0 24.1  4.3
## 9     ELN           Elan Corporation, plc       0.78 1.08      3.6 15.1  5.1
## 10    LLY           Eli Lilly and Company      73.84 0.18     27.9 31.0 13.5
## 11    GSK             GlaxoSmithKline plc     122.11 0.35     18.0 62.9 20.3
## 12    IVX                IVAX Corporation       2.60 0.65     19.9 21.4  6.8
## 13    JNJ              Johnson & Johnson     173.93 0.46     28.4 28.6 16.3
## 14    MRX Medicis Pharmaceutical Corporation       1.20 0.75     28.6 11.2  5.4
## 15    MRK              Merck & Co., Inc.     132.56 0.46     18.9 40.6 15.0
## 16    NVS                    Novartis AG      96.65 0.19     21.6 17.9 11.2
## 17    PFE                     Pfizer Inc     199.47 0.65     23.6 45.6 19.2
## 18    PHA           Pharmacia Corporation      56.24 0.40     56.5 13.5  5.7
## 19    SGP     Schering-Plough Corporation      34.10 0.51     18.9 22.6 13.3
## 20    WPI    Watson Pharmaceuticals, Inc.       3.26 0.24     18.4 10.2  6.8
## 21    WYE                          Wyeth      48.19 0.63     13.1 54.9 13.4
##    Asset_Turnover Leverage Rev_Growth Net_Profit_Margin Median_Recommendation
## 1             0.7     0.42       7.54              16.1          Moderate Buy
## 2             0.9     0.60       9.16               5.5          Moderate Buy
## 3             0.9     0.27       7.05              11.2            Strong Buy
## 4             0.9     0.00      15.00              18.0         Moderate Sell
## 5             0.6     0.34      26.81              12.9          Moderate Buy
## 6             0.6     0.00      -3.17               2.6                  Hold
## 7             0.9     0.57       2.70              20.6         Moderate Sell
## 8             0.6     3.51       6.38               7.5          Moderate Buy
## 9             0.3     1.07      34.21              13.3         Moderate Sell
## 10            0.6     0.53       6.21              23.4                  Hold
## 11            1.0     0.34      21.87              21.1                  Hold
## 12            0.6     1.45      13.99              11.0                  Hold
## 13            0.9     0.10       9.37              17.9          Moderate Buy
## 14            0.3     0.93      30.37              21.3          Moderate Buy
## 15            1.1     0.28      17.35              14.1                  Hold
## 16            0.5     0.06      -2.69              22.4                  Hold
## 17            0.8     0.16      25.54              25.2          Moderate Buy
## 18            0.6     0.35      15.00               7.3                  Hold
## 19            0.8     0.00       8.56              17.6                  Hold
## 20            0.5     0.20      29.18              15.1         Moderate Sell
```

```
## 21            0.6     1.12       0.36              25.5                   Hold
##       Location Exchange
## 1           US     NYSE
## 2       CANADA     NYSE
## 3           UK     NYSE
## 4           UK     NYSE
## 5       FRANCE     NYSE
## 6      GERMANY     NYSE
## 7           US     NYSE
## 8           US   NASDAQ
## 9      IRELAND     NYSE
## 10          US     NYSE
## 11          UK     NYSE
## 12          US     AMEX
## 13          US     NYSE
## 14          US     NYSE
## 15          US     NYSE
## 16 SWITZERLAND     NYSE
## 17          US     NYSE
## 18          US     NYSE
## 19          US     NYSE
## 20          US     NYSE
## 21          US     NYSE
```

```
Pharma1 <- Pharma[,3:11]
# Displaying the top six rows of Pharma1 using head function
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
```

```
# Printing summary statistics for Pharma1
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
```

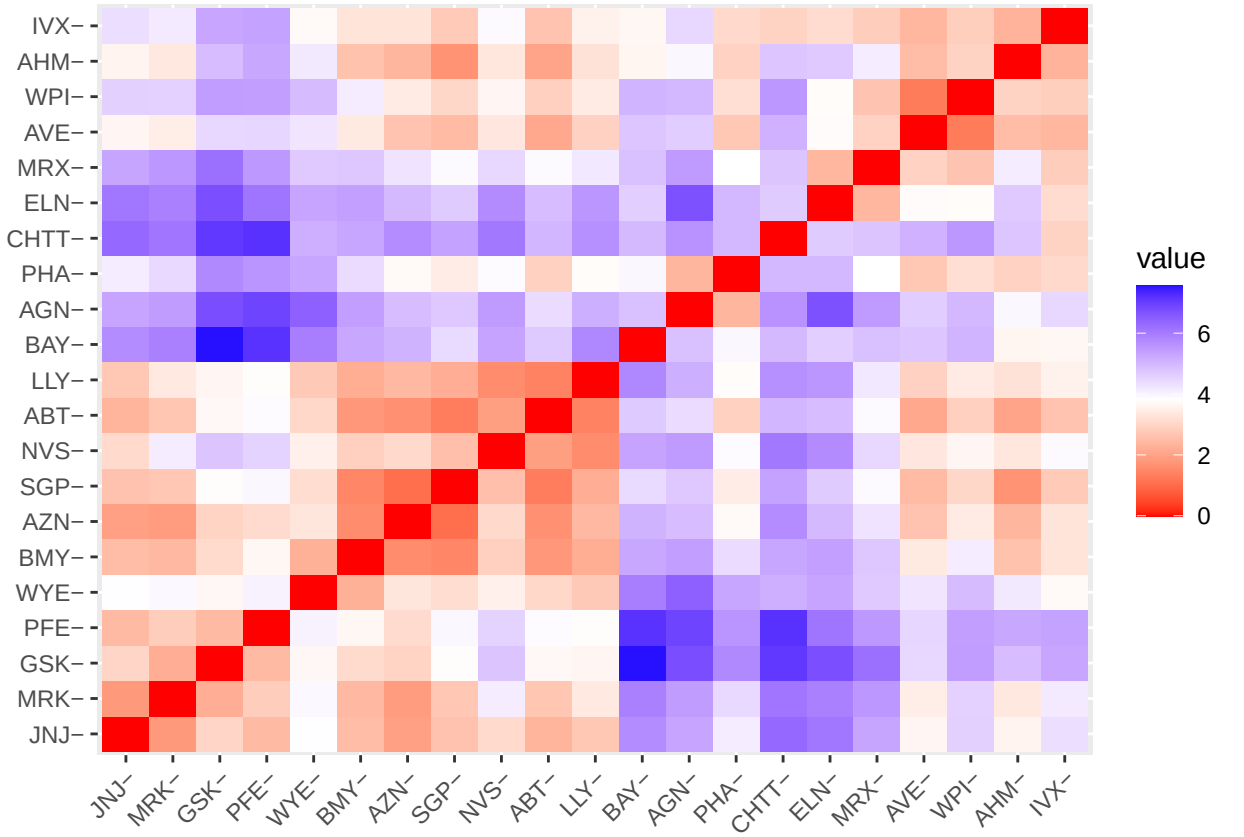
```
library(factoextra)
```

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

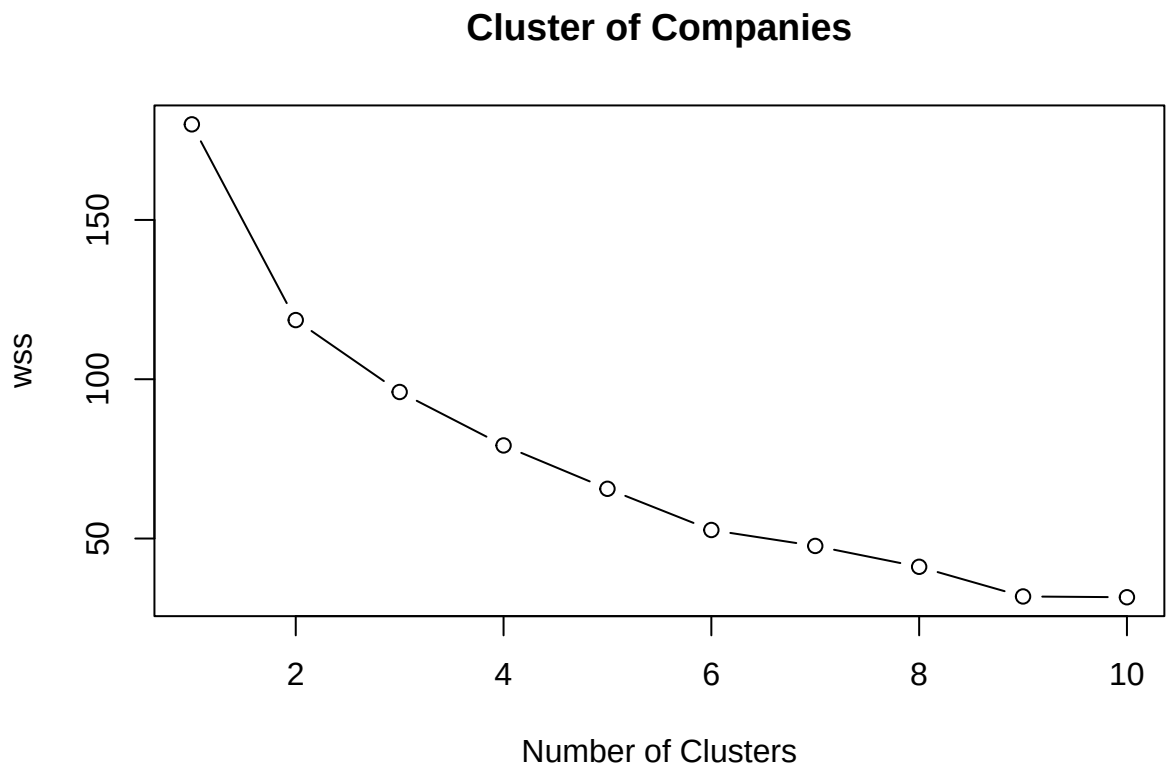
```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

Normalizing the data with scale method

```
Pharma2 <- scale(Pharma1)
# Set row names to match the first column of the original Pharma data
row.names(Pharma2) <- Pharma[,1]
# Calculate the distance matrix using get_dist
distance <- get_dist(Pharma2)
# Visualize the distance matrix using fviz_dist
fviz_dist(distance)
```




```
# 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(Pharma2,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")
```

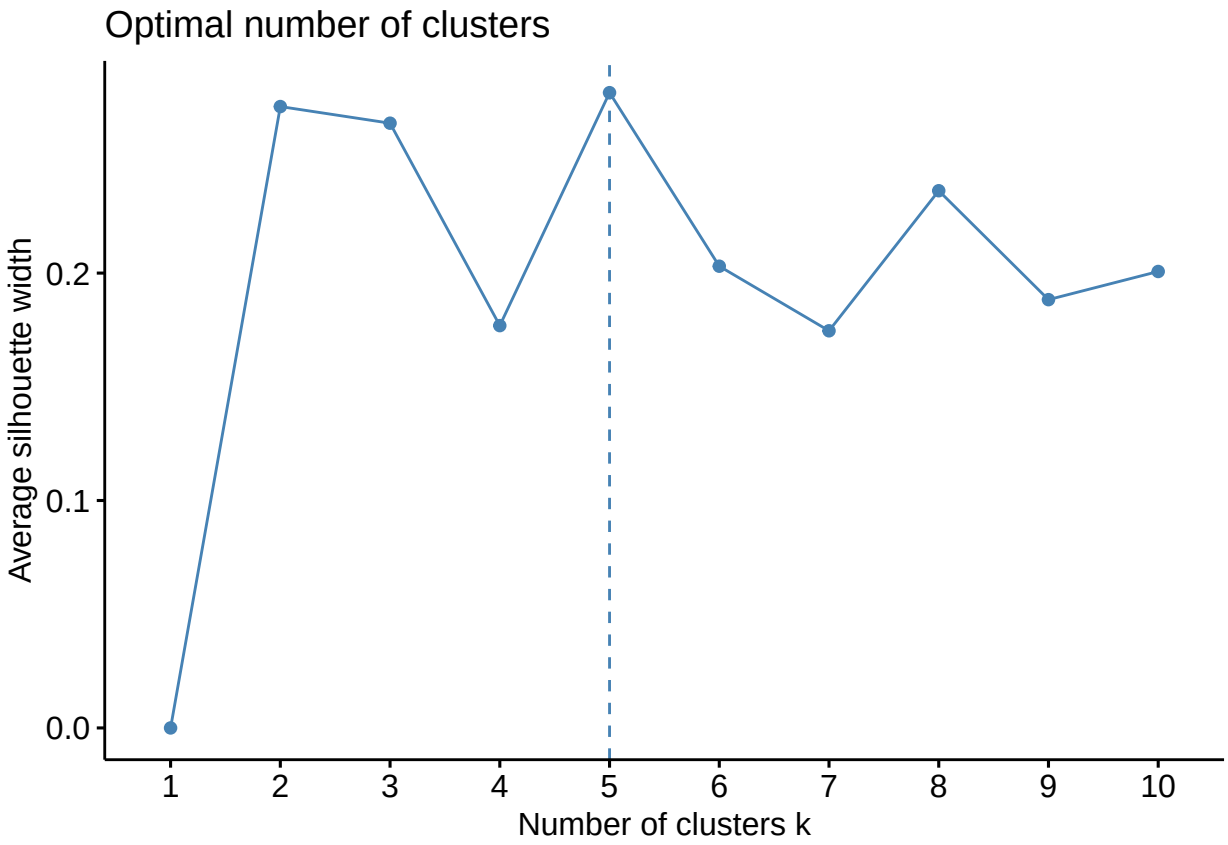



```
# Print the wss values for each number of clusters
wss
```

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

Silhouette Approach

```
# Use the fviz_nbclust function to determine the optimal number of clusters using the silhouette method
fviz_nbclust(Pharma2, kmeans, method = "silhouette")
```



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

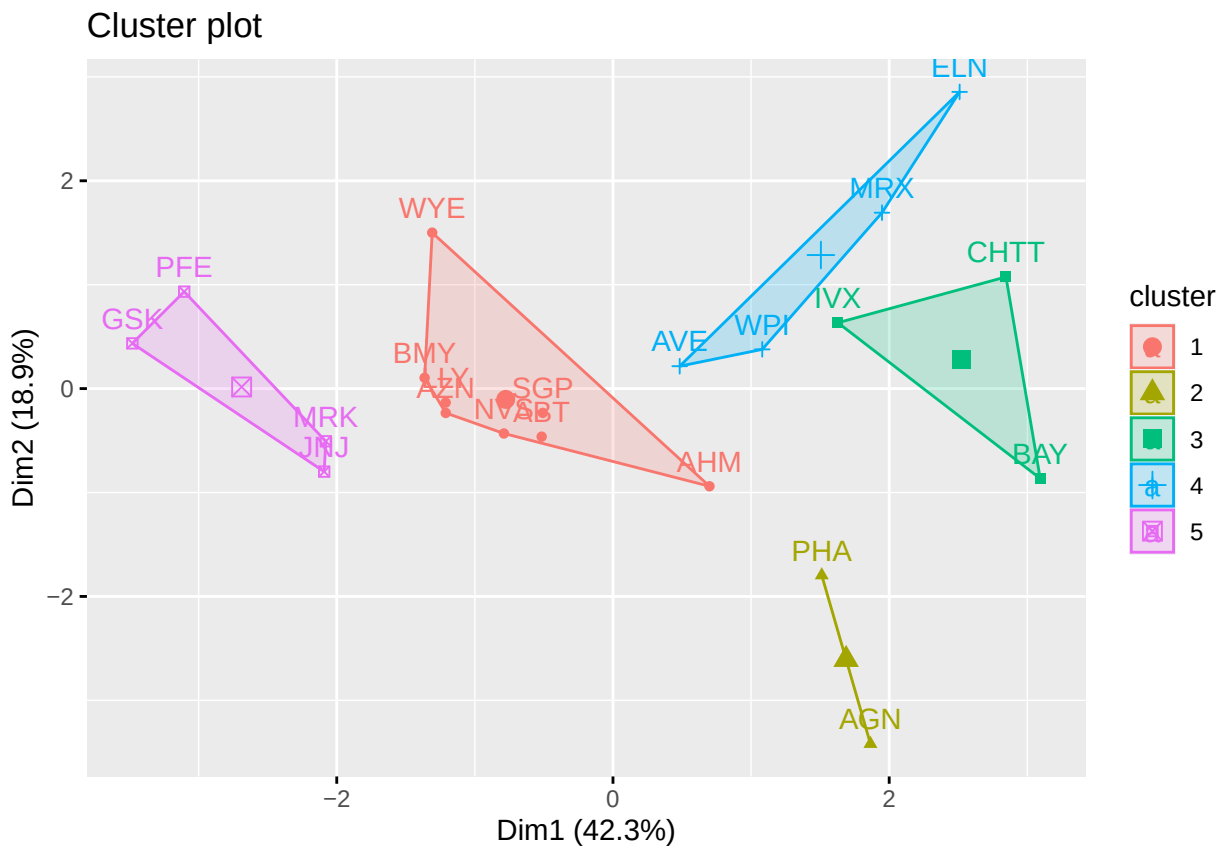
```
# Use the kmeans function to create 5 clusters and visualize the results using the fviz_cluster functio
set.seed(21)
clusterx <- kmeans(Pharma2, centers = 5, nstart = 25) # k = 5, number of restarts = 25
clusterx$centers
```

```
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1 -0.03142211 -0.4360989 -0.31724852  0.1950459  0.4083915      0.1729746
## 2 -0.43925134 -0.4701800  2.70002464 -0.8349525 -0.9234951      0.2306328
## 3 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478     -0.4612656
## 4 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
## 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 -0.14170336 -0.1168459      -1.416514761
## 3  1.36644699 -0.6912914      -1.320000179
## 4  0.06308085  1.5180158      -0.006893899
## 5 -0.46807818  0.4671788       0.591242521
```

```
clusterx$size
```

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

```
fviz_cluster(clusterx, data = Pharma2)
```



Manhattan Distance when using Kmeans Clustering.

```
set.seed(21)
# Use kcca function to create 5 clusters with Manhattan distance and k-medians algorithm
clusterY <- kcca(Pharma2, k = 5, kccaFamily("kmedians"))
# Print the results and visualize the clusters
clusterY
```

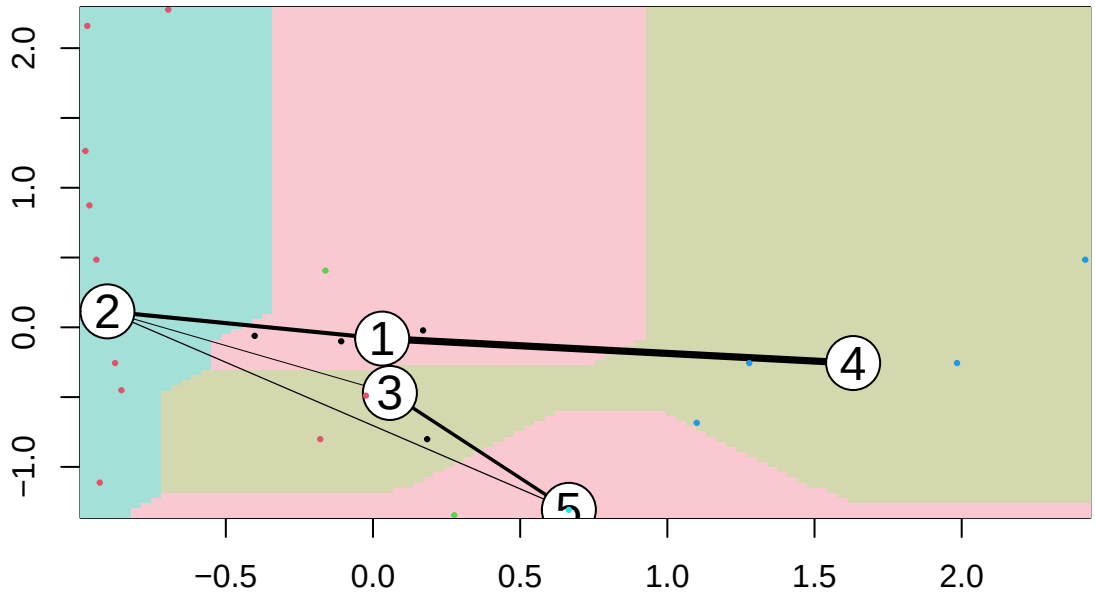
```
## kcca object of family 'kmedians'
##
## call:
## kcca(x = Pharma2, k = 5, family = kccaFamily("kmedians"))
##
## cluster sizes:
##
##  1  2  3  4  5
##  4 10  2  4  1
```

```
clusters_index <- predict(clusterY)
dist(clusterY@centers)
```

```
##          1        2        3        4
## 2 2.663586
```

```
## 3 2.113529 3.531320
## 4 2.359668 4.474483 3.022624
## 5 2.582322 3.396689 2.360814 3.868401
```

```
image(clusterY)
points(Pharma2, col = clusters_index, pch = 19, cex = 0.3)
```




```
library(tidyverse)
```

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

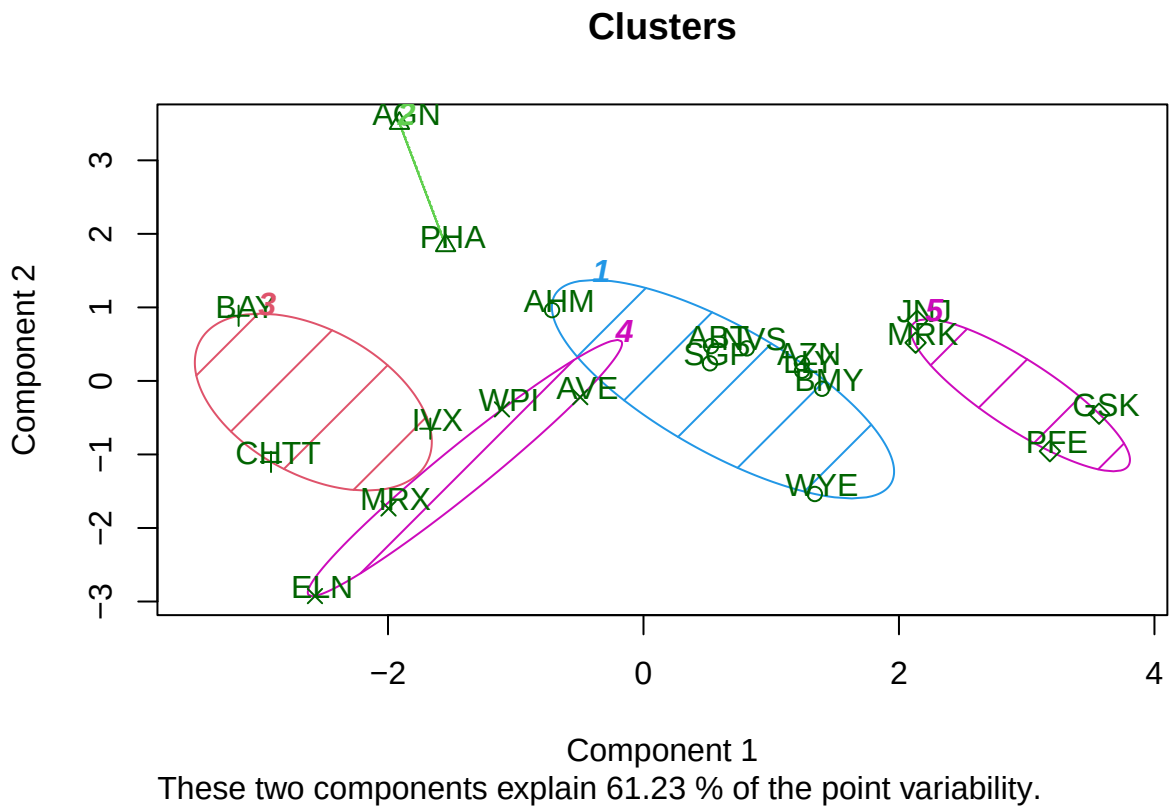
```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.3     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v lubridate 1.9.2     v tibble    3.2.1
## v purrr     1.0.2     v tidyr     1.3.0
## -- Conflicts ---------------------------------------- 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
```

```
Pharma1 %>% mutate(Cluster = clusterx$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      55.8  0.414     20.3  28.7 12.7           0.738    0.371
## 2       2      31.9  0.405     69.5  13.2  5.6           0.75     0.475
## 3       3       6.64 0.87      24.6  16.5  4.17          0.6      1.65
## 4       4      13.1  0.598     17.7  14.6  6.2           0.425    0.635
## 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(Pharma2,clusterx$cluster, main="Clusters",color = TRUE,shade = TRUE, labels = 2,lines = 0)
```



Companies are classified into different clusters as follows

Cluster1 : AHM,WYE,BMY,AZN,LLY,ABT,NVS,ABT and SGP

Cluster2 : AGN,PHA

Cluster3 : BAY,CHTT,IVX

Cluster4 : ELN,MRX,WPI,AVE

Cluster5 : JNJ,MRK,PFE,GSK

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

Cluster1 has a medium risk

Cluster2 has very high PE Ratio

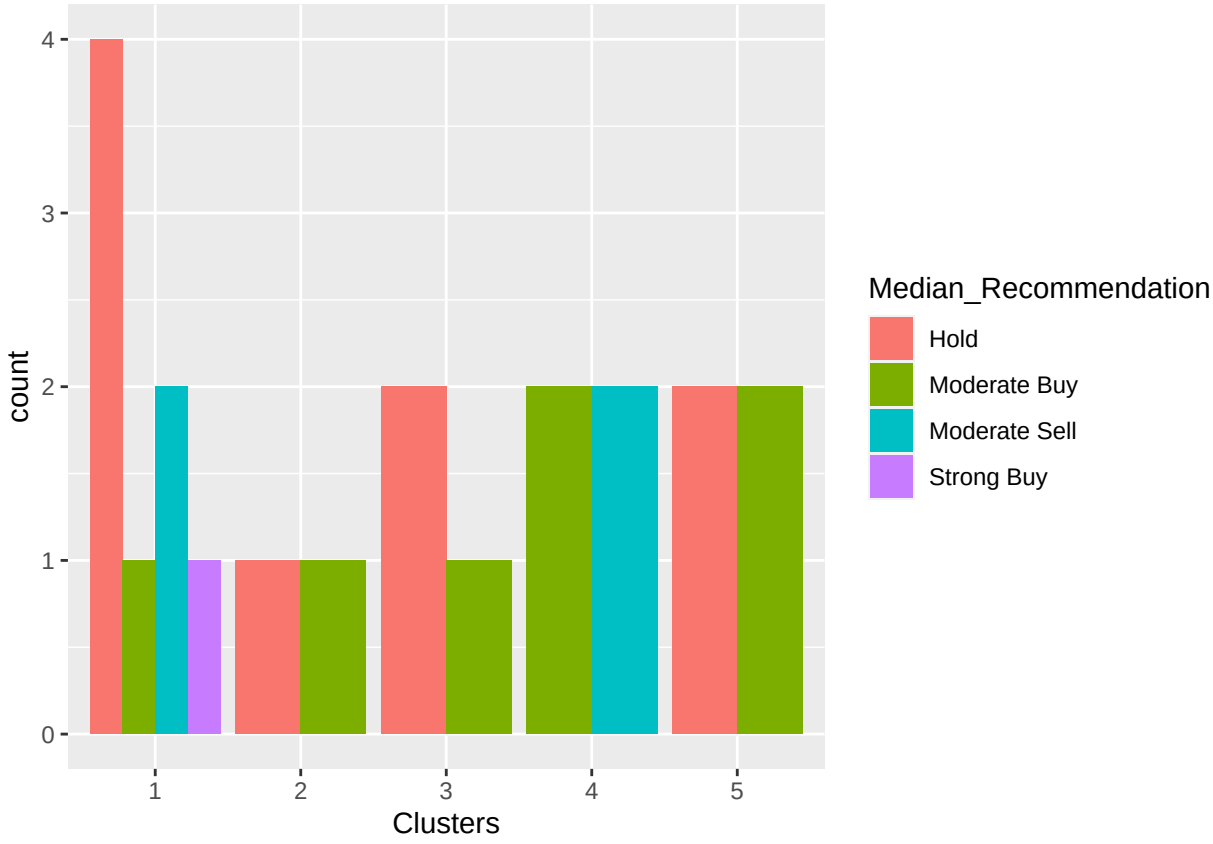
Cluster3 Despite having an excellent PE ratio, it is incredibly risky to own due to its extremely high risk, extremely high leverage, and poor Net Profit margin. Also very low in revenue growth.

Cluster4 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.

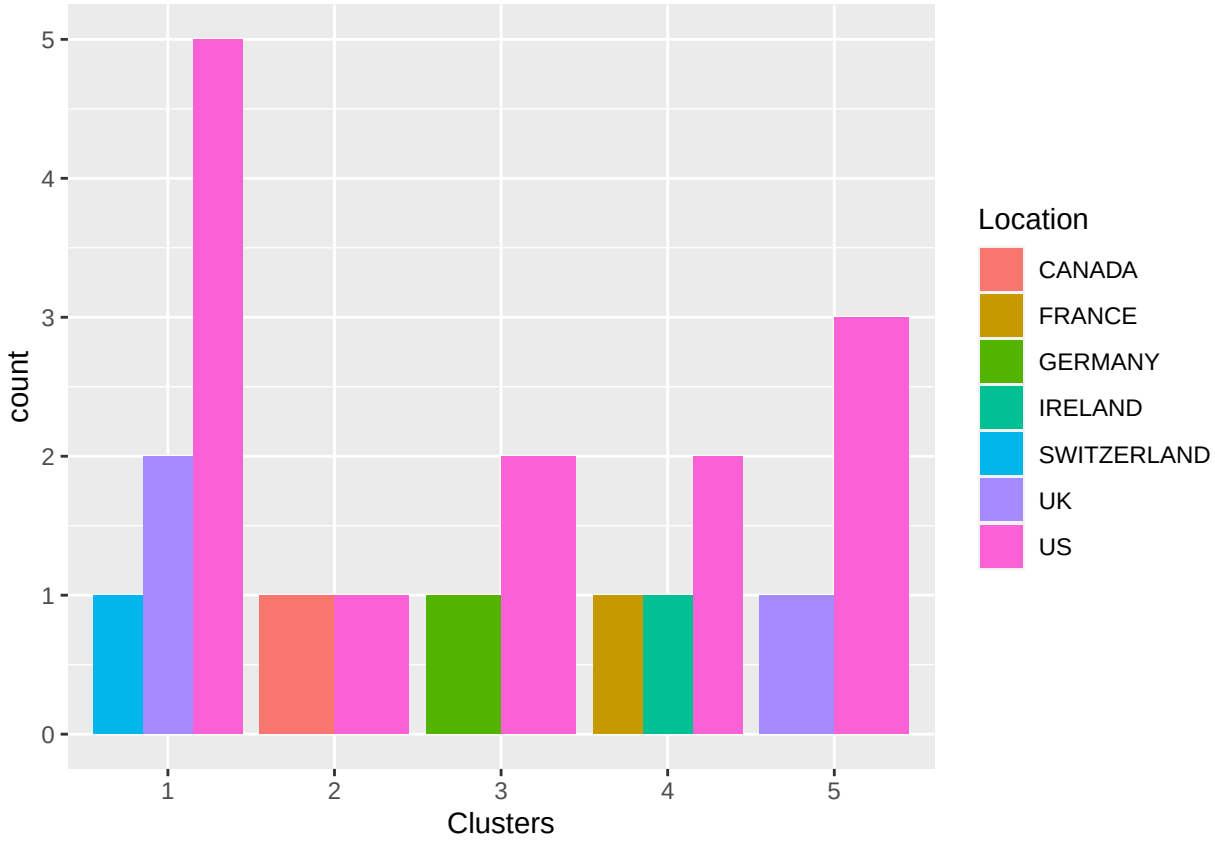
Cluster5 has strong market capitalization, ROI, ROA, ROA on assets, ROA on turnover of assets, and ROA on net profit margin. A low PE ratio indicates that the stock price is moderately valued and may thus be bought and kept. Revenue growth of 18.5% is also favorable.

Examining patterns by visualizing clusters against the variables

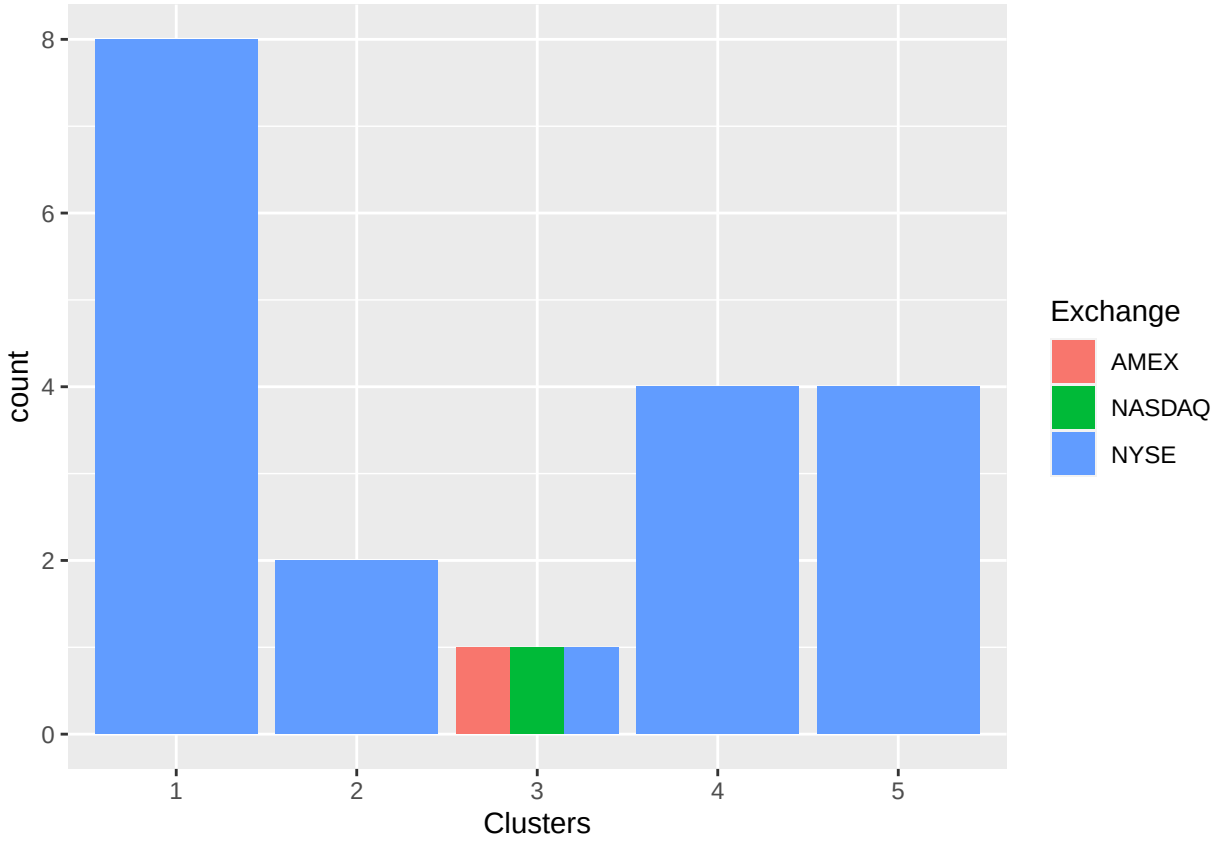
```
Pharma3 <- Pharma[12:14] %>% mutate(Clusters=clusterx$cluster)
ggplot(Pharma3, mapping = aes(factor(Clusters), fill =Median_Recommendation)) +
 geom_bar(position='dodge') + labs(x ='Clusters')
```




```
ggplot(Pharma3, mapping = aes(factor(Clusters),fill = Location)) +
 geom_bar(position = 'dodge') + labs(x ='Clusters')
```




```
ggplot(Pharma3, mapping = aes(factor(Clusters),fill = Exchange)) +
 geom_bar(position = 'dodge') + labs(x ='Clusters')
```



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

Cluster1: Attempt it Cluster

Cluster2: Significant Risk Cluster

Cluster3: Very Dangerous Cluster

Cluster4: Top Buying Cluster

Cluster5: A Perfect Asset