Assignment 05

April 11, 2019

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

```
In [2]: # Normalize the values of the input data to be [0, 1]
        def normalize(data):

            data_normalized = (data - min(data)) / (max(data) - min(data))

            return(data_normalized)

        # Distance function between two vectors x and y
        def distance(x, y):

            d = (x - y) ** 2
            s = np.sum(d)
            # r = np.sqrt(s)

            return(s)

        # Plot image
        def plot_image(img) :
            plt.imshow(img)
            plt.axis('off')


        # Plot energy
        def plot_energy(energy) :
            plt.plot(energy)
            plt.show()
```

```
In [3]: class KMeans() :
            def __init__(self, k) :
```

```
        self.k = k
        self.centroid_color = np.zeros((self.k, 3), dtype="long")
        self.centroid_count = np.zeros(self.k, dtype="int")
        self.energy_list = []

#     def plot_centroid(self) :
#             test_pix = np.zeros((1, 1, 3), dtype="uint8")

#             f = plt.figure(figsize=(6,2))

#             for i in range (self.k) :
#                 plt.subplot(1, self.k, i+1)

#                 test_pix[0, 0, :] = copy.deepcopy(self.centroid_color[i, :])

#                 plt.imshow(test_pix)
#                 plt.axis('off')

#             frame = plt.gca()
#             plt.show()


    def init_centroid(self) :
        for i in range(pix_size) :
            rand_label = random.randint(0, self.k-1)
            self.cur_center_label[i] = rand_label

#         print(self.cur_center_label)

    def update_centroid(self) :
        self.centroid_color = np.zeros((self.k, 3), dtype="int")
        self.centroid_count = np.zeros(self.k, dtype="int")

        for i in range (pix_size) :
            label = self.cur_center_label[i]
            self.centroid_color[label, :] += pix[i, :]
            self.centroid_count[label]    += 1

        for i in range (self.k) :
            if (self.centroid_count[i] != 0) :
                self.centroid_color[i] //= self.centroid_count[i]

#         print(self.centroid_color)
#         print(self.centroid_count)

#         self.plot_centroid()
```

```python
def labeling(self) :
    energy_sum : long = 0

    # Label for each pixel
    for i in range (pix_size) :
        # Calculate distance between each centroid and pix
        dist_sum = []
        for j in range (self.k) :
            dist_sum.append(distance(pix[i, :], self.centroid_color[j, :]))

        # Find minimum distance and it index
        min_dist  = min(dist_sum)
        min_index = dist_sum.index(min_dist)

        # Put index in the label
        self.cur_center_label[i] = min_index

        # Add distance value
        energy_sum += min_dist

    return energy_sum

def calculate_energy(self, energy) :
    if (energy < 0) :
        energy = abs(energy)
    return (energy / pix_size)


def make_image(self) :
    kmeans_img_list = np.zeros((pix_size, 3), dtype="uint8")

    for i in range (pix_size) :
        label = self.cur_center_label[i]
        kmeans_img_list[i, :] = self.centroid_color[label, :]

    kmeans_img = kmeans_img_list.reshape(row_size, col_size, 3)

    return (kmeans_img)


def train(self) :

    self.cur_center_label  = np.zeros(pix_size, dtype="uint8")
    self.prev_center_label = np.zeros(pix_size, dtype="uint8")

    iter = 0

    self.init_centroid()
```

```
        # One iteration
        while not (np.array_equal(self.cur_center_label, self.prev_center_label)) :

            iter += 1
#             print("\n===========================\n", "<",iter, ">")

            self.update_centroid()   # Get the color of centroid

            self.prev_center_label = copy.deepcopy(self.cur_center_label)

            energy = self.labeling()

            self.energy_list.append(self.calculate_energy(energy))
#             print(self.energy_list[iter - 1])

            # Make cur_center_label as image
            kmeans_img = self.make_image()
            # Plot image
#             plot_image(kmeans_img)

        # Make cur_center_label as image
        kmeans_img = self.make_image()

        return (kmeans_img, self.energy_list)
```

In [4]:

```
# Read image
im = pilimg.open("img2.jpg")

# Make and image as array
img = np.array(im)

# Show image
plt.imshow(img)
plt.axis('off')

# Check image size
print(np.shape(img))
print(type(img[0][0][0]))

row_size = len(img)
col_size = len(img[0])

# Resize Image
pix      = img.reshape(row_size * col_size, 3)
pix_size = len(pix)
```

```
        print(np.shape(pix))

(771, 420, 3)
<class 'numpy.uint8'>
(323820, 3)
```

```
In [5]: k_three = KMeans(2)
        k_three_image, k_three_energy = k_three.train()
        plot_image(k_three_image)

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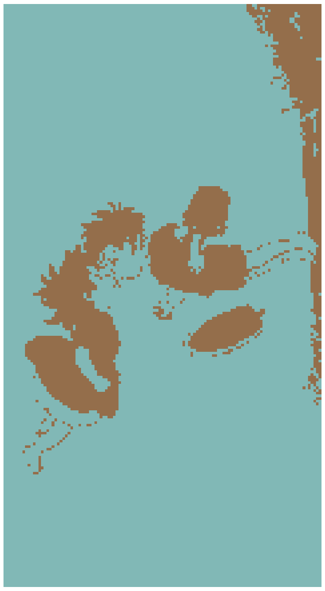
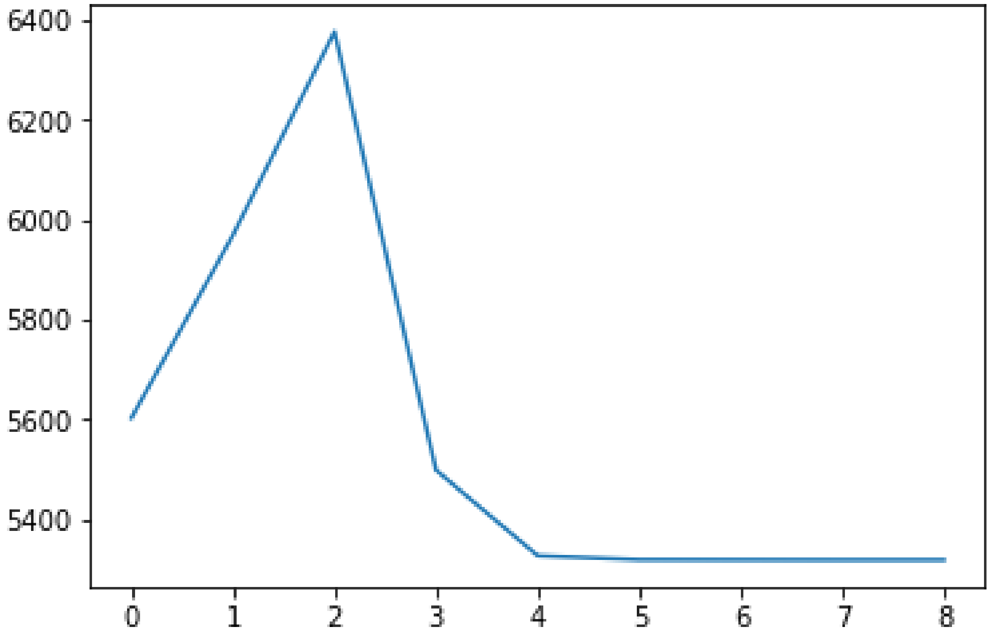
```



```
In [6]: plot_energy(k_three_energy)
```



```
In [7]: k_three = KMeans(4)
        k_three_image, k_three_energy = k_three.train()
        plot_image(k_three_image)
```

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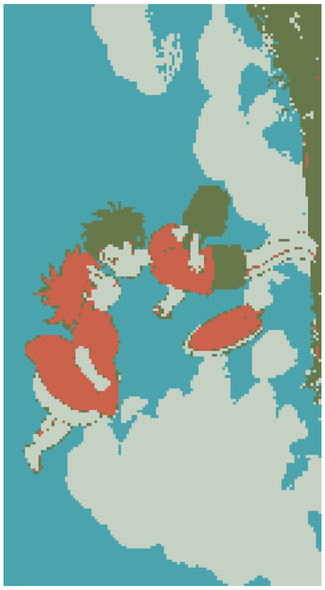
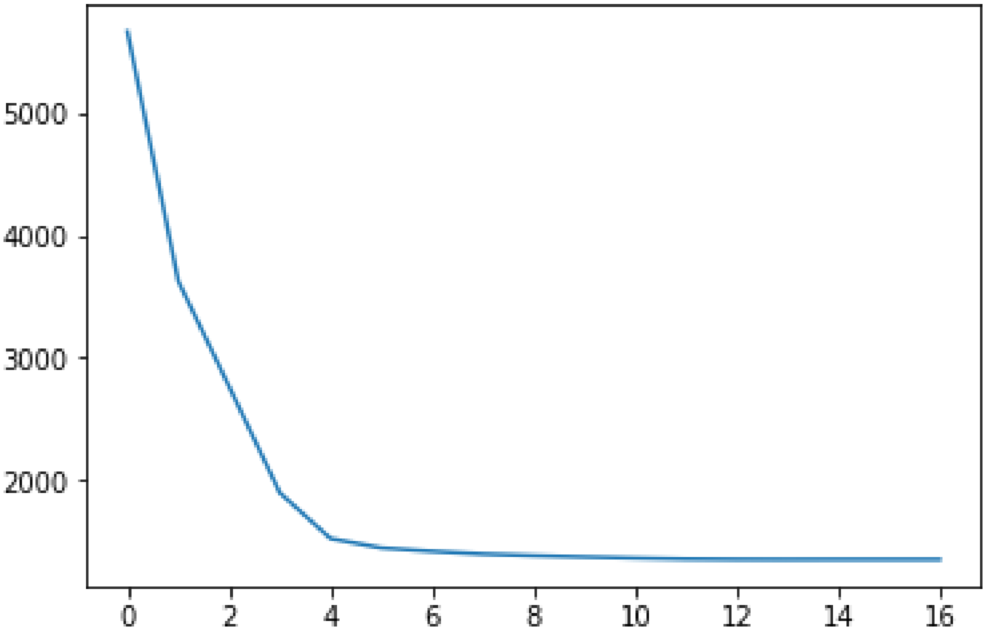


```
In [8]: plot_energy(k_three_energy)
```



```
In [9]: k_three = KMeans(8)
        k_three_image, k_three_energy = k_three.train()
        plot_image(k_three_image)
```

```
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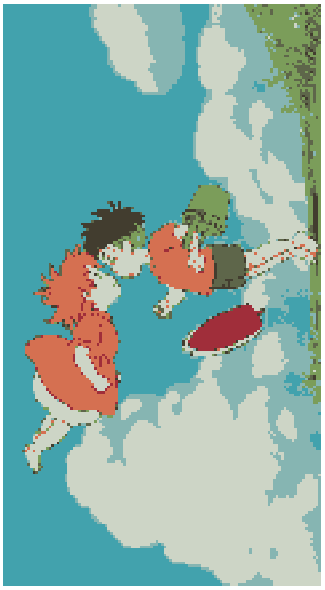
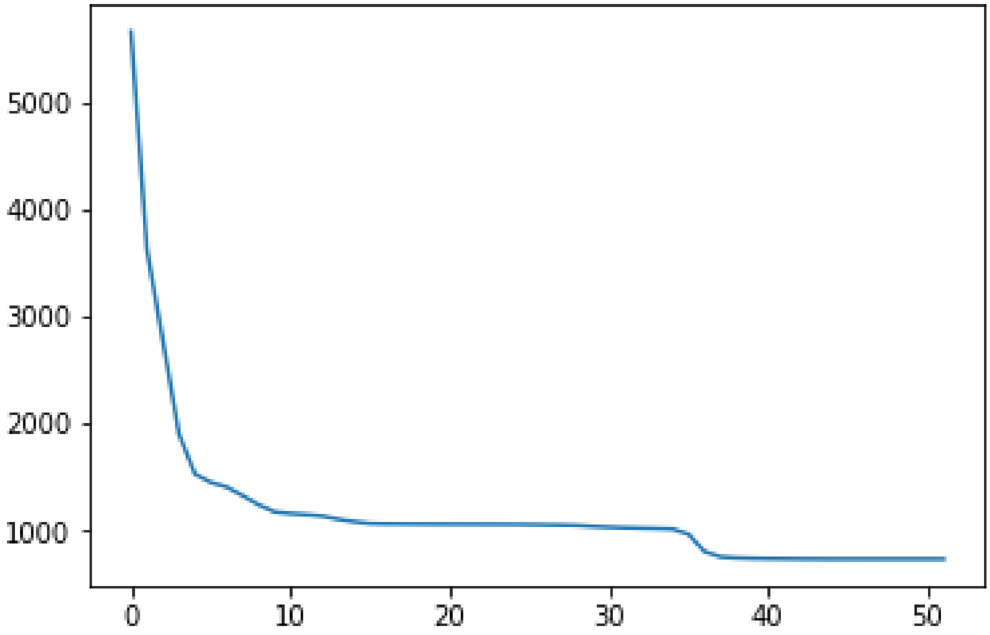
```



```
In [10]: plot_energy(k_three_energy)
```



```
In [11]: k_three = KMeans(16)
         k_three_image, k_three_energy = k_three.train()
         plot_image(k_three_image)
```

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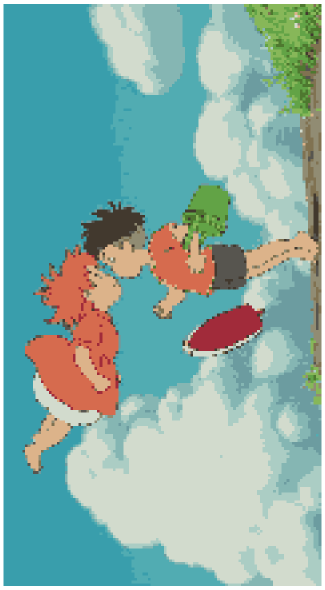
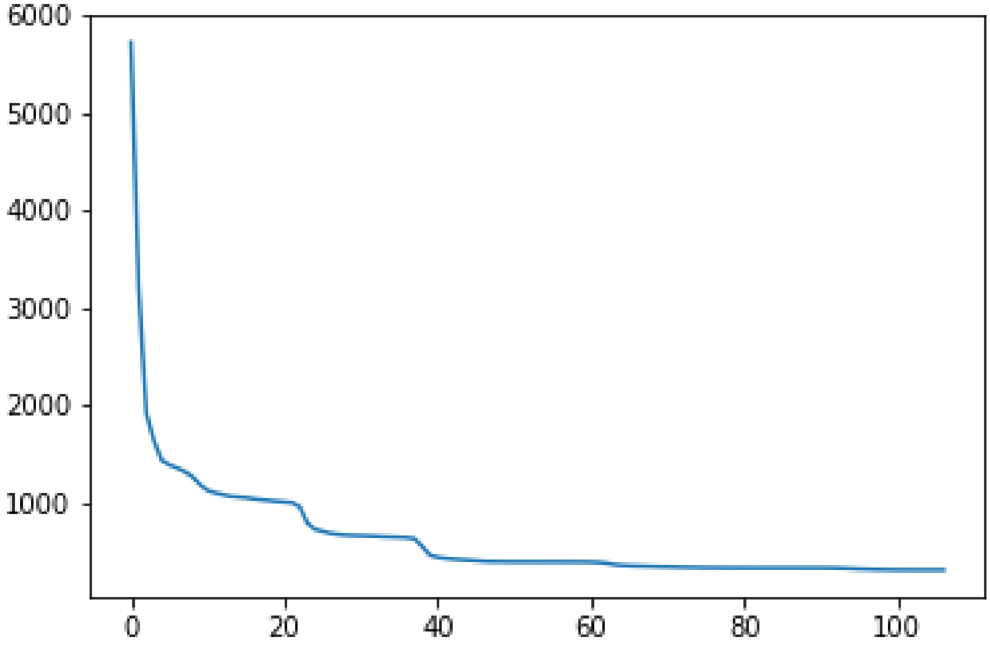
```



```
In [12]: plot_energy(k_three_energy)
```


6000
5000
4000
3000
2000
1000
0
20
40
60
80
100