```
from jupyterthemes import get_themes
import jupyterthemes as jt
from jupyterthemes.stylefx import set_nb_theme

set_nb_theme('chesterish')
```

```
import cv2
import matplotlib.pyplot as plt
import numpy as np
import math
from PIL import Image
```

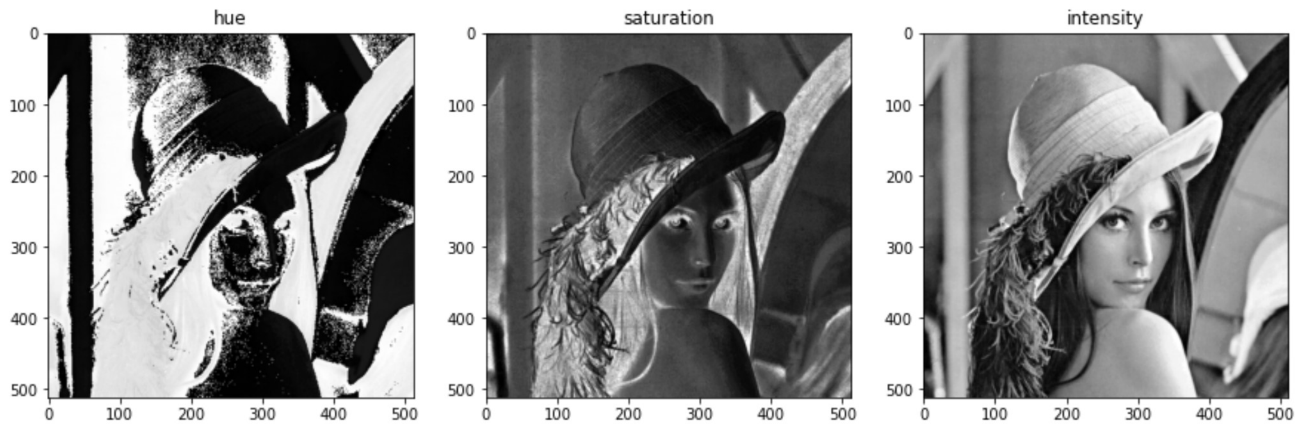
Problem 6.1.1 :

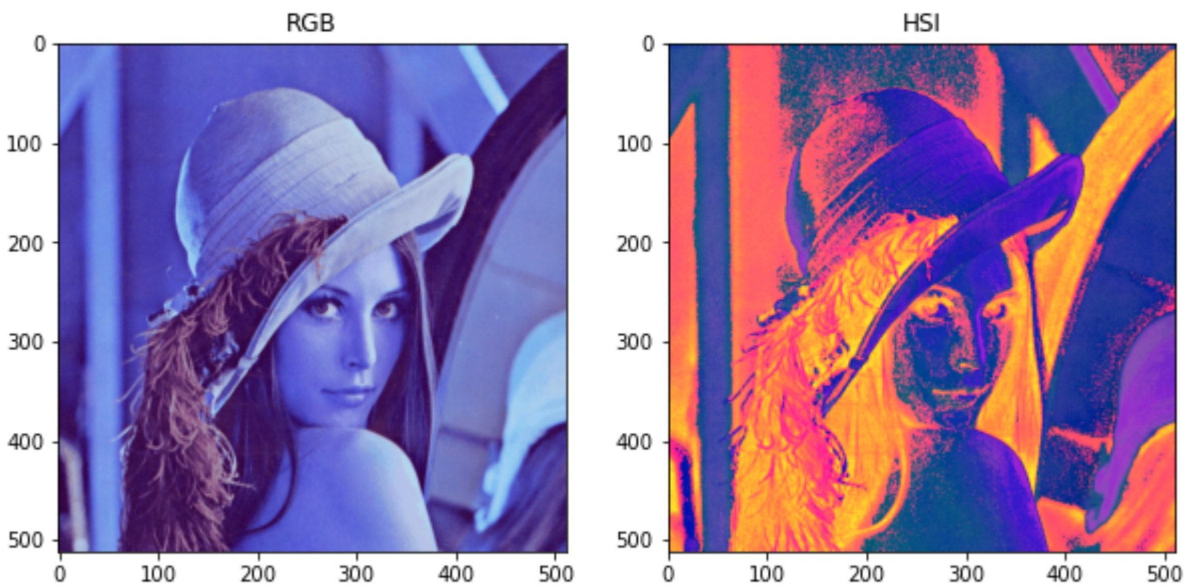
```
def Saturation(channels):
        (R, G, B) = channels
        min_value = np.minimum(np.minimum(R, G), B)
        return 1 - (3 * min_value)/ (R + G + B)


def Intensity(channels):
        (R, G, B) = channels
        return (R + G + B )/3


def Hue(channels):
        (R, G, B) = channels
        result_hue = np.copy(R)

        for i in range(0, B.shape[0]):
            for j in range(0, B.shape[1]):
                # Calculate numerator = ( 0.5 * [(R - G) + (R - B)] )
                numerator = 0.5 * ((R[i][j] - G[i][j]) + (R[i][j] - B[i][j]))

                # Calculate denominator = ([(R - G)^2 + (R - B)(G - B)]^0.5)
                denominator = math.sqrt((R[i][j] - G[i][j])**2 + ((R[i][j] - B[i][j]) * (G

                # Calculate divistion = numerator / denominator
                divistion = np.divide(numerator, denominator)
```

```
                result_hue[i][j] = math.acos(divistion)

                # If B > G then H = 360 - theta
                if B[i][j] > G[i][j]:
                    result_hue[i][j] = ((360 * math.pi) / 180.0) - result_hue[i][j]

        return result_hue

def R2GtoHSI(image):
        with np.errstate(divide='ignore', invalid='ignore'):
            # here we split the picture to the channels
            block = np.float32(image) / 255
            channels = (block[:,:,2], block[:,:,1], block[:,:,0])

            saturation = Saturation(channels)

            intensity = Intensity(channels)

            hue = Hue(channels)

            # Merge channels into one image
            hsi_img = cv2.merge((hue, saturation, intensity))


            figure = plt.figure(figsize=(15,15))

            figure.add_subplot(1,3,1)
            plt.title("hue")
            plt.imshow(hue, cmap="gray")

            figure.add_subplot(1,3,2)
            plt.title("saturation")
            plt.imshow(saturation, cmap="gray")

            figure.add_subplot(1,3,3)
            plt.title("intensity")
            plt.imshow(intensity, cmap="gray")


            return hsi_img


    img = cv2.imread("Lena.bmp")


    #here we cnvert RGB to HSI

    hsi = R2GtoHSI(img)
```

```
figure = plt.figure(figsize=(10,10))
figure.add_subplot(1,2,1)
plt.title("RGB")
plt.imshow(img, cmap="gray")
figure.add_subplot(1,2,2)
plt.title("HSI")
plt.imshow(hsi, cmap="gray")
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or
<matplotlib.image.AxesImage at 0x1dbe1802c70>
```





Problen 6.2.1 :

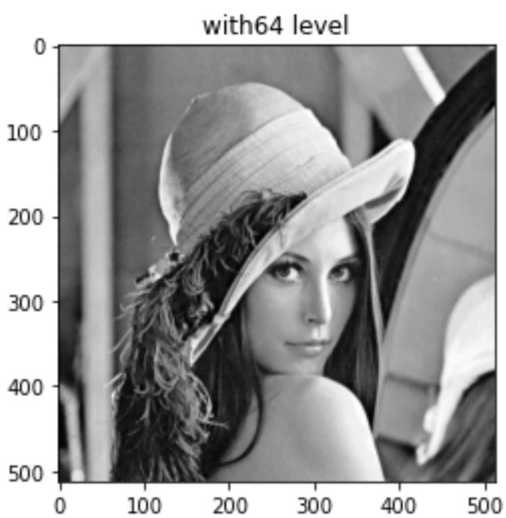
```
def quan_fanc(array, L):

    #     here  we want to quantize the numbers into L level
```

```
    coeff = 256//L
    return (array // coeff) * coeff
def MSE(image, new_Image):
    # cumulative difference
    err = np.sum((image.astype("float") - new_Image.astype("float")) ** 2)

    # divide by length*width
    err /= float(image.shape[0] * new_Image.shape[1])

    return format(err,'.6f')
```

```
from skimage.metrics import peak_signal_noise_ratio
lena = cv2.imread('Lena.bmp',cv2.IMREAD_GRAYSCALE)
```

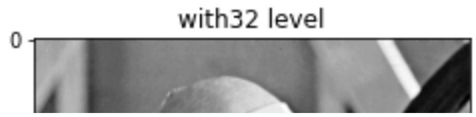
```
lena64 = quan_fanc(lena.copy(),64)
plt.imshow(lena64 , cmap='gray')
plt.title("with64 level")
print("MSE : " , MSE(lena, lena64))
print("PSNR : " + str(peak_signal_noise_ratio(lena , lena64)))
```

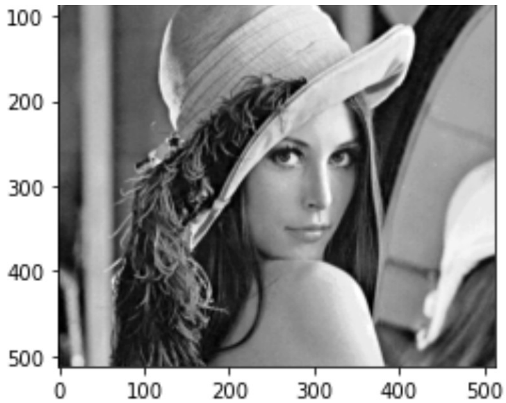
```
MSE :  3.521683
PSNR : 42.66330132120192
```




```
lena32 = quan_fanc(lena.copy(),32)
plt.imshow(lena32 , cmap='gray')
plt.title("with32 level")
print("MSE : " , MSE(lena, lena32))
print("PSNR : " + str(peak_signal_noise_ratio(lena , lena32)))
```

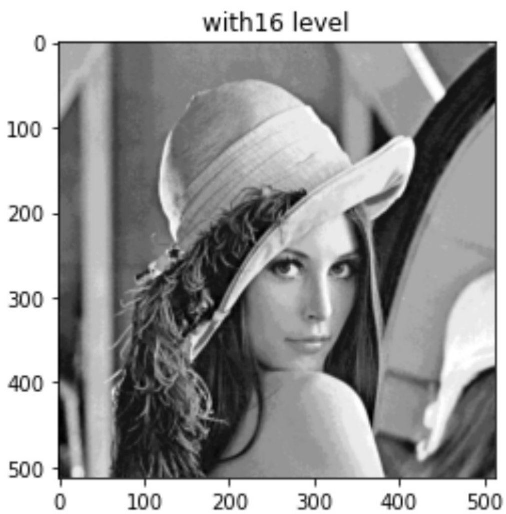
```
MSE :  17.090836
PSNR : 35.80317064962315
```





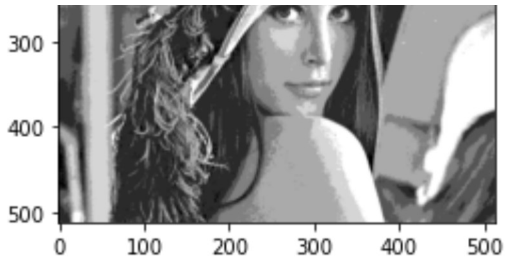

```
lena16 = quan_fanc(lena.copy(),16)
plt.imshow(lena16 , cmap='gray')
plt.title("with16 level")
print("MSE : " , MSE(lena, lena16))
print("PSNR : " + str(peak_signal_noise_ratio(lena , lena16)))
```

```
MSE :  78.838150
PSNR : 29.16343936072466
```



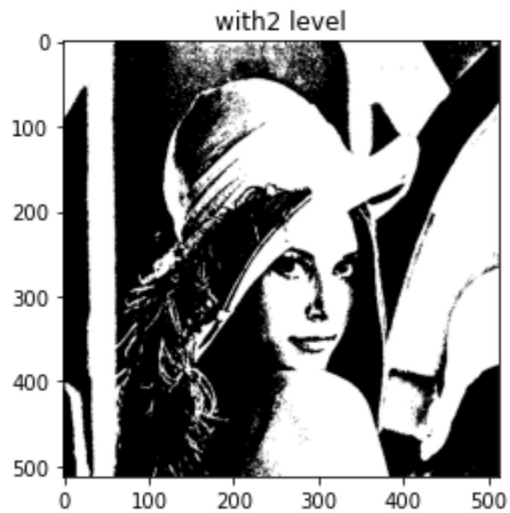

```
lena8 = quan_fanc(lena.copy(),8)
plt.imshow(lena8 , cmap='gray')
plt.title("with8 level")
print("MSE : " , MSE(lena, lena8))
print("PSNR : " + str(peak_signal_noise_ratio(lena , lena8)))
```

```
MSE :  313.441666
PSNR : 23.169236343419712
```




```
lena2 = quan_fanc(lena.copy(),2)
plt.imshow(lena2 , cmap='gray')
plt.title("with2 level")
```

```
Text(0.5, 1.0, 'with2 level')
```



Problem 6.2.2:

```
def subset_8(color):
    # colors divided into 8 subsets for each color space
    subsets = [[0,31], [32,63], [64,95], [96,127], [128,159], [160,191], [192,223], [224,2
    for index, subset in enumerate(subsets):
        if color >= subset[0] and  color <= subset[1]:
            return 31 * index

def subset_4(color):
    # colors divided into 4 subsets for each color space
     subsets = [[0,63], [64,127], [128,191], [192,255]]
     for index, subset in enumerate( subsets):
        if color >= subset[0] and  color <= subset[1]:
            return 63*index


def subset_2(color):
    # colors divided into 2 subsetss for each color space
    subsets = [[0,127], [128,255]]
    for index, subset in enumerate(subsets):
```

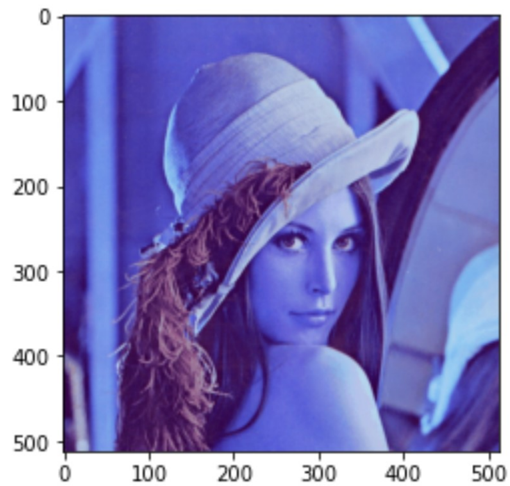
```
    for index, subset in enumerate(subsets):
        if color>= subset[0] and color <= subset[1]:
            return 127*index
```

```
print(subset_8(102))
```

```
93
```

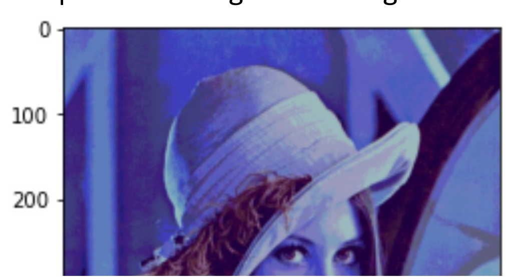
```
# here we show the real image
img = cv2.imread("Lena.bmp")
plt.imshow(img)
```

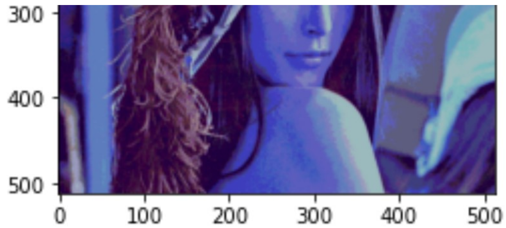
```
<matplotlib.image.AxesImage at 0x1dbe1986d30>
```




```
img = cv2.imread("Lena.bmp")
# loop through all pixels and the put the colors into the respective color regions
for rows in img:
    for pixel in rows:
#         we assign a number with 3 bits to R
        pixel[0] = subset_8(pixel[0])
#         we assign a number with 3 bits to R
        pixel[1] = subset_8(pixel[1])
#         we assign a number with 3 bits to R
        pixel[2] = subset_4(pixel[2])
plt.imshow(img)
```

```
<matplotlib.image.AxesImage at 0x1dbe1aee760>
```

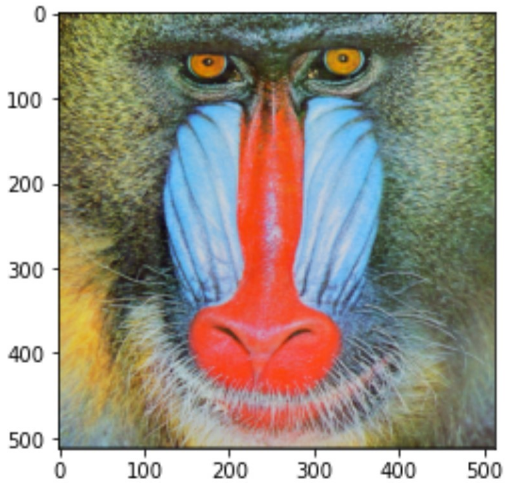




Problem 6.2.3 :

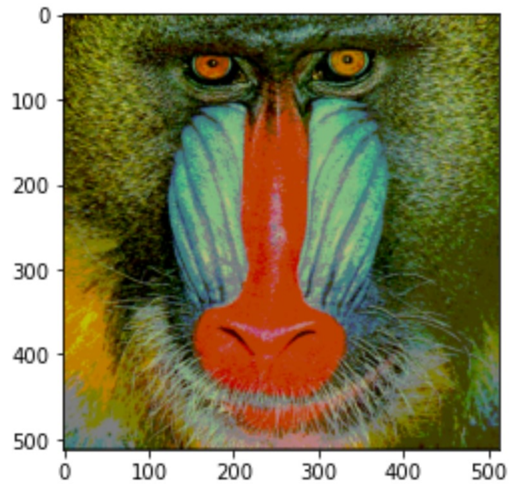
```
# this is the real image :
img = cv2.imread("Baboon.bmp"  , cv2.COLOR_BGR2RGB)
img = cv2.cvtColor(img ,cv2.COLOR_BGR2RGB)
plt.imshow(img , )
print(img.shape)
```

```
(512, 512, 3)
```



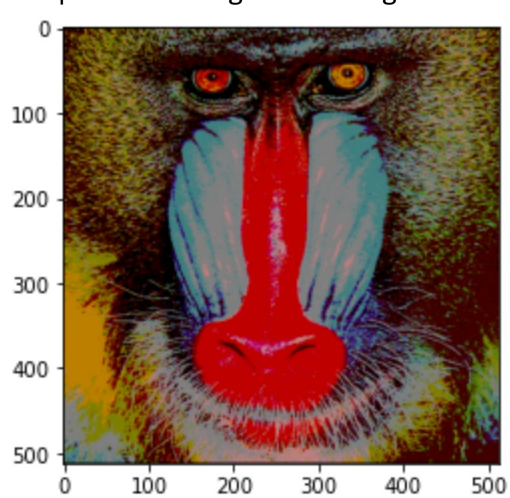
```
# here we implement the picture we 32 colors
# R = 4 reigens
# G = 4 rigens
# B = 2 reigens
img = cv2.imread("Baboon.bmp")
img = cv2.cvtColor(img ,cv2.COLOR_BGR2RGB)
# loop through all pixels and the put the colors into the respective color regions
for rows in img:
    for pixel in rows:
#         we assign a number with 3 bits to R
        pixel[0] = subset_4(pixel[0])
#         we assign a number with 3 bits to R
        pixel[1] = subset_4(pixel[1])
#         we assign a number with 3 bits to R
        pixel[2] = subset_2(pixel[2])
plt.imshow(img)
```

```
<matplotlib.image.AxesImage at 0x1dbe1baf610>
```




```
# here we implement the picture we 16 colors
# R = 4 reigens
# G = 4 rigens
# B = 2 reigens
img = cv2.imread("Baboon.bmp")
img = cv2.cvtColor(img ,cv2.COLOR_BGR2RGB)
# loop through all pixels and the put the colors into the respective color regions
for rows in img:
    for pixel in rows:
#         we assign a number with 3 bits to R
        pixel[0] = subset_4(pixel[0])
#         we assign a number with 3 bits to R
        pixel[1] = subset_2(pixel[1])
#         we assign a number with 3 bits to R
        pixel[2] = subset_2(pixel[2])
plt.imshow(img)
```

```
<matplotlib.image.AxesImage at 0x1dbe1c194c0>
```




```
# here we implement the picture we 32 colors
# R = 4 reigens
# G = 4 rigens
```

```
# B = 2 reigens
img = cv2.imread("Baboon.bmp")
img = cv2.cvtColor(img ,cv2.COLOR_BGR2RGB)
# loop through all pixels and the put the colors into the respective color regions
for rows in img:
    for pixel in rows:
#         we assign a number with 3 bits to R
        pixel[0] = subset_2(pixel[0])
#         we assign a number with 3 bits to R
        pixel[1] = subset_2(pixel[1])
#         we assign a number with 3 bits to R
        pixel[2] = subset_2(pixel[2])
plt.imshow(img)
```

```
<matplotlib.image.AxesImage at 0x1dbe1c7a670>
```