assignment03

October 3, 2018

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2 2018210031

3 Assignment 03

3.1 k-Means Clustering Algorithm

In this portion, the required libraries or packages are import for the execution of the code.

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt
        import random
        import copy
```

The function "generatePointandCluster(k,p)" takes two inputs k and p. k is the number of clusters and p is the number of points (x,y) for each cluster. and returns the data, centers, centers_old, centers_new and distances.

data = data is the points of array with 2 columns. center = centers are the randomly generated centeroid. centers_old = It is the numpy array for calculating the centers. It stores old centers. Initially, Its is the array of zeros. centers_new= It stores the updated (x,y) values of the centers. Its initial values is array of zeros. distances = its the varibale that stores the distance between two points

copy.deep copy is used to deeply copy the veriables with the same shape and elements.

```
In [2]: def generatePointandCluster(k,p):
            ######### Generate random points ################
            d=[]
            z=1
            i=1
            j=0
            data = np.random.randn(0, 2)
            m=2
            n=1
            center=[]
            while i<=k:
                ee=[]
                ee=np.array([m,n])
                m=m+3
                n=n+4
                i=i+1
                center=np.append(center,ee)

            while z<=k:

                d = np.random.randn(p, 2)+center[j:j+1]

                j=j+2
                z=z+1
                data = np.concatenate((data,d),axis=0)
            ############## create random centeroids using means and standard deviation
            c = data.shape[1]
            n = data.shape[0]
            mean = np.mean(data, axis = 0)
            std = np.std(data, axis = 0)
            centers = np.random.randn(k,c)*std + mean

            ##############Plot the random generated data and points
            plt.figure(0)
            plt.scatter(data[0:,0], data[0:,1], c='b', s=7)

            plt.scatter(centers[:,0], centers[:,1], marker='*', c='g', s=150)
            plt.title('Initial Data Plot')
            ############# creating initial variables for store old centers and new centers
            centers_old = np.zeros(centers.shape) # stores old centers
            centers_new = copy.deepcopy(centers) # Store new centers
            print ('Initial centers: ' , str(centers_new) )
            ################## Make the zeros array for cluster and distances
            clusters = np.zeros(n)
            distances = np.zeros((n,k))
            return data, centers, centers_old, centers_new, distances, clusters
```

This section computes the energy, error, or cost between the centers. We aim to minimize the energy.

$$||A||_F = [\sum_{i,j} abs(a_{i,j})^2]^{1/2}$$

```
In [3]: def computeEnergy(centers_new,centers_old):
            error = np.linalg.norm(centers_new - centers_old)
            return error
```

The ComputerDistance function computes the distance from each point to each center.

```
In [4]: def computeDistance(data, centers,distances):
            for i in range(k):
                    distances[:,i] = np.linalg.norm(data - centers[i], axis=1)
            return distances
```

assignlabels computes the minimus distance and assign the labels according to closest center

```
In [5]: def assignLable(distances,centers_new):
            clusters = np.argmin(distances, axis = 1)
            centers_old = copy.deepcopy(centers_new) ####### copy the old centers
            return clusters, centers_old
```

Computecenteroid calculate the new centers by calculating the average of the data points of each culusters

```
In [6]: def computeCentoroid(k,data, clusters):
            for i in range(k):
                    centers_new[i] = np.mean(data[clusters == i], axis=0)
            return centers_new
```

kMeans is the function that use all above define function it is iterative function that is handel from main function. It will execute till error=0.

```
In [7]: def kMeans(k, data, centers, centers_old, centers_new, distances,error):

            distances = computeDistance(data, centers,distances)
            clusters, centers_old = assignLable(distances,centers_new)
            centers_new = computeCentoroid(k,data, clusters)
            error = computeEnergy(centers_new,centers_old)



            return error,clusters,data,centers_new
```

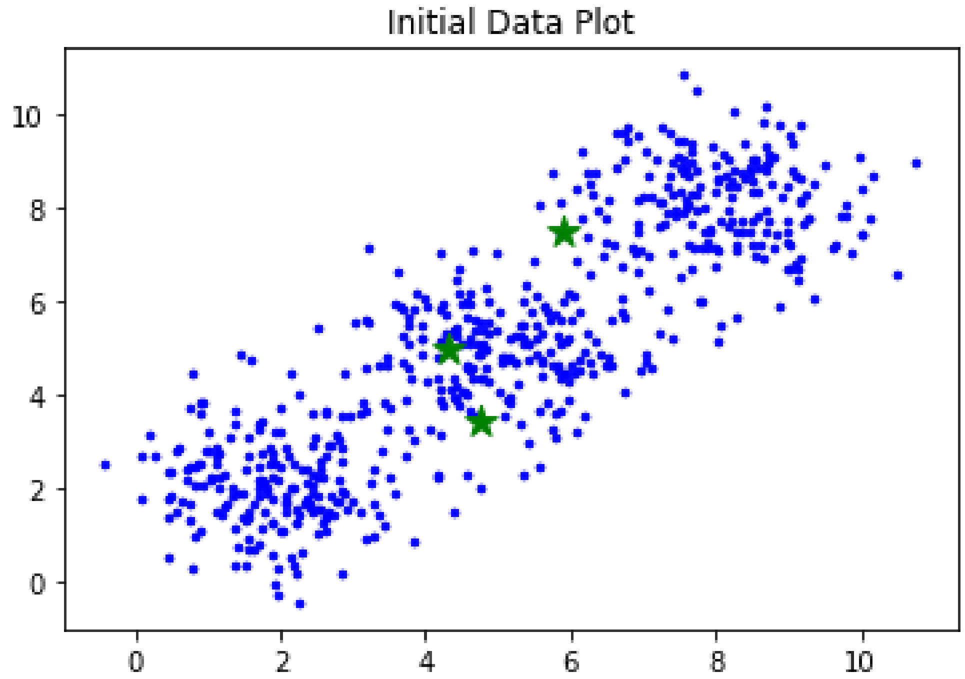
Below is the main function. It is the starting point of the kMeans clustering program's execution. We can set the k and p of own choice. k is the number of clusters and p is the points to be generate as training data.

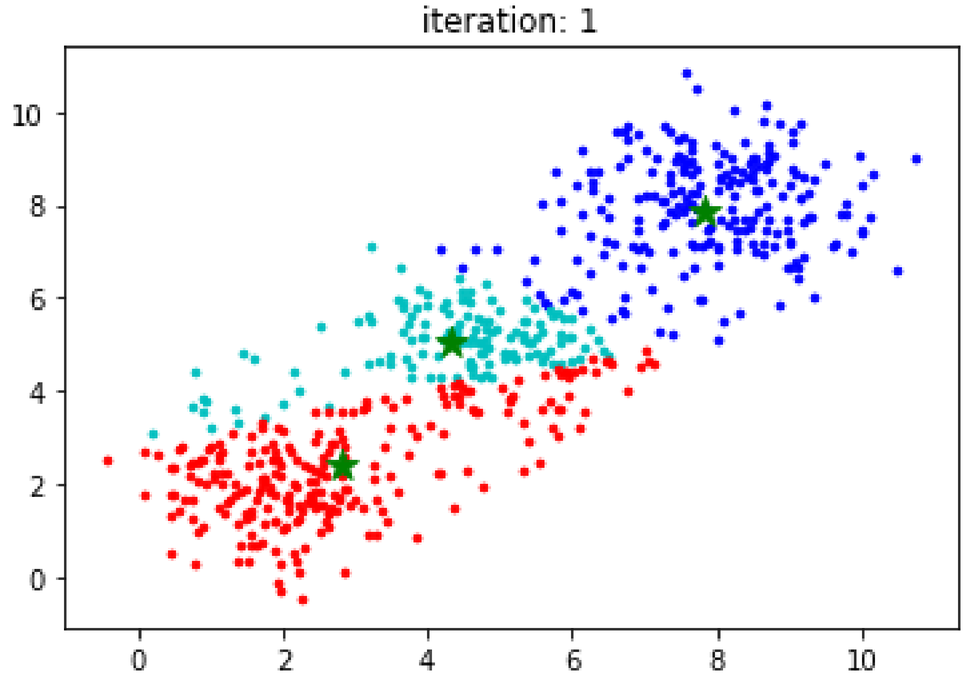
```
In [9]: if __name__== "__main__":
            k=3
            p=200
            ####################### Below function creates the data points and centers and ini
            data, centers, centers_old, centers_new, distances, clusters = generatePointandClu
            ####################### Computer initial error or energy between centeroids
            error = computeEnergy(centers_new,centers_old)
            print ('Results: ')
            print ('Initial Energy:',error)
```

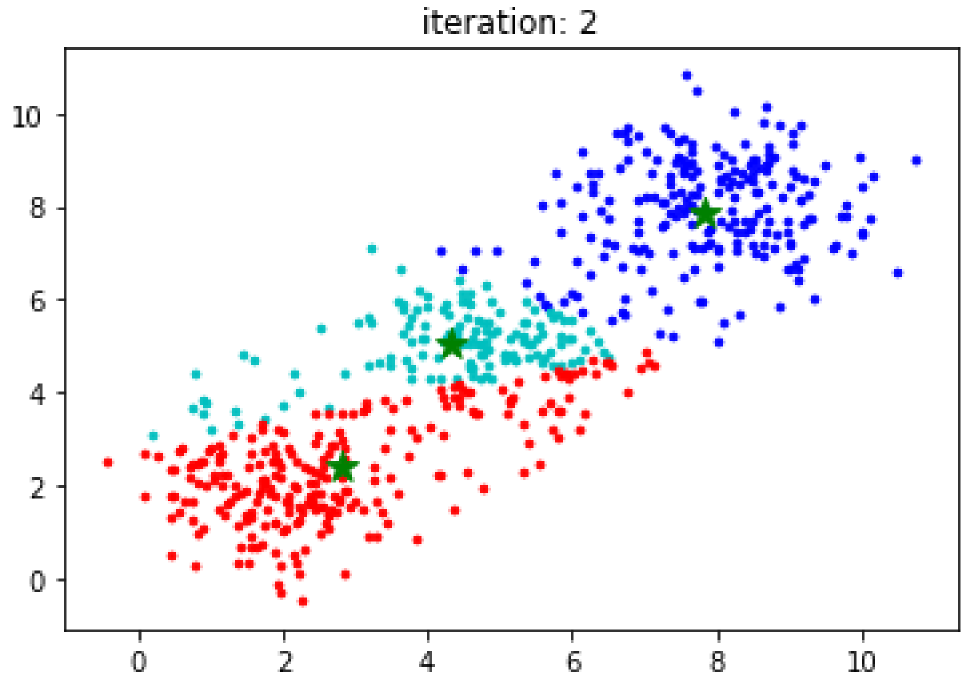
```
a=1
####################### Loop to iterate kMeans function. Loop will terminate when
while error != 0:
    print ('############ iteration', a)

    error,clusters,data,centers_new= kMeans(k, data, centers, centers_old, centers_
    print ('Centeroid: ',str(centers_new))
    plt.figure(a)
    #####################list of colors for plot points.
    colors=['b','c','r','m','y','k','w']
    ################################### loop for plotting each data point or clust
    for i in range(k):
        plt.scatter(data[clusters == i,0], data[clusters == i,1], c=colors[i], s=7
    plt.scatter(centers_new[:,0], centers_new[:,1], marker='*', c='g', s=150)
    plt.title('iteration: ' + str(a))
    print ('Energy:',error)
    a=a+1
```

```
Initial centers:  [[5.90050099 7.4495643 ]
 [4.30106406 4.98107235]
 [4.75018909 3.4211765 ]]
Results:
Initial Energy: 12.957272047624476
############ iteration 1
Centeroid:  [[7.81896257 7.88679054]
 [4.3304121  5.04898731]
 [2.81023996 2.40199552]]
Energy: 2.946059723915192
############ iteration 2
Centeroid:  [[7.81896257 7.88679054]
 [4.3304121  5.04898731]
 [2.81023996 2.40199552]]
Energy: 0.0
```


Initial Data Plot
10
8
6
4
2
0
0
2
4
6
8
10


iteration: 1
10
8
6
4
2
0
0
2
4
6
8
10



Initial data Plot: In this plot, all the randomly generated data points and clusters are shown.

Iteration{} plot: In this plot, the plot after the execution is shown. The updated data points are shown with in form of clusters with different colors.

[‘b’,‘c’,‘r’,‘m’,‘y’,‘k’,‘w’] This is the list of clusters. [blue, cyan, red, Magenta, yellow, Black, White]

Github Link: https://github.com/farhan-93/assignment03.git