MSMS 206 : Practical 01

Ananda Biswas

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Question : Perform $k-$means clustering for $\{2, 4, 10, 12, 3, 20, 30, 11, 25\}$ for $k = 2$. Assume 2 and 4 as initial cluster centroids.

After a choice of initial centroids, the $k-$means clustering algorithm is as follows :

(1) calculate the distance of each data-point from each of the centroids

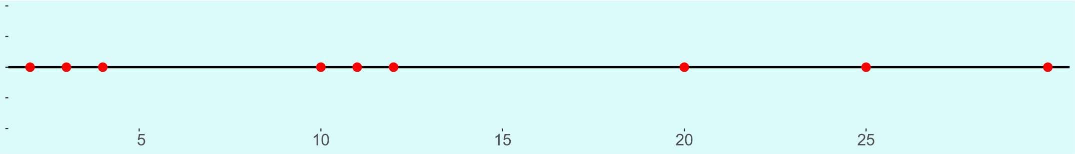
(2) assign each of the data-points to its closest centroid

(3) relocate the centroids to the average location of the data-points of similar group

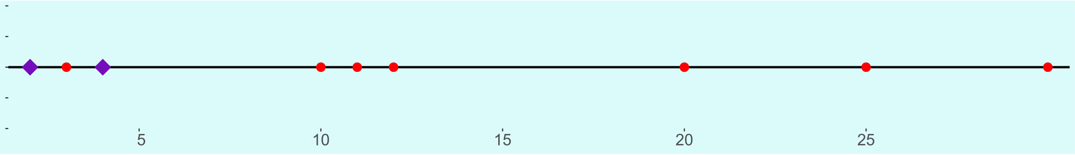
And we repeat this procedure until the assignments don't change after the centroid locations were recomputed.

```r
df <- data.frame(x = c(2, 4, 10, 12, 3, 20, 30, 11, 25))
```

Let us have a look at the data-points.



Now We put the initial centroids.



```r
m <- dim(df)[1] # number of data-points
n <- dim(df)[2] # dimension of data-points

k <- 2 # number of clusters
```

```r
X <- as.matrix(df)
```

Now we initialize the centroids as 2 and 4.

```
centroid <- matrix(data = c(2,
                            4),
                   nrow = k, ncol = 1, byrow = TRUE)
```

We now deploy our $k-$means clustering algorithm. We created a list named *iteration_record()* for visualization of the process that will come later.

```
cluster <- c()

iteration_record <- list()

repeat{
  dist_mat <- matrix(0, nrow = m, ncol = k)

  for (i in 1:k) {
    d <- apply(X, 1, FUN = function(x) return(x - centroid[i, ]))

    d <- matrix(d, nrow = m, ncol = n, byrow = TRUE)

    dist_mat[,i] <- sqrt(diag( d %*% t(d) ) )
  }

  cluster <- apply(dist_mat, 1, FUN = function(x) return(which(x == min(x))[1]))

  new_centroid <- matrix(data = 0, nrow = k, ncol = n)

  for (i in 1:k) {
    new_centroid[i, ] <- mean(X[which(cluster == i), ])
  }

  iteration_record <- append(iteration_record,
                             list(list(mat = cbind(X, dist_mat, cluster),
                                       new_centroid = new_centroid)))

  if(any(centroid - new_centroid != 0)){
    centroid <- new_centroid
  } else{
    break
  }
}
```

✎ The final clustering of the data-points is as follows :

```
cluster

## [1] 1 1 1 1 1 2 2 1 2
```

```
length(iteration_record)

## [1] 5
```

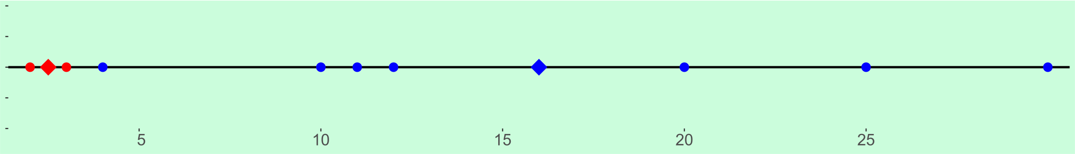
There were 5 iterations, we shall take a look at them one by one.

☞Iteration 1

```
iteration_record[[1]]$mat

##        x distance_from_centroid_1 distance_from_centroid_2 cluster
##  [1,]  2                        0                        2       1
##  [2,]  4                        2                        0       2
##  [3,] 10                        8                        6       2
##  [4,] 12                       10                        8       2
##  [5,]  3                        1                        1       1
##  [6,] 20                       18                       16       2
##  [7,] 30                       28                       26       2
##  [8,] 11                        9                        7       2
##  [9,] 25                       23                       21       2
```

The data-points along with relocated centroids are as follows :

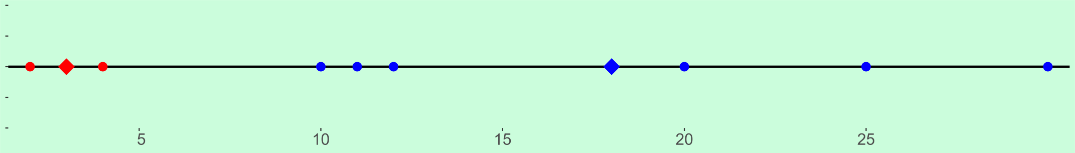


☞Iteration 2

```
iteration_record[[2]]$mat

##        x distance_from_centroid_1 distance_from_centroid_2 cluster
##  [1,]  2                      0.5                       14       1
##  [2,]  4                      1.5                       12       1
##  [3,] 10                      7.5                        6       2
##  [4,] 12                      9.5                        4       2
##  [5,]  3                      0.5                       13       1
##  [6,] 20                     17.5                        4       2
##  [7,] 30                     27.5                       14       2
##  [8,] 11                      8.5                        5       2
##  [9,] 25                     22.5                        9       2
```

The data-points along with relocated centroids are as follows :

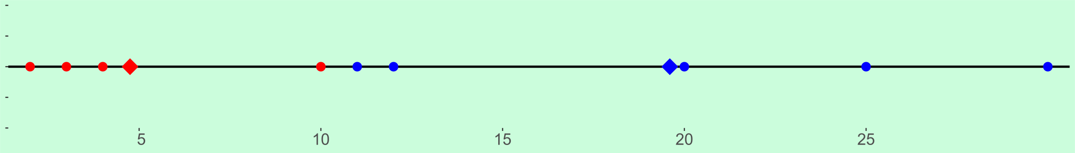


☞Iteration 3

```
iteration_record[[3]]$mat

##        x distance_from_centroid_1 distance_from_centroid_2 cluster
##   [1,]  2                        1                       16       1
##   [2,]  4                        1                       14       1
##   [3,] 10                        7                        8       1
##   [4,] 12                        9                        6       2
##   [5,]  3                        0                       15       1
##   [6,] 20                       17                        2       2
##   [7,] 30                       27                       12       2
##   [8,] 11                        8                        7       2
##   [9,] 25                       22                        7       2
```

The data-points along with relocated centroids are as follows :

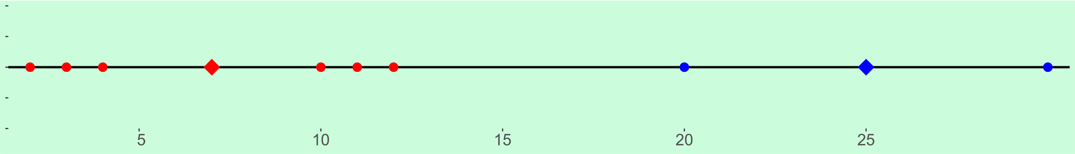


☞Iteration 4

```
iteration_record[[4]]$mat

##        x distance_from_centroid_1 distance_from_centroid_2 cluster
##   [1,]  2                     2.75                     17.6       1
##   [2,]  4                     0.75                     15.6       1
##   [3,] 10                     5.25                      9.6       1
##   [4,] 12                     7.25                      7.6       1
##   [5,]  3                     1.75                     16.6       1
##   [6,] 20                    15.25                      0.4       2
##   [7,] 30                    25.25                     10.4       2
##   [8,] 11                     6.25                      8.6       1
##   [9,] 25                    20.25                      5.4       2
```

The data-points along with relocated centroids are as follows :

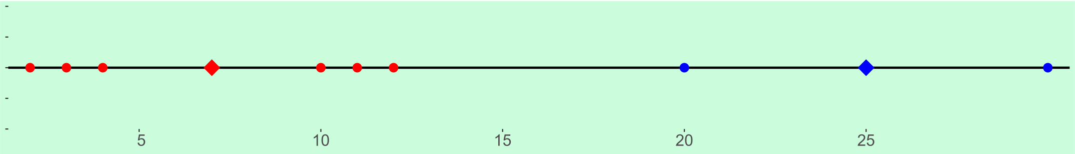


☞Iteration 5

```
iteration_record[[5]]$mat

##       x distance_from_centroid_1 distance_from_centroid_2 cluster
##  [1,]  2                        5                       23       1
##  [2,]  4                        3                       21       1
##  [3,] 10                        3                       15       1
##  [4,] 12                        5                       13       1
##  [5,]  3                        4                       22       1
##  [6,] 20                       13                        5       2
##  [7,] 30                       23                        5       2
##  [8,] 11                        4                       14       1
##  [9,] 25                       18                        0       2
```

The data-points along with relocated centroids are as follows :



✎ We notice that there is no change in location centroids from Iteration 4 to Iteration 5. So the process stops and we get our final set of clusters.