K-Means Clustering Mini-Project

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2/2/2018

First we are asked to get the proper packages set up and load the data.

```
require(cluster)
```

```
## Loading required package: cluster
```

```
require(rattle.data)
```

```
## Loading required package: rattle.data
```

```
require(NbClust)
```

```
## Loading required package: NbClust
```

```
data(wine, package="rattle.data")
head(wine)
```

```
##   Type Alcohol Malic  Ash Alcalinity Magnesium Phenols Flavanoids
## 1    1   14.23  1.71 2.43       15.6       127    2.80       3.06
## 2    1   13.20  1.78 2.14       11.2       100    2.65       2.76
## 3    1   13.16  2.36 2.67       18.6       101    2.80       3.24
## 4    1   14.37  1.95 2.50       16.8       113    3.85       3.49
## 5    1   13.24  2.59 2.87       21.0       118    2.80       2.69
## 6    1   14.20  1.76 2.45       15.2       112    3.27       3.39
##   Nonflavanoids Proanthocyanins Color  Hue Dilution Proline
## 1          0.28            2.29  5.64 1.04     3.92    1065
## 2          0.26            1.28  4.38 1.05     3.40    1050
## 3          0.30            2.81  5.68 1.03     3.17    1185
## 4          0.24            2.18  7.80 0.86     3.45    1480
## 5          0.39            1.82  4.32 1.04     2.93     735
## 6          0.34            1.97  6.75 1.05     2.85    1450
```

Exercise 1 – Remove the first column from the data and scale it using the scale() function.

```
df <- scale(wine[,-1])
scale(df)
```

```
##            Alcohol       Malic         Ash   Alcalinity   Magnesium
##   [1,]  1.51434077 -0.56066822  0.23139979 -1.166303174  1.90852151
##   [2,]  0.24559683 -0.49800856 -0.82566722 -2.483840525  0.01809398
##   [3,]  0.19632522  0.02117152  1.10621386 -0.267982252  0.08810981
##   [4,]  1.68679140 -0.34583508  0.48655389 -0.806974805  0.92829983
##   [5,]  0.29486844  0.22705328  1.83522559  0.450674485  1.27837900
##   [6,]  1.47738706 -0.51591132  0.30430096 -1.286079296  0.85828399
##   [7,]  1.71142720 -0.41744613  0.30430096 -1.465743481 -0.26196936
##   [8,]  1.30493643 -0.16680747  0.88751034 -0.567422559  1.48842650
##   [9,]  2.25341491 -0.62332789 -0.71631546 -1.645407665 -0.19195352
##  [10,]  1.05857838 -0.88291793 -0.35180959 -1.046527051 -0.12193769
```

```
##  [11,]  1.35420804 -0.15785609 -0.24245783 -0.447646437  0.36817315
##  [12,]  1.37884384 -0.76654998 -0.16955666 -0.806974805 -0.33198519
##  [13,]  0.92308146 -0.54276546  0.15849862 -1.046527051 -0.75208020
##  [14,]  2.15487169 -0.54276546  0.08559744 -2.423952463 -0.61204853
##  [15,]  1.69910930 -0.41744613  0.04914686 -2.244288279  0.15812565
##  [16,]  0.77526663 -0.47115441  1.21556562 -0.687198682  0.85828399
##  [17,]  1.60056608 -0.37268923  1.28846679  0.151234178  1.41841067
##  [18,]  1.02162467 -0.68598755  0.92396093  0.151234178  1.06833150
##  [19,]  1.46506916 -0.66808479  0.41365272 -0.896806897  0.57822065
##  [20,]  0.78758453  0.68357369  0.70525741 -1.286079296  1.13834733
##  [21,]  1.30493643 -0.63227927 -0.31535901 -1.046527051  1.83850567
##  [22,] -0.08698653  1.31017034  1.03331269 -0.267982252  0.15812565
##  [23,]  0.87380985 -0.42639751 -0.02375431 -0.866862867  0.08810981
##  [24,] -0.18552975 -0.65913341  0.55945507 -0.507534498 -0.33198519
##  [25,]  0.61513390 -0.47115441  0.88751034  0.151234178 -0.26196936
##  [26,]  0.06082829 -0.25632128  3.11099611  1.648435713  1.69847400
##  [27,]  0.47963697 -0.50695994  0.92396093 -1.016583020 -0.47201686
##  [28,]  0.36877585 -0.55171684 -0.82566722 -0.747086744 -0.40200103
##  [29,]  1.07089628 -0.39059199  1.58007149 -0.028430007  0.50820482
##  [30,]  1.25566482 -0.58752236 -0.57051311 -1.046527051 -0.26196936
##  [31,]  0.89844565 -0.74864721  1.21556562  0.899834945  0.08810981
##  [32,]  0.71367712 -0.60542512 -0.02375431 -0.118262099  0.43818899
##  [33,]  0.83685614 -0.45325165 -0.02375431 -0.687198682  0.29815732
##  [34,]  0.93539936 -0.72179307  1.21556562  0.001514024  2.25860068
##  [35,]  0.62745180 -0.48010579  1.03331269 -0.148206130  0.71825232
##  [36,]  0.59049809 -0.47115441  0.15849862  0.300954331  0.01809398
##  [37,]  0.34414005 -0.62332789  1.72587383 -1.196247204  0.71825232
##  [38,]  0.06082829 -0.61437650  0.66880683 -0.447646437 -0.12193769
##  [39,]  0.08546410 -0.74864721 -0.97146956 -1.196247204 -0.12193769
##  [40,]  1.50202286  1.48024658  0.52300448 -1.884959911  1.97853734
##  [41,]  0.68904131 -0.56066822 -0.20600725 -0.986638989  1.20836316
##  [42,]  0.50427278  1.34597587 -0.89856839 -0.208094191 -0.68206436
##  [43,]  1.08321419 -0.39954337  0.81460917 -1.345967358  0.08810981
##  [44,]  0.29486844  1.47129519 -0.27890842 -0.597366590  0.22814148
##  [45,]  0.06082829 -0.50695994 -0.97146956 -0.747086744  0.50820482
##  [46,]  1.48970496  1.52500348  0.26785038 -0.178150160  0.78826816
##  [47,]  1.69910930  1.12219135 -0.31535901 -1.046527051  0.15812565
##  [48,]  1.10784999 -0.58752236 -0.89856839 -1.046527051  0.08810981
##  [49,]  1.35420804 -0.28317542  0.12204803 -0.208094191  0.22814148
##  [50,]  1.15712160 -0.54276546 -0.35180959 -0.627310621  0.57822065
##  [51,]  0.06082829 -0.54276546 -1.19017308 -2.124512156 -0.54203270
##  [52,]  1.02162467 -0.61437650  0.85105976 -0.687198682 -0.40200103
##  [53,]  1.00930677 -0.52486270  0.19494920 -1.645407665  0.78826816
##  [54,]  0.94771726 -0.39059199  1.14266445 -0.717142713  1.06833150
##  [55,]  0.91076355 -0.59647374 -0.42471076 -0.926750928  1.27837900
##  [56,]  0.68904131 -0.54276546  0.34075155  0.300954331  1.13834733
##  [57,]  1.50202286 -0.56961960 -0.24245783 -0.956694959  1.27837900
##  [58,]  0.35645795 -0.32793232  1.14266445 -0.806974805  0.15812565
##  [59,]  0.88612775 -0.81130688  0.48655389 -0.836918836  0.57822065
##  [60,] -0.77678907 -1.24992453 -3.66881295 -2.663504709 -0.82209603
##  [61,] -0.82606067 -1.10670244 -0.31535901 -1.046527051  0.08810981
##  [62,] -0.44420570 -0.87396654 -1.26307425 -0.806974805  0.01809398
##  [63,]  0.82453824 -0.97243173 -1.62758012 -0.447646437 -0.40200103
##  [64,] -0.77678907 -1.07984830 -0.75276604 -0.148206130 -0.89211187
```

```
##  [65,] -1.02314711 -0.79340412  0.59590565 -0.148206130  0.29815732
##  [66,] -0.77678907 -1.00823725  0.70525741 -0.417702406 -0.12193769
##  [67,]  0.13473571 -1.18726487 -2.42949302 -1.345967358 -1.52225438
##  [68,] -0.77678907 -1.04404278 -1.62758012  0.031458055 -1.52225438
##  [69,]  0.41804746 -1.24992453 -0.02375431 -0.747086744  0.71825232
##  [70,] -0.97387550 -1.02614002 -2.24724008 -0.806974805  3.58890153
##  [71,] -0.87533228 -0.65018203 -0.57051311  0.271010300  0.22814148
##  [72,]  1.05857838 -0.73969583  1.10621386  1.648435713 -0.96212770
##  [73,]  0.60281600 -0.60542512 -0.46116135  1.348995406 -0.89211187
##  [74,] -0.01307912 -0.59647374  0.85105976  3.145637249  2.74871152
##  [75,] -1.28182306 -1.11565382 -0.24245783  0.450674485  0.08810981
##  [76,] -1.65136013 -0.40849475 -1.62758012 -1.046527051 -0.19195352
##  [77,]  0.03619249 -1.28573006 -2.39304243 -1.046527051 -0.96212770
##  [78,] -1.42963789  0.49559470 -0.49761194 -0.447646437  0.85828399
##  [79,] -0.82606067 -1.20516763 -1.51822836 -1.405855419  2.53866402
##  [80,] -0.37029829  1.37283001  0.12204803  1.049555099  0.08810981
##  [81,] -1.23255145 -1.26782729 -1.33597542 -0.148206130 -0.96212770
##  [82,] -0.34566248 -0.47115441 -0.60696370 -0.208094191 -0.96212770
##  [83,] -1.13400823 -1.07984830  0.52300448  1.348995406 -1.52225438
##  [84,]  0.06082829  1.36387863 -0.16955666  0.899834945 -1.03214354
##  [85,] -1.42963789 -1.29468144  0.77815859 -0.447646437 -0.40200103
##  [86,] -0.40725200 -1.21411901 -0.46116135 -0.447646437 -0.05192185
##  [87,] -1.03546501 -0.65018203 -0.20600725  0.989667037 -0.68206436
##  [88,] -1.66367803 -0.59647374  0.92396093  1.947876020 -0.82209603
##  [89,] -1.67599593 -0.24736990  0.34075155  0.630338669 -1.10215937
##  [90,] -1.13400823 -0.90082069 -0.24245783  1.229219283 -2.08238105
##  [91,] -1.13400823 -0.45325165 -0.16955666 -0.297926283 -1.31220687
##  [92,] -1.23255145 -0.73969583  0.19494920  0.750114792 -0.96212770
##  [93,] -0.38261619 -0.72179307 -0.38826018  0.360842393 -1.38222271
##  [94,] -0.87533228  0.44188642 -0.53406252 -0.447646437 -0.82209603
##  [95,] -1.70063174 -0.31002956 -0.31535901 -0.447646437 -0.12193769
##  [96,] -0.65361004 -0.73074445 -0.60696370 -0.148206130  4.35907571
##  [97,] -1.46659160 -0.19366161  1.36136797  0.600394638  2.39863235
##  [98,] -0.87533228 -0.82920964 -1.40887660 -1.046527051 -1.03214354
##  [99,] -0.77678907 -1.13355658 -0.97146956 -0.297926283 -0.82209603
## [100,] -0.87533228  0.74623336 -0.57051311 -0.447646437 -0.82209603
## [101,] -1.13400823 -0.22946714 -2.42949302 -0.597366590 -0.19195352
## [102,] -0.49347731 -0.89186931 -1.70048129 -0.297926283 -0.82209603
## [103,] -0.81374277  0.10173395  0.34075155  0.450674485 -0.12193769
## [104,] -1.45427369 -0.55171684 -1.77338246  0.001514024 -0.96212770
## [105,] -0.60433843 -0.54276546 -1.40887660  0.300954331 -1.03214354
## [106,] -0.71519955  0.19124776 -0.35180959  0.750114792 -0.68206436
## [107,] -0.92460389 -0.54276546 -0.89856839 -0.148206130 -1.38222271
## [108,] -0.34566248 -0.52486270 -0.31535901  0.899834945 -1.10215937
## [109,] -0.96155760 -0.93662621 -1.55467894 -0.148206130 -0.54203270
## [110,] -1.71294964 -0.88291793  1.21556562  0.151234178 -0.40200103
## [111,] -1.89771818  1.25646206 -1.99208598  0.001514024  0.50820482
## [112,] -0.59202053  0.08383119 -0.71631546  0.450674485 -0.82209603
## [113,] -1.52818111  0.30761571  2.01747852  0.151234178  0.22814148
## [114,] -1.95930769 -1.42895215  0.48655389  0.450674485 -0.82209603
## [115,] -1.13400823 -0.84711240  0.48655389  0.899834945 -1.10215937
## [116,] -2.42738798 -0.73969583 -0.60696370  0.600394638 -1.03214354
## [117,] -1.45427369 -0.77550136 -1.37242601  0.390786423 -0.96212770
## [118,] -0.71519955 -0.65018203 -0.64341428  0.899834945  0.57822065
```

```
## [119,] -0.28407297  0.97896926 -1.40887660 -1.046527051 -1.38222271
## [120,] -1.23255145  0.97896926 -1.33597542 -0.148206130 -0.89211187
## [121,] -1.91003608  0.05697705  0.19494920  0.151234178 -0.26196936
## [122,] -1.77453915 -0.25632128  3.14744670  2.696476788  1.34839483
## [123,] -0.71519955  1.87410733  1.32491738  2.097596174  0.15812565
## [124,]  0.06082829  3.10044648 -0.86211780  0.600394638 -0.96212770
## [125,] -1.39268418  1.76669076  0.08559744  0.450674485 -1.24219104
## [126,] -1.14632613 -0.15785609 -0.71631546  0.450674485 -1.03214354
## [127,] -0.70288165 -0.72179307 -0.27890842  0.600394638 -0.96212770
## [128,] -1.49122740 -0.18471023  1.50717031  2.696476788 -0.54203270
## [129,] -0.77678907 -0.63227927 -0.24245783  1.498715559 -0.82209603
## [130,] -1.18327984  1.75773938  0.04914686  0.750114792 -1.38222271
## [131,] -0.17321185 -0.88291793 -0.16955666 -0.447646437  1.55844234
## [132,] -0.14857605  0.58510851  0.12204803  0.151234178  0.29815732
## [133,] -0.23480136 -0.02358538  0.12204803  1.348995406 -0.12193769
## [134,] -0.37029829  1.08638583 -0.02375431  0.600394638  0.43818899
## [135,] -0.60433843 -0.98138311 -0.42471076 -0.597366590 -1.03214354
## [136,] -0.49347731  0.11068533 -0.60696370 -0.297926283 -0.40200103
## [137,] -0.92460389  2.13369737  0.63235624  0.450674485 -0.75208020
## [138,] -0.57970263  2.84085644  0.99686210  1.648435713 -0.26196936
## [139,]  0.60281600  1.12219135 -0.64341428  0.001514024 -0.82209603
## [140,] -0.19784766  0.55825437  0.88751034  1.348995406  0.08810981
## [141,] -0.08698653  0.42398365  1.21556562  0.450674485 -0.26196936
## [142,]  0.44268327  0.20019914 -0.06020490  0.151234178 -0.75208020
## [143,]  0.63976970  0.74623336  1.28846679  1.199275252 -0.19195352
## [144,]  0.76294873  2.33957912 -0.06020490  0.151234178 -0.54203270
## [145,] -0.92460389  1.38178139 -0.60696370 -0.297926283  0.85828399
## [146,]  0.19632522  1.10428859 -0.78921663  0.450674485  0.15812565
## [147,]  1.08321419  2.42014155 -0.49761194  0.151234178 -1.38222271
## [148,] -0.16089395  2.03523218  0.41365272  0.600394638 -0.96212770
## [149,]  0.39341166  0.80889302  0.04914686  0.600394638 -0.54203270
## [150,]  0.09778200  1.39968415 -0.02375431  0.600394638  0.92829983
## [151,]  0.61513390  0.70147646  0.92396093  1.348995406  1.62845817
## [152,] -0.25943717  0.29866433  0.41365272  0.750114792  0.85828399
## [153,]  0.13473571 -0.39059199  1.39781855  1.798155867  1.13834733
## [154,]  0.28255053  0.86260131 -0.31535901 -0.297926283 -0.12193769
## [155,] -0.51811312 -0.93662621 -0.97146956  0.151234178  0.22814148
## [156,]  0.20864312  2.55441226 -0.16955666  0.750114792 -0.47201686
## [157,]  1.03394258  1.59661452  0.04914686  0.001514024 -0.75208020
## [158,] -0.67824585  0.62091403  0.99686210  2.247316327 -0.19195352
## [159,]  1.64983769 -0.58752236  1.21556562  1.648435713 -0.12193769
## [160,]  0.59049809 -0.59647374  0.99686210  0.899834945 -0.75208020
## [161,] -0.78910697  1.33702448  0.04914686  0.450674485 -0.82209603
## [162,]  0.84917404  0.82679579  0.63235624  0.151234178  0.50820482
## [163,] -0.18552975  0.83574717  0.77815859  0.750114792  0.43818899
## [164,] -0.05003283  0.99687202 -0.06020490 -0.297926283  0.43818899
## [165,]  0.96003516  0.37922675 -0.24245783  0.750114792 -0.68206436
## [166,]  0.89844565  1.81144766 -0.38826018  0.899834945 -0.82209603
## [167,]  0.55354439  1.22065654  0.85105976  1.049555099  0.78826816
## [168,] -0.22248346  0.92526097 -0.24245783  0.001514024 -0.82209603
## [169,]  0.71367712  0.21810190  1.17911504  1.498715559  0.36817315
## [170,]  0.49195487  2.02628080  1.79877500  1.648435713  0.85828399
## [171,] -0.98619340  0.62091403 -0.16955666 -0.148206130 -0.26196936
## [172,] -0.28407297  0.04802567 -0.31535901  0.001514024 -0.96212770
```

```
## [173,]  1.42811545  0.15544223  0.41365272  0.151234178 -0.61204853
## [174,]  0.87380985  2.96617577  0.30430096  0.300954331 -0.33198519
## [175,]  0.49195487  1.40863553  0.41365272  1.049555099  0.15812565
## [176,]  0.33182214  1.73983662 -0.38826018  0.151234178  1.41841067
## [177,]  0.20864312  0.22705328  0.01269627  0.151234178  1.41841067
## [178,]  1.39116174  1.57871176  1.36136797  1.498715559 -0.26196936
##             Phenols    Flavanoids Nonflavanoids Proanthocyanins
##   [1,]  0.806721729  1.0319080692   -0.65770780      1.22143845
##   [2,]  0.567048088  0.7315652835   -0.81841060     -0.54318872
##   [3,]  0.806721729  1.2121137407   -0.49700500      2.12995937
##   [4,]  2.484437221  1.4623993954   -0.97911340      1.02925134
##   [5,]  0.806721729  0.6614853002    0.22615759      0.40027531
##   [6,]  1.557699140  1.3622851335   -0.17559941      0.66234866
##   [7,]  0.327374446  0.4912910549   -0.49700500      0.67982021
##   [8,]  0.487156874  0.4812796287   -0.41665360     -0.59560339
##   [9,]  0.806721729  0.9518166597   -0.57735640      0.67982021
##  [10,]  1.094330099  1.1220109049   -1.13981619      0.45268998
##  [11,]  1.046395371  1.2922051502   -1.13981619      1.37868246
##  [12,] -0.151972837  0.4011882192   -0.81841060     -0.03651359
##  [13,]  0.487156874  0.7315652835   -0.57735640      0.38280376
##  [14,]  1.286069013  1.6626279192    0.54756319      2.12995937
##  [15,]  1.605633868  1.6125707883   -0.57735640      2.39203271
##  [16,]  0.886612943  0.8817366764   -0.49700500     -0.22870071
##  [17,]  0.806721729  1.1119994787   -0.25595080      0.66234866
##  [18,]  1.046395371  1.3722965597    0.30650899      0.22555975
##  [19,]  1.605633868  1.9029021478   -0.33630220      0.47016154
##  [20,]  0.646939302  1.0018737906   -1.54157319      0.12073042
##  [21,]  1.126286585  1.1420337573   -0.97911340      0.88947889
##  [22,]  0.183570261  0.3811653668   -0.89876200      0.67982021
##  [23,]  0.503135117  0.8517023978   -0.73805920      0.17314508
##  [24,]  0.295417961  0.3411196621   -0.81841060     -0.22870071
##  [25,]  0.375309174  0.5813938906   -0.65770780      0.12073042
##  [26,]  0.535091602  0.6514738740    0.86896878      0.57499088
##  [27,]  0.886612943  0.9117709549   -0.17559941     -0.24617226
##  [28,]  0.167592018  0.1609139906   -0.73805920     -0.42088782
##  [29,]  1.046395371  0.9418052335    0.06545479      0.29544598
##  [30,]  0.567048088  0.3010739573   -0.81841060      0.67982021
##  [31,]  1.126286585  1.2221251668   -0.57735640      1.37868246
##  [32,]  0.902591186  1.1620566097   -1.13981619      0.62740554
##  [33,]  0.199548504  0.6614853002    0.46721179      0.66234866
##  [34,]  1.046395371  0.7115424311    1.11002298     -0.42088782
##  [35,]  0.087700804  0.5013024811   -0.57735640     -0.08892826
##  [36,]  0.646939302  0.9518166597   -0.81841060      0.47016154
##  [37,]  0.487156874  0.6514738740   -0.17559941     -0.40341627
##  [38,]  0.247483232  0.4011882192   -0.57735640     -0.26364382
##  [39,]  0.167592018  0.6114281692   -0.65770780     -0.38594471
##  [40,]  1.126286585  1.0118852168   -1.30051899      0.85453577
##  [41,]  1.365960227  1.2621708716   -0.17559941      1.30879623
##  [42,]  0.247483232  0.6514738740   -0.73805920     -0.19375759
##  [43,]  1.525742654  1.5324793788   -1.54157319      0.19061664
##  [44,]  0.551069845  0.6014167430   -0.33630220      0.12073042
##  [45,]  1.126286585  0.9718395121   -0.65770780      0.76717799
##  [46,]  0.886612943  0.6214395954   -0.49700500     -0.59560339
##  [47,]  1.525742654  1.1420337573   -0.73805920      1.04672289
```

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##  [48,]  1.286069013  1.3622851335   -1.22016759      0.95936511
##  [49,]  0.726830515  0.8917481025   -0.33630220      1.37868246
##  [50,]  0.934547672  1.5124565264   -0.33630220      0.85453577
##  [51,]  0.678895787  1.2421480192   -1.54157319      2.30467493
##  [52,]  0.247483232  0.9618280859   -1.13981619      1.22143845
##  [53,]  2.532371949  1.7126850502   -0.33630220      0.48763309
##  [54,]  1.126286585  0.7615995621    0.22615759      0.15567353
##  [55,]  0.487156874  0.8717252502   -1.22016759      0.05084419
##  [56,]  1.062373614  0.7515881359   -1.30051899      1.50098335
##  [57,]  1.445851440  0.9718395121   -0.81841060      0.76717799
##  [58,]  1.126286585  1.2021023145   -0.41665360      0.12073042
##  [59,]  1.765416296  1.6426050669   -1.38087039      0.78464955
##  [60,] -0.503494178 -1.4609370523   -0.65770780     -2.04574255
##  [61,] -0.391646479 -0.9403428904    2.15459116     -2.06321410
##  [62,] -0.439581207 -0.6199772522    1.35107717     -1.69631142
##  [63,] -0.311755265 -0.2395430570   -0.33630220     -1.50412430
##  [64,]  1.925198724  1.0719537740   -1.38087039      0.48763309
##  [65,] -0.647298363 -0.2795887618    0.70826598     -0.97997762
##  [66,]  0.199548504  0.6214395954    0.06545479      0.85453577
##  [67,]  1.094330099  1.1520451835   -0.81841060      1.20396690
##  [68,] -0.295777022 -0.0293031070   -0.73805920     -0.96250606
##  [69,]  0.375309174 -0.7301029403    1.51177997     -2.04574255
##  [70,] -0.711211334 -0.7501257927   -1.78262739      1.58834113
##  [71,] -1.909579543 -1.0104228737    0.06545479     -0.22870071
##  [72,]  1.046395371  0.8316795454   -1.22016759      0.48763309
##  [73,] -0.663276606 -0.1894859260   -0.73805920     -0.97997762
##  [74,]  1.605633868  0.8617138240   -1.22016759      0.64487710
##  [75,]  1.733459810  0.1108568597   -1.86297878      0.10325886
##  [76,] -1.094689161 -0.4597944332   -0.17559941     -0.77031895
##  [77,] -0.551428907  0.0007311716   -0.97911340     -0.22870071
##  [78,] -0.918928490 -0.7100800880    0.54756319     -1.11975007
##  [79,] -0.631320120 -0.1794744999   -0.09524801      2.04260159
##  [80,]  0.854656458  0.5213253335    0.54756319      0.62740554
##  [81,]  0.199548504  0.2309939740   -0.49700500     -0.28111538
##  [82,] -0.151972837  0.5013024811   -0.81841060      0.31291753
##  [83,] -0.471537693 -0.4497830070    0.30650899     -0.33353004
##  [84,] -1.030776190 -0.4397715808    1.99388837      0.05084419
##  [85,] -0.151972837  0.1809368430   -1.13981619      1.32626779
##  [86,] -0.151972837 -0.0893716641   -0.49700500     -0.22870071
##  [87,] -0.823059034 -0.3396573189    0.54756319     -0.05398515
##  [88,] -0.599363635 -0.4197487284    0.30650899     -0.43835938
##  [89,] -0.551428907 -0.3396573189    0.94932018     -0.42088782
##  [90,] -0.151972837 -0.4397715808    0.46721179     -0.36847316
##  [91,] -1.110667404 -0.5298744165    1.27072578      0.08578730
##  [92,] -1.350341045 -0.7801600713    1.11002298      0.06831575
##  [93,] -1.462188745 -0.5699201213    1.75283417      0.05084419
##  [94,]  0.247483232  0.2209825478   -0.89876200      0.69729177
##  [95,]  1.158243070  0.2309939740   -1.54157319     -0.42088782
##  [96,]  0.327374446  0.2410054002   -0.33630220      2.95112251
##  [97,] -1.110667404 -1.0404571523   -1.78262739     -0.05398515
##  [98,]  0.407265660  0.4712682025   -0.57735640      0.31291753
##  [99,]  1.957155209  1.7226964764   -0.97911340      0.62740554
## [100,]  0.886612943  0.9618280859    0.70826598      2.12995937
## [101,] -0.104038109  0.1408911382   -0.81841060     -0.33353004
```

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## [102,] -1.350341045 -0.6700343832   -0.57735640     -0.42088782
## [103,]  0.423243903  0.0808225811   -0.17559941     -0.49077405
## [104,]  0.327374446 -0.3897144499    0.06545479     -0.29858693
## [105,] -0.151972837 -0.1093945165   -0.33630220     -0.19375759
## [106,] -0.982841462 -0.1894859260    2.39564536     -0.29858693
## [107,] -1.030776190  0.0007311716    0.06545479      0.06831575
## [108,] -1.462188745 -0.2695773356    0.94932018      0.06831575
## [109,]  0.103679047  0.0107425978    0.22615759      0.85453577
## [110,]  0.710852273  0.8917481025   -0.57735640      1.57086958
## [111,]  1.413894955  0.5513596121   -0.97911340      3.47526919
## [112,]  0.407265660  0.2410054002   -0.81841060     -0.64801805
## [113,] -0.870993762  0.0007311716    1.91353697     -0.94503451
## [114,]  0.295417961 -0.0192916808    0.46721179     -0.26364382
## [115,]  0.423243903  0.2610282525    0.54756319     -0.96250606
## [116,]  0.263461475  0.1408911382    1.27072578      0.73223488
## [117,] -0.503494178 -0.4297601546   -0.49700500     -0.10639981
## [118,] -0.471537693  0.0607997287   -0.17559941      0.03337264
## [119,] -1.062732675 -0.7801600713    0.54756319     -1.32940874
## [120,] -0.471537693 -0.3897144499    0.06545479      0.48763309
## [121,]  0.966504157  0.7615995621   -0.33630220      0.41774687
## [122,]  1.413894955  3.0542161597    0.86896878      0.48763309
## [123,] -0.151972837  0.1008454335    0.54756319      0.20808820
## [124,]  0.519113359  0.6214395954   -0.49700500      0.73223488
## [125,]  0.902591186  1.0018737906   -1.22016759      2.30467493
## [126,]  0.487156874  0.6214395954    0.06545479     -0.42088782
## [127,]  0.710852273  1.1220109049    0.22615759      0.31291753
## [128,] -0.263820537  0.2109711216    1.75283417      0.29544598
## [129,] -0.120016352  0.4212110716    0.30650899      0.54004776
## [130,] -0.311755265 -0.2795887618    0.46721179     -0.42088782
## [131,] -1.254471589 -0.7801600713   -1.22016759     -1.13722163
## [132,] -1.590014687 -0.8101943499   -0.97911340     -1.32940874
## [133,] -1.829688329 -0.9403428904   -0.73805920     -1.32940874
## [134,] -0.950884976 -0.8302172023   -1.54157319     -1.31193719
## [135,] -0.471537693 -1.4509256261    1.91353697     -0.59560339
## [136,] -1.078710918 -1.3708342166    2.15459116     -1.13722163
## [137,] -1.462188745 -1.5610513142    1.35107717     -1.38182341
## [138,] -0.807080791 -1.4309027737    2.15459116     -0.85767673
## [139,] -1.078710918 -1.5510398880    1.75283417     -1.24205096
## [140,]  0.039766076 -1.4309027737    1.35107717     -1.36435186
## [141,] -1.206536860 -1.5310170356    1.35107717     -1.46918119
## [142,] -1.430232259 -1.5310170356    0.06545479     -1.66136831
## [143,] -1.190558618 -1.5109941832    1.11002298     -1.81861232
## [144,] -0.471537693 -1.2306742499    0.86896878     -0.99744918
## [145,] -1.462188745 -1.2506971023   -0.57735640     -0.78779050
## [146,] -1.270449832 -1.4809599046    0.54756319     -0.50824560
## [147,] -2.101318456 -1.6911998547    0.30650899     -1.59148209
## [148,] -0.950884976 -1.3808456427    0.86896878     -1.27699407
## [149,] -0.583385392 -1.2707199546    0.70826598     -0.59560339
## [150,] -1.414254017 -0.6400001046   -0.17559941     -0.78779050
## [151,] -1.430232259 -0.4597944332   -1.13981619     -0.59560339
## [152,] -1.302406317 -0.6700343832   -0.97911340     -0.57813183
## [153,] -0.151972837 -0.7501257927   -0.81841060     -0.05398515
## [154,] -0.791102548 -1.2006399713    1.99388837      0.48763309
## [155,] -1.302406317 -1.4509256261    1.35107717     -0.33353004
```

```
## [156,] -0.886972005 -1.4008684951    1.99388837     -0.07145670
## [157,] -0.791102548 -1.2006399713    0.94932018     -0.05398515
## [158,] -0.631320120 -1.4509256261    2.15459116     -0.78779050
## [159,]  0.806721729 -0.7200915142    1.35107717      1.93777225
## [160,]  0.487156874 -0.9303314642    1.27072578      1.22143845
## [161,]  0.007809591 -1.1105371356    1.11002298     -0.96250606
## [162,] -0.743167820 -1.4709484785    1.11002298     -1.38182341
## [163,] -1.030776190 -1.4309027737    1.91353697     -1.10227851
## [164,] -1.446210502 -1.3307885118    0.30650899     -1.13722163
## [165,] -1.510123473 -1.3508113642    0.38686039     -0.97997762
## [166,] -1.621971173 -1.5610513142    1.27072578     -0.77031895
## [167,] -0.950884976 -1.1105371356    0.54756319     -0.22870071
## [168,] -1.302406317 -1.3708342166    0.30650899     -1.08480696
## [169,] -1.190558618 -1.1906285451    0.22615759     -0.08892826
## [170,] -0.503494178 -1.0704914308   -0.73805920     -0.84020517
## [171,] -1.669905901 -1.5410284618    0.30650899     -1.50412430
## [172,] -1.446210502 -1.5210056094    0.94932018     -1.66136831
## [173,] -0.982841462 -1.3307885118    0.62791458     -0.61307494
## [174,] -0.982841462 -1.4208913475    1.27072578     -0.92756295
## [175,] -0.791102548 -1.2807313808    0.54756319     -0.31605849
## [176,] -1.126645647 -1.3407999380    0.54756319     -0.42088782
## [177,] -1.030776190 -1.3508113642    1.35107717     -0.22870071
## [178,] -0.391646479 -1.2707199546    1.59213137     -0.42088782
##               Color         Hue    Dilution      Proline
##   [1,]  0.251008784  0.36115849  1.84272147  1.010159388
##   [2,] -0.292496232  0.40490846  1.11031723  0.962526349
##   [3,]  0.268262912  0.31740852  0.78636920  1.391223700
##   [4,]  1.182731669 -0.42634104  1.18074072  2.328006800
##   [5,] -0.318377423  0.36115849  0.44833648 -0.037767469
##   [6,]  0.729810822  0.40490846  0.33565890  2.232740722
##   [7,]  0.082781041  0.27365854  1.36384178  1.724654973
##   [8,] -0.003489596  0.44865844  1.36384178  1.740532653
##   [9,]  0.061213382  0.53615839  0.33565890  0.946648670
##  [10,]  0.932546820  0.22990857  1.32158768  0.946648670
##  [11,]  0.298457635  1.27990794  0.78636920  2.423272878
##  [12,] -0.025057256  0.92990815  0.29340481  1.692899614
##  [13,]  0.233754657  0.84240820  0.40608239  1.819921051
##  [14,]  0.147484019  1.27990794  0.16664254  1.280079943
##  [15,]  1.053325713  1.06115807  0.54692935  2.540767708
##  [16,]  0.967055075  1.41115786  0.37791299  1.788165692
##  [17,]  0.492566569  0.49240841  0.05396496  1.692899614
##  [18,]  0.665107844  0.75490825 -0.05871261  1.216569224
##  [19,]  1.570949537  1.19240799  0.29340481  2.963113987
##  [20,]  0.018078063  0.01115870  1.05397844  0.311541483
##  [21,]  0.255322316  0.57990836  1.54694284  0.105131647
##  [22,] -0.240733849  0.31740852  1.27933359  0.073376288
##  [23,] -0.542681081  0.66740831  1.95539905  0.914893310
##  [24,] -0.486605166  0.57990836  1.43426526  0.851382592
##  [25,] -0.663459973  0.71115828  1.70187450  0.311541483
##  [26,] -0.637578782  0.75490825  0.82862329  0.263908444
##  [27,] -0.111327893 -0.16384119  0.85679269  1.422979059
##  [28,] -0.477978102  0.27365854  0.22298133  1.708777293
##  [29,] -0.240733849  1.27990794  1.11031723  0.533828998
##  [30,] -0.154463212  0.36115849  1.37792647  0.914893310
```

```
##  [31,]  0.276889975  1.01740810  0.13847314  1.708777293
##  [32,]  0.794513800  0.57990836  0.37791299  2.439150558
##  [33,] -0.525426953  1.19240799  0.36382829  0.771994193
##  [34,]  0.147484019  1.27990794  0.54692935  1.550000497
##  [35,] -0.370139806  0.62365833  0.36382829  1.105425466
##  [36,]  0.018078063  0.36115849  1.20891011  0.549706678
##  [37,] -0.197598531  0.57990836  0.23706602  0.422685241
##  [38,] -0.348572146  0.71115828 -0.14322079  1.137180826
##  [39,] -0.585816399  0.97365812  0.11030375  0.867260271
##  [40,]  0.018078063 -0.29509111  1.29341829  0.041620929
##  [41,]  0.462371846 -0.03259127  1.08214784  0.152764686
##  [42,] -0.335631551 -0.20759117  0.54692935  0.914893310
##  [43,]  0.160424615 -0.33884109  1.33567238  1.105425466
##  [44,] -0.301123296 -0.60134093  0.54692935 -0.212421946
##  [45,] -0.007803128 -0.33884109  1.03989375  0.438562920
##  [46,]  0.078467509 -0.38259106  1.01172435  1.057792427
##  [47,] -0.068192574  0.36115849  1.16665602  1.010159388
##  [48,]  0.449431250 -0.20759117  1.01172435  0.756116514
##  [49,]  0.492566569  0.49240841  0.19481193  0.994281709
##  [50,]  1.657220175  0.71115828  0.68777632  1.629388895
##  [51,]  0.923919756  0.71115828  0.42016708  1.280079943
##  [52,]  0.233754657  1.23615797  1.06806314  1.645266575
##  [53,]  0.859216778  0.22990857  0.91313147  1.407101380
##  [54,]  0.535701888  0.75490825  0.44833648  1.994575527
##  [55,]  0.341592953 -0.16384119  0.82862329  0.994281709
##  [56,]  0.514134228  0.09865865  0.58918345  1.184813865
##  [57,]  0.570210143 -0.07634125  0.98355496  0.708483475
##  [58,]  0.406295932  0.49240841  0.32157420  1.661144254
##  [59,]  0.751378481 -0.29509111  0.36382829  1.708777293
##  [60,] -1.340684477  0.40490846 -1.11506488 -0.720507695
##  [61,] -0.771298270  1.27990794 -1.32633534 -0.212421946
##  [62,]  0.298457635  0.09865865 -1.43901291 -0.942795210
##  [63,] -0.542681081  1.19240799 -0.21364428 -0.371198742
##  [64,] -0.262301509  1.14865802  0.36382829 -1.038061288
##  [65,] -0.909331290  2.15490741 -0.53759231 -1.244471124
##  [66,] -0.197598531  1.01740810 -0.43899943 -0.218773018
##  [67,]  0.104348700  0.71115828  0.80045390 -0.777667342
##  [68,] -0.163090276  0.71115828  1.22299481 -0.752263054
##  [69,] -0.814433589  0.27365854 -0.96013322  0.009865569
##  [70,] -0.952466609  1.41115786  0.64552223 -0.091751580
##  [71,] -0.866195971 -0.22509116 -1.11506488  0.390929881
##  [72,] -0.723849419  1.76115765  0.77228450 -1.069816648
##  [73,] -0.568562272  0.09865865  0.23706602 -0.872933420
##  [74,] -0.736790015  1.54240778  1.25116420  0.756116514
##  [75,] -0.797179461  0.14240862  0.73003041  0.441738456
##  [76,] -0.542681081  1.19240799 -0.66435458 -1.012657001
##  [77,] -0.197598531  1.01740810 -0.18547489 -1.126976294
##  [78,] -1.038737246  0.01115870 -0.12913610 -0.784018414
##  [79,] -0.715222356  0.44865844 -0.42491473  0.009865569
##  [80,] -1.073245501  1.01740810  0.73003041 -0.901513243
##  [81,] -1.103440224  1.84865760  0.71594572 -1.488987391
##  [82,] -0.499545762  0.88615818  0.74411511 -0.104453724
##  [83,] -1.232846180  1.54240778  0.15255784 -0.371198742
##  [84,] -0.111327893 -0.51384098 -0.84745564 -0.736385375
```

```
##  [85,] -0.866195971 -0.73259085  0.65960693 -0.720507695
##  [86,] -1.051677842  1.19240799  0.77228450 -0.942795210
##  [87,] -1.125007884  1.62990773 -0.49533822 -0.799896093
##  [88,] -1.060304905  1.76115765  0.84270799 -0.587135186
##  [89,] -0.974034268  0.18615860  0.19481193 -0.212421946
##  [90,] -1.431268647  0.49240841  0.84270799 -0.387076422
##  [91,] -1.146575543  0.53615839 -0.48125352 -0.847529132
##  [92,] -0.628951718  0.40490846  0.05396496 -0.942795210
##  [93,] -0.866195971  0.01115870 -0.77703216 -0.799896093
##  [94,] -1.254413840  0.84240820  0.96947026 -1.450880959
##  [95,] -0.779925334  0.88615818  0.49059057 -1.276226483
##  [96,] -1.060304905  0.88615818  0.02579557  0.603690789
##  [97,] -1.103440224 -0.03259127 -0.49533822 -0.387076422
##  [98,] -0.930898949  1.19240799  0.18072723 -1.012657001
##  [99,] -0.240733849  0.36115849  0.22298133 -0.275932664
## [100,] -1.189710862  2.02365749  0.30748951 -1.082518791
## [101,] -0.758357674  1.36740789  0.49059057 -0.117155868
## [102,] -1.125007884  0.36115849  0.22298133 -0.587135186
## [103,] -0.974034268 -0.68884088  1.08214784 -0.980901641
## [104,] -1.293235627 -0.07634125 -0.24181367 -1.053938968
## [105,] -0.913644822  0.36115849  1.34975708 -0.237826233
## [106,] -1.017169587 -0.42634104  0.96947026 -1.371492561
## [107,] -0.715222356  0.18615860  0.78636920 -0.752263054
## [108,] -0.758357674 -0.33884109 -0.26998307 -0.822124845
## [109,] -1.017169587 -0.42634104  0.57509875 -1.381019169
## [110,] -1.038737246  0.01115870  0.91313147 -0.212421946
## [111,] -0.930898949 -0.90759075  0.27932011 -0.587135186
## [112,] -1.319116818 -0.25134114  0.23706602 -1.339737202
## [113,] -0.542681081  1.19240799 -0.15730549 -0.444236069
## [114,] -0.853255375  0.62365833 -0.42491473 -0.993603785
## [115,] -0.930898949 -0.12009122  0.81453860 -1.149205046
## [116,] -1.362252137  3.29240673  0.36382829 -1.079343255
## [117,] -1.340684477 -0.03259127  1.01172435 -0.799896093
## [118,] -1.293235627  0.44865844  0.49059057 -1.276226483
## [119,] -0.715222356 -1.12634062 -0.69252397 -1.190487013
## [120,] -1.629691113 -0.12009122  0.61735284 -0.580784114
## [121,] -0.779925334 -0.68884088  1.09623253 -0.387076422
## [122,]  0.406295932 -0.12009122  1.51877344 -0.895162171
## [123,] -1.284608563 -0.16384119  0.71594572 -1.212715765
## [124,] -1.060304905 -0.99509069  0.68777632 -1.165082726
## [125,] -0.974034268 -0.90759075  1.44834996 -1.165082726
## [126,] -0.991288395 -0.42634104  0.94130087 -1.171433797
## [127,] -0.482291634 -1.17009059  0.32157420 -1.253997732
## [128,] -0.887763630  0.05490867 -0.24181367 -0.891986635
## [129,] -1.267354435 -0.29509111  0.23706602 -1.285753091
## [130,] -1.060304905 -0.73259085 -0.05871261 -0.529975539
## [131,] -0.413275124 -0.86384077 -1.86155382 -0.371198742
## [132,]  0.147484019 -0.95134072 -1.67845276 -0.688752336
## [133,]  0.276889975 -1.30134051 -1.76296094 -0.593486258
## [134,] -0.025057256 -0.77634083 -1.86155382 -0.466464820
## [135,]  0.169051679 -0.90759075 -1.55169049 -0.307688024
## [136,]  0.880784438 -0.99509069 -1.45309761 -0.164788907
## [137,] -0.521113421 -0.90759075 -1.88972321 -0.085400508
## [138,] -0.025057256 -0.60134093 -1.29816594 -0.736385375
```

```
## [139,]  0.276889975 -0.64509090 -1.11506488 -0.529975539
## [140,] -0.059565511 -0.29509111 -0.65026988 -0.498220180
## [141,] -0.197598531 -0.82009080 -0.42491473 -0.466464820
## [142,]  0.233754657 -1.12634062 -0.19955958  0.105131647
## [143,] -0.305436828 -0.29509111 -0.77703216 -0.720507695
## [144,] -0.283869168 -0.20759117 -0.79111685 -0.625241617
## [145,]  1.359586476 -1.34509048 -0.86154034  0.343296842
## [146,] -0.456410443 -1.56384035 -1.31225064  0.263908444
## [147,] -0.068192574 -1.65134030 -1.80521503 -1.053938968
## [148,]  1.118028691 -1.82634020 -1.05872609 -0.387076422
## [149,]  1.450170645 -1.78259022 -1.39675882 -0.307688024
## [150,]  1.872896769 -1.69509027 -1.80521503 -0.625241617
## [151,]  1.527814219 -1.60759033 -1.84746912 -0.784018414
## [152,]  2.476791231 -2.08884004 -1.60802927 -0.847529132
## [153,]  0.880784438 -1.52009038 -1.80521503 -1.022183609
## [154,]  2.356012338 -1.73884025 -1.55169049 -0.228299625
## [155,]  1.096461031 -1.65134030 -1.49535170 -0.339443383
## [156,]  1.225866988 -1.56384035 -1.59394458 -0.069522829
## [157,]  1.704669026 -1.69509027 -1.36858943 -0.847529132
## [158,]  1.053325713 -1.25759054 -1.24182715  0.422685241
## [159,]  3.425768243 -1.69509027 -0.91787912 -0.275932664
## [160,]  2.886576759 -1.69509027 -1.17140367 -0.402954102
## [161,]  1.118028691 -1.73884025 -1.45309761 -0.720507695
## [162,]  0.354533549  0.01115870 -1.11506488 -0.212421946
## [163,]  0.225127593 -0.38259106 -0.70660867 -0.561730898
## [164,]  0.095721637 -1.21384056 -1.21365776 -0.228299625
## [165,]  1.950540342 -1.12634062 -1.31225064 -0.418831781
## [166,]  0.673734908 -0.77634083 -1.21365776 -0.720507695
## [167,]  2.425028848 -0.47009101 -1.48126700 -0.164788907
## [168,]  2.243860510 -1.03884067 -1.21365776 -0.196544266
## [169,]  1.553695410 -0.95134072 -1.14323428  0.009865569
## [170,]  1.484678900 -1.25759054 -0.97421791 -0.371198742
## [171,]  0.190619338 -1.30134051 -1.10098018 -0.752263054
## [172,]  2.088572931 -1.69509027 -1.38267412 -0.879284492
## [173,]  2.002302725 -1.47634041 -1.26999655 -0.275932664
## [174,]  1.139596350 -1.38884046 -1.22774246 -0.021889790
## [175,]  0.967055075 -1.12634062 -1.48126700  0.009865569
## [176,]  2.217979318 -1.60759033 -1.48126700  0.279786124
## [177,]  1.829761450 -1.56384035 -1.39675882  0.295663803
## [178,]  1.786626131 -1.52009038 -1.42492821 -0.593486258
## attr(,"scaled:center")
##         Alcohol           Malic             Ash      Alcalinity
##   -8.594093e-16   -6.734236e-17    8.046486e-16   -7.684922e-17
##       Magnesium         Phenols      Flavanoids   Nonflavanoids
##   -4.095117e-17   -1.391677e-17    6.950589e-17   -1.041614e-16
## Proanthocyanins           Color             Hue        Dilution
##   -1.223272e-16    3.676054e-17    2.100087e-16    3.009648e-16
##         Proline
##   -1.037131e-16
## attr(,"scaled:scale")
##         Alcohol           Malic             Ash      Alcalinity
##               1               1               1               1
##       Magnesium         Phenols      Flavanoids   Nonflavanoids
##               1               1               1               1
```

```
## Proanthocyanins           Color             Hue        Dilution
##               1               1               1               1
##         Proline
##               1
```

```
head(df)
```

```
##        Alcohol       Malic        Ash Alcalinity  Magnesium   Phenols
## [1,] 1.5143408 -0.56066822  0.2313998 -1.1663032 1.90852151 0.8067217
## [2,] 0.2455968 -0.49800856 -0.8256672 -2.4838405 0.01809398 0.5670481
## [3,] 0.1963252  0.02117152  1.1062139 -0.2679823 0.08810981 0.8067217
## [4,] 1.6867914 -0.34583508  0.4865539 -0.8069748 0.92829983 2.4844372
## [5,] 0.2948684  0.22705328  1.8352256  0.4506745 1.27837900 0.8067217
## [6,] 1.4773871 -0.51591132  0.3043010 -1.2860793 0.85828399 1.5576991
##      Flavanoids Nonflavanoids Proanthocyanins      Color        Hue
## [1,]  1.0319081    -0.6577078       1.2214385  0.2510088  0.3611585
## [2,]  0.7315653    -0.8184106      -0.5431887 -0.2924962  0.4049085
## [3,]  1.2121137    -0.4970050       2.1299594  0.2682629  0.3174085
## [4,]  1.4623994    -0.9791134       1.0292513  1.1827317 -0.4263410
## [5,]  0.6614853     0.2261576       0.4002753 -0.3183774  0.3611585
## [6,]  1.3622851    -0.1755994       0.6623487  0.7298108  0.4049085
##       Dilution     Proline
## [1,] 1.8427215  1.01015939
## [2,] 1.1103172  0.96252635
## [3,] 0.7863692  1.39122370
## [4,] 1.1807407  2.32800680
## [5,] 0.4483365 -0.03776747
## [6,] 0.3356589  2.23274072
```

Next to use K Means clustering. First we are asking how many clusters to use?

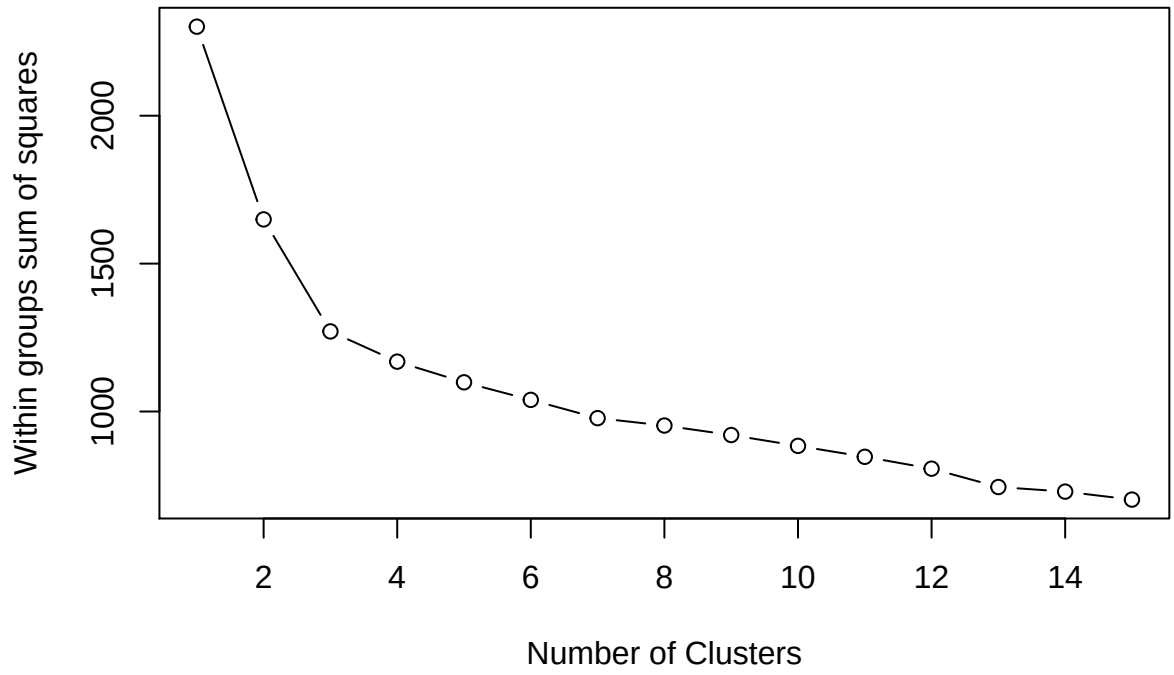
```
wssplot <- function(data, nc=15, seed=1234){

  wss <- (nrow(data)-1)*sum(apply(data,2,var))
    for (i in 2:nc){
          set.seed(seed)
     wss[i] <- sum(kmeans(data, centers=i)$withinss)}

  plot(1:nc, wss, type="b", xlab="Number of Clusters",
       ylab="Within groups sum of squares")
}
str(wssplot)
```

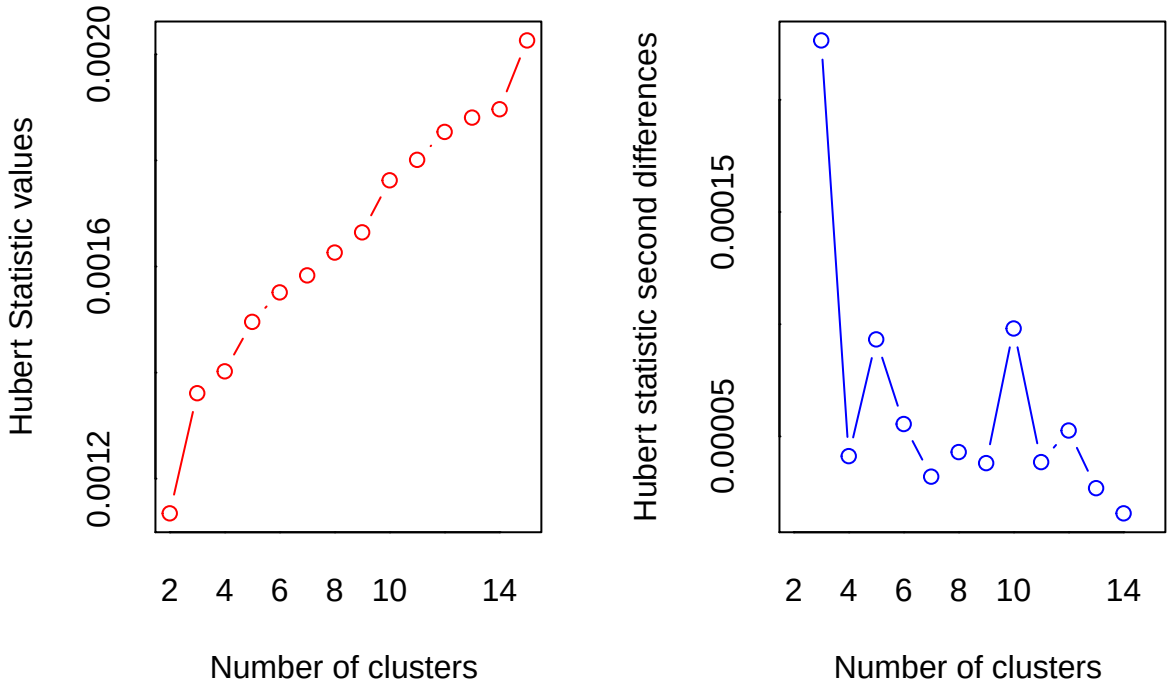
```
## function (data, nc = 15, seed = 1234)
##  - attr(*, "srcref")=Class 'srcref'  atomic [1:8] 1 12 10 1 12 1 1 10
##   .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x7fc7f746c8d0>
```

```
wssplot(df)
```



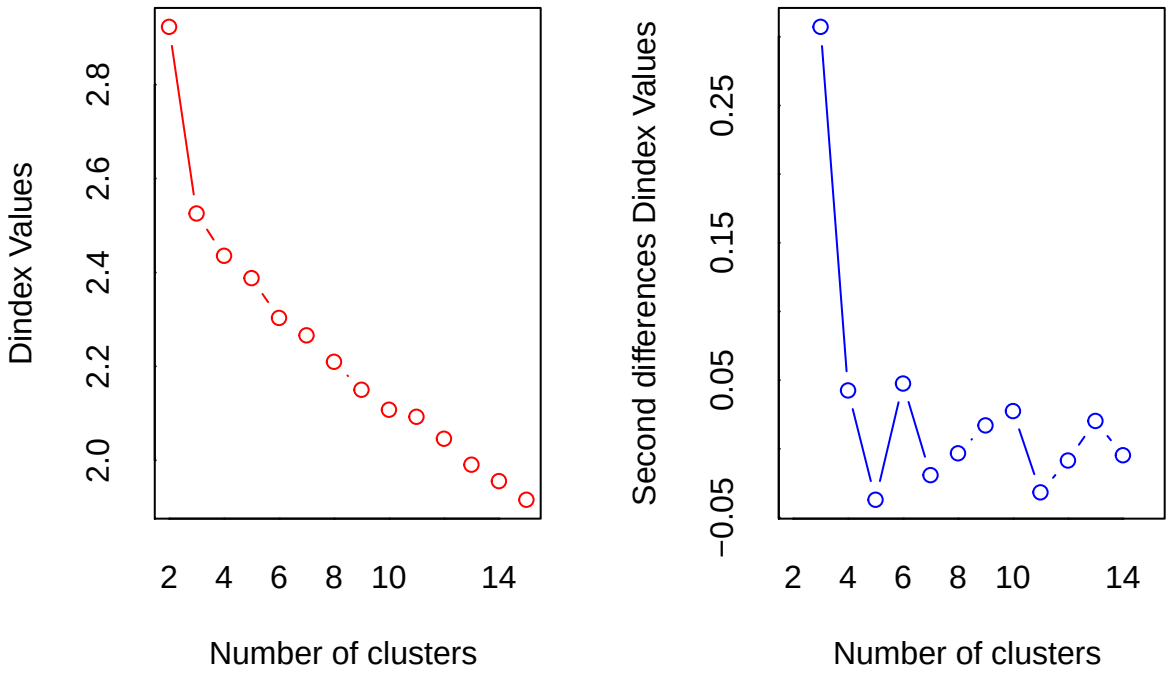
This one seems to suggest using 3 clusters. 3 clusters represents the biggest improvement in previous error compared with the size of the next improvement in error.

```
library(NbClust)
set.seed(1234)
nc <- NbClust(df, min.nc=2, max.nc=15, method="kmeans")
```



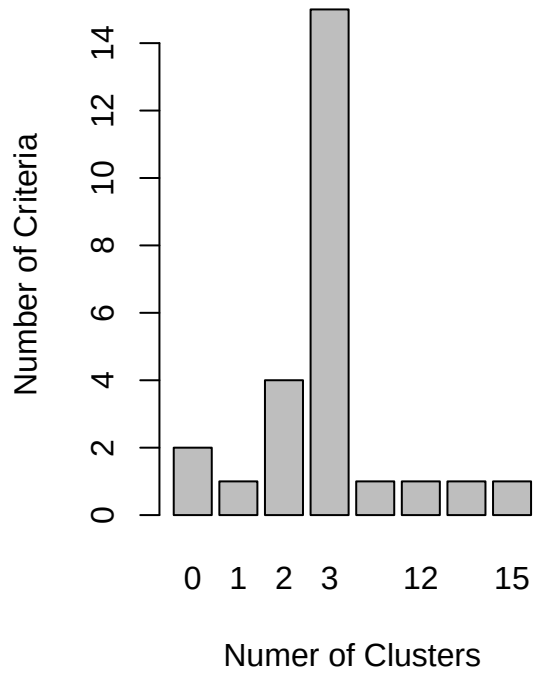

```
## *** : The Hubert index is a graphical method of determining the number of clusters.
##                In the plot of Hubert index, we seek a significant knee that corresponds to a
##                significant increase of the value of the measure i.e the significant peak in Hubert
##                index second differences plot.
```

##




```
## *** : The D index is a graphical method of determining the number of clusters.
##                 In the plot of D index, we seek a significant knee (the significant peak in Dindex
##                 second differences plot) that corresponds to a significant increase of the value of
##                 the measure.
##
## *******************************************************************
## * Among all indices:
## * 4 proposed 2 as the best number of clusters
## * 15 proposed 3 as the best number of clusters
## * 1 proposed 10 as the best number of clusters
## * 1 proposed 12 as the best number of clusters
## * 1 proposed 14 as the best number of clusters
## * 1 proposed 15 as the best number of clusters
##
##                    ***** Conclusion *****
##
## * According to the majority rule, the best number of clusters is  3
##
##
## *******************************************************************
```

```
barplot(table(nc$Best.n[1,]),
              xlab="Numer of Clusters", ylab="Number of Criteria",
                    main="Number of Clusters Chosen by 26 Criteria")
```



This one also seems to suggest we run 3 clusters. 0 has a high bar here for some reason, and 2 also has somewhat of a bar, but this strategy really suggests using 3 clusters.

```
fit.km <- kmeans(df, 3, nstart=25)
table(fit.km$cluster)
```

```
##
##  1  2  3
## 51 65 62
```

```
table(wine$Type)
```

```
##
##  1  2  3
## 59 71 48
```

```
fit.km
```

```
## K-means clustering with 3 clusters of sizes 51, 65, 62
##
## Cluster means:
##      Alcohol      Malic        Ash Alcalinity   Magnesium     Phenols
## 1  0.1644436  0.8690954  0.1863726  0.5228924 -0.07526047 -0.97657548
## 2 -0.9234669 -0.3929331 -0.4931257  0.1701220 -0.49032869 -0.07576891
## 3  0.8328826 -0.3029551  0.3636801 -0.6084749  0.57596208  0.88274724
##    Flavanoids Nonflavanoids Proanthocyanins      Color        Hue
## 1 -1.21182921    0.72402116     -0.77751312  0.9388902 -1.1615122
## 2  0.02075402   -0.03343924      0.05810161 -0.8993770  0.4605046
## 3  0.97506900   -0.56050853      0.57865427  0.1705823  0.4726504
##     Dilution    Proline
## 1 -1.2887761 -0.4059428
## 2  0.2700025 -0.7517257
```

```
## 3  0.7770551  1.1220202
##
## Clustering vector:
##   [1] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
##  [36] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 2 2 1 2 2 2 2 2 2 2 2 2
##  [71] 2 2 2 3 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2 2 3 2 2 2 2 2 2 2 2 2
## [106] 2 2 2 2 2 2 2 2 2 2 2 2 2 1 2 2 3 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1
## [141] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [176] 1 1 1
##
## Within cluster sum of squares by cluster:
## [1] 326.3537 558.6971 385.6983
##  (between_SS / total_SS =  44.8 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"
```

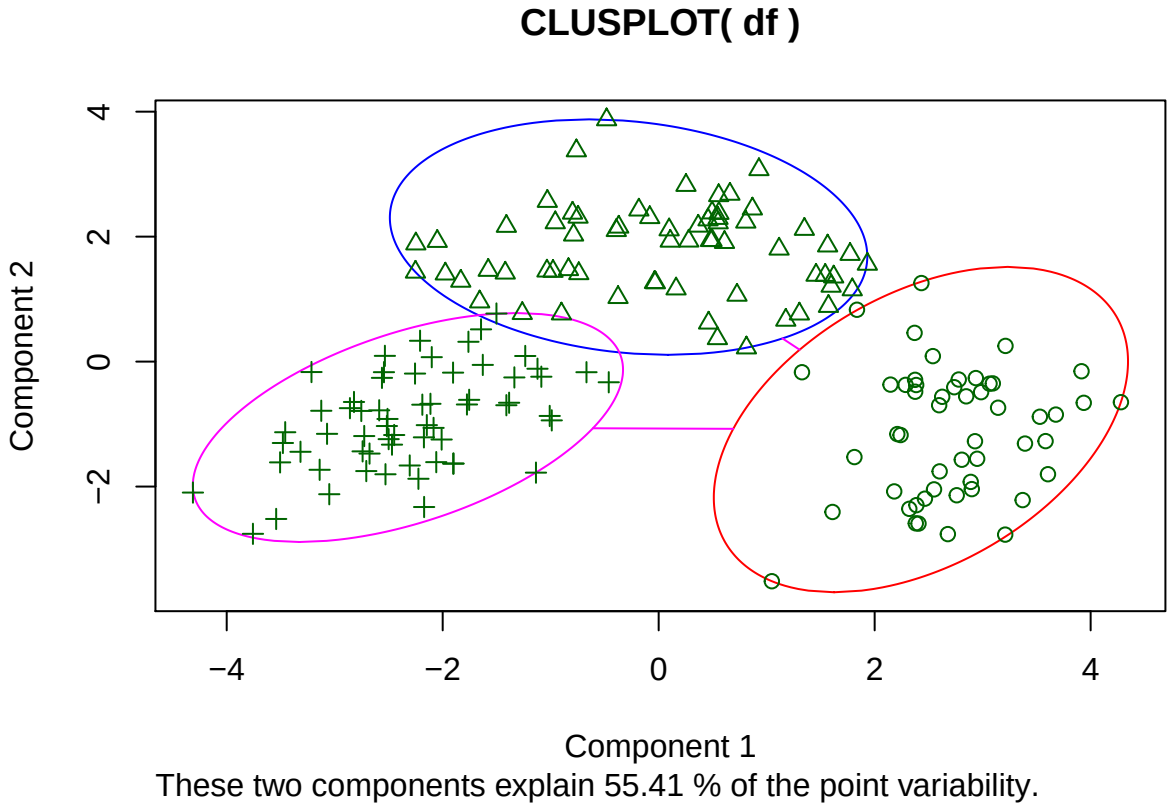
This is an interesting clustering, it seems to be based primarily off color. First and foremost, we see our three clusters have 3 distinct wine colors that act as the basis for the 3 clusters. We see a sum of squared errors at 44.8%, so this isn't terribly good or bad at predictions one way or another, it's decent but could likely use a larger sample size.

Exercise 6: Visualize these clusters

```
aggregate(wine[-1], by=list(cluster=fit.km$cluster), mean)
```

```
##   cluster  Alcohol    Malic      Ash Alcalinity Magnesium  Phenols
## 1       1 13.13412 3.307255 2.417647   21.24118  98.66667 1.683922
## 2       2 12.25092 1.897385 2.231231   20.06308  92.73846 2.247692
## 3       3 13.67677 1.997903 2.466290   17.46290 107.96774 2.847581
##   Flavanoids Nonflavanoids Proanthocyanins    Color       Hue Dilution
## 1  0.8188235     0.4519608        1.145882 7.234706 0.6919608 1.696667
## 2  2.0500000     0.3576923        1.624154 2.973077 1.0627077 2.803385
## 3  3.0032258     0.2920968        1.922097 5.453548 1.0654839 3.163387
##     Proline
## 1  619.0588
## 2  510.1692
## 3 1100.2258
```

```
#We are asked to use clusplot() to model this
clusplot(df, fit.km$cluster, color=TRUE)
```



After getting this to graph, it does look like the most sensible way to cluster this data on a 2d frame.