

# Final Project Part 3

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```
library('rattle')
library('fpc')
data(wine, package="rattle")
```

## 1. Algorithm and function

### Algorithm

- a. Randomly assigned three clusters means
- b. Decide each data should belong in which cluster  
Compute the distance between one data with all means, and the data should belong in the cluster with the least distance.

- c. Compute the objection function

$$J = \sum_{n=1}^N \sum_{k=1}^K r_{nk} \|x_n - \mu_k\|^2$$

- d. Now change the means for different cluster Since all the data has changed their cluster, for each cluster mean, it also need to update.

$$\mu_k = \frac{\sum_n r_{nk} x_n}{\sum_n r_{nk}}$$

- e. Then compute the objection function again
- f. start again from step b, until the J is stable

### Main function

```
K_means = function(X, k){
  # group function compute for each data should belong to which cluster
  # compute the distance between data with each means
  group = function(mu, X, n){
    r = rep(0,n)
    for(i in 1:n){r[i] = which.min(rowSums(sweep(mu, 2, X[i,], "-") ^ 2))}
    return(r)
  }
  # j functions compute given means and assigned cluster, the objection function
  # clustering error
  J = function(X, mu, n, r){
    s = 0
    for(i in 1:n){s = s + sum((X[i,] - mu[r[i],])^2)}
    return(s)
  }
  # mu_adj function compute each cluster means
```

```

mu_adj = function(r, X ,k){
  mu = matrix(0, k, dim(X)[2])
  for(i in 1:k){
    mu[i,] = ((r == i) * 1) %*% X / sum(r == i)
  }
  return(mu)
}

# Main function
# Compute the first two steps
n = dim(X)[1]; mu_start = X[1:k,]
r_start=group(mu_start,X,n)
Iter=0
j_dm=J(X,mu_start,n,r_start)
mu=mu_adj(r_start,X,k)
Iter=1
j_dm = c(j_dm,J(X,mu,n,r_start))
r=group(mu,X,n)
Iter = 2

# Use the while loops to do the K-means, and stop when J keeps the same
while(abs(j_dm[Iter]-j_dm[Iter-1])!=0){
  mu=mu_adj(r,X,k)
  Iter=Iter+1
  j_dm=c(j_dm,J(X,mu,n,r))

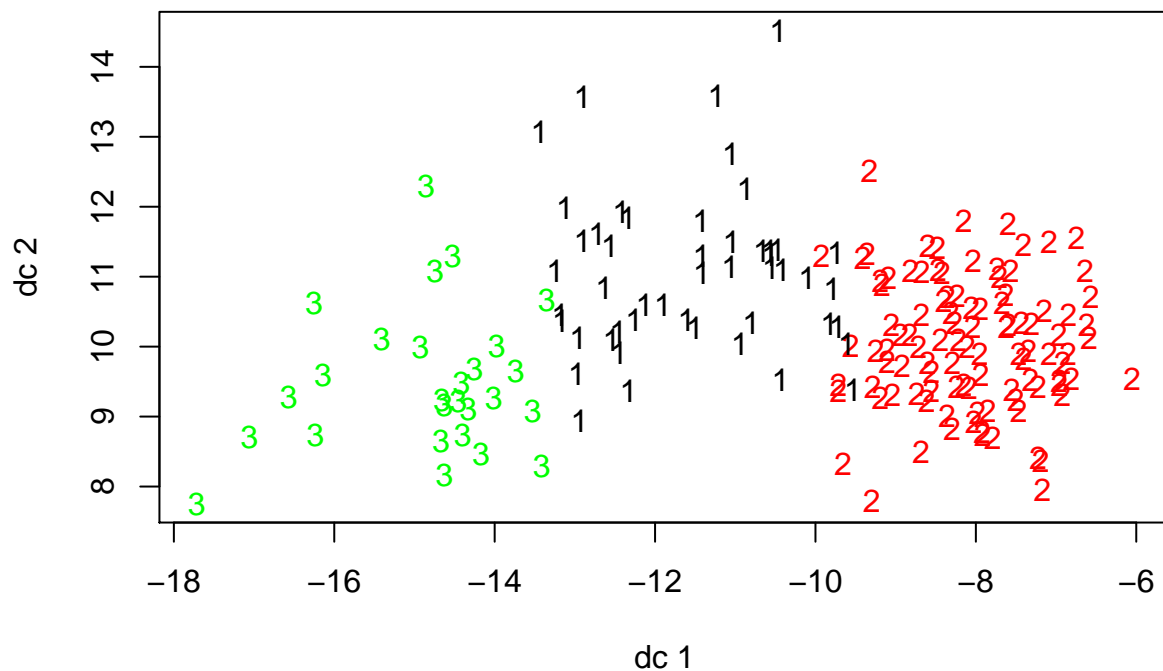
  r=group(mu,X,n)
  Iter=Iter+1
  j_dm=c(j_dm,J(X,mu,n,r))
}
return(r)
}

```

## 2. Wine data

Train data without scale

```
data.train = data.matrix(wine[-1]); k = 3
r1 = K_means(data.train,k)
plotcluster(data.train,r1)
```



It seems that the data has been separated, but the boundaries of these three clusters are not clear. Now we bring another quantify called “accuracy” to test the clustering efficiency.

$$Accuracy = \frac{correct}{n}$$

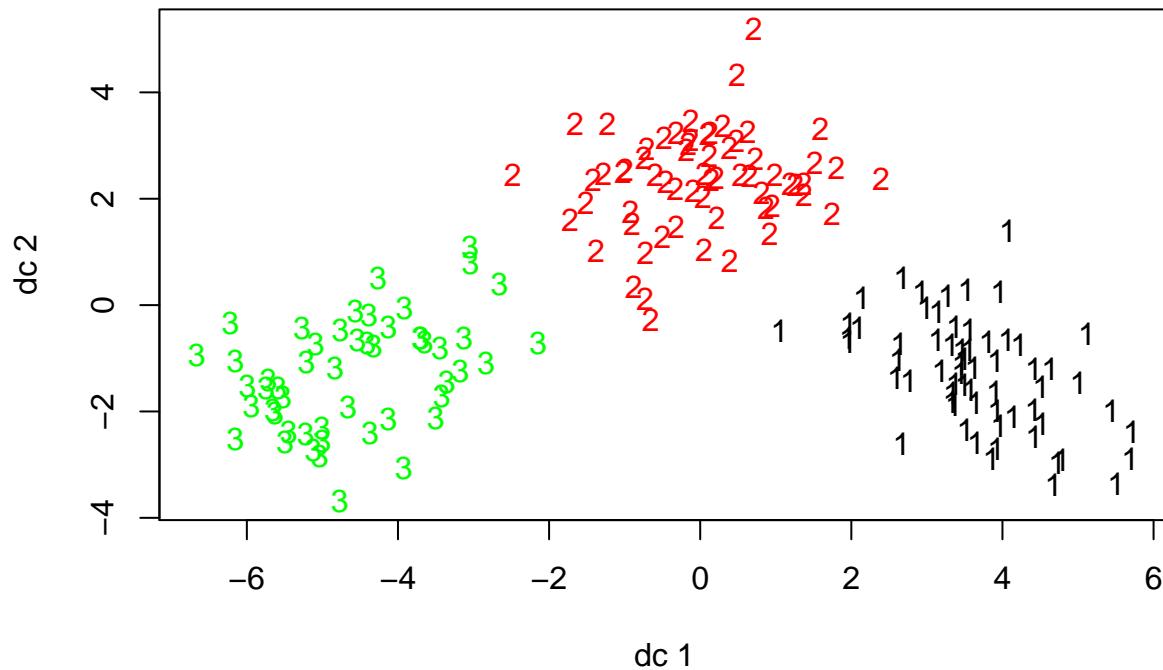
```
Accuracy = sum(r1 == wine[1])/length(r1)
print(paste("the Accuracy for non-scale data is ", Accuracy))
```

```
## [1] "the Accuracy for non-scale data is 0.533707865168539"
```

We find the accuracy for the data without scale is slightly greater than 50%, and it meets our observation that the boundary is blurred.

## Train data with scale

```
data.train = scale(wine[-1])
r2 = K_means(data.train,k)
plotcluster(data.train,r2)
```



```
Accuracy = sum(r2 == wine[1])/length(r2)
print(paste("the Accuracy for scale data is ", Accuracy))
```

```
## [1] "the Accuracy for scale data is 0.955056179775281"
```

The scale data has a highly accuracy (>90%) after the clustering, and three clusters in the graph also separate thoroughly.

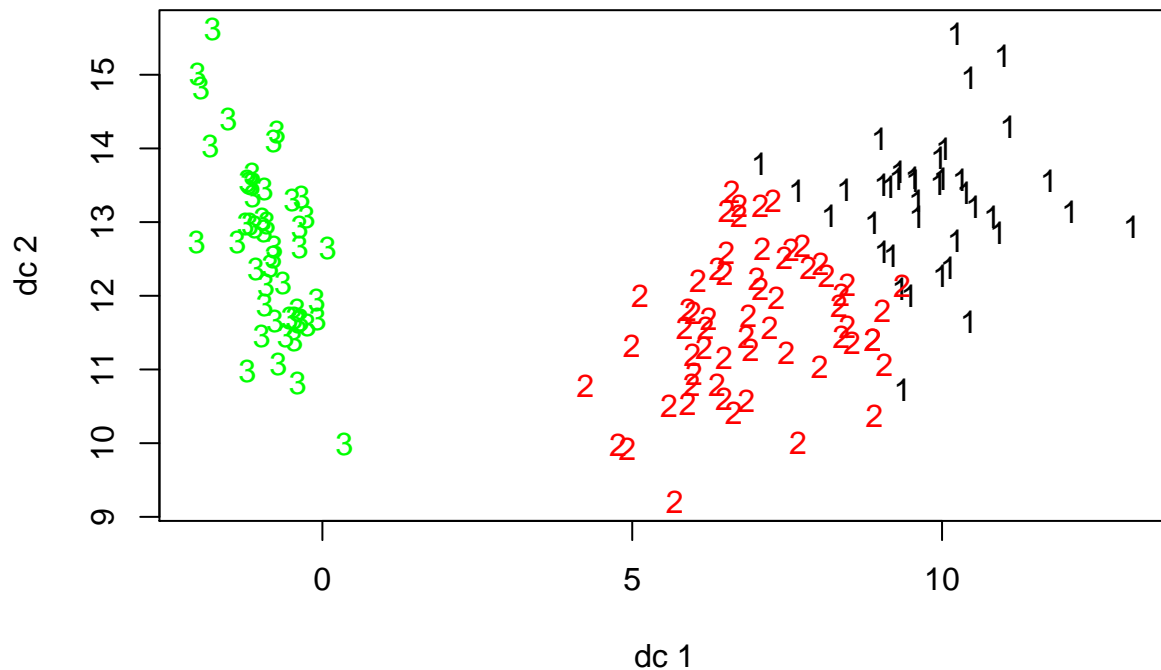
The reason is that for the non-scale data, some variable may much larger than the others, and it will dominate the error when doing the K-means. But this problem could be solved using scale data.

### 3. Iris data

Train data without scale

```
data(iris)
data.train = data.matrix(iris[1:4]); k = 3; true_cat = iris[5]
true_cat = as.numeric(factor(true_cat$Species, levels = sort(unique(true_cat$Species))))
```

```
r3 = K_means(data.train,k)
plotcluster(data.train,r3)
```

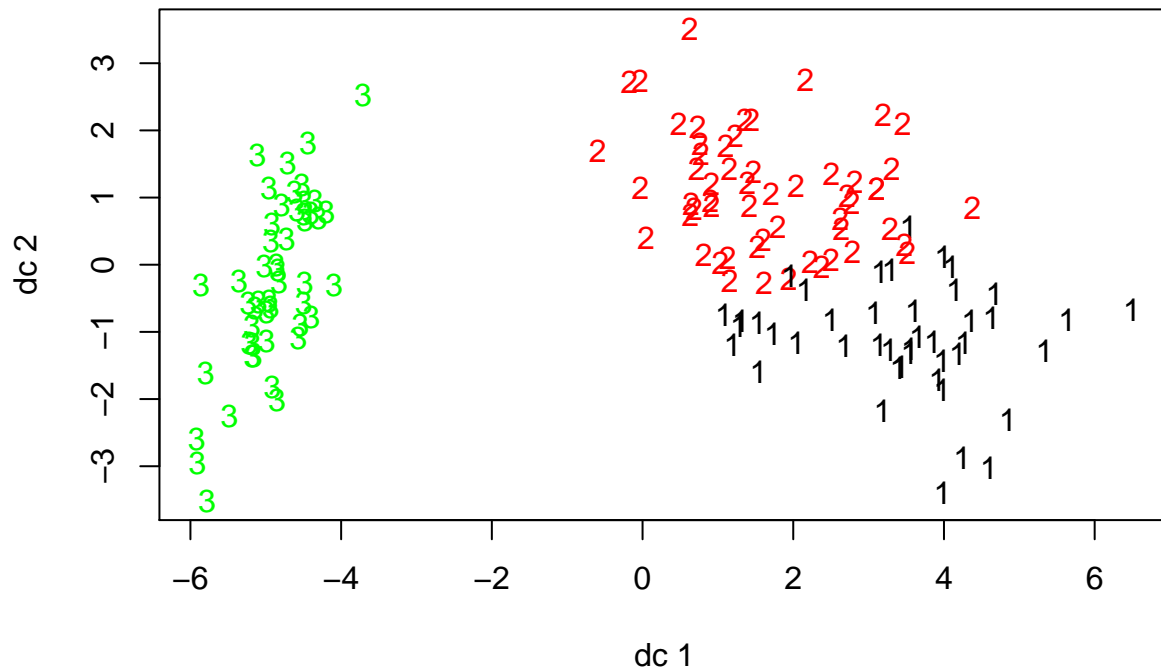


```
Accuracy = sum(r3 == true_cat)/length(r3)
print(paste("the accuracy of non-scale data is ", Accuracy))
```

```
## [1] "the accuracy of non-scale data is 0.313333333333333"
```

## Train data with scale

```
data.train = scale(data.matrix(iris[1:4]))
r4 = K_means(data.train,k)
plotcluster(data.train,r4)
```



```
Accuracy = sum(r4 == true_cat)/length(r4)
print(paste("the accuracy of scale data is ", Accuracy))
```

```
## [1] "the accuracy of scale data is  0.26"
```

For this data, both scale and non-scale data has very low accuracy, which means that K-means might NOT work well for classifying this dataset, and the scale does NOT help.