

1. Spatially filter (convolve) the image on the left with the 3 x 3 mask (kernel) shown. State the assumptions you make for the pixels outside the source image.

Assume all pixels outside the image are 0. Output image:

```
0  1  2  1  0
1  6 10  6  1
2 12 20 12  2
1 10 18 10  1
0  3  6  3  0
```

2. What is the result of mean filtering (averaging pixels with their 8-connected neighbors) for the following image?

Round to nearest whole number. Assume all pixels outside the image are 0.
Output image:

```
4  6 10 13 11
16 19 25 20 17
16 20 25 20 16
17 20 24 19 16
5  7 10 13 10
```

3. What is the result of median filtering (using 8-connected neighbors) for the following image?

Round to nearest whole number. Assume all pixels outside the image are 0.
Output image:

```
0  9  9  9  0
9  9 11 24 24
9 10 12 23 23
10 11 12 22 22
0 10 11 12  0
```

4. What is the result of unsharp masking using an $A = 1$ (a 5 in the center) mask?

```
31 26 0 68 57
11 14 -9 44 67
18 1 -8 37 51
25 13 8 35 37
28 25 0 53 81
```

5. This question walks through the computational steps for gradient-magnitude edge detection for the following image: (For this question, don't worry about the border pixels.)

(a) What is the result of applying the x-derivative Sobel filter? (Remember to divide by 8.)

(b) What is the result of applying the y-derivative Sobel filter? (Remember to divide by 8.)

(c) What is the gradient magnitude at each pixel?

Part A: x-derivative Sobel filter

0.1	7.8	8.4
0.2	7.5	7.6
0.1	6.4	6.5

Part B: y-derivative Sobel filter

-0.9	-0.5	0.1
1.0	0.5	-1.1
0.9	0.1	-0.5

Part C: Sum of x and y

0.9	7.8	8.4
1.0	7.5	7.7
0.9	6.4	6.5