Assignment05

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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]:
```
# 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.figure(figsize=(5,5))
    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 init_centroid(self) :
        for i in range(pix_size) :
            rand_label = random.randint(0, self.k-1)
            self.cur_center_label[i] = rand_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]


    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
            if (i == 0):
                energy_sum += min_dist
            else :
                energy_sum = (energy_sum + min_dist) / 2

        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

            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(energy)

#             if (iter > 100):
#                 break

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

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

        return (kmeans_img, self.energy_list)
```

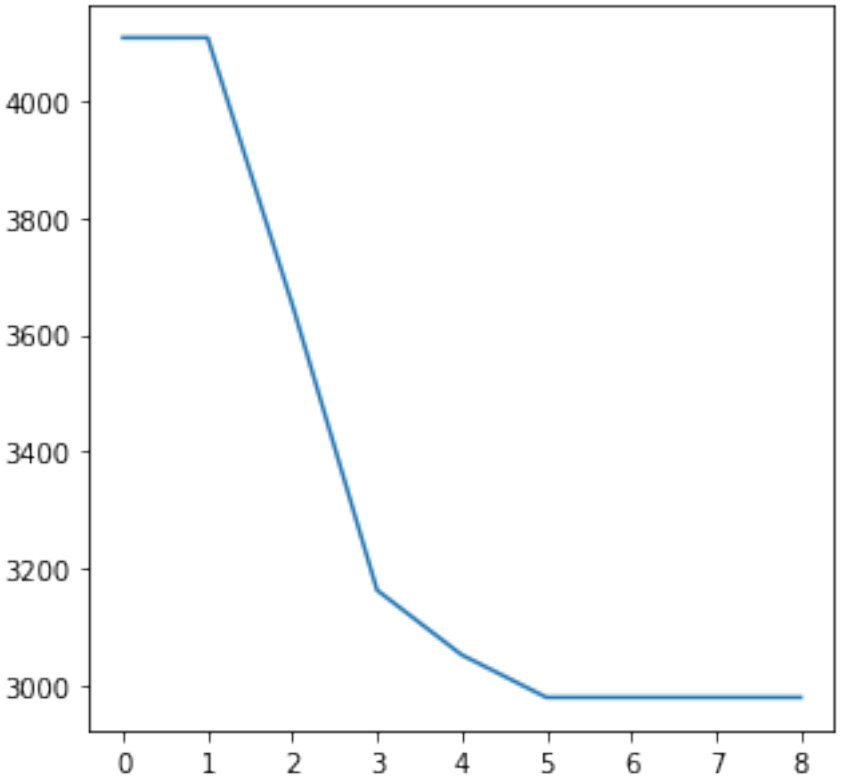
In [4]:
```
# Read image
im = pilimg.open("img2.jpg")

# 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)
```

1.0.1 K = 2

```
In [5]: k_two = KMeans(2)
        k_two_image, k_two_energy = k_two.train()
        plot_image(k_two_image)
```

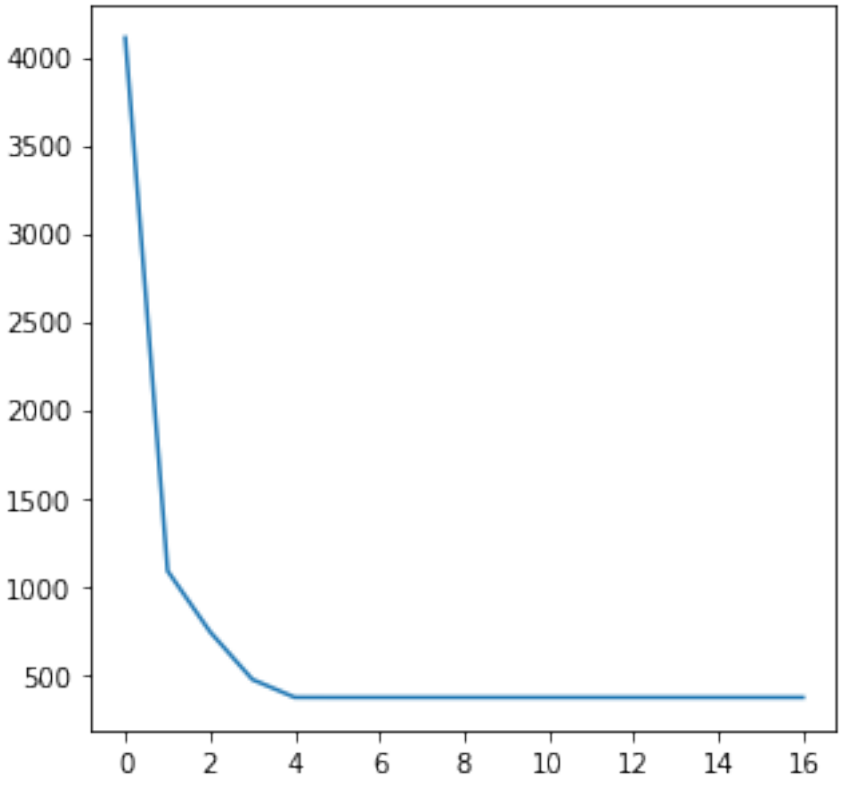
```
In [6]: plot_energy(k_two_energy)
```



1.0.2 K = 4

```
In [7]: k_four = KMeans(4)
        k_four_image, k_four_energy = k_four.train()
        plot_image(k_four_image)
```

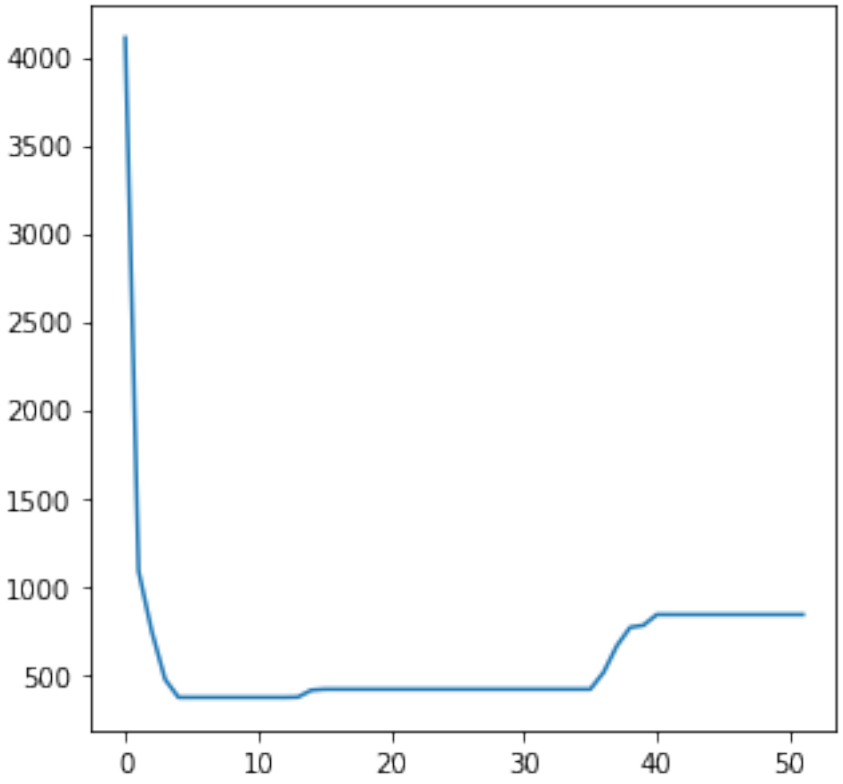
In [8]: plot_energy(k_four_energy)



1.0.3 K = 8

In [9]:
```
k_eight = KMeans(8)
k_eight_image, k_eight_energy = k_eight.train()
plot_image(k_eight_image)
```

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



1.0.4 K = 16

```
In [11]: k_sixteen = KMeans(16)
         k_sixteen_image, k_sixteen_energy = k_sixteen.train()
         plot_image(k_sixteen_image)
```

In [12]: `plot_energy(k_sixteen_energy)`