CSE428: Image Processing

Assignment 1

Neighbourhood Processing

Question 1

Consider an input image with pixel intensities given in the following table:

6	2	1	9
2	0	2	4
1	9	9	5
2	0	1	2

You are given the following 3 × 3 gaussian kernel:

$$\frac{1}{16} \times \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

a. Determine minimum padding width so that after convolution (stride = 1) with the above kernel, the height and width of the output image remains the same as the input image. **[2 marks]**

b. Consider that there is no padding. Determine the blurred output image we will get after convolution (stride = 1) with the above kernel. Clip the pixel values where necessary. **[10 marks]**

c. Calculate the unsharp mask using the input image and the blurred image determined in **b**. [**4 marks**]

d. Determine the sharpened image you will get using unsharp masking (k=1). **[4 marks]**

Question 2

Consider the following image. Design one edge detection filter that can detect almost all the edges in this picture. *{Hint: Think about the directions of the edges}*. **[10 marks]**

Question 3

Consider the following image. Design one edge detection filter that can detect almost all the edges in this picture. *{Hint: Think about the directions of the edges}*. **[10 marks]**

CNN

Question 4

Alice is a BRACU student and she is taking **CSE428** this semester. For her final project, she is trying to implement a CNN architecture for a classification task that comprises of the following layers:

Layer	**Input Dimensions**	**Filter Size**	**#Filters** or, **#Neurons**	**Padding**	**Output Dimensions**	**#Params**
Conv1	128 * 128 * 3	7*7	8	2		
MaxPool1		2*2	—	0		
Conv2		5*5	16	2		
MaxPool2		2*2	—	0		
Conv3		3*3	32	0		
AvgPool3		4*4	—	0		
Flatten		—	—	—		
FC		—	256	—		
FC		—	128	—		
FC (Output)		—	4	—		

In the table above, *Conv-X* denotes a **Convolutional** layer, *Pool-X* denotes a **Pooling** layer and *FC* denotes a **Fully Connected** layer.

a. Determine the number of classes and the activation function used in the final layer. **[2 marks]**

b. Calculate the **input** and **output dimensions** for each of the layers. (Complete the 2nd and 6th columns of the table). **[10 marks]**

c. Calculate the **number of Parameters** for each of the layers. (Complete the last column of the table). **[8 marks]**

d. Repeat Question **b** considering a Mini-Batch size of **32** instead of individual inputs. **[5 marks]**

e. Suppose, Alice used **Batch Normalization** layers after each **Convolutional** and **Fully Connected** layer. Would it Change the total **number of trainable parameters**? If **Yes**, then, by **how much**? **[5 marks]**