Blur Filter

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1 Blurring Filter

Using weighted average of surrounding images to blur image. The blur filter changes the amount of blurring: use a larger filter for more blurring.

1. Create a filter (larger is more blurring)
2. Iterate through the three colors channels
3. For each channel, iterate through the rows and columns of the image
4. At each step, element-wise multiply the filter times the patch
5. Take the weighted average of the patch and assign the pixel value to all pixels in the patch
6. Normalize the multiplication results and convert to integers between 0 and 255
7. Visualize Images
8. Try different filters to adjust the level of blurring

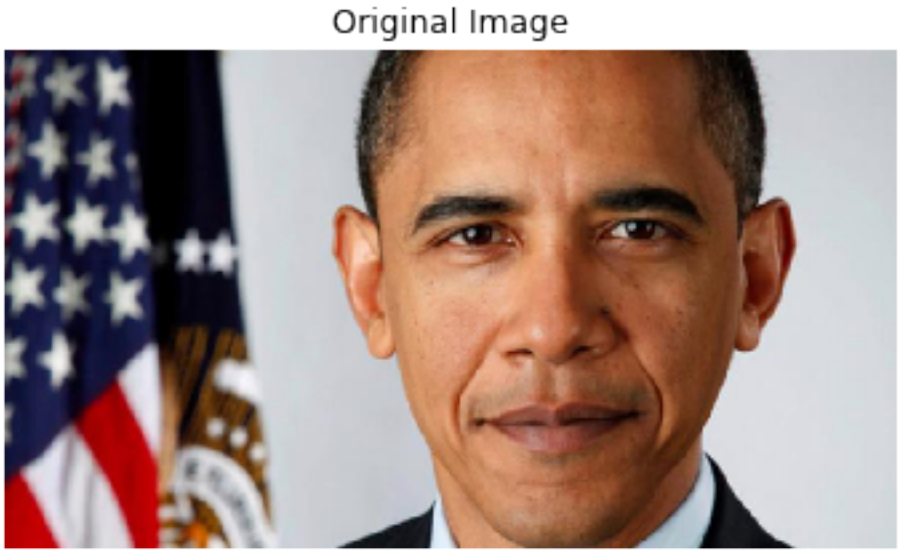
In [1]:
```
# numpy for arrays
import numpy as np

# matplotlib for plotting images
import matplotlib.pyplot as plt
from matplotlib.image import imread

# PIL for loading images
from PIL import Image
```

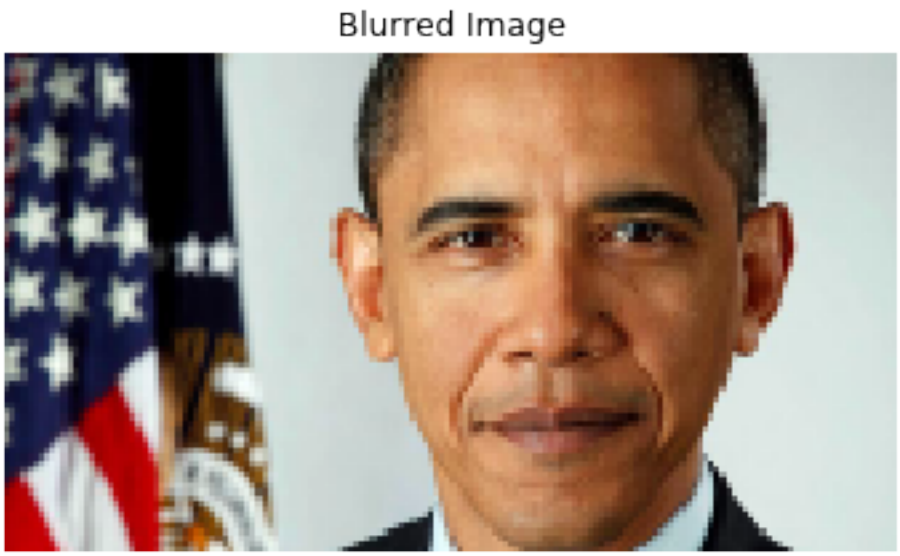
In [2]:
```
def apply_blur_filter(blur_filter, image_path):

    # Load in the image
    image = Image.open(image_path)

    # Crop to correct size
    image = image.crop(box=(0, 0, int(image.size[0] / blur_filter.shape[0]) * blur_filte
                                   int(image.size[1] / blur_filter.shape[1]) * blur_filte

    im_array = np.array(image)

    # Horizontal and vertical moves, using a stride of filter shape
    h_moves = int(im_array.shape[1] / blur_filter.shape[1])
    v_moves = int(im_array.shape[0] / blur_filter.shape[0])
```

```
new_image = np.zeros(shape = im_array.shape)

k = np.sum(blur_filter)

# Iterate through 3 color channels
for i in range(im_array.shape[2]):
    # Extract the layer and create a new layer to fill in
    layer = im_array[:, :, i]
    new_layer = np.zeros(shape = layer.shape, dtype='uint8')

    # Left and right bounds are determined by columns
    l_border = 0
    r_border = blur_filter.shape[1]


    # Iterate through the number of horizontal and vertical moves
    for h in range(h_moves):
        # Top and bottom bounds are determined by rows
        b_border = 0
        t_border = blur_filter.shape[0]
        for v in range(v_moves):
            patch = layer[b_border:t_border, l_border:r_border]

            # Take the element-wise product of the patch and the filter
            product = np.multiply(patch, blur_filter)

            # Find the weighted average of the patch
            product = np.sum(product) / k
            new_layer[b_border:t_border, l_border:r_border] = product

            b_border = t_border
            t_border = t_border + blur_filter.shape[0]

        l_border = r_border
        r_border = r_border + blur_filter.shape[1]


    new_image[:, :, i] = 255 * ( (new_layer - np.min(new_layer)) / (np.max(new_layer


# Convert to correct type for plotting
new_image = new_image.astype('uint8')

plt.imshow(image); plt.title('Original Image'); plt.axis('off')
plt.show()

plt.imshow(new_image); plt.title('Blurred Image'); plt.axis('off')
```

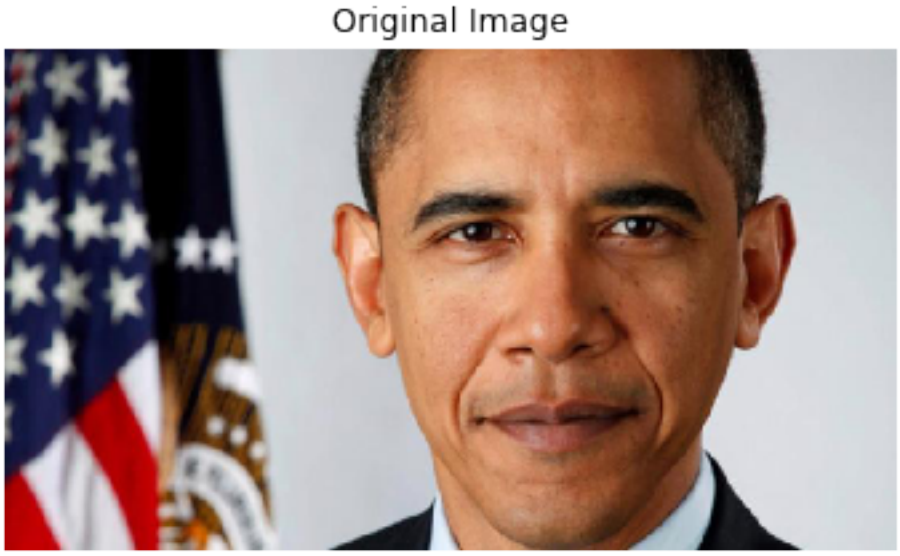
```
            plt.show()

            return new_image
```

```
In [3]: blur_filter = np.array([[1, 4, 6, 4, 1],
                                [2, 8, 12, 8, 2],
                                [6, 24, 36, 24, 6],
                                [2, 8, 12, 8, 2],
                                [1, 4, 6, 4, 1]])

        blurred_image = apply_blur_filter(blur_filter, 'images/president-barack-obama.jpg')
```





In [4]:
```
blur_filter = np.array([[1, 2, 1],
                        [2, 4, 2],
                        [1, 2, 1]])

blurred_image = apply_blur_filter(blur_filter, 'images/president-barack-obama.jpg')
```



Blurred Image

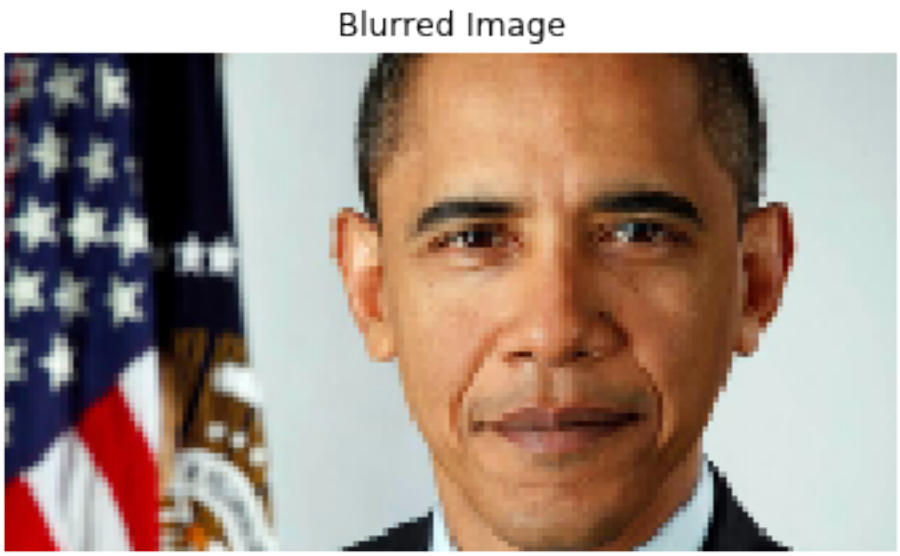
```
In [5]: blur_filter = np.array([[1, 2, 4, 8, 4, 2, 1],
                                [2, 4, 16, 32, 16, 4, 2],
                                [4, 16, 32, 64, 32, 16, 4],
                                [2, 4, 16, 32, 16, 4, 2],
                                [1, 2, 4, 8, 4, 2, 1]])

        blurred_image = apply_blur_filter(blur_filter, 'images/president-barack-obama.jpg')
```

Original Image

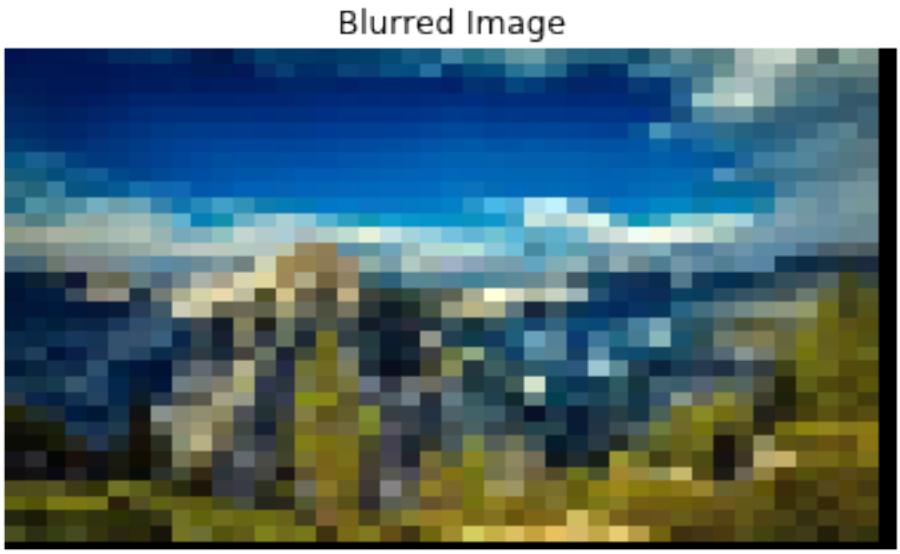
Blurred Image

In [6]:
```
blur_filter = np.array([[0, 0, 0, 0, 0],
                        [0, 0, 0, 0, 0],
                        [16, 32, 64, 32, 16],
                        [0, 0, 0, 0, 0],
                        [0, 0, 0, 0, 0]])

blurred_image = apply_blur_filter(blur_filter, 'images/president-barack-obama.jpg')
```

Original Image



In [7]:
```
blur_filter = np.array([[1, 2, 4, 8, 4, 2, 1],
                        [2, 4, 16, 32, 16, 4, 2],
                        [4, 16, 32, 64, 32, 16, 4],
                        [2, 4, 16, 32, 16, 4, 2],
                        [1, 2, 4, 8, 4, 2, 1]])

blurred_image = apply_blur_filter(blur_filter, 'images/mountains.jpg')
```




```
In [8]: blur_filter = np.array([[1, 2, 1],
                                [2, 4, 2],
                                [1, 2, 1]])

        blurred_image = apply_blur_filter(blur_filter, 'images/mountains.jpg')
```

Blurred Image