Assignment5

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1 Information

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Project : *K* − *means algorithm on color image*

2 import library

```
In [1]: from collections import Counter
        from collections import OrderedDict
        import matplotlib.pyplot as plt
        import numpy as np
        import random as rd
        from PIL import Image
```

3 Load file

```
In [2]: image = Image.open('Lenna.png').convert('RGB')
        np_image = np.array(image)
```

4 Global parameter

```
In [3]: size_row = np_image.shape[0]        # height of the image
        size_col = np_image.shape[1]         # width of the image
        size_data = size_row*size_col

        pre_list_label  = np.empty(size_data, dtype=int)
        cluster_label = np.empty(size_data, dtype=int)
```

5 Function: normalize the values of the input data to be [0, 1]

```
In [4]: def normalize(data):

            data_normalized = (data - np.min(data)) / (np.max(data) - np.min(data))
            return(data_normalized)
```

6 Function: Distance between two vectors x and y

```
In [5]: def distance(x, y):

            d = (x - y) * (x - y)
            s = np.sum(d)
            r = np.sqrt(s)

            return(s)
```

7 Function: Centroid Combination

```
In [6]: def centroid_combination(centroid, centroid_label):
            result = np.zeros((size_row, size_col, 3), dtype=float)
            for i in range(size_row):
                for j in range(size_col):
                    result[i,j,:] = centroid[:, centroid_label[i,j]]

            return(normalize(result))
```

8 Function: Visualizer

```
In [7]: def visualizer(data, data_label):
            f1 = plt.figure(1)

            plt.title(data_label)
            plt.imshow(data, interpolation='None')

            frame   = plt.gca()
            frame.axes.get_xaxis().set_visible(False)
            frame.axes.get_yaxis().set_visible(False)

            plt.show()
```

9 Function: Initialize Centroid Label

```
In [8]: def initialize_centroid_label(k, num_data):
            centroid_label = np.empty(num_data, dtype=int)

            # clustering
            for i in range(num_data):
                label = rd.randint(1, k) - 1
                centroid_label[i] = label
            return(centroid_label.reshape((size_row, size_col)))
```

10 Function: Calculate Centroid

```
In [9]: def calculate_average_centroid(k, train_data, centroid_label, num_train):

            centroid = np.zeros((3, k), dtype=float)
            count = np.zeros(k,dtype=int)

            # Create centroid image
            for i in range(size_row):
                for j in range(size_col):
                    index = centroid_label[i,j]
                    centroid[:,index] += train_data[i,j,:]
                    count[index] += 1

            for i in range(k):
                if (count[i] != 0):
                    centroid[:, i] /= count[i]

            return(centroid)
```

11 Function: Clustering Data

```
In [10]: def clustering(num, train_image, centroid, num_train):
             cluster_label = np.empty((size_row, size_col),dtype=int)
             dist = np.empty(num, dtype=float)

             for i in range(size_row):
                 for j in range(size_col):
                     for k in range(num):
                         dist[k] = distance(train_image[i,j,:], centroid[:,k])
                     cluster_label[i,j] = np.argmin(dist)

             return(cluster_label)
```

12 Function: Energy

$\frac{1}{n}\sum_{x\in\Omega}\|f(x)-m_c\|^2$
where k_i *denotes the category of* x_i, *and* c_{k_i} *denotes the centroid of category* x_i

```
In [11]: def calculate_energy(train_data, num_train, centroid, centroid_label):
             energy = 0

             for i in range(size_row):
                 for j in range(size_col):
                     energy += distance(train_data[i,j,:], centroid[:,centroid_label[i,j]])

             return(energy/(size_row*size_col))
```

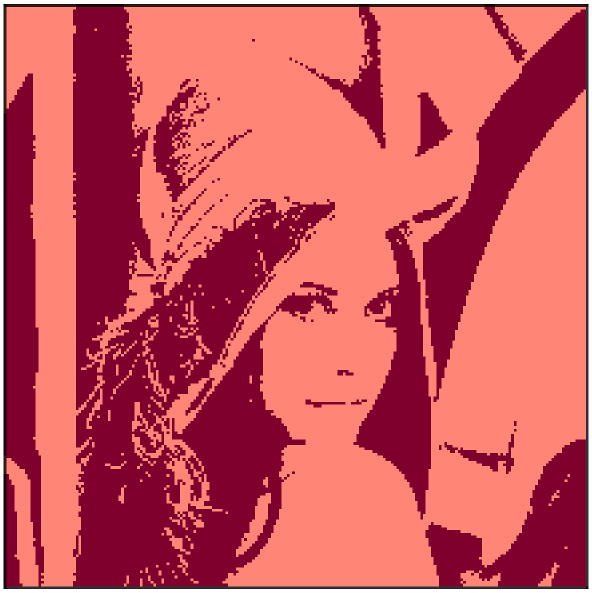
13 Function: K Means Algorithms

```
In [12]: def k_means(k, train_data, num_train):
             iteration = 0
             energy = []
             train_accuracy = []
             test_accuracy = []
             real_label = np.empty(k, dtype=int)

             previous_label = np.zeros((size_row, size_col), dtype=int)
             centroid_label = initialize_centroid_label(k, num_train)

             while (~np.all(previous_label == centroid_label)):
                 iteration+=1

                 centroid = calculate_average_centroid(k, train_data, centroid_label, num_train

                 # check traaining energy
                 energy.append(calculate_energy(train_data, num_train, centroid, centroid_label

                 previous_label = centroid_label
                 centroid_label = clustering(k, train_data, centroid, num_train)


             # Visualize K centroid images for each category.
             visualizer(np_image,'Origin')
             visualizer(centroid_combination(centroid, centroid_label), 'Segmentation')

             # Plot the training energy per optimization iteration.
             plt.plot(energy, label='Training Energy')
             plt.legend(loc='lower right')
             plt.show()
```

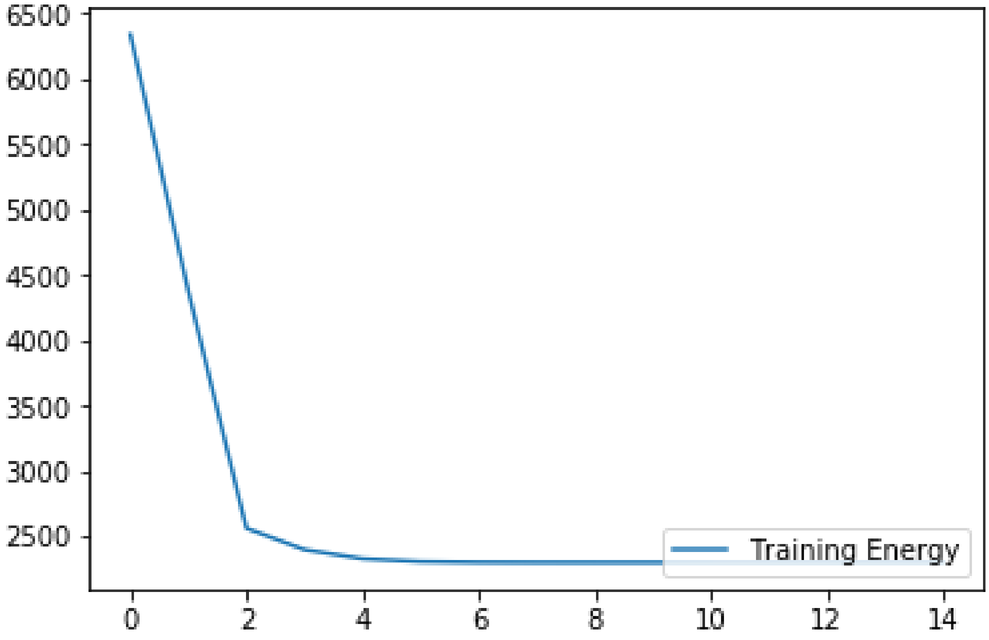
14 K = 2

```
In [13]: k=2
         k_means(k, np_image, size_data)
```

Origin

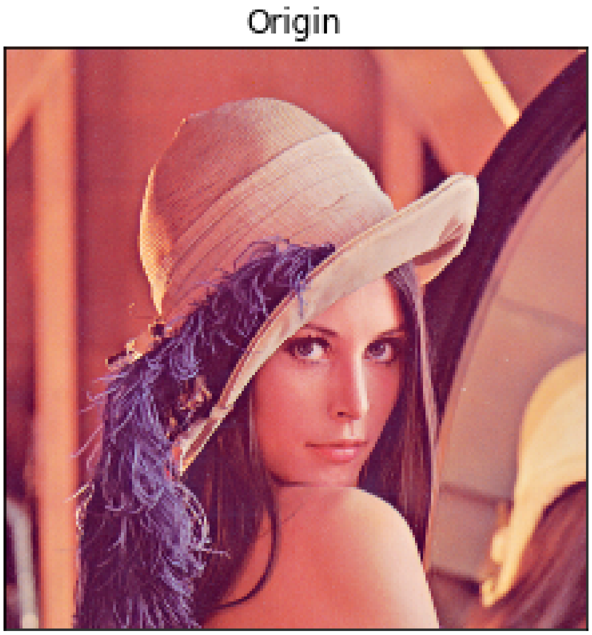


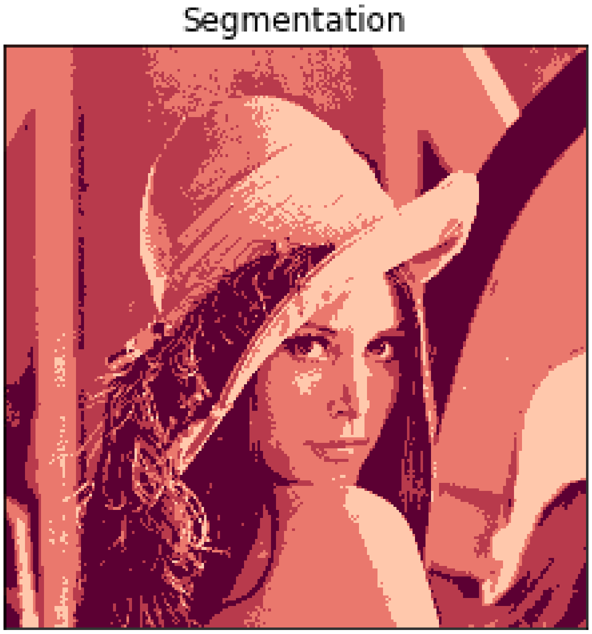
Segmentation



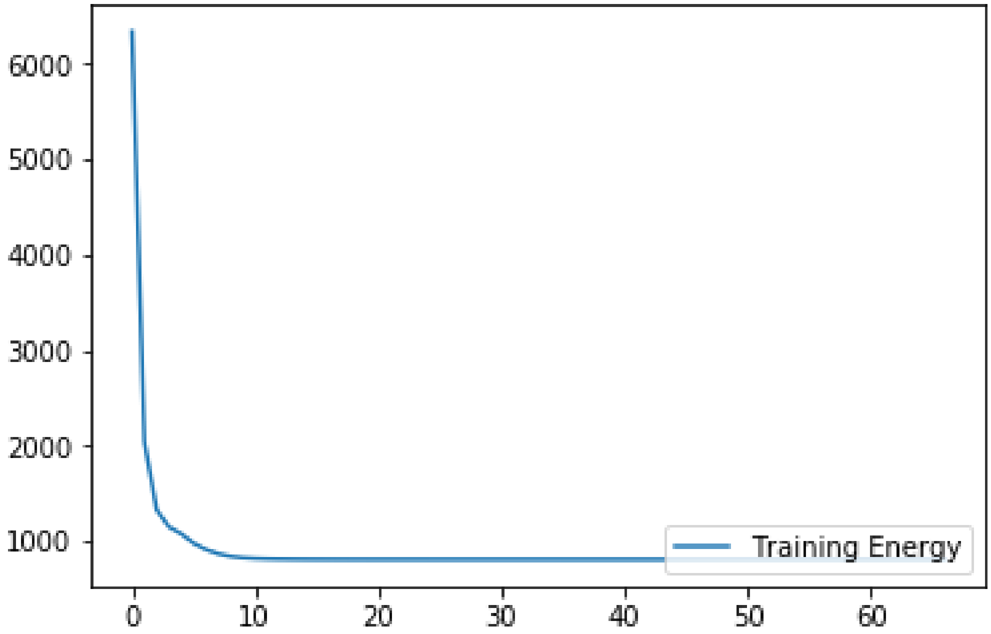
15 K = 4

```
In [14]: k=4
         k_means(k, np_image, size_data)
```


Origin

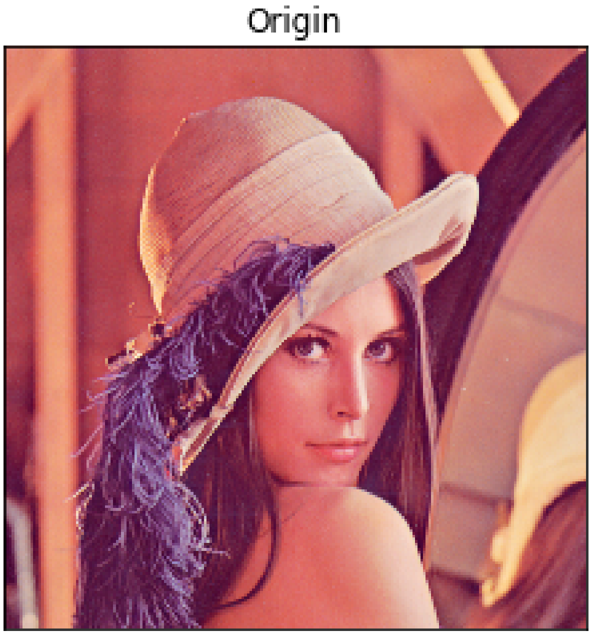


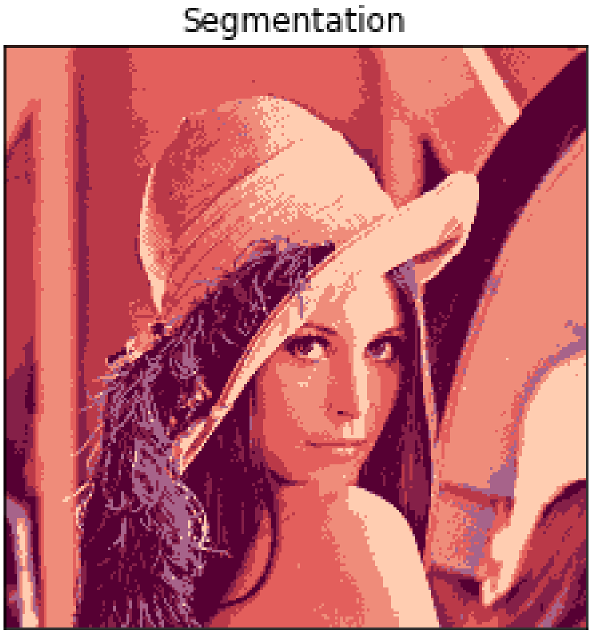
Segmentation

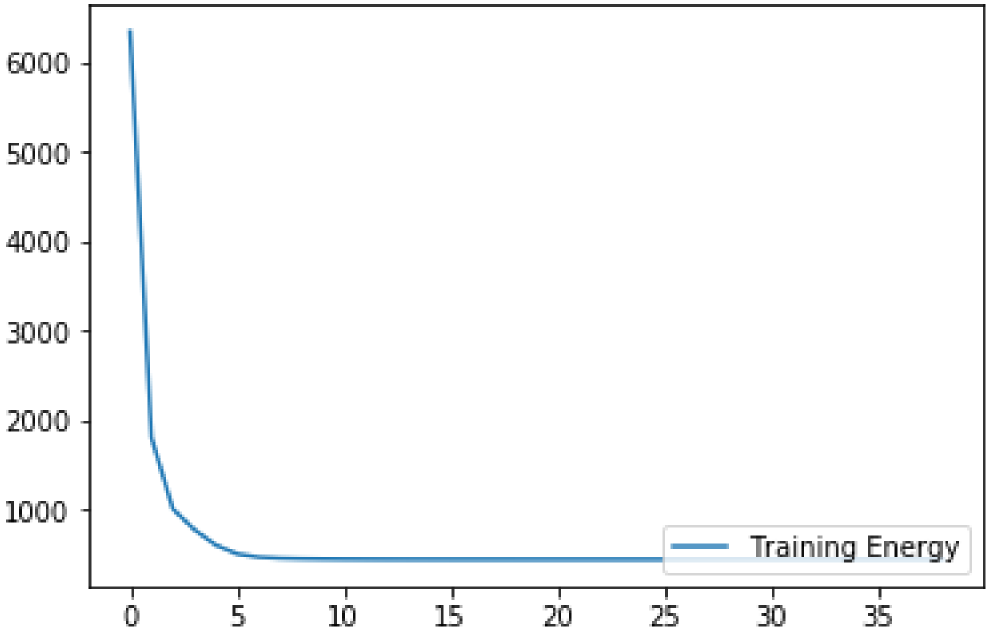


16 K = 8

```
In [15]: k=8
         k_means(k, np_image, size_data)
```

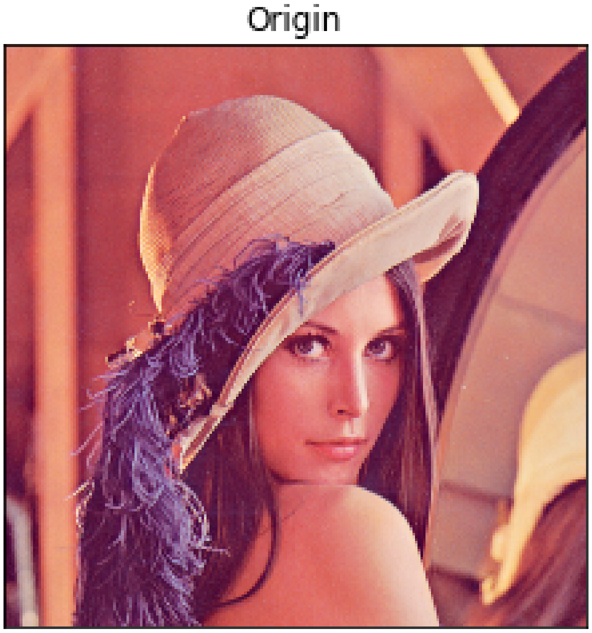


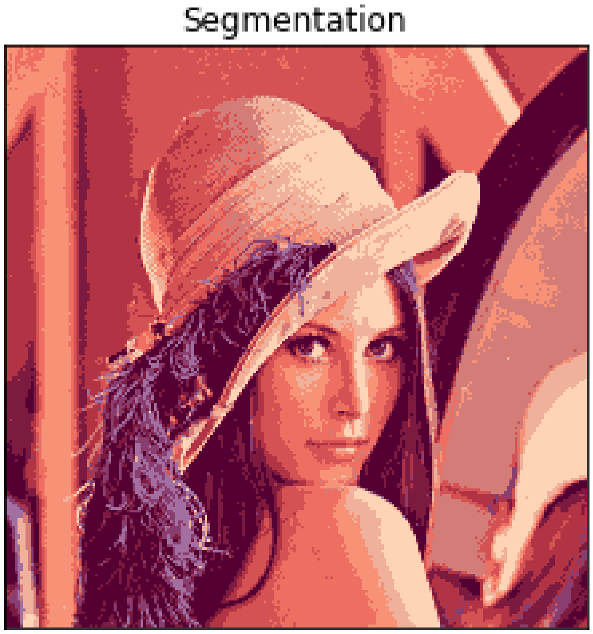


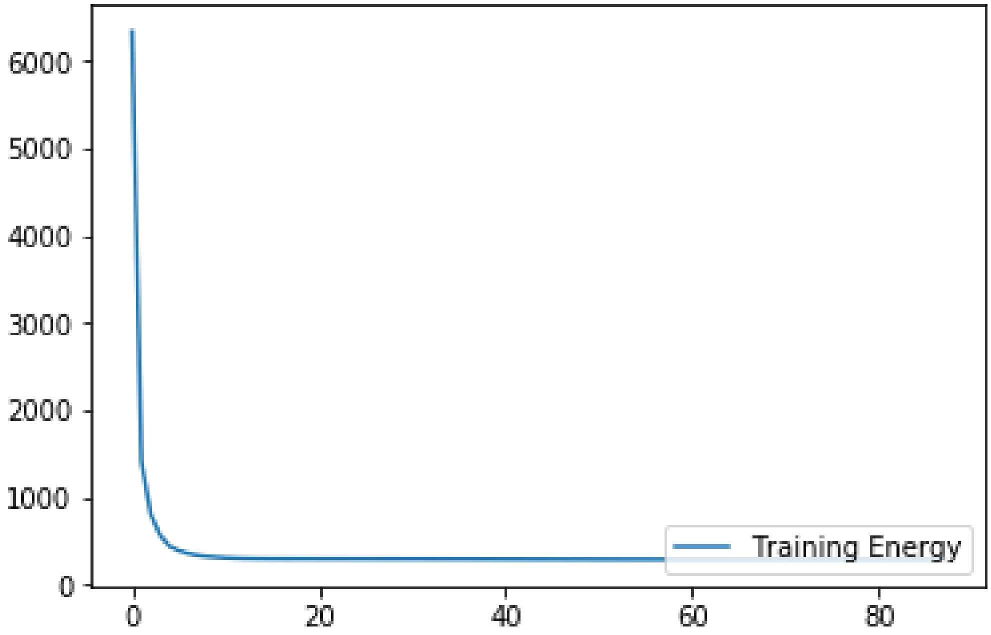


17 K = 16

```
In [16]: k=16
         k_means(k, np_image, size_data)
```




Segmentation


6000
5000
4000
3000
2000
1000
0
0
20
40
60
80
Training Energy

```
In [ ]:
```