

IERG 4160 Image and Video Processing

Homework Assignment2

Due on Dec. 17th 2019

Question 1

Given the following three image filters, please answer the questions below.

$$A = \begin{bmatrix} 1 & 4 & 7 & 4 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 7 & 26 & 41 & 26 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 1 & 4 & 7 & 4 & 7 \end{bmatrix} \quad (1)$$

$$B = \frac{1}{16} \begin{bmatrix} -1 & -2 & -1 \\ -2 & 12 & -2 \\ -1 & -2 & -1 \end{bmatrix} \quad (2)$$

$$C = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \quad (3)$$

(a) Given an image below. Please compute the output value corresponding to the highlighted location when applying the image filter B and the image filter C respectively.

A 6x6 grid of numbers. The grid is labeled with 'x' and 'y' axes. The cell containing '60' at row 2, column 3 is highlighted with a thick black border.

10	10	60	20	13	46
10	10	60	10	16	63
30	10	60	20	83	18
93	88	60	13	26	35
28	21	71	24	3	14
50	31	83	96	41	28

(b) Given two images, the left is the original image and the right one is the result image after some filtering operation. Which of the above filters is the most possible one used to filter the original image, A , B , or C ?



Question 2

Deep networks are also utilized in the task of object detection. Please elaborate **the difference** between the following classical deep frameworks for object detection:

- (a) R-CNN
- (b) Fast R-CNN
- (c) Faster R-CNN

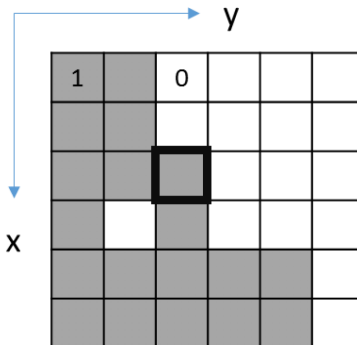
Question 3

Convolutional neural networks (CNN) are widely used for processing images nowadays. Given an input image I of size 96×96 pixels, answer the following questions:

- (a) What is the computational complexity (i.e. times of multiplications) of convolving this image with 400 kernels/filters of size 7×7 pixels?
- (b) What is the size of the result image R by convolving the original image with a 7×7 kernel (no padding, stride=1)?
- (c) What is the size of the output by applying 9×9 Max-pooling operation on the convolved result R calculated in the above question (b)?

Question 4

Given an image below, where all the shaded pixels have value 1, and non-shaded pixels have value 0. please answer the following questions.



- (a) Write down the corresponding image filter (in matrix form) for the following operations:

$$\frac{\partial f}{\partial x} = f(x+1, y-1) + 2f(x+1, y) + f(x+1, y+1) - [f(x-1, y-1) + 2f(x-1, y) + f(x-1, y+1)]$$

$$\frac{\partial f}{\partial y} = f(x-1, y+1) + 2f(x, y+1) + f(x+1, y+1) - [f(x-1, y-1) + 2f(x, y-1) + f(x+1, y-1)]$$

- (b) By using the image operator that you have just designed in (a), please compute:

- (1) the direction of gradient vector
- (2) the magnitude of gradient vector
- (3) the direction of edge for the highlighted pixel