Ex7_part1

October 25, 2019

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In [1]: import numpy as np
        import pandas as pd
        from random import random
        from numpy import linalg as LA
        import matplotlib.pyplot as plt
        from sklearn import datasets
        from scipy.stats.mstats import gmean
```

```
In [2]: iris = datasets.load_iris()
        X = iris.data
        y = iris.target
        n = X.shape[0]   #num of observations
        d = X.shape[1]   #dimentionality of data

        k = 3  #num of clusters
        r = 5  #num of restarts
        p = 0  #percision of the optimization
```

```
In [3]: def best_cluster(mu_mat, sample):
            '''input: cluster centeroids and one sample
            output: number fo the best cluster for the input sample'''
            distances = LA.norm(mu_mat - sample, axis=1)**2
            cluster_num = np.argmin(distances, axis=0)
            return cluster_num
```

```
In [4]: def partition(data, mu_mat):
            '''input: data samples and clusters mu (matrix)
            output: a vector containing cluster number for each sample'''
            cluster_num_vec = [None] * data.shape[0]
            for i in range(0,data.shape[0]):
                cluster_num_vec[i] = best_cluster(mu_mat, data[i,:])
            cluster_num_vec = np.array(cluster_num_vec)
            return cluster_num_vec
```

```
In [5]: def cost(data, mu_mat, cluster_num_vec):
            '''input: samples, cluster centers, and a vector containing the respective cluster
            output: the cost value of this partitioning'''
            cluster_num_vec = np.array(cluster_num_vec)
            cost_val = 0
            for i in range(mu_mat.shape[0]):
                cluster = data[cluster_num_vec==i, :]  #the i-th cluster
                for j in range(cluster.shape[0]):
                    cost_val = cost_val + LA.norm(mu_mat[i,:] - cluster[j,:], axis=0)**2
        #         if cluster:  #this means it is not empty
            cost_val = cost_val/data.shape[0]
            return cost_val

In [6]: def update_centeroids(data, cluster_num_vec, num_of_clusters):
            '''input: data and a vector containing the respective cluster for each sample, and
            output: updated mu matrix (the mean of clusters)'''
            new_mu_mat = [None] * num_of_clusters
            for i in range(num_of_clusters):
                new_mu_mat[i] = [None] * data.shape[1]
            new_mu_mat = np.array(new_mu_mat)
            for i in range(num_of_clusters):
                cluster = data[cluster_num_vec==i, :]  #the i-th cluster
                if cluster.shape:  #this means it is not empty
                    new_mu_mat[i,:] = cluster.mean(0)
                else:
                    pass
            return new_mu_mat

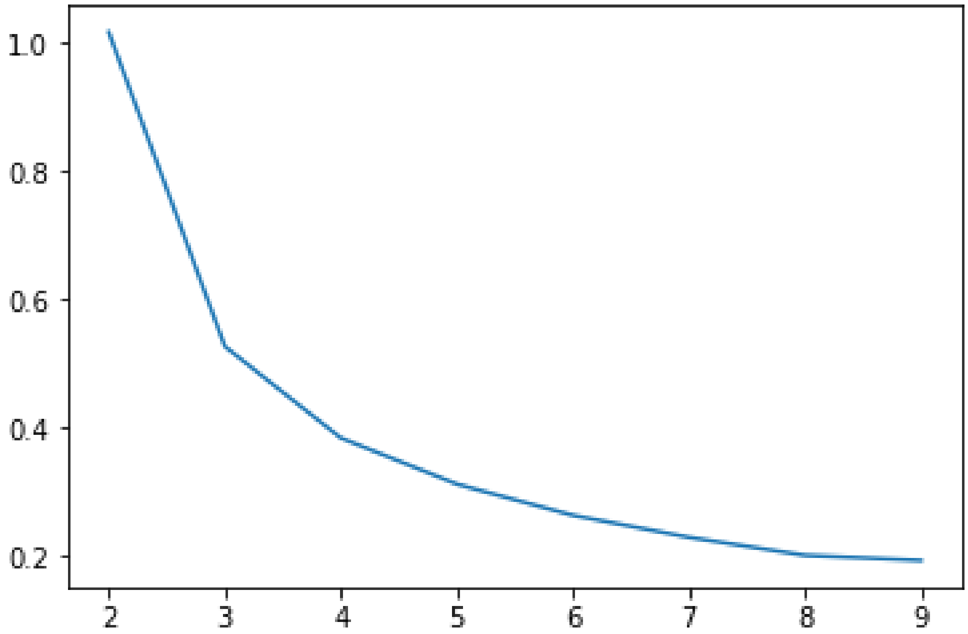
In [7]: def Lloyd(X, n, d, k, r, p):
            final_cost = float("inf")
            for restart in range(1,r):
                #initialization
                random_indeces = np.random.randint(n, size=k)
                mu_mat = X[random_indeces,:]
                main_partition = partition(X, mu_mat)
                previous_cost = cost(X, mu_mat, main_partition);
                new_cost = 0
                flag = True
                while abs(previous_cost-new_cost) > p and flag:
                    new_mu_mat = update_centeroids(X, main_partition, k)
                    new_mu_mat = np.float64(new_mu_mat)
                    new_partition = partition(X, new_mu_mat)
                    new_cost = cost(X, mu_mat, new_partition)
                    previous_cost = cost(X, mu_mat, main_partition)
                    if abs(previous_cost-new_cost) > p:
                        main_partition = new_partition
                        mu_mat = new_mu_mat
                previous_cost = cost(X, mu_mat, main_partition);
                if final_cost > previous_cost:
                    final_partition = main_partition
                    final_mu = mu_mat
                    final_cost = previous_cost
```

```
#     print("final_cost cost:", final_cost)
    return final_partition, final_mu, final_cost
```

```
In [8]: cluster_range = range (2,10)
        the_cost = [None] * (len(cluster_range))
        the_cost = np.array(the_cost)
        for number_of_clusters in cluster_range:
            _, _, the_cost[number_of_clusters-2] = Lloyd(X=X, n=n, d=d, k=number_of_clusters,
        plt.plot(cluster_range, the_cost)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:11: RuntimeWarning: Mean of e
  # This is added back by InteractiveShellApp.init_path()
C:\Users\Amin\AppData\Roaming\Python\Python37\site-packages\numpy\core\_methods.py:154: Runtime
  ret, rcount, out=ret, casting='unsafe', subok=False)
```

```
Out[8]: [<matplotlib.lines.Line2D at 0x1b908d995f8>]
```



```
In [9]: partitions, mus, outcost = Lloyd(X=X, n=n, d=d, k=k, r=r, p=p)


        ratio_cat1 = np.amax(np.bincount(partitions[y==0]))/len(partitions[y==0])
        ratio_cat2 = np.amax(np.bincount(partitions[y==1]))/len(partitions[y==1])
        ratio_cat3 = np.amax(np.bincount(partitions[y==2]))/len(partitions[y==2])
        print(ratio_cat1, ratio_cat2, ratio_cat3)
        gmean([ratio_cat1, ratio_cat2, ratio_cat3])
```

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1.0 0.96 0.72
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Out[9]: 0.8841675596736928
```