BRAC University

Department of Computer Science and Engineering

Inspiring Excellence

Final Exam

Semester: **Fall 2023**

Course Code: **CSE428**

Course Title: **Image Processing**

Full Marks: **15 x 3 = 45**

Time: **1 hour 30 minutes**

Date: **19th December, 2023**

Set A

Student ID:	Name:	Section:

[Answer **all questions** of the following]

[Each question carries equal marks.]

[After the exam, *the question paper should be turned in along with the answer script.*]

Q.1 Suppose a **Faster R-CNN** based object detector predicts **7** bounding boxes on a sample of **3** images with **5** ground truth annotations. The prediction confidence for each of the bounding boxes along with the **TP / FP** labels are given in the following table:

Images	Confidence (%)	TP / FP Label
Image 1	86	TP
Image 1	65	TP
Image 2	90	FP
Image 2	70	TP
Image 2	56	FP
Image 3	73	FP
Image 3	92	TP

(a)	**Calculate** the **Precision** values for each of the predictions.	**6**
(b)	**Calculate** the **Recall** values for each of the predictions.	**6**
(c)	**Draw** the **Precision vs Recall** curve for the object detector.	**3**

Q.2 Suppose a shallow dense neural network with a single hidden layer of only **2** neurons has been trained for a binary **dark** (label: **0**) vs **light** (label: **1**) image classification task. After sufficient training period, you want to test the performance of the network with a **2 x 2** input image. The pixel intensity values of the input image and the weight-bias parameters for the layers are given below:

0.7	0.8
0.6	0.9

Input **to** ***Hidden*** layer weight and bias parameters:

$$W_{input-hidden} = \begin{bmatrix} 0.1 & 0.5 & 0.3 & 0.1 \\ 0.2 & 0.4 & 0.09 & 0.3 \end{bmatrix}$$

$$b_{hidden} = \begin{bmatrix} -0.32 \\ -0.28 \end{bmatrix}$$

Hidden **to** ***Output*** layer weight and bias parameters:

$$W_{hidden-output} = \begin{bmatrix} 0.5 & 0.9 \end{bmatrix}$$

$$b_{output} = \begin{bmatrix} 0.5 \end{bmatrix}$$

The activation functions used in the **Hidden** and **Output** layers are given in the following table:

Layer	**Activation function**
Hidden	tanh
Output	sigmoid

(a)	Explain why linear activation functions are not ideal for neural networks.	**2**
(b)	Draw the architecture of the neural network to be used for the above classifier.	**5**
(c)	Determine the outputs of individual layers using the given parameters and predict the classification label of the test image determined by the neural network. [Hint: Output at any layer can be determined using the following equation:] $$output = activation(W \times input + b)$$	**8**

Q.3 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 dimension**	**Filter size**	**Pad width**	**Number of filters**	**Output dimension**	**Memory**	**FLOPs**
Conv-1	$56 \times 56 \times 3$	7×7	3	10			
Pool-1		2×2	0	-			
Conv-2		5×5	2	20			
Pool-2		4×4	0	-			
Flatten		-	-	-			
FC (output)		-	-	5			

	In the table above, *Conv-X* denotes a **Convolutional** layer, *Pool-X* denotes a **Pooling** layer and *FC* denotes a **Fully Connected** layer. Assume that for the floating point operations, Alice uses **64 bit** floating point numbers.		
	(a)	**Determine** the number of classes Alice is trying to classify for her project. (Explain your answer briefly)	**2**
	(b)	**Calculate** the input and output dimensions for each of the layers. (Complete the *2nd* and *6th* columns of the table)	**5**
	(c)	**Calculate** the memory requirements for each of the layers. (Complete the *7th* column of the table)	**4**
	(d)	**Calculate** the FLOPs for each of the layers. (Complete the *8th* column of the table)	**4**