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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION
 DURATION: 1 HOUR 30 MINUTES

SUMMER SEMESTER, 2022-2023
 FULL MARKS: 75

CSE 4835: Pattern Recognition

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 3 (three) questions. Figures in the right margin indicate full marks of questions with corresponding COs and POs in parentheses.

1.
 - a) Define Pattern Recognition. Discuss some of the sub-problems in designing efficient pattern recognition systems. 1 + 4
(CO1)
(PO1)
 - b) Discuss the role of the hyperparameters of the k -Nearest Neighbour (KNN) algorithm on the shape of the decision boundary. How can the KNN algorithm be used to compare similarities between documents? 3 + 2
(CO2)
(PO2)
 - c) In a Neural Network, each node in the hidden layer learns different representations of the data, combining which the model produces an appropriate prediction. Despite having no prior direction on what feature to look for, how does the network learn the relevant features? How does it know which node(s) should be triggered by what amount while predicting certain classes? 8
(CO2)
(PO2)
 - d) Discuss the role of batch size on the shape of the learning curve of an optimizer. Why does the loss curve of the SGD combined with Momentum optimization algorithm tend to overshoot near the minima? How does Adagrad optimizer deal with this situation? 2 +
4 + 4
(CO1)
(PO1)
2.
 - a) Although AlexNet architecture was the first to revolutionize Deep Learning (DL) by winning the ImageNet challenge in 2012, the architecture has similarities to earlier architectures such as LeNet (1998) and Neocognitron (1980). Despite these early developments, DL took decades to gain mainstream recognition. Considering the historical context, discuss the potential factors contributing to this delayed adoption. 5
(CO1)
(PO1)
 - b) Discuss the motivation of the GoogLeNet architecture for using Auxiliary classifiers at multiple intermediate points in the network. Propose an alternative approach to this design choice with the necessary justification. 3 + 2
(CO1)
(PO1)
 - c) Criticize whether the following design choices will improve computational efficiency and/or classification performance:
 - i. The VGG16 and VGG19 both have five convolutional stages. The VGG19 architecture has three additional convolution layers in the later stages. Assume these additional layers are introduced in the earlier stages instead of later.
 - ii. Residual Networks use a stem network at the beginning of the architecture that converts the 224×224 input image to a 56×56 size activation map. Assume the network design is tweaked to produce the activation map of size 28×28 .5 × 2
(CO3)
(PO3)
3.
 - a) Consider a node in the middle of a computation graph that performs the multiplication of two matrices (x, w) and produces an output y that is passed to another node leading towards the calculation of Loss value L . Given the values of x, w , and the upstream gradient dL/dy , show the detailed steps to calculate dL/dx . 12
(CO1)
(PO1)

$$x = \begin{bmatrix} 2 & 1 & -3 \\ -3 & 4 & 2 \end{bmatrix}, w = \begin{bmatrix} 3 & 2 & 1 & -1 \\ 2 & 1 & 3 & 2 \\ 3 & 2 & 1 & -2 \end{bmatrix}, \text{ and } dL/dy = \begin{bmatrix} 2 & 3 & -3 & 9 \\ -8 & 1 & 4 & 6 \end{bmatrix}$$

- b) Consider the network configuration shown in Figure 1, and calculate the output feature map, parameter count, and FLOP count for each layer. 5 × 3
(CO2)
(PO2)

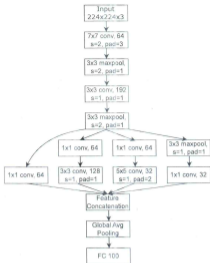


Figure 1: Network architecture for Question 3.b