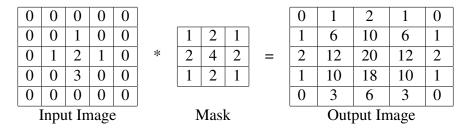
CS 355 Homework #6: Simple Image Processing Operations

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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.

ANSWER: Here is the answer assuming 0 padding. If you made other assumptions for the border pixels, the center 3×3 area should still be the same.



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

ANSWER: Here is the answer again assuming 0 padding. If you made other assumptions for the border pixels, the center 3×3 area should still be the same.

10	11	9	25	22
8	10	9	26	28
9	99	9	24	25
11	11	12	23	22
10	11	9	22	25

Input 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

Output Image

3. What is the result of median filtering (using 8-connected neighbors) for the following image? **ANSWER:** Here is the answer again assuming 0 padding. If you made other assumptions for the border pixels, the center 3×3 area should still be the same.

10	11	9	25	22
8	10	9	26	28
9	99	9	24	25
11	11	12	23	22
10	11	9	22	25

Input 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

Output Image

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

ANSWER: Here is the answer again assuming 0 padding. If you made other assumptions for the border pixels, the center 3×3 area should still be the same. This is without clipping negative values. If you clip these values (as you should for unsigned pixel types), the two negative values should be 0.

10	11	9	25	22
8	10	9	26	28
9	8	9	24	25
11	11	12	23	22
10	11	9	22	25

Input Image

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

Output Image

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.)

10	11	9	25	22
8	10	9	26	28
9	8	9	24	25
11	11	12	23	22
10	11	9	22	25

Input Image

ANSWER: For the following answers, I've shown the values to one decimal place. If you've rounded to integers, that's OK. The y derivatives might be negated depending on which way you have as the positive y direction, but that doesn't change the gradient magnitude once you square these values.

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

X	X	X	X	X
X	0.1	7.8	8.4	X
X	0.3	7.5	7.6	X
X	0.1	6.4	6.5	X
X	X	X	X	X

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

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

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

X	X	X	X	X
X	0.9	7.8	8.4	X
X	1.0	7.5	7.7	X
X	0.9	6.4	6.5	X
X	X	X	X	X