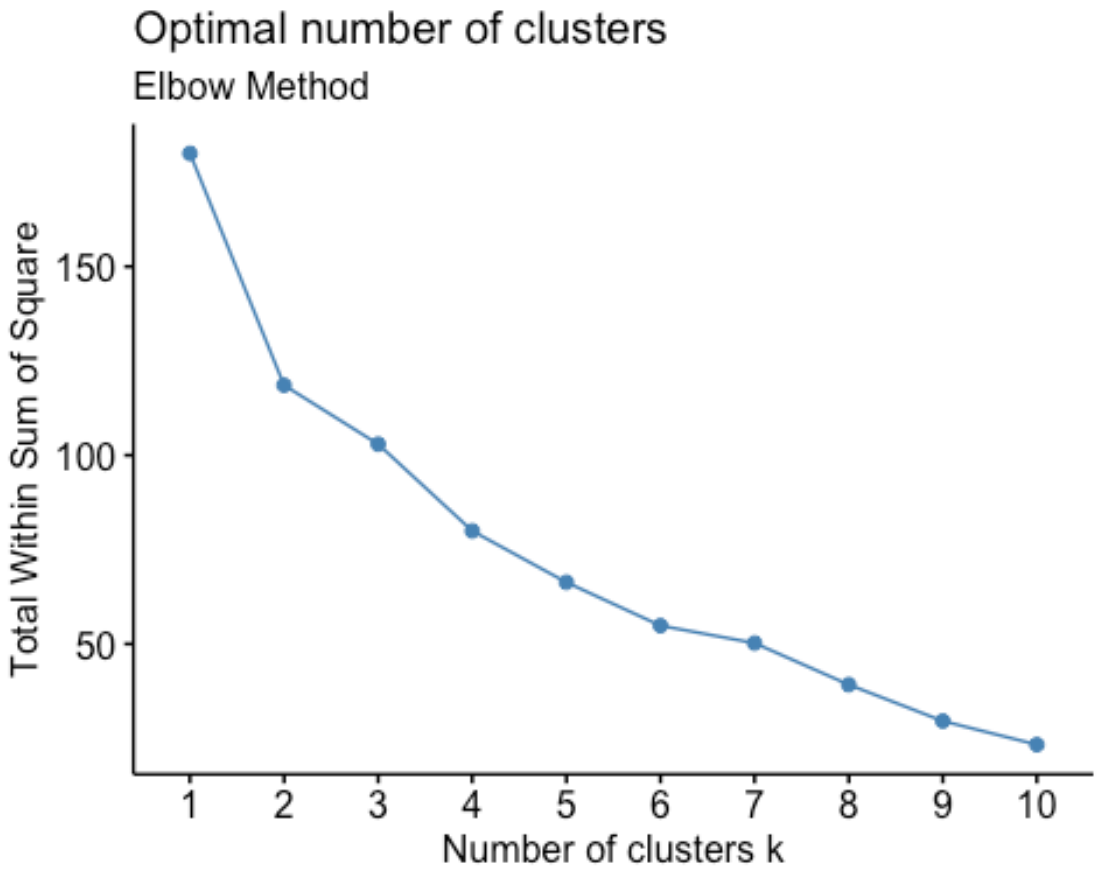
Assignment 4 Machine Learning

library(caret) library(dcast) library(reshape) library(e1071) library(naivebayes) library(klaR) library(bnclassify) library(rmarkdown) library(tinytex) library(cluster) library(factoextra)

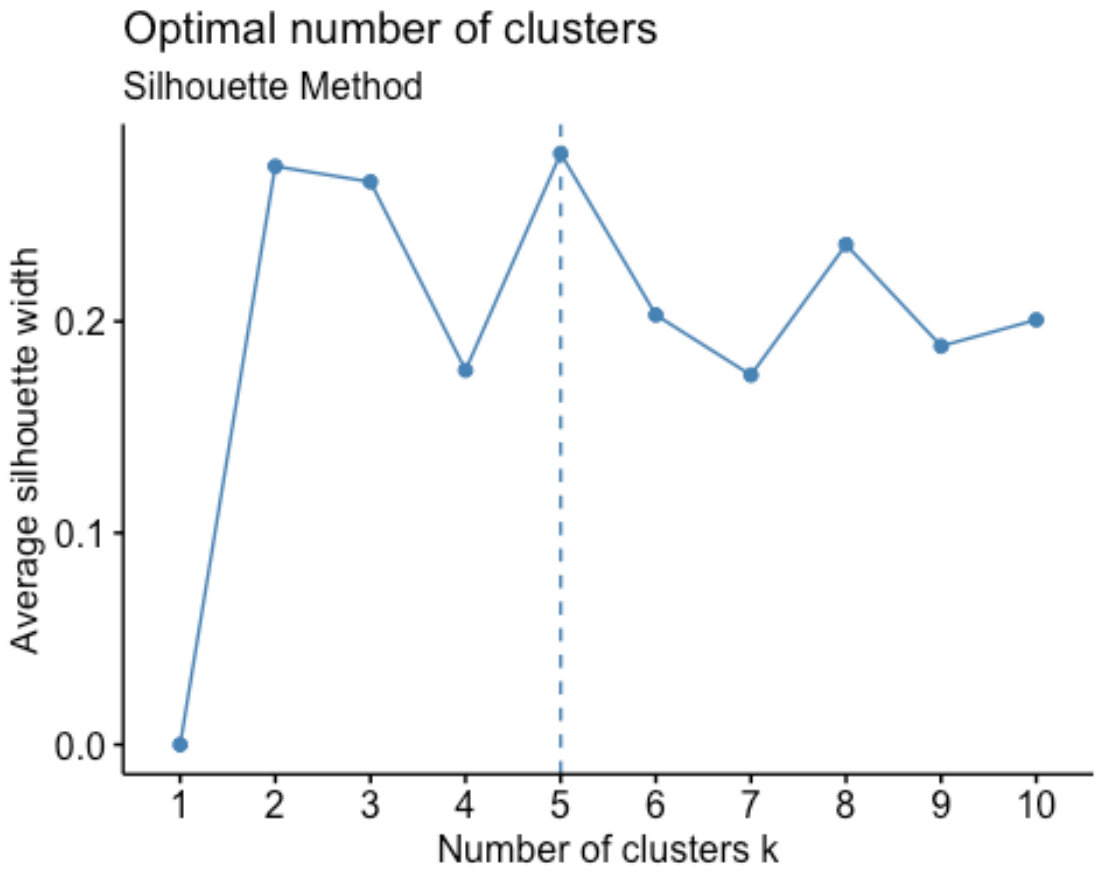
#Reading the Pharmaceutical data set

```
Myfile <- read.csv("Pharmaceuticals.csv")
head(Myfile)

##   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

X <- Myfile[,3:11]
head(X)

##   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

#scale quantitative variables
scale <- scale(X)
head(scale)

##      Market_Cap        Beta    PE_Ratio         ROE        ROA
Asset_Turnover
## [1,]  0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121
0.0000000
## [2,] -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871
0.9225312
## [3,] -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700
0.9225312
## [4,]  0.1702742 -0.02225704 -0.24290879  0.10638147  0.9181259
0.9225312
## [5,] -0.1790256 -0.80125356 -0.32874435 -0.26484883 -0.5664461     -
0.4612656
## [6,] -0.6953818  2.27578267  0.14948233 -1.45146000 -1.7127612     -
0.4612656
##        Leverage Rev_Growth Net_Profit_Margin
## [1,] -0.2120979 -0.5277675        0.06168225
## [2,]  0.0182843 -0.3811391       -1.55366706
## [3,] -0.4040831 -0.5721181       -0.68503583
## [4,] -0.7496565  0.1474473        0.35122600
## [5,] -0.3144900  1.2163867       -0.42597037
## [6,] -0.7496565 -1.4971443       -1.99560225

##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.
library(factoextra)

## Loading required package: ggplot2

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

#Using the elbow method and silhouette method to cluster
fviz_nbclust(scale, kmeans, method= "wss") + labs(subtitle = "Elbow Method")
```




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



##Looking at the plots produced above in the silhouette method you can see that 5 clusters are appropriate. I choose to use the silhoette method because the k value is more clear at 5.

```
#Using the silhouette method to produce a cluster plot
set.seed(10)
kmeans5 <- kmeans(scale,centers=5,nstart=25)
kmeans5$centers
```

```
##    Market_Cap       Beta    PE_Ratio        ROE        ROA Asset_Turnover
## 1  1.69558112 -0.1780563 -0.19845823  1.2349879  1.3503431      1.1531640
## 2 -0.03142211 -0.4360989 -0.31724852  0.1950459  0.4083915      0.1729746
## 3 -0.76022489  0.2796041 -0.47742380 -0.7438022 -0.8107428     -1.2684804
## 4 -0.87051511  1.3409869 -0.05284434 -0.6184015 -1.1928478     -0.4612656
## 5 -0.43925134 -0.4701800  2.70002464 -0.8349525 -0.9234951      0.2306328
##      Leverage Rev_Growth Net_Profit_Margin
## 1 -0.46807818  0.4671788       0.591242521
## 2 -0.27449312 -0.7041516       0.556954446
## 3  0.06308085  1.5180158      -0.006893899
## 4  1.36644699 -0.6912914      -1.320000179
## 5 -0.14170336 -0.1168459      -1.416514761
```

```
#5 clusters, data must be fitted to
fitkmeans<- kmeans(scale,5)
```

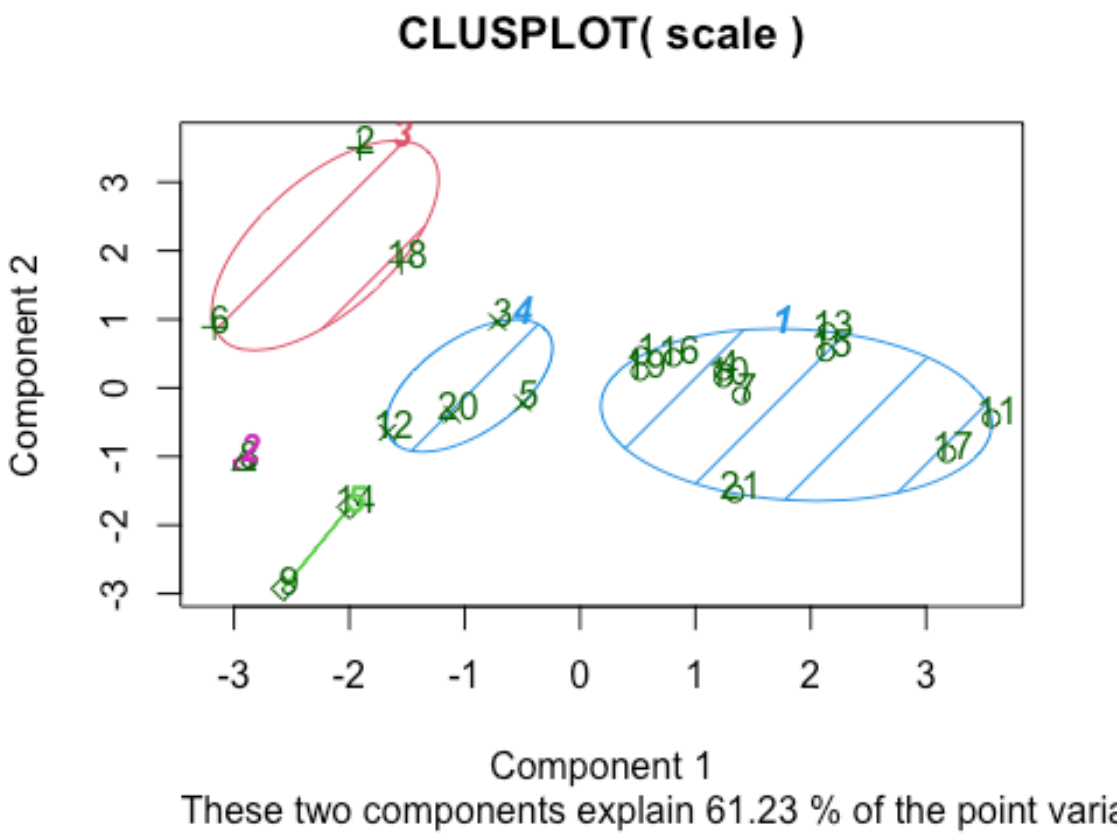
```
library(cluster)
aggregate(scale,by=list(fitkmeans$cluster), FUN=mean)
```

```
##   Group.1 Market_Cap       Beta    PE_Ratio        ROE        ROA
## 1       1  0.6733825 -0.3586419 -0.27635122  0.6565978  0.8344159
## 2       2 -0.9767669  1.2630872  0.03299122 -0.1123792 -1.1677918
## 3       3 -0.5246281  0.4451409  1.84984387 -1.0404550 -1.1865838
## 4       4 -0.7307042 -0.4214928 -0.34867046 -0.5780744 -0.6181243
## 5       5 -0.9668697  1.5162611 -0.57398880 -0.8382671 -0.9892673
##   Asset_Turnover    Leverage Rev_Growth Net_Profit_Margin
## 1   4.612656e-01 -0.33310678 -0.2902163         0.6823310
## 2  -4.612656e-01  3.74279705 -0.6327607        -1.2488842
## 3   1.480297e-16 -0.34435439 -0.5769454        -1.6095439
## 4  -2.306328e-01 -0.02651224  0.5327995        -0.4793074
## 5  -1.845062e+00  0.53024482  1.7123890         0.2445520
```

```
Y <- data.frame(scale,fitkmeans$cluster)
Y
```

```
##    Market_Cap        Beta    PE_Ratio         ROE        ROA
Asset_Turnover
## 1   0.1840960 -0.80125356 -0.04671323  0.04009035  0.2416121
0.0000000
## 2  -0.8544181 -0.45070513  3.49706911 -0.85483986 -0.9422871
0.9225312
## 3  -0.8762600 -0.25595600 -0.29195768 -0.72225761 -0.5100700
0.9225312
## 4   0.1702742 -0.02225704 -0.24290879  0.10638147  0.9181259
0.9225312
## 5  -0.1790256 -0.80125356 -0.32874435 -0.26484883 -0.5664461     -
0.4612656
## 6  -0.6953818  2.27578267  0.14948233 -1.45146000 -1.7127612     -
0.4612656
## 7  -0.1078688 -0.10015669 -0.70887325  0.59693581  0.8617498
0.9225312
## 8  -0.9767669  1.26308721  0.03299122 -0.11237924 -1.1677918     -
0.4612656
## 9  -0.9704532  2.15893320 -1.34037772 -0.70899938 -1.0174553     -
1.8450624
## 10  0.2762415 -1.34655112  0.14948233  0.34502953  0.5610770     -
0.4612656
## 11  1.0999201 -0.68440408 -0.45749769  2.45971647  1.8389364
1.3837968
## 12 -0.9393967  0.48409069 -0.34100657 -0.29136529 -0.6979905     -
0.4612656
## 13  1.9841758 -0.25595600  0.18013789  0.18593083  1.0872544
0.9225312
## 14 -0.9632863  0.87358895  0.19240011 -0.96753478 -0.9610792     -
1.8450624
## 15  1.2782387 -0.25595600 -0.40231769  0.98142435  0.8429577
```

```
1.8450624
## 16  0.6654710 -1.30760129 -0.23677768 -0.52338423  0.1288598     -
0.9225312
## 17  2.4199899  0.48409069 -0.11415545  1.31287998  1.6322239
0.4612656
## 18 -0.0240846 -0.48965495  1.90298017 -0.81506519 -0.9047030     -
0.4612656
## 19 -0.4018812 -0.06120687 -0.40231769 -0.21181593  0.5234929
0.4612656
## 20 -0.9281345 -1.11285216 -0.43297324 -1.03382590 -0.6979905     -
0.9225312
## 21 -0.1614497  0.40619104 -0.75792214  1.92938746  0.5422849     -
0.4612656
##       Leverage  Rev_Growth Net_Profit_Margin fitkmeans.cluster
## 1  -0.21209793 -0.52776752        0.06168225                 1
## 2   0.01828430 -0.38113909       -1.55366706                 3
## 3  -0.40408312 -0.57211809       -0.68503583                 4
## 4  -0.74965647  0.14744734        0.35122600                 1
## 5  -0.31449003  1.21638667       -0.42597037                 4
## 6  -0.74965647 -1.49714434       -1.99560225                 3
## 7  -0.02011273 -0.96584257        0.74744375                 1
## 8   3.74279705 -0.63276071       -1.24888417                 2
## 9   0.61983791  1.88617085       -0.36501379                 5
## 10 -0.07130879 -0.64814764        1.17413980                 1
## 11 -0.31449003  0.76926048        0.82363947                 1
## 12  1.10620040  0.05603085       -0.71551412                 4
## 13 -0.62166634 -0.36213170        0.33598685                 1
## 14  0.44065173  1.53860717        0.85411776                 5
## 15 -0.39128411  0.36014907       -0.24310064                 1
## 16 -0.67286239 -1.45369888        1.02174835                 1
## 17 -0.54487226  1.10143723        1.44844440                 1
## 18 -0.30169102  0.14744734       -1.27936246                 3
## 19 -0.74965647 -0.43544591        0.29026942                 1
## 20 -0.49367621  1.43089863       -0.09070919                 4
## 21  0.68383297 -1.17763919        1.49416183                 1

#visualize the cluster
clusplot(scale,fitkmeans$cluster, color = TRUE, shade = TRUE, labels= 2,
lines = 0)
```



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

```
#Cluster 1: rows 1, 4, 7, 10, 11, 13, 15, 16, 17,  19, 21
#Cluster 2: row 8
#Cluster 3: rows 2, 6, 18
#Cluster 4: rows 3, 5, 12, 20
#Cluster 5: rows 9, 14

# Analyzing the clusters in respect to the mean
#Cluster 1 has the highest market cap, highest ROE, highest ROA, highest
asset turnover, and the highest net profit margin.
#Cluster 2 has the lowest market cap, lowest asset turnover, highest
leverage, and the lowest rev growth.
#Cluster 3 has the highest PE ratio, lowest ROE, lowest ROA, lowest leverage,
and the lowest net profit margin.
#Cluster 4 has the lowest beta.
#Cluster 5 has the highest beta, lowest PE ratio, and the highest rev growth.
```

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

```
#Using the clusters and the .csv file I can conclude that:
#Cluster 1 has a majority hold recommendation.
#Cluster 2 has majority moderate buy.
#Cluster 3 has majority hold.
#Cluster 4 has equal on strong buy, moderate buy, hold, moderate sell.
#Cluster 5 has equal moderate sell and moderate buy.

#The pattern that I see in respect to the numerical variables is that Cluster
1 and Cluster 3 have a majority of hold recommendation. Cluster 2 and 5 have
a majority of the moderate buy.
```

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

```
# Cluster 1 new name = High Market cap, ROE, ROA, asset turnover, and net
profit margin.
# Cluster 2 new name= lowest market cap, asset turnover, rev growth and
highest leverage.
# Cluster 3 new name= highest PE ratio, lowest ROE,  ROA,  leverage, and net
profit margin
# Cluster 4 new name= lowest beta.
# Cluster 5 new name= highest rev growth, beta and lowest PE ratio.
```