rpn2_mp2_part2_code

March 5, 2019

1 Common imports

In [1]:
```
%matplotlib inline
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
from PIL import Image
import copy
from scipy import ndimage
from matplotlib.patches import Circle
import math
from skimage.transform import resize
import time
```

2 Provided functions

2.0.1 Image loading and saving

In [2]:
```
def LoadInputImage(subject_name):

    ''' Read and convert the image to grayscale'''
    fname = subject_name+".jpg"
    im = Image.open(fname, 'r')
    img = im.convert('L')
    input_im =  (np.asarray(img)/255)
    print(input_im.shape, np.amin(input_im), np.amax(input_im))
    return input_im.astype(float)
```

In [3]:
```
def plot_image(subject_image, title):
    fig = plt.figure()
    plt.imshow(subject_image*255, cmap='gray')
    #plt.axis('off')
    plt.title(title)
```

2.1 Scale-space generation filters

```
In [4]: def upsize_filter(input_image, initial_sigma = 2, levels = 15, scale_factor = 1.189):
            ''' LoG filter and return squared scale normalized values in scale-space 3D array'
            scale_space = np.empty((input_image.shape[0],input_image.shape[1],levels))
            sigma = initial_sigma
            for i in range(levels):
                scale_space[:,:,i] =  (ndimage.filters.gaussian_laplace(input_image, sigma = si
                #plot_one_image(scale_space[:,:,i], subject_name + "_" + str(sigma))
                sigma = sigma * scale_factor
            return scale_space
```

```
In [5]: def downsample_image(input_image, sigma = 2 , levels = 15, scale_factor = 1.189):
            ''' Downsample the image and upsample the result.
                no scale normalization needed, resize and square the response'''
            scale_space = np.empty((input_image.shape[0],input_image.shape[1],levels))

            for i in range(levels):

                resized_x = round(input_image.shape[0] / (scale_factor ** i))
                resized_y = round(input_image.shape[1] / (scale_factor ** i))
                resized_image = resize(input_image, (resized_x,resized_y ), anti_aliasing=True
                log_image = ndimage.filters.gaussian_laplace(resized_image, sigma = sigma)
                #print(log_image.shape, np.amin(log_image), np.amax(log_image))
                scale_space[:,:,i] = resize(log_image, (input_image.shape[0],input_image.shape

            return scale_space
```

```
In [6]: def non_maximum_suppression(scale_space, kernel_2d_size = 3):

            ''' 3D non-maximum suppression in 2 stages'''
            image_max_filter = np.empty((input_image.shape[0],input_image.shape[1],levels))


            #2D suppression
            for i in range(levels):
                image_max_filter[:,:,i] = ndimage.maximum_filter(scale_space[:,:,i], size = (ke

            #3D folow-up

            for i in range(1, levels - 1):
                image_max_filter[:,:,i] = np.maximum(image_max_filter[:,:,i-1], image_max_filte
                image_max_filter[:,:,i] = np.maximum(image_max_filter[:,:,i+1], image_max_filte
```

```
        #Special case for first and  last levels
        image_max_filter[:,:,0] = np.maximum(image_max_filter[:,:,0],image_max_filter[:,:,
        image_max_filter[:,:,levels-1] = np.maximum(image_max_filter[:,:,levels-1],image_ma

        #Create image mask and return NMS image
        image_mask = (scale_space == image_max_filter)
        masked_output_image = np.multiply(image_max_filter, image_mask)

        return masked_output_image
```

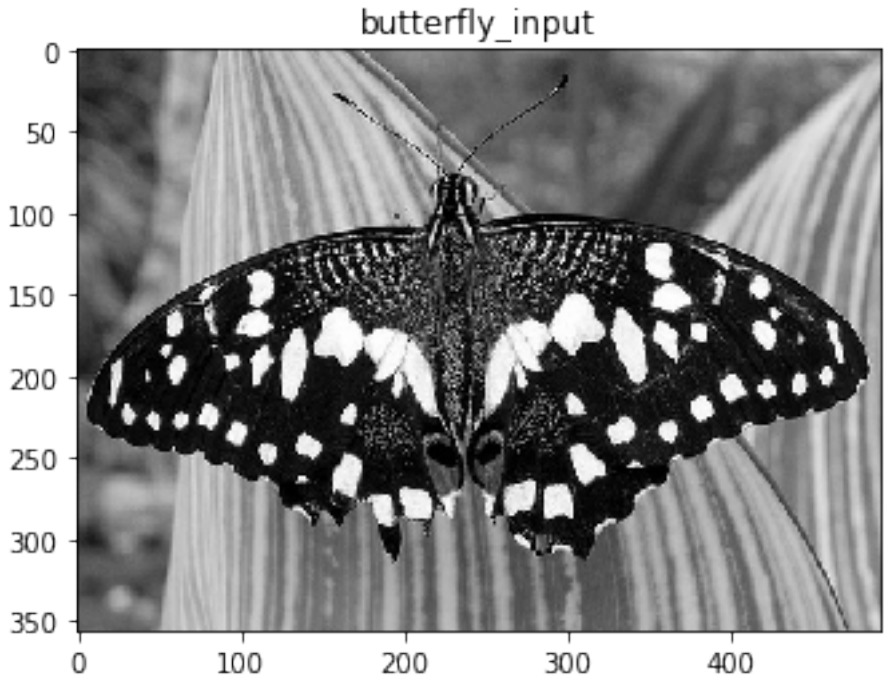
In [7]:
```
def show_all_circles(image, cx, cy, rad, color='r'):
    """
    image: numpy array, representing the grayscsale image
    cx, cy: numpy arrays or lists, centers of the detected blobs
    rad: numpy array or list, radius of the detected blobs
    """


    fig, ax = plt.subplots()
    ax.set_aspect('equal')
    ax.imshow(image, cmap='gray')
    for x, y, r in zip(cx, cy, rad):
        circ = Circle((x, y), r, color=color, fill=False)
        ax.add_patch(circ)

    plt.title('%i circles' % len(cx))
    plt.show()
```

In [8]:
```
def generate_circles(masked_output_image, sigma, scale_factor, threshold = 0.009):
    ''' Function to generate circle centres and radii from NMS image using threshold''


    cx_list = []
    cy_list = []
    rad_list = []
    #print("Number of circles, sigma, radius")
    for i in range(levels):
        cx, cy = np.where(masked_output_image[:,:,i] > threshold)
        rad = sigma * math.sqrt(2)
        cx_list.extend(cx)
        cy_list.extend(cy)
        rad_list.extend([rad]*len(cx))
        #print(len(cx), sigma, rad)
        sigma = sigma * scale_factor
    return cx_list, cy_list, rad_list
```

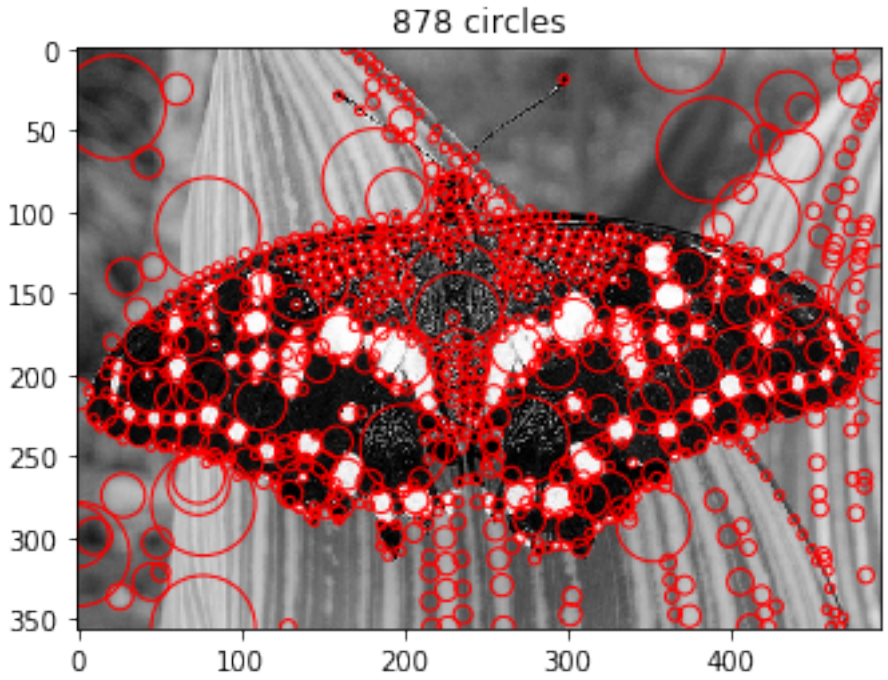
2.2 Main function

In [9]:
```
#(Image_name, initial_sigma, levels, scale, kernel_size, threshold_upsize, threshold_d
#Butterly image, 2, 15, 1.189, 5,0.013, 0.001
#einstein, 2,15,1.273,7,0.003,0.0002
#fishes, 2,13,1.257,5,0.005,0.0004
#sunflower, 2, 15, 1.189, 0.01, 0.007
#small_ball 2,15,1.21,5,0.005,0.0008
#tulips 2,15,1.189,5,0.005,0.0003
# horses 2,15,1.189,7,0.001, 0.00007
# zebra 2,15,1.189,5,0.02, 0.0015

subject_name = 'butterfly'
initial_sigma = 2
levels = 15
scale_factor = 1.189
kernel_2d_size = 5  # Window size for 2D non-maximum suppression
input_image = LoadInputImage(subject_name)
plot_image(input_image, subject_name+"_input")
threshold_upfilter = 0.013
threshold_downimage = 0.001
```

```
(356, 493) 0.0 1.0
```



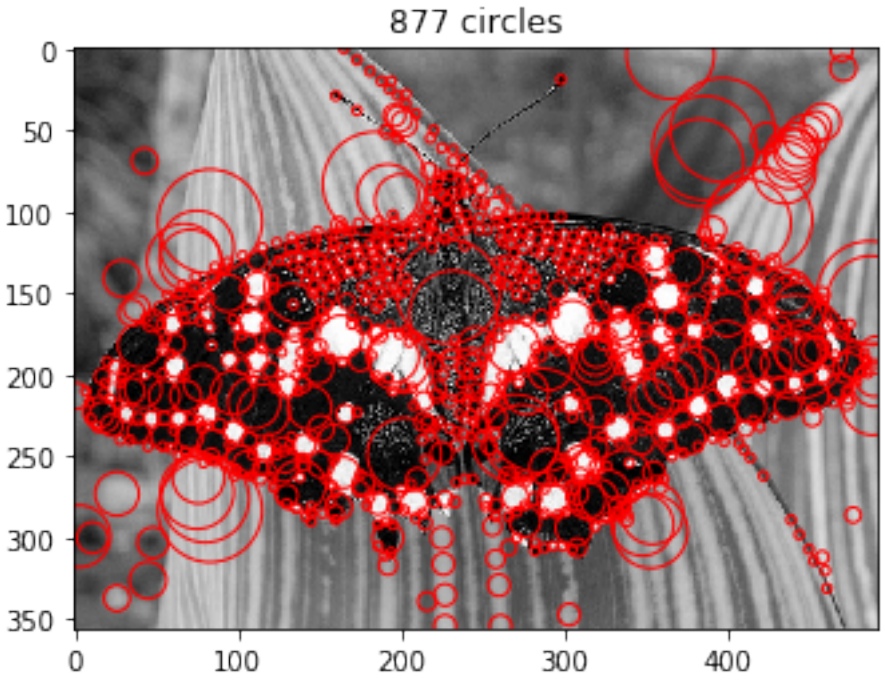
In [10]:
```
#Method 1
#Average 10 times to get runtime
total_time = 0
#Change the range to 10 for time calculation part only
for i in range(1):
    start = time.process_time()
    scale_space = upsize_filter(input_image, initial_sigma, levels, scale_factor)
    masked_image = non_maximum_suppression(scale_space, kernel_2d_size)
    cx_list, cy_list, rad_list = generate_circles(masked_image, initial_sigma,scale_fa
    show_all_circles(input_image, cy_list, cx_list, rad_list, color='r')
    total_time = total_time + time.process_time() - start

print(" Upsize filter execution time ", total_time/10)
```




```
 Upsize filter execution time  0.3150938
```

In [11]:
```
##### Method2 : Downsample image
#Average run-time 10 times to get runtime
total_time = 0
#Change the range to 10 for time calculation part only
for i in range(1):
    start = time.process_time()
    scale_space = downsample_image(input_image, initial_sigma, levels, scale_factor)
    masked_image = non_maximum_suppression(scale_space, kernel_2d_size)
```

```
        cx_list, cy_list, rad_list = generate_circles(masked_image, initial_sigma,scale_fa
        show_all_circles(input_image, cy_list, cx_list, rad_list, color='r')
        total_time = total_time + time.process_time() - start
    print(" Average Downsample image execution time ", total_time/10)
```




```
Average Downsample image execution time  0.21448099999999987
```