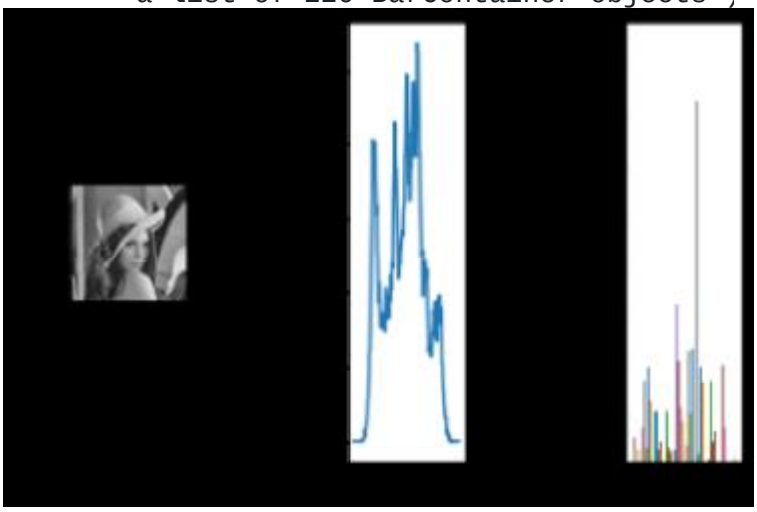
In [2]:
```
import numpy as np
import cv2
import matplotlib.pyplot as plt
```

Grayscale histograms

cv2.calcHist(images, channels, mask, histSize, ranges[, hist[, accumulate]])

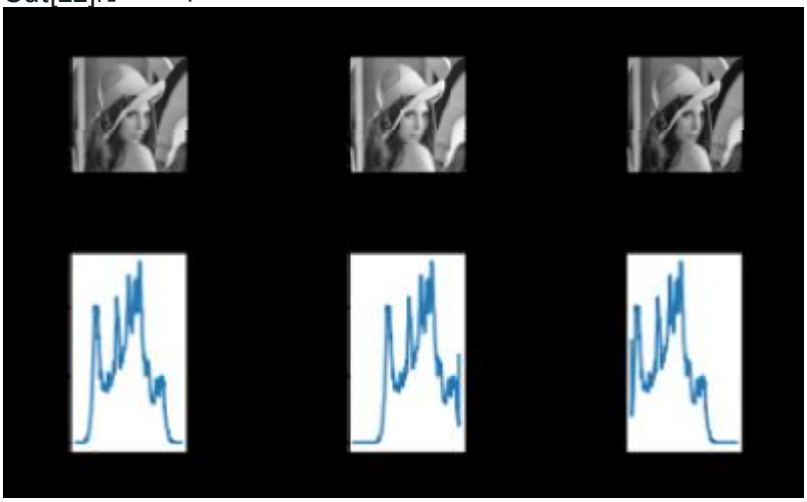
In [21]:
```
image = cv2.imread('data/lenna.png')
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
hist = cv2.calcHist([gray_image], [0], None, [256], [0, 256])
plt.subplot(1,5,1)
plt.imshow(gray_image,cmap='gray')
plt.subplot(1,5,3)
plt.plot(hist)
plt.subplot(1,5,5)
plt.hist(gray_image)
```

Out[21]:
```
(array([[21., 35., 27., ...,  0.,  0.,  0.],
        [21., 33., 29., ...,  0.,  0.,  0.],
        [17., 34., 29., ...,  1.,  0.,  0.],
        ...,
        [ 5., 37., 21., ..., 10., 36.,  0.],
        [ 4., 41., 17., ..., 10., 37.,  0.],
        [ 4., 45., 13., ...,  9., 37.,  0.]]),
 array([ 21. ,  42.9,  64.8,  86.7, 108.6, 130.5, 152.4, 174.3, 196.2,
        218.1, 240. ]),
 <a list of 220 BarContainer objects>)
```



In [...
```
# Add 35 to every pixel on the grayscale image (the result will look ligh
M = np.ones(gray_image.shape, dtype="uint8") * 35
added_image = cv2.add(gray_image, M)
hist_added_image = cv2.calcHist([added_image], [0], None, [256], [0, 256]
# Subtract 35 from every pixel (the result will look darker) and calculat
subtracted_image = cv2.subtract(gray_image, M)
hist_subtracted_image = cv2.calcHist([subtracted_image], [0], None, [256]
plt.subplot(2,5,1)
plt.imshow(gray_image,cmap='gray')
plt.title('gray_image')
plt.subplot(2,5,3)
plt.imshow(added_image,cmap='gray')
plt.title('added_image')
```

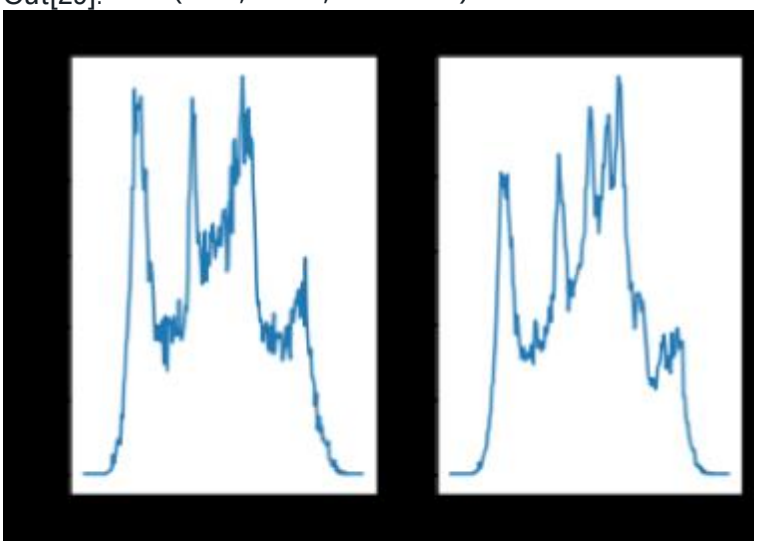
Out[22]: `[<matplotlib.lines.Line2D at 0x90f4849310>]`



Grayscale histograms with a mask

In [29]:
```
mask = np.zeros(gray_image.shape[:2], np.uint8)
mask[30:190, 30:190] = 255

hist_mask = cv2.calcHist([gray_image], [0], mask, [256], [0, 256])
plt.subplot(1,2,1)
plt.plot(hist_mask)
plt.title('hist_mask')
plt.subplot(1,2,2)
plt.plot(hist)
plt.title('hist')
```

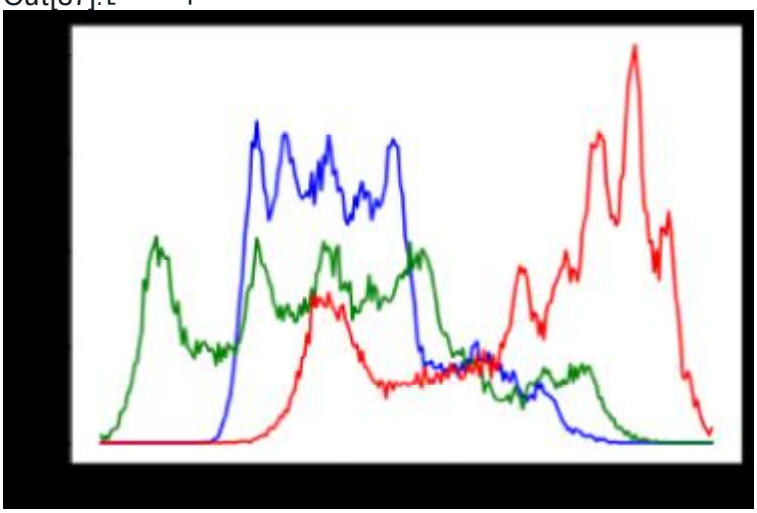
Out[29]: `Text(0.5, 1.0, 'hist')`



Color histograms

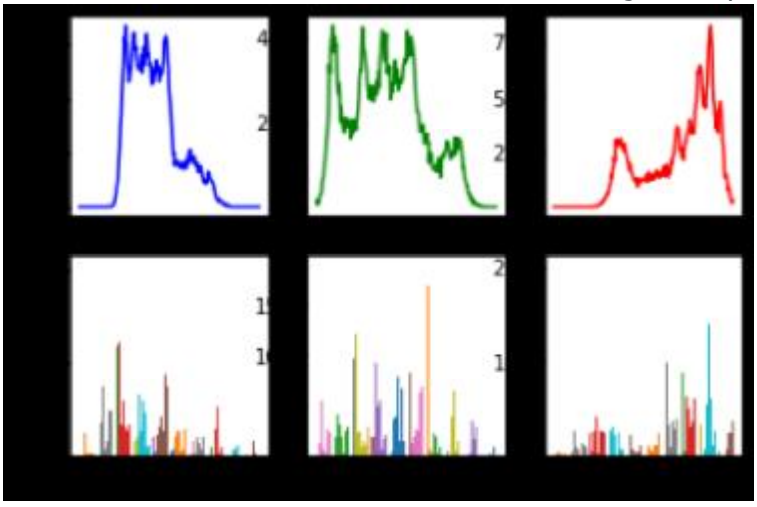
In [37]:
```
def hist_color_img(img):
    #Calculates the histogram from a three-channel image
        histr = []
        histr.append(cv2.calcHist([img], [0], None, [256], [0, 256]))
        histr.append(cv2.calcHist([img], [1], None, [256], [0, 256]))
```

Out[37]:
```
[<matplotlib.lines.Line2D at 0x90f4fa5940>]
```



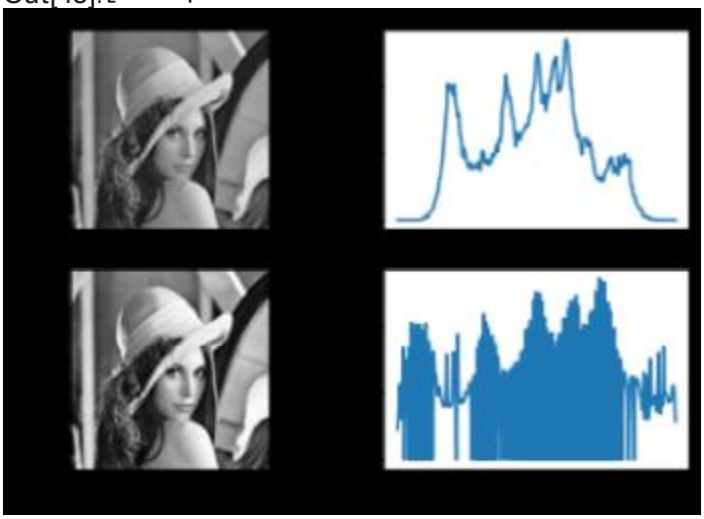
In [42]:
```
image = cv2.imread('data/lenna.png')
img_B=image[:,:,0]
img_G=image[:,:,1]
img_R=image[:,:,2]
plt.subplot(2,3,1)
plt.plot(hist_color[0],color='b')
plt.subplot(2,3,4)
plt.hist(img_B)
plt.subplot(2,3,2)
plt.plot(hist_color[1],color='g')
plt.subplot(2,3,5)
plt.hist(img_G)
plt.subplot(2,3,3)
plt.plot(hist_color[2],color='r')
plt.subplot(2,3,6)
plt.hist(img_R)
```

Out[42]:
```
(array([[ 6., 25., 24., ...,  1., 35.,  5.],
        [ 4., 22., 26., ...,  1., 34.,  5.],
        [ 1., 18., 29., ...,  1., 31.,  6.],
        ...,
        [ 1.,  9., 32., ..., 70., 11., 39.],
        [ 2., 11., 30., ..., 69., 17., 33.],
        [ 1.,  9., 35., ..., 67., 25., 31.]]),
 array([ 52. ,  72.3,  92.6, 112.9, 133.2, 153.5, 173.8, 194.1, 214.4,
        234.7, 255. ]),
 <a list of 220 BarContainer objects>)
```



In [45]:
```
image = cv2.imread('data/lenna.png')
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
hist = cv2.calcHist([gray_image], [0], None, [256], [0, 256])

gray_image_eq = cv2.equalizeHist(gray_image)
hist_eq = cv2.calcHist([gray_image_eq], [0], None, [256], [0, 256])

plt.subplot(2,2,1)
plt.imshow(gray_image,cmap='gray')
plt.subplot(2,2,2)
plt.plot(hist)
plt.subplot(2,2,3)
plt.imshow(gray_image_eq,cmap='gray')
plt.subplot(2,2,4)
plt.plot(hist_eq)
```

Out[45]:
```
[<matplotlib.lines.Line2D at 0x90fee5ee50>]
```

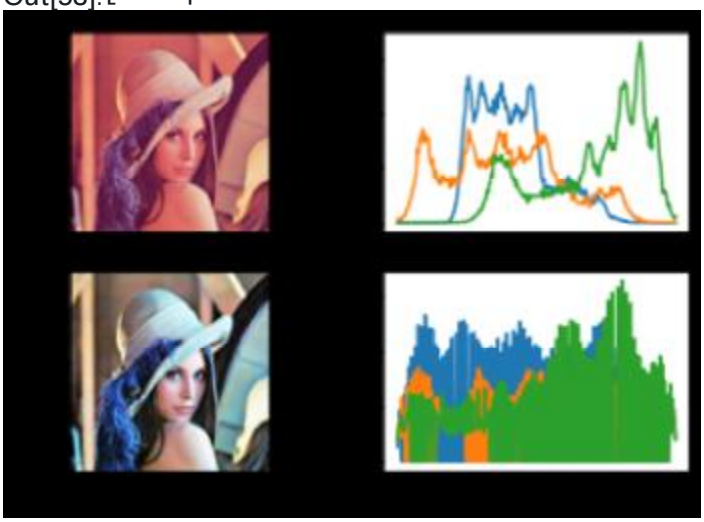


Color histogram equalization

We have commented that equalizing the three channels is not a good approach because the color shade changes dramatically.

In [...
```
def equalize_hist_color(img):
#Equalize the image splitting the image applying cv2.equalizeHist() to ea
    channels = cv2.split(img)
    eq_channels = []
    for ch in channels:
        eq_channels.append(cv2.equalizeHist(ch))
    eq_image = cv2.merge(eq_channels)
    return eq_image

def hist_color_img(img):
#Calculates the histogram from a three-channel image
    histr = []
    histr.append(cv2.calcHist([img], [0], None, [256], [0, 256]))
    histr.append(cv2.calcHist([img], [1], None, [256], [0, 256]))
    histr.append(cv2.calcHist([img], [2], None, [256], [0, 256]))
    return histr
```

Out[53]:`[<matplotlib.lines.Line2D at 0x90816ce4f0>]`



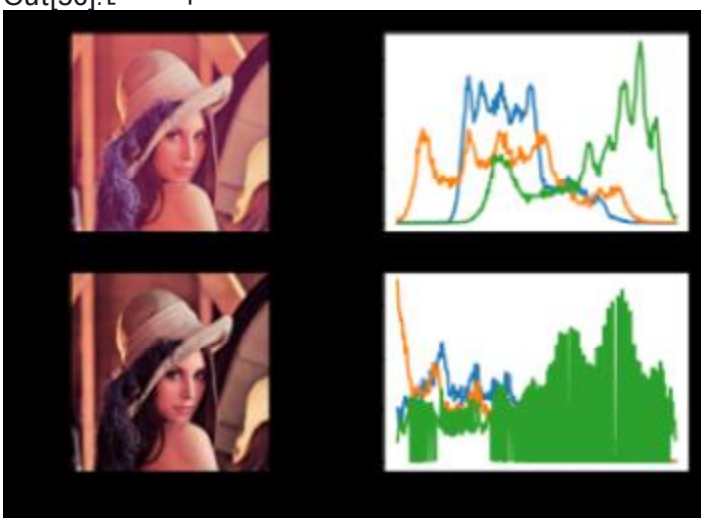
We have commented that equalizing the three channels is not a good approach because the color shade changes dramatically.

A better approach is to convert the BGR image to a color space containing a luminance/intensity channel (Yuv, Lab, HSV, and HSL). Then, we apply histogram equalization only on the luminance channel and, finally, perform inverse transformation, that is, we merge the channels and convert them back to the BGR color space.

In [...

```
def equalize_hist_color_hsv(img):
# '''Equalize the image splitting the image after HSV conversion and appl
#    to the V channel, merging the channels and convert back to the BGR c
    H, S, V = cv2.split(cv2.cvtColor(img, cv2.COLOR_BGR2HSV))
    eq_V = cv2.equalizeHist(V)
    eq_image = cv2.cvtColor(cv2.merge([H, S, eq_V]), cv2.COLOR_HSV2BGR)
    return eq_image

def hist_color_img(img):
#Calculates the histogram from a three-channel image
    histr = []
    histr.append(cv2.calcHist([img], [0], None, [256], [0, 256]))
    histr.append(cv2.calcHist([img], [1], None, [256], [0, 256]))
    histr.append(cv2.calcHist([img], [2], None, [256], [0, 256]))
    return histr

image = cv2.imread('data/lenna.png')

hist_color = hist_color_img(image)

eq_image=equalize_hist_color_hsv(image)

hist_color_eq= hist_color_img(eq_image)

image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
eq_image=cv2.cvtColor(eq_image, cv2.COLOR_BGR2RGB)
plt.subplot(2,2,1)
plt.imshow(image)
plt.subplot(2,2,2)
plt.plot(hist_color[0])
plt.plot(hist_color[1])
plt.plot(hist_color[2])
```

Out[56]: `[<matplotlib.lines.Line2D at 0x90817f4670>]`



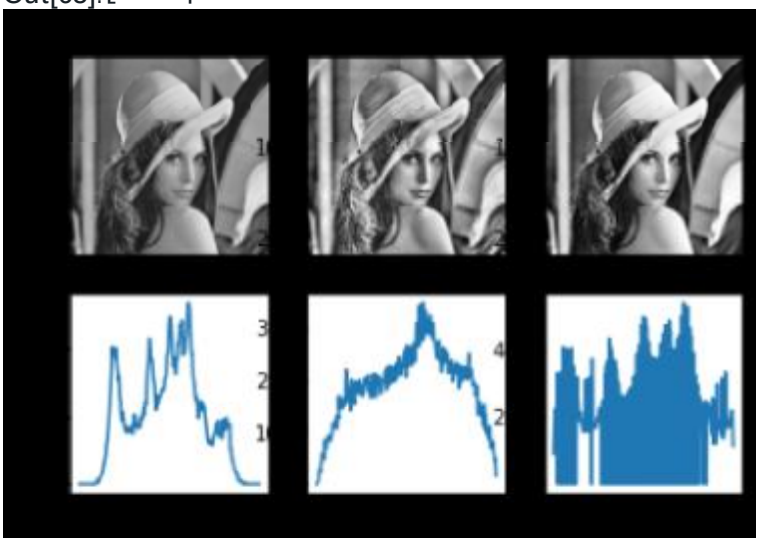
Contrast Limited Adaptive Histogram Equalization

In [5...
```
image = cv2.imread('data/lenna.png')
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
hist = cv2.calcHist([gray_image], [0], None, [256], [0, 256])

clahe = cv2.createCLAHE(clipLimit=2.0)
#The first one is clipLimit, which sets the threshold for
#contrast limiting.
gray_image_clahe = clahe.apply(gray_image)
hist_clahe = cv2.calcHist([gray_image_clahe], [0], None, [256], [0, 256]

plt.subplot(2,2,1)
plt.imshow(gray_image,cmap='gray')
plt.subplot(2,2,2)
plt.plot(hist)
plt.subplot(2,2,3)
plt.imshow(gray_image_clahe,cmap='gray')
plt.subplot(2,2,4)
plt.plot(hist_clahe)
```

Out[59]: `[<matplotlib.lines.Line2D at 0x9082dc6850>]`

In [6...
```
image = cv2.imread('data/lenna.png')
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
hist = cv2.calcHist([gray_image], [0], None, [256], [0, 256])

#Histogram equalization
gray_image_eq = cv2.equalizeHist(gray_image)
hist_eq = cv2.calcHist([gray_image_eq], [0], None, [256], [0, 256])

#Contrast Limited Adaptive Histogram Equalization
clahe = cv2.createCLAHE(clipLimit=4.0)
gray_image_clahe = clahe.apply(gray_image)
hist_clahe = cv2.calcHist([gray_image_clahe], [0], None, [256], [0, 256]

# ploting
plt.subplot(2,3,1)
plt.imshow(gray_image,cmap='gray')
plt.title('gray_image')

plt.subplot(2,3,2)
plt.imshow(gray_image_clahe,cmap='gray')
plt.title('gray_image_clahe')

plt.subplot(2,3,3)
plt.imshow(gray_image_eq,cmap='gray')
plt.title('gray_image_eq')

plt.subplot(2,3,4)
plt.plot(hist)

plt.subplot(2,3,5)
plt.plot(hist_clahe)

plt.subplot(2,3,6)
plt.plot(hist_eq)
```

Out[65]: `[<matplotlib.lines.Line2D at 0x908355c940>]`



In [6...
```
image = cv2.imread('data/lenna.png')
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
gray_image_eq = cv2.equalizeHist(gray_image)
```

Out[66]: `[<matplotlib.lines.Line2D at 0x9083624580>]`

In [67]:
```
image = cv2.imread('data/lenna.png')

gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)


clahe = cv2.createCLAHE(clipLimit=4.0)
gray_image_clahe = clahe.apply(gray_image)
gray_image_eq = cv2.equalizeHist(gray_image_clahe)
hist_eq = cv2.calcHist([gray_image_eq], [0], None, [256], [0, 256])

plt.subplot(1,2,1)
plt.imshow(gray_image_eq,cmap='gray')
plt.subplot(1,2,2)
plt.plot(hist_eq)
```

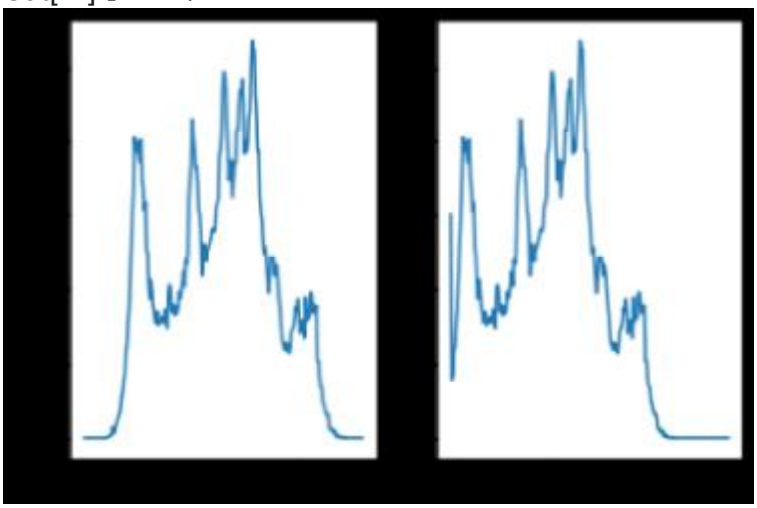
Out[67]: `[<matplotlib.lines.Line2D at 0x90836c6340>]`

Histogram comparison

In [72]:
```
image = cv2.imread('data/lenna.png')
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
M = np.ones(gray_image.shape, dtype="uint8") * 35
subtracted_image = cv2.subtract(gray_image, M)
h1 = cv2.calcHist([gray_image], [0], None, [256], [0, 256])
h2 = cv2.calcHist([subtracted_image], [0], None, [256], [0, 256])
```

```
corr: 0.3457234204243703
match: 0.4011130822829297
```

Out[72]:`[<matplotlib.lines.Line2D at 0x9083805670>]`



In [ ]: