```
import numpy as np
import pandas as pd
import cv2
from matplotlib import pyplot as plt
import matplotlib.cm as cm
import matplotlib.gridspec as gridspec
from pylab import imread
from skimage.color import rgb2gray
import pywt
```

```
def ShowImage(ImageList, nRows = 1, nCols = 2, WidthSpace = 0.00, HeightSpace = 0.00):
    from matplotlib import pyplot as plt
    import matplotlib.gridspec as gridspec

    gs = gridspec.GridSpec(nRows, nCols)
    gs.update(wspace=WidthSpace, hspace=HeightSpace) # set the spacing between axes.
    plt.figure(figsize=(20,10))
    for i in range(len(ImageList)):
        ax1 = plt.subplot(gs[i])
        ax1.set_xticklabels([])
        ax1.set_yticklabels([])
        ax1.set_aspect('equal')

        plt.subplot(nRows, nCols,i+1)

        image = ImageList[i].copy()
        if (len(image.shape) < 3):
            plt.imshow(image, plt.cm.gray)
        else:
            plt.imshow(image)
        plt.title("Image " + str(i))
        plt.axis('off')

    plt.show()
```

```
# Read Image
image_color = imread("Sample05/balloon.jpg")
# Convert Image into Gray
image_gray = cv2.cvtColor(image_color, cv2.COLOR_RGB2GRAY)
# Display Image
ShowImage([image_color, image_gray], 1, 2)

import pywt
import pywt.data
from pywt import dwt2, idwt2
from pywt._doc_utils import wavedec2_keys, draw_2d_wp_basis

discrete_wavelets = ['db5', 'sym5', 'coif5', 'bior1.3', 'haar']

x = image_gray.astype(np.float32)
shape = x.shape

max_lev = 2       # how many levels of decomposition to draw
label_levels = 2  # how many levels to explicitly label on the plots
```

```
for i in discrete_wavelets:
    fig, axes = plt.subplots(2, max_lev + 1, figsize=[14, 8])
    for level in range(0, max_lev + 1):
        if level == 0:
            # show the original image before decomposition
            axes[0, 0].set_axis_off()
            axes[1, 0].imshow(x, cmap=plt.cm.gray)
            axes[1, 0].set_title('Image')
            axes[1, 0].set_axis_off()
            continue

        # plot subband boundaries of a standard DWT basis
        draw_2d_wp_basis(shape, wavedec2_keys(level), ax=axes[0, level],
                         label_levels=label_levels)
        axes[0, level].set_title('{} level\ndecomposition'.format(level))

        # compute the 2D DWT
        c = pywt.wavedec2(x, i, mode='periodization', level=level)
        # normalize each coefficient array independently for better visibility
        c[0] /= np.abs(c[0]).max()
        for detail_level in range(level):
            c[detail_level + 1] = [d/np.abs(d).max() for d in c[detail_level + 1]]
        # show the normalized coefficients
        arr, slices = pywt.coeffs_to_array(c)
        axes[1, level].imshow(arr, cmap=plt.cm.gray)
        axes[1, level].set_title('Coefficients\n({} level)'.format(level))
        axes[1, level].set_axis_off()
```

Image 0

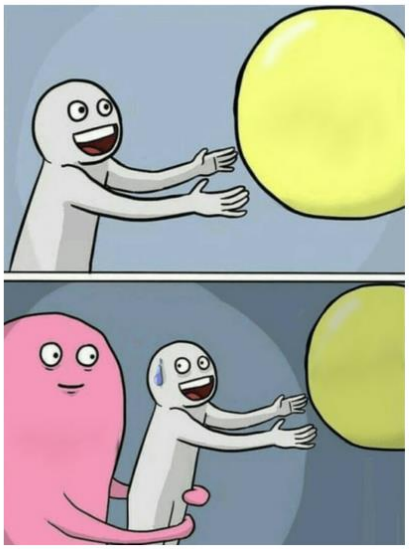
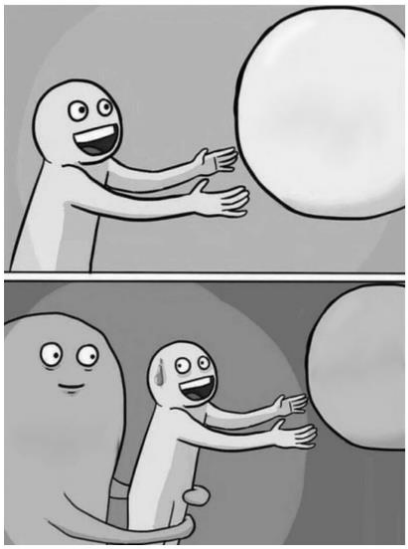
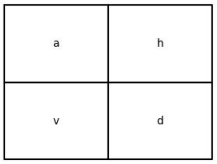


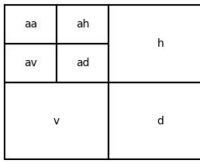
Image 1



1 level
decomposition

2 level
decomposition





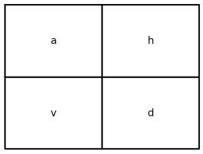
Image

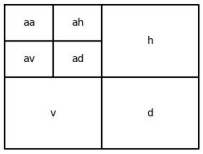
Coefficients
(1 level)

1 level
decomposition

Coefficients
(2 level)

2 level
decomposition





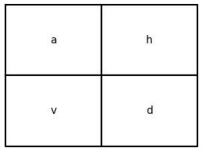
Image

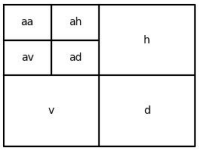
Coefficients
(1 level)

1 level
decomposition

Coefficients
(2 level)

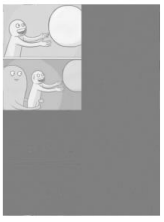
2 level
decomposition





Image

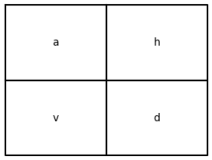
Coefficients
(1 level)

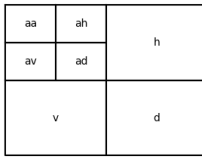


Coefficients
(2 level)

1 level
decomposition

2 level
decomposition





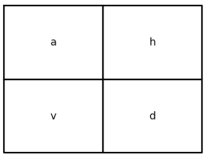
Image

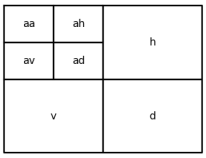
Coefficients
(1 level)

Coefficients
(2 level)

1 level
decomposition

2 level
decomposition





Image

Coefficients
(1 level)

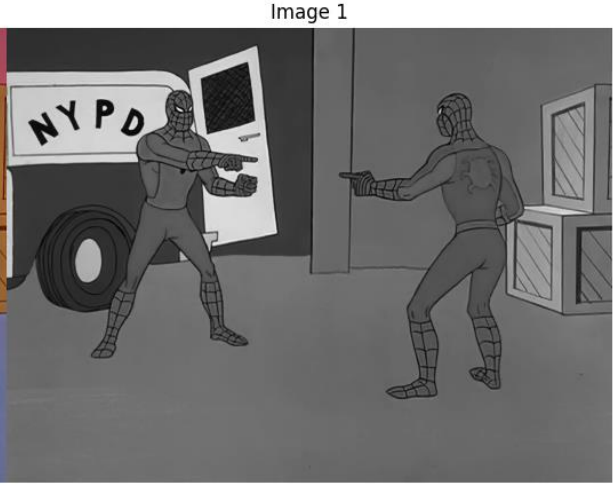
Coefficients
(2 level)

```python
def my_func(img, wavelet, de_level):
    image_color = imread("Sample05/" + img)
    image_gray = cv2.cvtColor(image_color, cv2.COLOR_RGB2GRAY)
    ShowImage([image_color, image_gray], 1, 2)

    titles = ['Approximation', ' Horizontal detail',
          'Vertical detail', 'Diagonal detail']
    coeffs2 = dwt2(image_gray, wavelet)
    LL, (LH, HL, HH) = coeffs2

    cmapList = [cm.gray, cm.jet, cm.rainbow, cm.viridis, cm.cubehelix, cm.RdBu]
    fig = plt.figure(figsize=(20,10))
    for i, a in enumerate([LL, LH, HL, HH]):
        ax = fig.add_subplot(2, 2, i + 1)
        ax.imshow(a, interpolation="nearest", cmap=cmapList[5])
        ax.set_title(titles[i], fontsize=10)
        ax.set_xticks([])
        ax.set_yticks([])

    fig.tight_layout()
    plt.show()
    x = image_gray.astype(np.float32)
    shape = x.shape

    max_lev = de_level       # how many levels of decomposition to draw
    label_levels = de_level  # how many levels to explicitly label on the plots

    fig, axes = plt.subplots(2, max_lev + 1, figsize=[14, 8])
    for level in range(0, max_lev + 1):
        if level == 0:
            # show the original image before decomposition
            axes[0, 0].set_axis_off()
            axes[1, 0].imshow(x, cmap=plt.cm.gray)
            axes[1, 0].set_title('Image')
            axes[1, 0].set_axis_off()
            continue

        # plot subband boundaries of a standard DWT basis
        draw_2d_wp_basis(shape, wavedec2_keys(level), ax=axes[0, level],
                         label_levels=label_levels)
        axes[0, level].set_title('{} level\ndecomposition'.format(level))

        # compute the 2D DWT
        c = pywt.wavedec2(x, wavelet, mode='periodization', level=level)
        # normalize each coefficient array independently for better visibility
        c[0] /= np.abs(c[0]).max()
        for detail_level in range(level):
            c[detail_level + 1] = [d/np.abs(d).max() for d in c[detail_level + 1]]
        # show the normalized coefficients
        arr, slices = pywt.coeffs_to_array(c)
        axes[1, level].imshow(arr, cmap=plt.cm.gray)
        axes[1, level].set_title('Coefficients\n({} level)'.format(level))
        axes[1, level].set_axis_off()

    plt.tight_layout()
    plt.show()
```

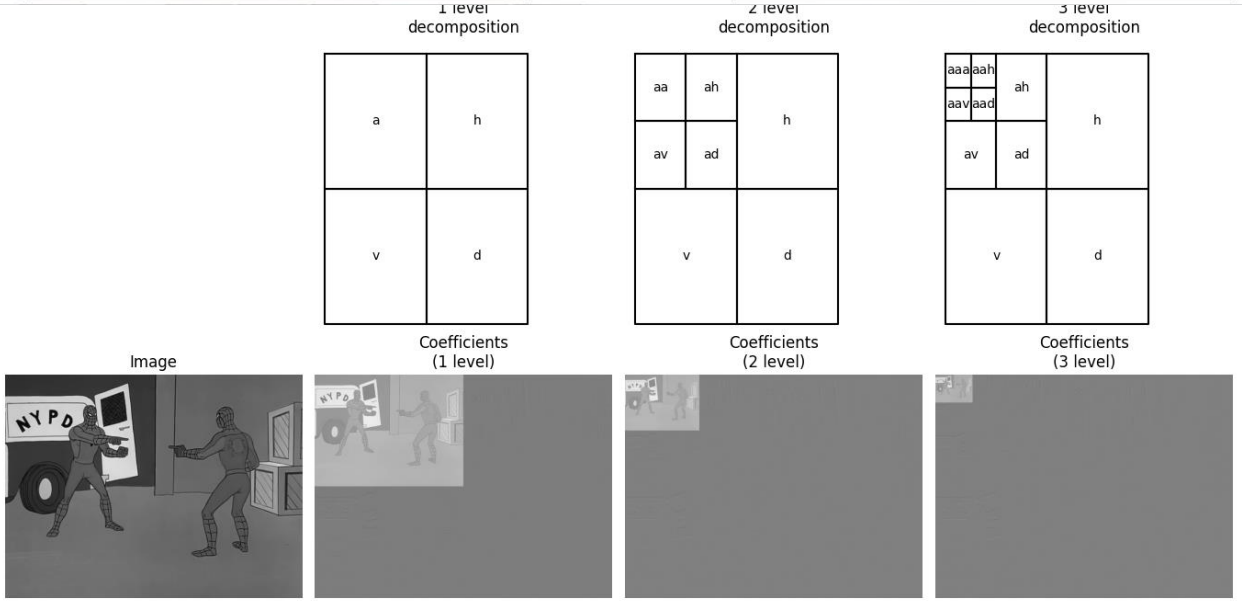
```
183     my_func("spider.jpg", "bior1.3", 3)
```

Image 0

Image 1




Approximation
Horizontal detail
Vertical detail
Diagonal detail
NYPD


1 level
decomposition
2 level
decomposition
3 level
decomposition
a
h
v
d
aa
ah
av
ad
aaa
aah
aav
aad
Image
Coefficients
(1 level)
Coefficients
(2 level)
Coefficients
(3 level)
NYPD