Exercises on Image Smoothing - Noise Removal

1. Draw the following sequence, *f[n1, n2]*, computer and draw the result of applying different 3x3 filters to f. Comment on your results. [Hint: embed f with zeros]

    a. Low Pass Filter =(1/9)[(1,1,1),(1,1,1),(1,1,1)]

    b. High Pass Filter =[(1,1,1),(1,-8,1),(1,1,1)]

    c. Median Filter

Image 1

1	2	50
2	2	70
5	6	80

Image 2

1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	50	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1

2. Erosion is one of the basic operators in the area of mathematical morphology. It is typically applied to binary images. The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels (i.e. white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger. The erosion operator takes two pieces of data as inputs. The first is the image, *f*, which is to be eroded. The second is a structuring element, *h*. It is this structuring element that determines the precise effect of the erosion on the input image.

To compute the erosion of a binary input image by this structuring element, we consider each of the foreground pixels in the input image in turn. For each foreground pixel (which we will call the input pixel) we superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel coordinates. If for every pixel in the structuring element, the corresponding pixel in the image underneath is a foreground pixel, then the input pixel is left as it is. If any of the corresponding pixels in the image are background, however, the input pixel is also set to background value.
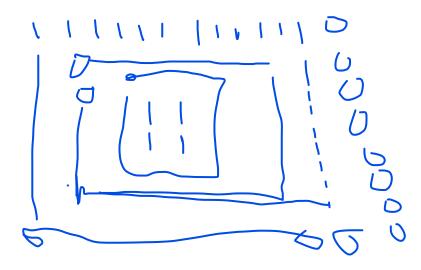
Consider the following structuring elements; show the effect of using them to erode the image, *f*, shown in problem 1. Comment on your results.

a. *h* = [(1,1),(1,1)], origin in upper left corner
b. *h* = [(1,1,1),(1,1,1),(1,1,1)], origin in the middle

3. Repeat problem 1 and 2 using the following image, *f*. Comment on your results.

1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	1	1	1	0	0	1	1
1	1	0	0	1	1	1	0	0	1	1
1	1	0	0	1	1	1	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	0	0	0	1	1
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1

$$a \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$