# ECE 148 Homework 3

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## Problem 1: Moving Average Filter

The moving average filter is defined as:

$$\boldsymbol{H} = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

The smoothed image obtained by applying this filter is shown below:

Figure 1: Smoothed Image using Moving Average Filter

# Problem 2: Smoothing Effect with Different Weights

Composite images illustrating the smoothing effect with different weights are shown below:

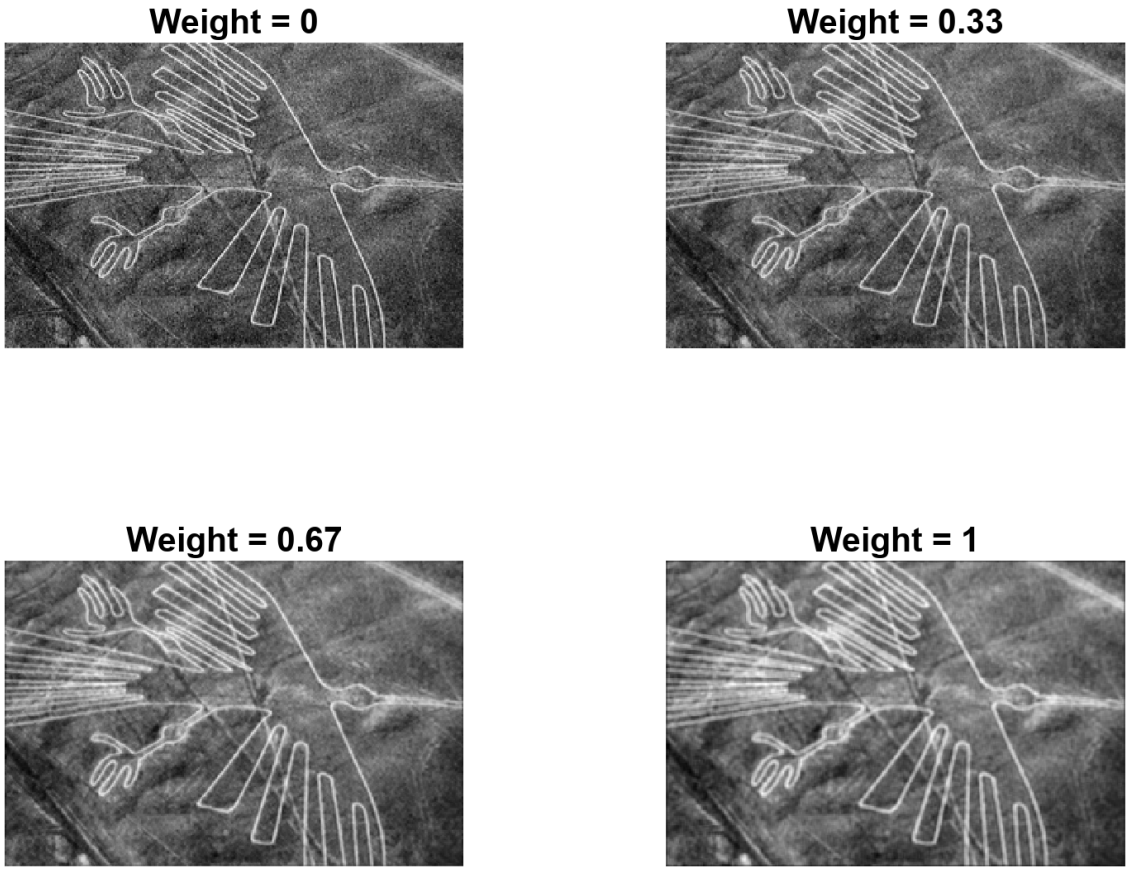


Figure 2: Composite Images with Smoothing Effect

# Problem 3: Gradient Filter for Edge Detection

The gradient filters for horizontal and vertical edge detection are defined as:

$$\boldsymbol{H_x} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, \quad \boldsymbol{H_y} = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

The combined gradient filter is:

$$\boldsymbol{H_{combined}} = \begin{bmatrix} -1+j & 2j & 1+j \\ -2 & 0 & 2 \\ -1-j & -2j & 1-j \end{bmatrix}$$

The edge profiles obtained using these filters are shown below:

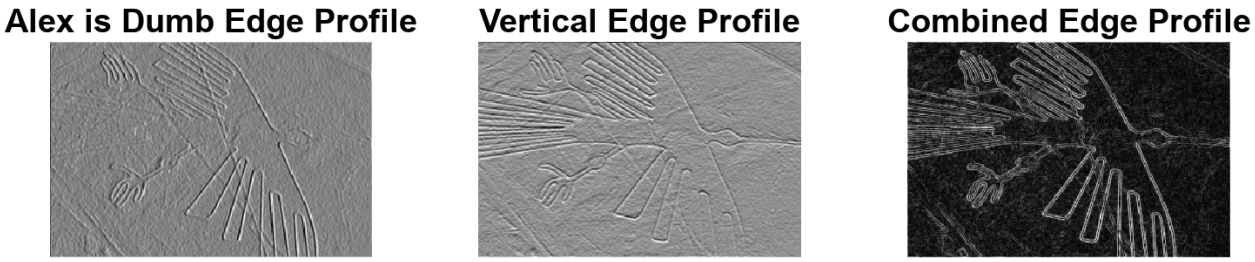


Figure 3: Edge Profiles: Horizontal, Vertical, and Combined

# Problem 4: Composite Images with Edge Detection

Composite images illustrating the edge-detection effect are shown below:

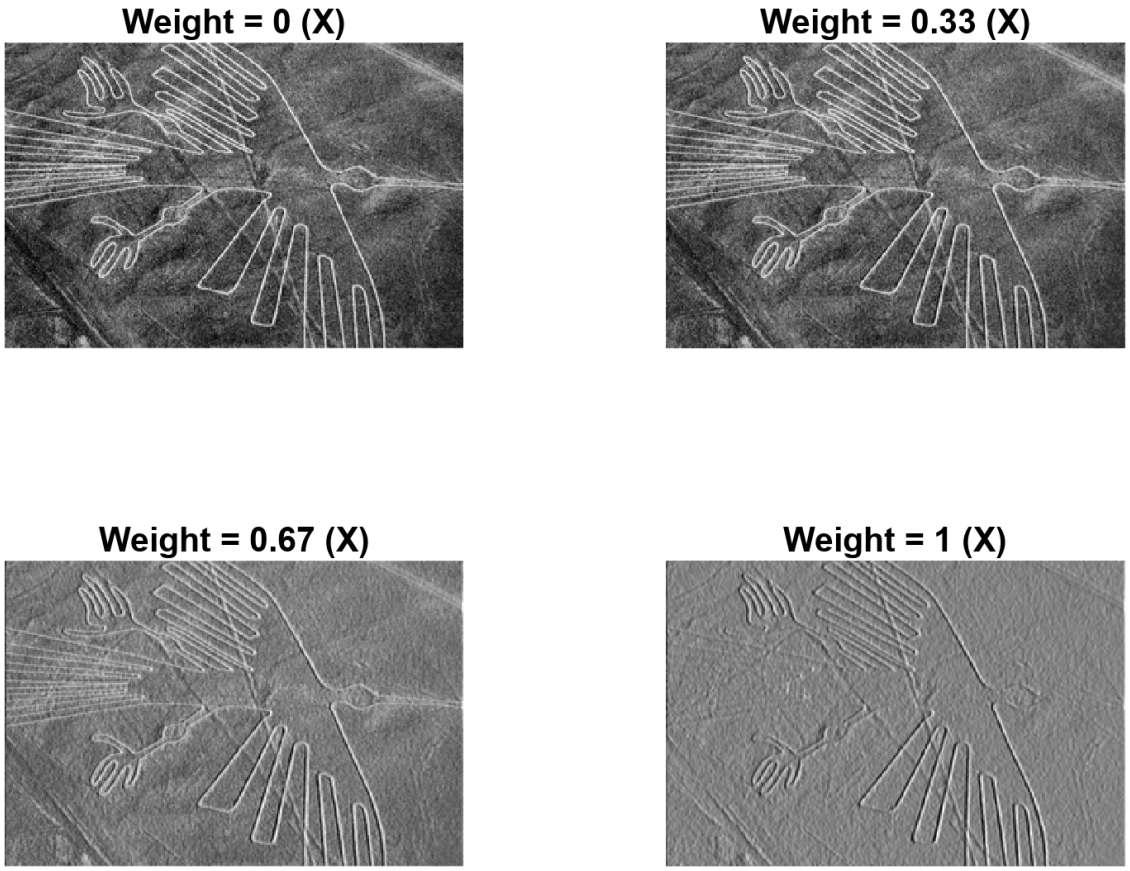


Figure 4: Composite Images with Horizontal Edge Detection

*Continued below.*

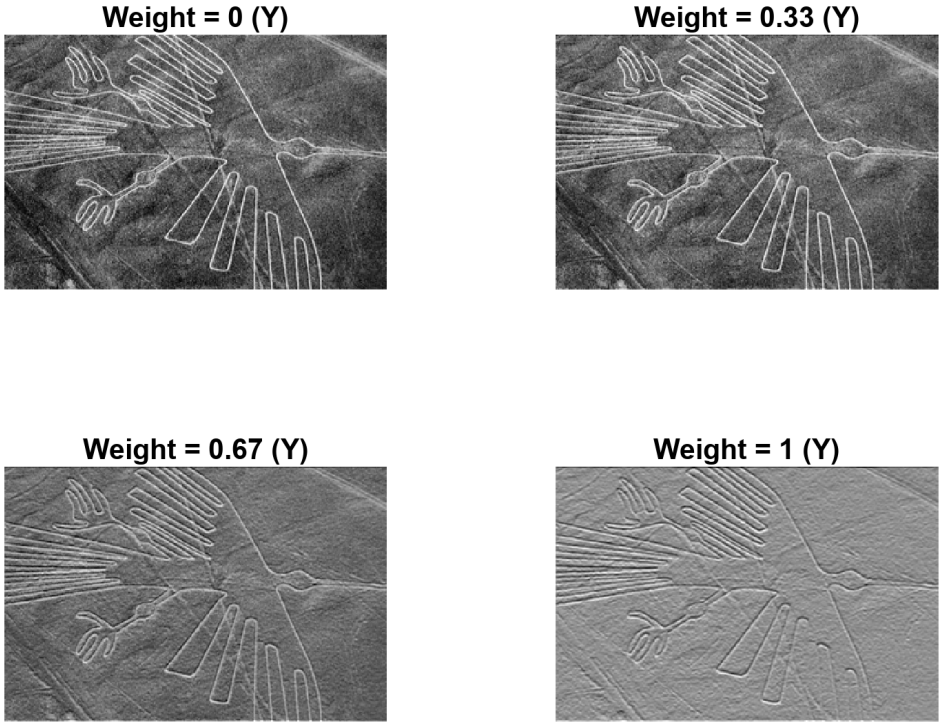


Figure 5: Composite Images with Vertical Edge Detection

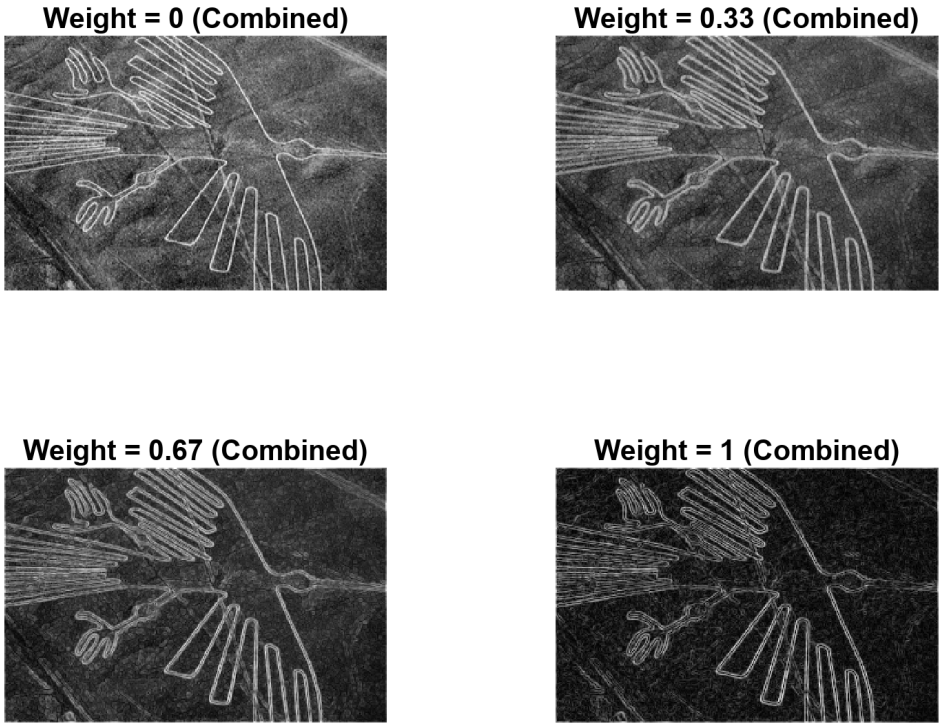


Figure 6: Composite Images with Combined Edge Detection

# Problem 5: Laplacian Filter for Peak Detection

The Laplacian filter is defined as:

$$\boldsymbol{H} = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

The image obtained by applying the Laplacian filter for peak detection is shown below:

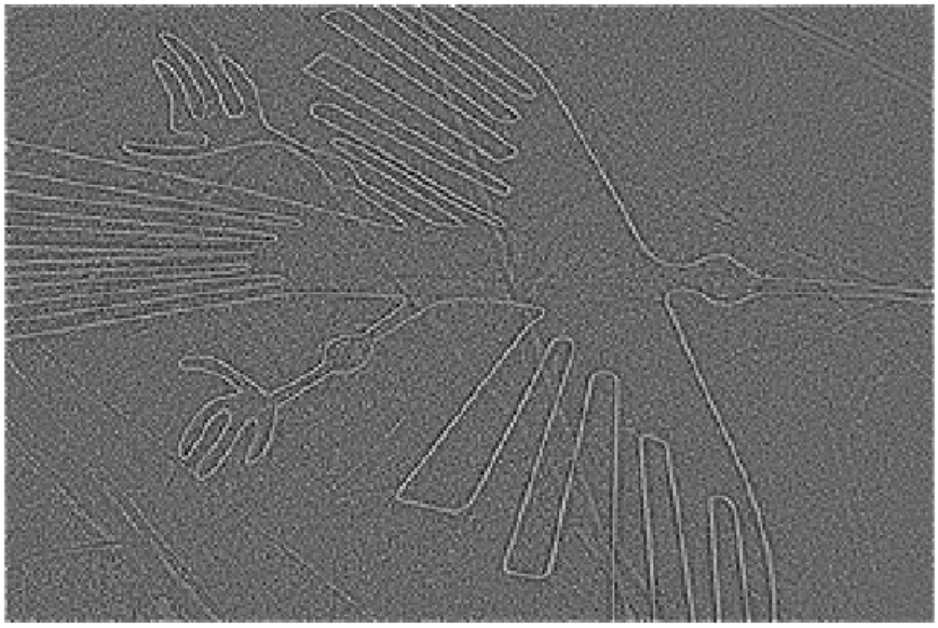

Figure 7: Laplacian Filtered Image for Peak Detection

# Problem 6: Composite Images with Peak Detection

Composite images illustrating the peak-detection effect are shown below:

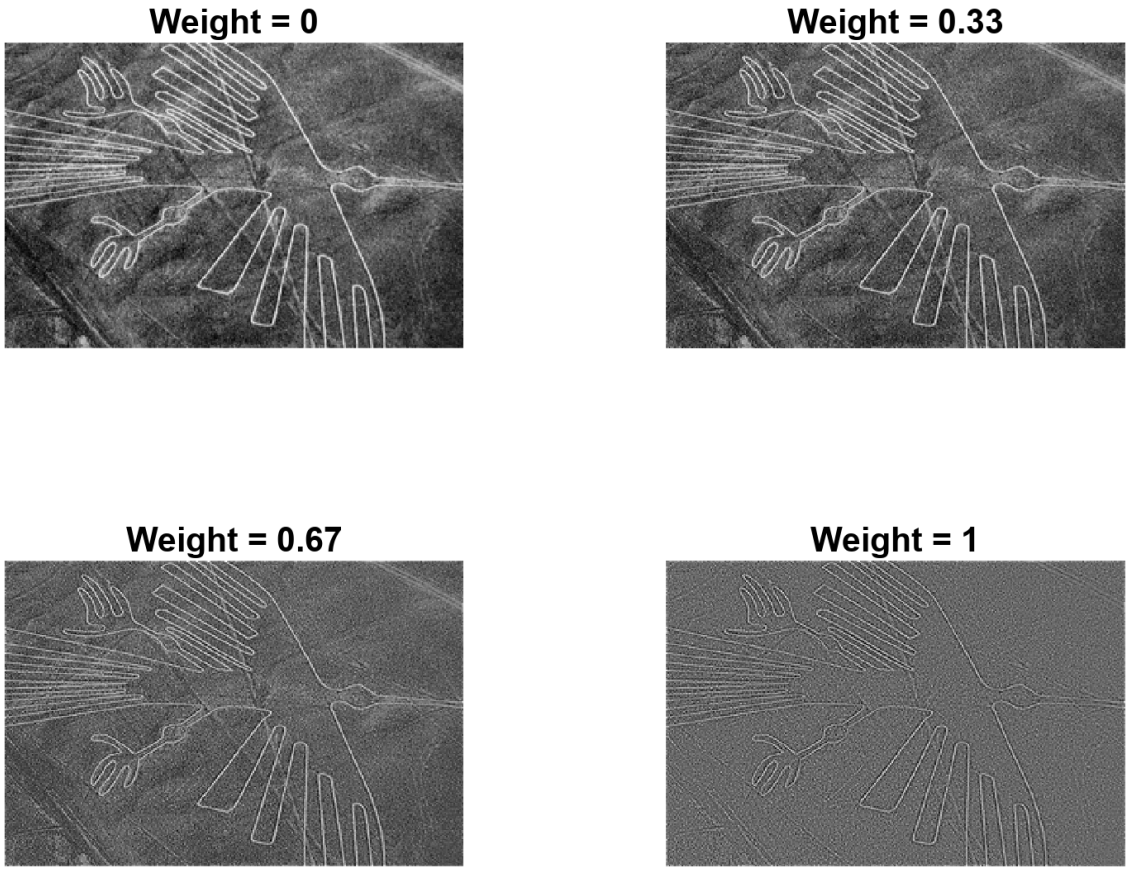


Figure 8: Composite Images with Peak Detection Effect

# Summary

- The moving average filter effectively smooths the image, as shown in the smoothed image and composite results.
- A larger kernel filter would likely produce a more pronounced smoothing effect.
- The gradient filters successfully detect edges in horizontal, vertical, and combined directions, with clear edge profiles.
- The composite images demonstrate the edge-detection effect, with distinct edges highlighted.
- The combined gradient filter captures both horizontal and vertical edges, enhancing the edge-detection effect.
- This is especially apparent when you zoom in; one can perceive two distinct lines around the bird shape.
- The Laplacian filter highlights peaks in the image, and the composite images demonstrate the peak-detection effect.
- Interstingly, the Laplacian filter does not produce the contrast of the combined gradient filter, but it does produce a more pronounced peak-detection effect.
- There is no "two line" effect from the Laplacian filter; it's geared to bicked up the center of the lines.