Unsupervised Learning - K-mean Clustering

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R Markdown

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```
set.seed(256)
# Load iris dataset into a new variable iris2
data(iris)
str(iris)
```

```
## 'data.frame':    150 obs. of  5 variables:
##  $ Sepal.Length: num  5.1 4.9 4.7 4.6 5 5.4 4.6 5 4.4 4.9 ...
##  $ Sepal.Width : num  3.5 3 3.2 3.1 3.6 3.9 3.4 3.4 2.9 3.1 ...
##  $ Petal.Length: num  1.4 1.4 1.3 1.5 1.4 1.7 1.4 1.5 1.4 1.5 ...
##  $ Petal.Width : num  0.2 0.2 0.2 0.2 0.2 0.4 0.3 0.2 0.2 0.1 ...
##  $ Species     : Factor w/ 3 levels "setosa","versicolor",..: 1 1 1 1 1 1 1 1 1 1 ...
```

```
#Remove the initial label of Species from original dataset
iris2 <- iris[,-5]
iris2
```

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width
## 1            5.1         3.5          1.4         0.2
## 2            4.9         3.0          1.4         0.2
## 3            4.7         3.2          1.3         0.2
## 4            4.6         3.1          1.5         0.2
## 5            5.0         3.6          1.4         0.2
## 6            5.4         3.9          1.7         0.4
## 7            4.6         3.4          1.4         0.3
## 8            5.0         3.4          1.5         0.2
## 9            4.4         2.9          1.4         0.2
## 10           4.9         3.1          1.5         0.1
## 11           5.4         3.7          1.5         0.2
## 12           4.8         3.4          1.6         0.2
## 13           4.8         3.0          1.4         0.1
## 14           4.3         3.0          1.1         0.1
## 15           5.8         4.0          1.2         0.2
## 16           5.7         4.4          1.5         0.4
## 17           5.4         3.9          1.3         0.4
## 18           5.1         3.5          1.4         0.3
## 19           5.7         3.8          1.7         0.3
## 20           5.1         3.8          1.5         0.3
## 21           5.4         3.4          1.7         0.2
## 22           5.1         3.7          1.5         0.4
## 23           4.6         3.6          1.0         0.2
## 24           5.1         3.3          1.7         0.5
## 25           4.8         3.4          1.9         0.2
## 26           5.0         3.0          1.6         0.2
## 27           5.0         3.4          1.6         0.4
## 28           5.2         3.5          1.5         0.2
## 29           5.2         3.4          1.4         0.2
## 30           4.7         3.2          1.6         0.2
## 31           4.8         3.1          1.6         0.2
## 32           5.4         3.4          1.5         0.4
## 33           5.2         4.1          1.5         0.1
## 34           5.5         4.2          1.4         0.2
## 35           4.9         3.1          1.5         0.2
## 36           5.0         3.2          1.2         0.2
## 37           5.5         3.5          1.3         0.2
## 38           4.9         3.6          1.4         0.1
## 39           4.4         3.0          1.3         0.2
## 40           5.1         3.4          1.5         0.2
## 41           5.0         3.5          1.3         0.3
## 42           4.5         2.3          1.3         0.3
## 43           4.4         3.2          1.3         0.2
## 44           5.0         3.5          1.6         0.6
## 45           5.1         3.8          1.9         0.4
## 46           4.8         3.0          1.4         0.3
## 47           5.1         3.8          1.6         0.2
## 48           4.6         3.2          1.4         0.2
## 49           5.3         3.7          1.5         0.2
## 50           5.0         3.3          1.4         0.2
## 51           7.0         3.2          4.7         1.4
## 52           6.4         3.2          4.5         1.5
## 53           6.9         3.1          4.9         1.5
## 54           5.5         2.3          4.0         1.3
## 55           6.5         2.8          4.6         1.5
## 56           5.7         2.8          4.5         1.3
## 57           6.3         3.3          4.7         1.6
## 58           4.9         2.4          3.3         1.0
## 59           6.6         2.9          4.6         1.3
## 60           5.2         2.7          3.9         1.4
## 61           5.0         2.0          3.5         1.0
## 62           5.9         3.0          4.2         1.5
## 63           6.0         2.2          4.0         1.0
## 64           6.1         2.9          4.7         1.4
## 65           5.6         2.9          3.6         1.3
## 66           6.7         3.1          4.4         1.4
## 67           5.6         3.0          4.5         1.5
## 68           5.8         2.7          4.1         1.0
## 69           6.2         2.2          4.5         1.5
## 70           5.6         2.5          3.9         1.1
## 71           5.9         3.2          4.8         1.8
## 72           6.1         2.8          4.0         1.3
## 73           6.3         2.5          4.9         1.5
## 74           6.1         2.8          4.7         1.2
## 75           6.4         2.9          4.3         1.3
## 76           6.6         3.0          4.4         1.4
## 77           6.8         2.8          4.8         1.4
## 78           6.7         3.0          5.0         1.7
## 79           6.0         2.9          4.5         1.5
## 80           5.7         2.6          3.5         1.0
## 81           5.5         2.4          3.8         1.1
## 82           5.5         2.4          3.7         1.0
## 83           5.8         2.7          3.9         1.2
## 84           6.0         2.7          5.1         1.6
## 85           5.4         3.0          4.5         1.5
## 86           6.0         3.4          4.5         1.6
## 87           6.7         3.1          4.7         1.5
## 88           6.3         2.3          4.4         1.3
## 89           5.6         3.0          4.1         1.3
## 90           5.5         2.5          4.0         1.3
## 91           5.5         2.6          4.4         1.2
## 92           6.1         3.0          4.6         1.4
## 93           5.8         2.6          4.0         1.2
## 94           5.0         2.3          3.3         1.0
## 95           5.6         2.7          4.2         1.3
## 96           5.7         3.0          4.2         1.2
## 97           5.7         2.9          4.2         1.3
## 98           6.2         2.9          4.3         1.3
## 99           5.1         2.5          3.0         1.1
## 100          5.7         2.8          4.1         1.3
## 101          6.3         3.3          6.0         2.5
## 102          5.8         2.7          5.1         1.9
## 103          7.1         3.0          5.9         2.1
## 104          6.3         2.9          5.6         1.8
## 105          6.5         3.0          5.8         2.2
## 106          7.6         3.0          6.6         2.1
## 107          4.9         2.5          4.5         1.7
## 108          7.3         2.9          6.3         1.8
## 109          6.7         2.5          5.8         1.8
## 110          7.2         3.6          6.1         2.5
## 111          6.5         3.2          5.1         2.0
## 112          6.4         2.7          5.3         1.9
## 113          6.8         3.0          5.5         2.1
## 114          5.7         2.5          5.0         2.0
## 115          5.8         2.8          5.1         2.4
## 116          6.4         3.2          5.3         2.3
## 117          6.5         3.0          5.5         1.8
## 118          7.7         3.8          6.7         2.2
## 119          7.7         2.6          6.9         2.3
## 120          6.0         2.2          5.0         1.5
## 121          6.9         3.2          5.7         2.3
## 122          5.6         2.8          4.9         2.0
## 123          7.7         2.8          6.7         2.0
## 124          6.3         2.7          4.9         1.8
## 125          6.7         3.3          5.7         2.1
## 126          7.2         3.2          6.0         1.8
## 127          6.2         2.8          4.8         1.8
## 128          6.1         3.0          4.9         1.8
## 129          6.4         2.8          5.6         2.1
## 130          7.2         3.0          5.8         1.6
## 131          7.4         2.8          6.1         1.9
## 132          7.9         3.8          6.4         2.0
## 133          6.4         2.8          5.6         2.2
## 134          6.3         2.8          5.1         1.5
## 135          6.1         2.6          5.6         1.4
## 136          7.7         3.0          6.1         2.3
## 137          6.3         3.4          5.6         2.4
## 138          6.4         3.1          5.5         1.8
## 139          6.0         3.0          4.8         1.8
## 140          6.9         3.1          5.4         2.1
## 141          6.7         3.1          5.6         2.4
## 142          6.9         3.1          5.1         2.3
## 143          5.8         2.7          5.1         1.9
## 144          6.8         3.2          5.9         2.3
## 145          6.7         3.3          5.7         2.5
## 146          6.7         3.0          5.2         2.3
## 147          6.3         2.5          5.0         1.9
## 148          6.5         3.0          5.2         2.0
## 149          6.2         3.4          5.4         2.3
## 150          5.9         3.0          5.1         1.8
```

```
# Apply K-mean clustering to understand the Species from other attributes
?kmeans
```

```
## starting httpd help server ... done
```

```
kmeans.result <- kmeans(iris2, centers = 3, nstart = 20)
kmeans.result
```

```
## K-means clustering with 3 clusters of sizes 50, 38, 62
##
## Cluster means:
##   Sepal.Length Sepal.Width Petal.Length Petal.Width
## 1     5.006000    3.428000     1.462000    0.246000
## 2     6.850000    3.073684     5.742105    2.071053
## 3     5.901613    2.748387     4.393548    1.433871
##
## Clustering vector:
##   [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 1 1 1 1
##  [38] 1 1 1 1 1 1 1 1 1 1 1 1 1 3 3 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
##  [75] 3 3 3 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 2 3 2 2 2 2 3 2 2 2 2
## [112] 2 2 3 3 2 2 2 2 3 2 3 2 3 2 2 3 3 2 2 2 2 2 3 2 2 2 2 3 2 2 2 3 2 2 2 3 2
## [149] 2 3
##
## Within cluster sum of squares by cluster:
## [1] 15.15100 23.87947 39.82097
##  (between_SS / total_SS =  88.4 %)
```

```
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

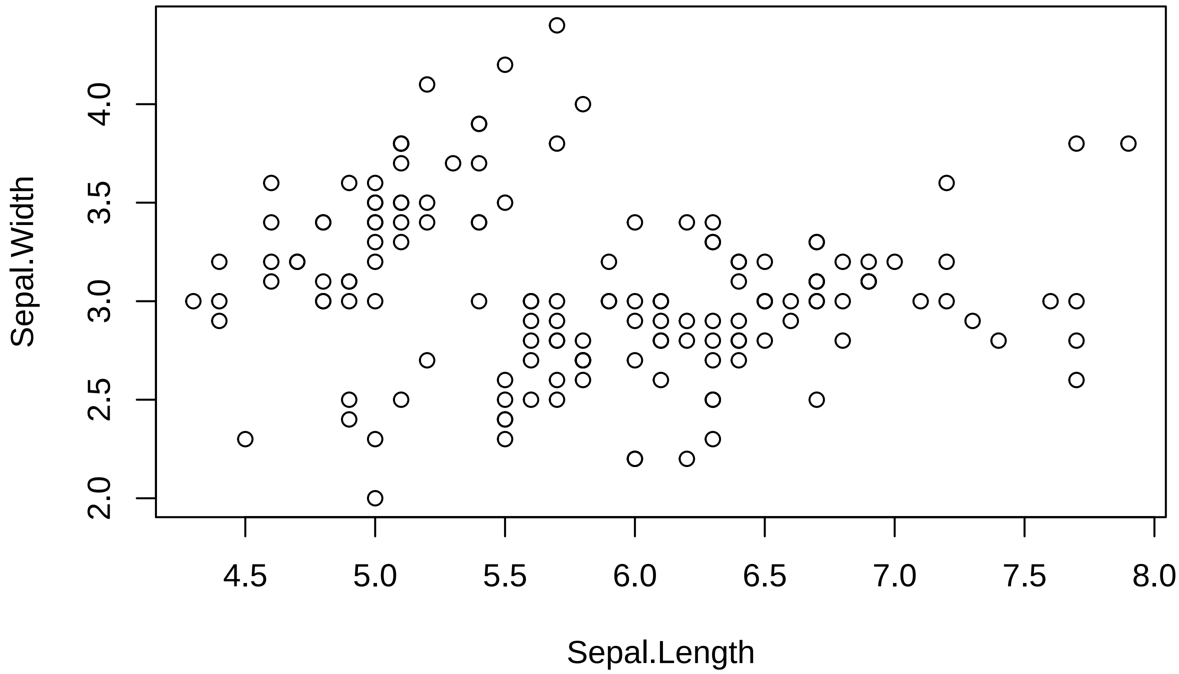
```
# See the cluster identification for each observation
kmeans.result$cluster
```

```
##   [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 1 1 1 1
##  [38] 1 1 1 1 1 1 1 1 1 1 1 1 1 3 3 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
##  [75] 3 3 3 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 2 3 2 2 2 2 3 2 2 2 2
## [112] 2 2 3 3 2 2 2 2 3 2 3 2 3 2 2 3 3 2 2 2 2 2 3 2 2 2 2 3 2 2 2 3 2 2 2 3 2
## [149] 2 3
```

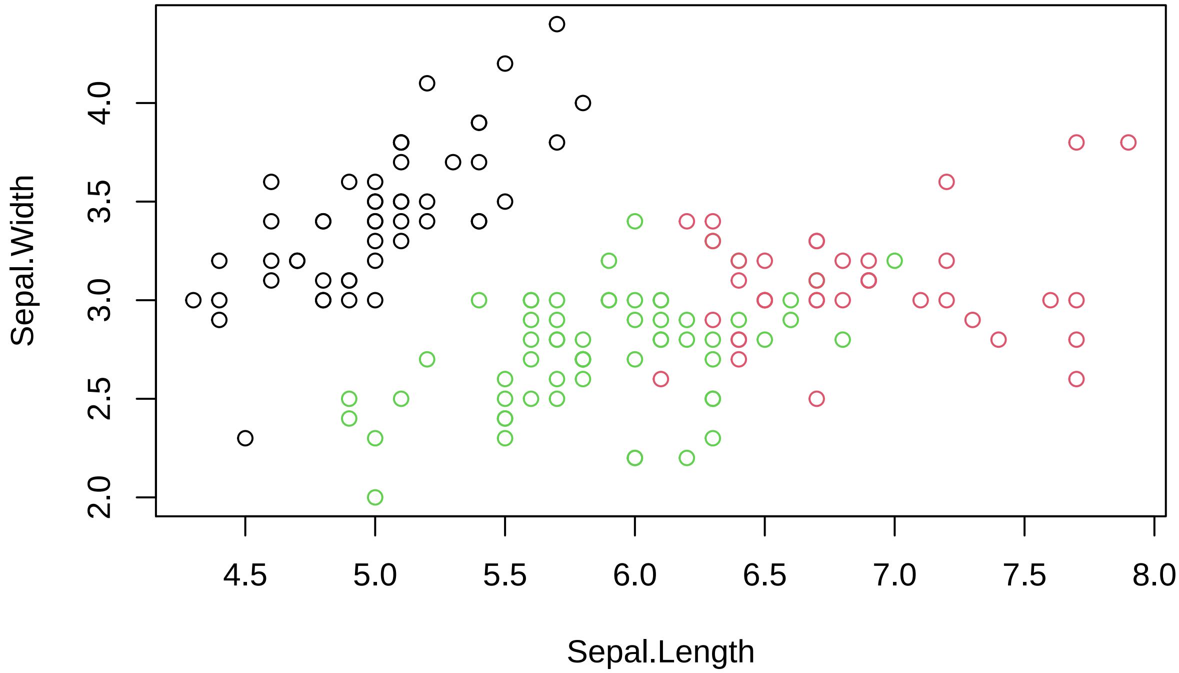
```
# Compare with original label
table(iris$Species, kmeans.result$cluster)
```

```
##
##               1  2  3
##   setosa     50  0  0
##   versicolor  0  2 48
##   virginica   0 36 14
```

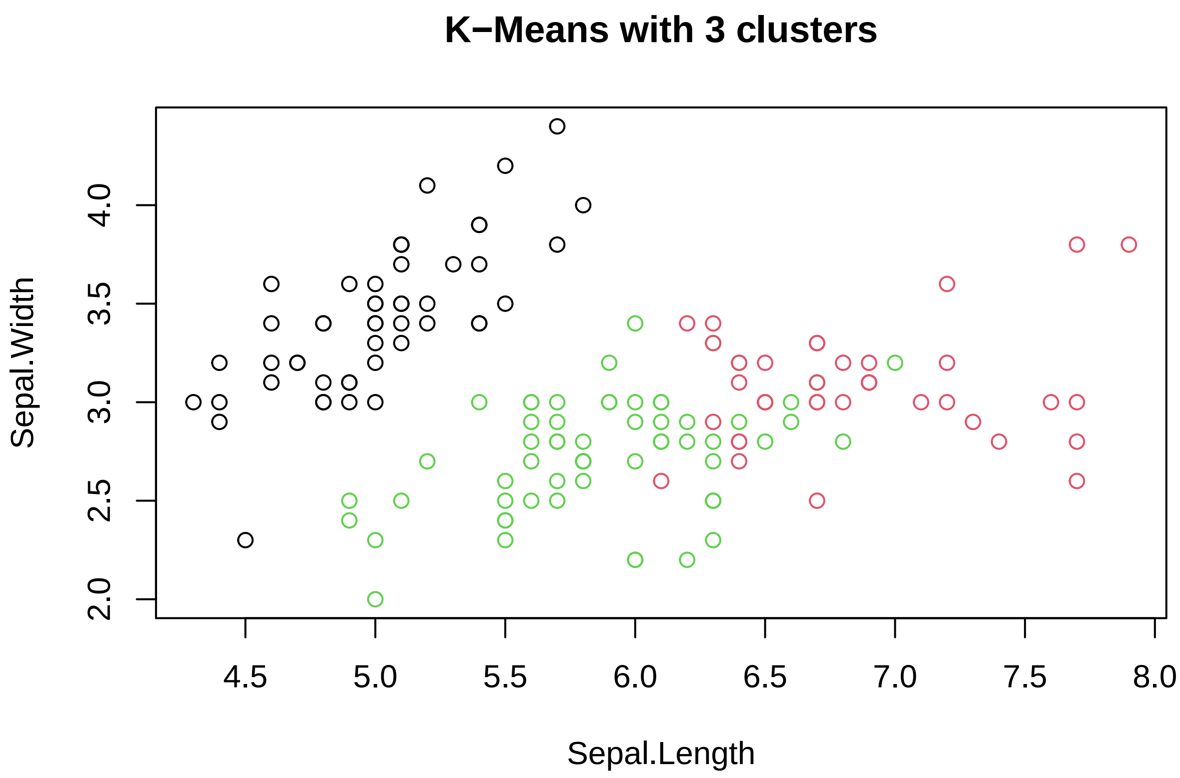
```
# Visualizing and interpreting results of k-means()
plot(iris2[c("Sepal.Length", "Sepal.Width")])
```



```r
plot(iris2[c("Sepal.Length", "Sepal.Width")], col = kmeans.result$cluster)
```



```r
plot(iris2[c("Sepal.Length", "Sepal.Width")], col = kmeans.result$cluster, main = "K-Means with 3 clust
```



```
# plot cluster centers
kmeans.result$centers
```

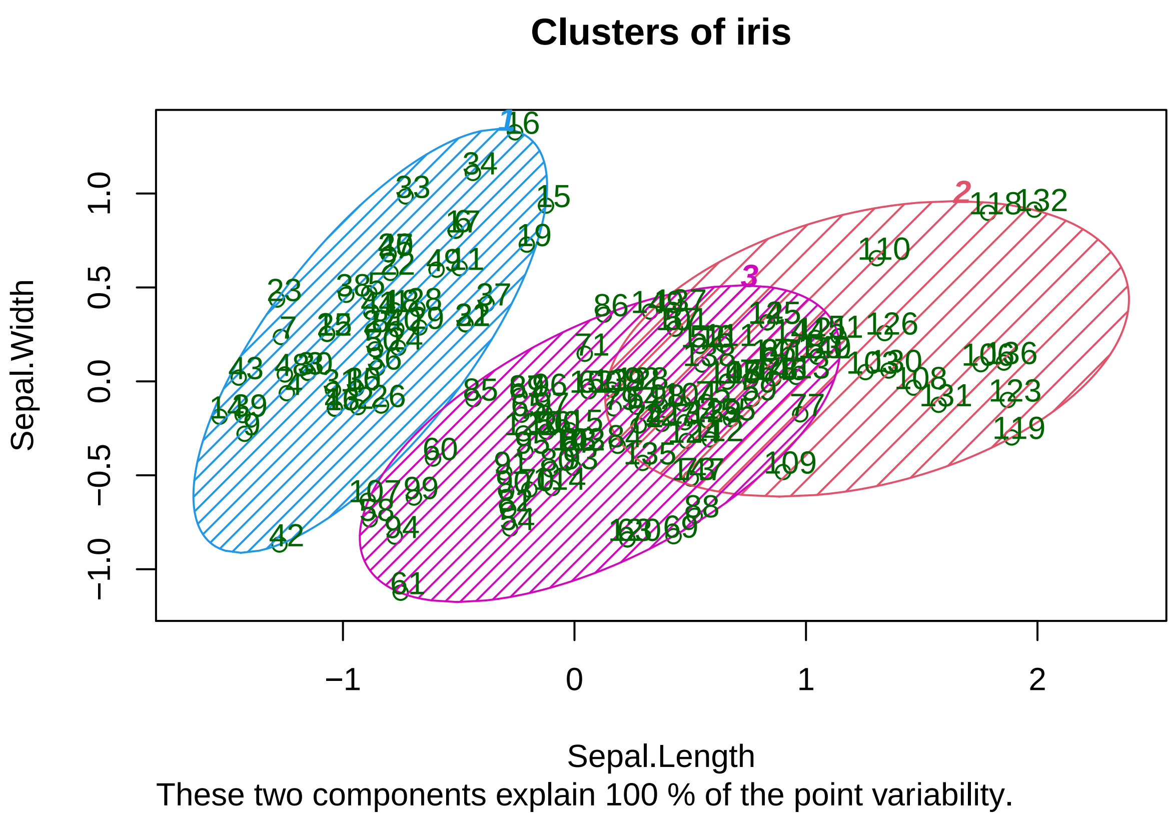
```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width
## 1     5.006000    3.428000     1.462000    0.246000
## 2     6.850000    3.073684     5.742105    2.071053
## 3     5.901613    2.748387     4.393548    1.433871
```

```
kmeans.result$centers[,c("Sepal.Length", "Sepal.Width")]
```

```
##   Sepal.Length Sepal.Width
## 1     5.006000    3.428000
## 2     6.850000    3.073684
## 3     5.901613    2.748387
```

```
#points(kmeans.result$centers[,c("Sepal.Length", "Sepal.Width")], col = 1:3,pch = 8, cex=3)
```

```
# Visualising the clusters
library(cluster)
y_kmeans <- kmeans.result$cluster
?clusplot()
clusplot(iris2[,c("Sepal.Length", "Sepal.Width")],
         y_kmeans,
         lines = 0,
         shade = TRUE,
         color = TRUE,
         labels = 2,
         plotchar = FALSE,
         span = TRUE,
         main = paste('Clusters of iris'),
         xlab = 'Sepal.Length',
         ylab = 'Sepal.Width')
```

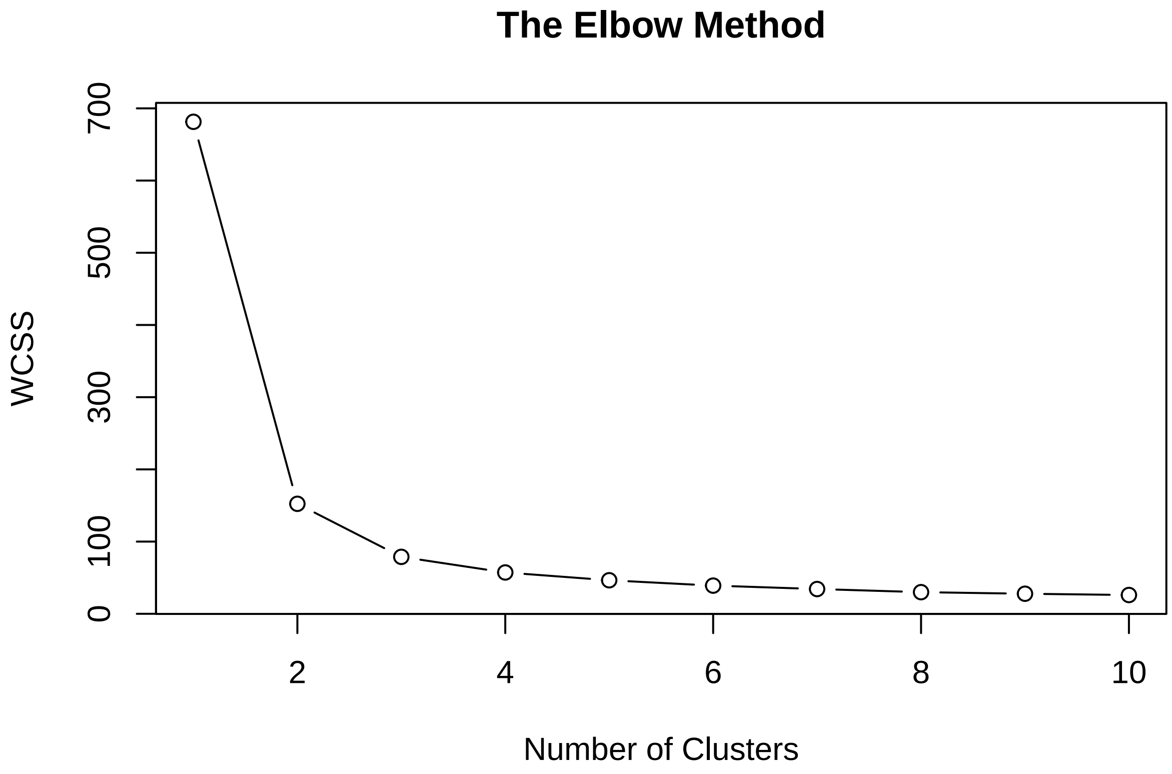


```
# Determining number of clusters
# See Total within sum of square error
kmeans.result$tot.withinss
```

```
## [1] 78.85144
```

```
# Initialize total within cluster sum of squares error: wcss
set.seed(6)
wcss = vector()
```

```
# For 1 to 15 cluster centers check the WCSS
for (i in 1:10) wcss[i] = sum(kmeans(iris2, centers = i,nstart = 20)$withinss)
# Plot WSS vs. number of clusters
plot(1:10,
     wcss,
     type = "b",
     main = paste('The Elbow Method'),
     xlab = "Number of Clusters",
     ylab = "WCSS")
```



```
# Set k equal to the number of clusters corresponding to the elbow location
k <-3

# Fitting K-Means to the dataset
set.seed(29)
kmeans.result <- kmeans(iris2, centers = 3, nstart = 20)
y_kmeans = kmeans.result$cluster
```