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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations Nov/Dec-19

Electronics and Communication Engineering

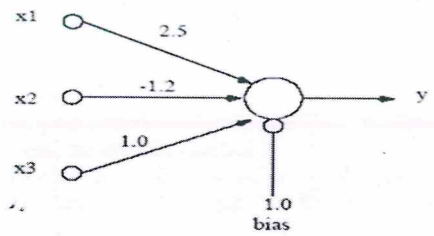
ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING (ELECTIVE)

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

PART-A

1	1.1	Consider the following orthonormal sets of key patterns applied to a correlation matrix memory $X_1 = [1 \quad 0 \quad 0 \quad 0]^T, X_2 = [0 \quad 1 \quad 0 \quad 0]^T, X_3 = [0 \quad 0 \quad 1 \quad 0]^T$ and the respective stored patterns are : $Y_1 = [5 \quad 1 \quad 0]^T$, $Y_2 = [-2 \quad 1 \quad 6]^T, Y_3 = [-2 \quad 4 \quad 3]^T$ a) Calculate the memory matrix M b) Calculate the memory response for the noisy key pattern $X = [0.8, \quad -.15, \quad 0.15, \quad -0.20]^T$	02
	1.2	Draw the block diagram of a system identification model.	02
	1.3	Find the output of an artificial neuron model given in Fig 1.3 for the inputs $[0.8,2,-0.5]$. Assume the activation function as sigmoid.  Fig 1.3	02
	1.4	The likelihood value of the function $L(Mu = 30, sigma = 2 \mid x = 32)$ *is* _____.	02
	1.5	Let the output of the convolutional layer is 127×127. If 7×7 matrix is applied with stride three, what is the dimension of the matrix after max pooling.	02
	1.6	Let the function of a neuron is given by $f = x^3$. Find the gradient of 'f' with respect to x if the input 'x' is $= 10$. Using back propagation algorithm.	02
	1.7	What is the output of a SoftMax activation function for an input $[1,2,3,4,1,2,3]$?	02
	1.8	Find the feature map for the segment of an image shown in Fig 1.8. Use a suitable 3×3 kernel to enhance the image. 1 1 1 0 0 0 1 1 1 0 0 0 1 1 1 1 0 0 1 1 1 1 0 0 1 Fig 1.8	02

1.9 A study was conducted to understand the effect of number of hours the students spent studying to their performance in the final exams. Table 1.9 shows samples from the study. What is the best linear fit on this dataset?

Table 1.9: Number of hours spent vs final score

Number of hours spent studying(x)	*score in the final exam*$(01-00)$ (y)
10	95
9	80
2	10
15	50
10	45
16	98
11	38
16	93

02

1.10 What would be the weights and bias if the network shown in Fig 1.10 is used to implement an *AND* function using a single neuron with ReLu activation function.

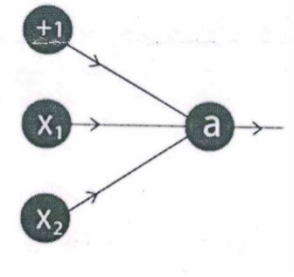


Fig 1.10 02

PART-B

2 a Explain basic elements of an artificial neural network with block diagram and mathematical expressions. Show the analogy between biological and artificial neuron model. 04

b A neuron receives inputs from four neurons whose activity levels are $5,12,6,-4$. The respective synaptic weights of neuron are $0.6,0.3,1.2,-0.4$. Calculate the output of neuron for the following two situations:

i) The neuron is linear
ii) The neuron is represented by a MaCulloch-Pitts model.
iii) The activation function of neuron is sigmoid. 06

c A three layer neural network contains 2 input layer neurons, 2 hidden layer neurons and 2 output layer neurons. The activation function of the hidden–layer is sigmoid function and signum function for output layer.

If the weight matrix connected between input-layer and hidden layer is

$$\begin{bmatrix} 0.4 & 1.2 \\ 2.2 & -0.6 \end{bmatrix}$$

and the hidden layer and output layer is

$$\begin{bmatrix} -0.4 & 1.8 \\ -1.5 & 1.0 \end{bmatrix}$$

Draw the network and find the output activities of input of $(1.0 \quad -0.2)^T$. Assume zero bias. 06

3 a Suggest an unsupervised, non-parametric statistical technique used for dimensionality reduction in machine learning and write the algorithm to perform the necessary action. 04

b Let the feature subset of a particular dataset is given by $(1,1),(1.5,2),(3,4),(5,7),(3.5,5)(4.5,5)(3.5,4.5)$. implement k-means clustering algorithm to classify the dataset into 2 clusters. 06

c The coordinates of a sample distribution of three classes off balls are given as follows: Blue balls $(2,2),(3,1)$, green balls$(8,2),(9,3)$ Red balls $(5,7),(6,8)$
If the coordinate of a new ball is given by (7,9), estimate and classify the new ball using Maximum Likelihood Estimation. 06

OR

4 a What happens when a large gap is noticed between the training error and generalization error in the learning curve for a polynomial regression model? What are the different ways to solve this problem?. 04

b Write a program in Python without using $API's$ to implement a classification model using logistic regression and plot the graph for small dataset of your choice. 06

c The dataset shown in Table 4(c) contains information related to selection of candidate for a company. Using the dataset, identify the root node to construct a decision tree by calculating the entropy and information gain values.
the parameters of dataset is as follows:
$CGPA$: High (> 8.5), Medium (> 6.5 & < 8.5), Low(< 6.5)
written test marks: Good: $(15\ to\ 20)$, Normal$(8\ to\ 14)$, Poor(< 8)

Table 4 (c)

$Students$	$CGPA$	$Written\ test\ marks$	$Technical\ round$	$HR\ rating$	$Selected$
$N1$	9.2	16	$Weak$	$High$	No
$N2$	8.7	19	$Strong$	$High$	No
$N3$	7.9	17	$Weak$	$High$	Yes
$N4$	5.9	10	$Weak$	$High$	Yes
$N5$	6.2	6	$Weak$	$Normal$	Yes
$N6$	6.4	7	$Strong$	$Normal$	No
$N7$	8.1	2	$Strong$	$Normal$	Yes

06

5 a The Table 5(a) shows sample data obtained from two different fruits.

i) Train a single layer perceptron model using the parameters with $w1(0) = -30$, $w2(0) = 300$, $b(0) = 1230$, learning rate= 0.01. use Signum function and LMS algorithm.

ii) Using the model parameters obtained, classify the fruit with weight $140gm$ and length $17.9cm$

Table 5(a)

	$Weight\ (grams)$	$Length\ (cm)$
$Fruit\ 1$	121	16.8
$Fruit\ 1$	114	15.2
$Fruit\ 2$	210	9.4
$Fruit\ 2$	195	8.1

06

b Derive an expression for weight vector updation using Least Means Square (LMS) algorithm in an adaptive linear combiner. Write an algorithm to explain the LMS Process. 10

OR

6	a	A machine is developed to separate orange and mango fruits based on their shape, texture and weight using a set of sensors. Fruits are loaded on a conveyer belt. This conveyer passes through a set of sensors, which measure three properties of the fruit: shape, texture and weight. The shape sensor will output a 1 if the fruit is approximately round and $a-1$ I if it is elliptical. The texture sensor will output a 1 if the fruit is smooth and -1 if it is rough. The weight of sensor will output 1 if the fruit is more than $50grams$ and -1 if it is less than $50grams$. The three sensor outputs is given as input to a neural network. Design a perceptron model to classify Orange and mango fruits. Draw the network model with weight vector and activation function. Verify the model with two datasets.	08
	b	Explain gradient descent algorithm with graphical representation to minimize cost function. Write the steepest Descent algorithm to implement either in $MATLAB$/Python.	08
7	a	A feed forward network is described by a function $f(x,y,z,w) = 2 * [(x * y) + max(z,w)] with\ x = 3, y = -4, z = 2, w = -1.$ Draw the computational graph and calculate the gradient of the function with respect to x, y, z and w using back propagation algorithm and chain rule.	08
	b	What is the significance of cost function in deep feed forward networks? Explain different types of cost functions used in prediction and classification networks.	08
8	a	Configure the convolution layer, Relu layer and Max pooling layer to identify handwritten digit '0' from the given below image segment. Select one suitable 3×3 kernel and use 2×2 matrix, stride 1 for max pooling. $\begin{bmatrix} -1 & -1 & -1 & -1 & -1 \\ -1 & 1 & 1 & 1 & -1 \\ -1 & 1 & -1 & 1 & -1 \\ -1 & 1 & 1 & 1 & -1 \\ -1 & -1 & -1 & -1 & -1 \end{bmatrix}$	08
	b	Develop a recurrent neural network to predict the word '$RVCE$'. Assume for the letter 'R', the previous state as '0'. The weight matrices W_{xh}, W_{hy} are used to transform the input to the hidden state and hidden state to output state respectively are shown below. The weight and bias of all the hidden layers is given by $W_{hh} = 0.42$ and $bias = 0.56$ respectively. $W_{Xh} = \begin{bmatrix} 0.28 & 0.84 & 0.57 & 0.48 \\ 0.90 & 0.87 & 0.69 & 0.18 \\ 0.53 & 0.09 & 0.55 & 0.49 \end{bmatrix}$ $Why = \begin{bmatrix} 0.37 & 0.97 & 0.83 \\ 0.39 & 0.28 & 0.65 \\ 0.64 & 0.09 & 0.33 \\ 0.91 & 0.32 & 0.14 \end{bmatrix}$ Calculate the output for the letter $'V'$ from the previous hidden state value. Use Tanh and Softmax functions for hidden layer and output layers.	08