MANIPAL ACADEMY of HIGHER EDUCATION
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Question Paper - Report

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Question Paper

MANIPAL ACADEMY OF HIGHER EDUCATION

Deep Learning [AML 5202]

Marks: 50 **Duration: 90 mins.**

A

Answer all the questions.

1) [10 points] [L5, CO 1] Suppose $\mathbf{X}$ represents the data matrix (samples along columns) containing information about 100 individuals

$$\text{with features} \begin{cases} \text{age}, \\ \text{annual income}, \\ \text{credit limit}, \\ \text{gender (female or male)}, \\ \text{education level (graduate, high school, post graduate)}, \end{cases} \quad \text{and categories} \begin{cases} \text{does not default payment}, \\ \text{defaults payment}. \end{cases}$$

(10)

(a) Suppose we want to apply softmax classifier to the dataset. What will be the shape of the weights matrix $\mathbf{W}$ assuming that the bias trick has been done?

(b) What will be the shape of the raw scores matrix comprising the raw scores of all 100 samples?

(c) In plain English and using the data as context, explain what each of the following represents assuming indexing starts from 1:

$$w_{:,2},\ w_{1,:},\ w_{1,8},\ w_{2,5}.$$

2) [10 points] [L5, CO3] Consider the following initial weights matrix (assuming that the bias trick has been done) for dense layer l in a deep neural network:

$$\mathbf{W} = \begin{bmatrix} 0.01 & -0.01 & 0.08 & 0.1 \\ 0.01 & -0.01 & 0.08 & 0.1 \end{bmatrix}.$$

(10)

(a) How many nodes are there in layer $l-1$ and layer l?

(b) Is there any issue with the initial values of the weights given here? Justify your answer in 1-2 lines.

(c) Calculate the $L2$-regularization loss for dense layer l.

3) [10 points] [L5, CO3] Suppose we want to implement a dropout layer after dense layer l of a deep neural network with a dropout probability of 0.2. Consider the following dropout-matrix:

$$\mathbf{D} = \begin{bmatrix} 0.49 & 0.47 & 0.7 & 0.99 \\ 0.86 & 0.49 & 0.76 & 0.96 \\ 0.13 & 0.98 & 0.87 & 0.54 \\ 0.48 & 0.96 & 0.76 & 0.32 \\ 0.62 & 0.15 & 0.23 & 0.58 \end{bmatrix}$$

(a) What is the number of neurons in dense layer l?

(b) What is the batch size?

(c) Each batch sample contributes to the learning of specific neurons of dense layer l. Identify those neurons for each batch sample and fill in the table below (counting starts from 0): (10)

Batch sample	Neurons
0	?, ?, ...
⋮	⋮

(d) How does the activations vector for dense layer l for the 0th sample denoted as $\mathbf{a}^{[l](0)}$ gets forward propagated through this dropout layer? Your answer should be a vector whose elements involve the elements of the vector $\mathbf{a}^{[l](0)}$.

(e) Compare and contrast dropout vs. loss-based regularization in not more than 2-3 lines.

(f) Is dropout applied to test data? In one line, justify your answer.

4) (10)

[10 points] [L5, CO4] Consider the following sample matrix:

$$\mathbf{X} = \begin{bmatrix} -6 & -5 & 6 & 4 \\ 7 & -10 & -2 & 5 \\ 1 & 1 & 7 & -8 \\ -2 & 2 & 1 & 1 \end{bmatrix}.$$

(a) Suppose you are told that this sample represents a grayscale image. Justify why you see negative numbers in the sample matrix.

(b) Convolve this sample with the kernel $K = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix}$ using no zero padding and unit stride.

(c) In one line, intuitively interpret the effect of convolving the image with the given kernel.

5) [10 points] [L3, CO4] Consider the convolutional neural network defined by the layers in the left column in the table below. Fill in the shape of the output volume and the number of parameters corresponding to each layer using the notations below:

- CONVx-N denotes a convolutional layer with N filters with kernel height and width both equal to x. Padding is 2, and stride is 1.
- POOL-N denotes an $N \times N$ max-pooling layer with stride of N and no zero padding.
- FLATTEN flattens its inputs.
- FC-N denotes a fully-connected layer with N neurons.

Layer	Output Volume Shape	Number of Parameters
Input	$32 \times 32 \times 3$	0
CONV3-16	?	?
Leaky ReLU	?	?
POOL-2	?	?
FLATTEN	?	?
FC-10	?	?

(10)