INDIAN INSTITUTE OF INFORMATION TECHNOLOGY UNA [HP]

An Institute of National Importance under MoE

Saloh, Una (HP) – 177 209

Website: www.iiitu.ac.in

AY 2022-23

School of Electronics

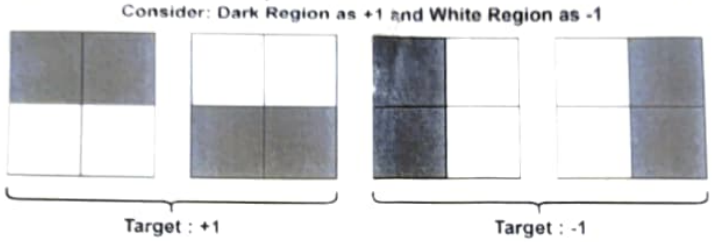
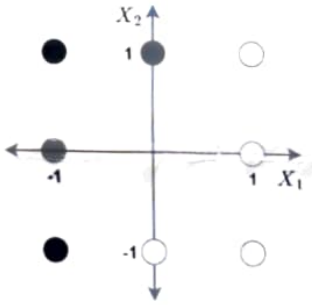
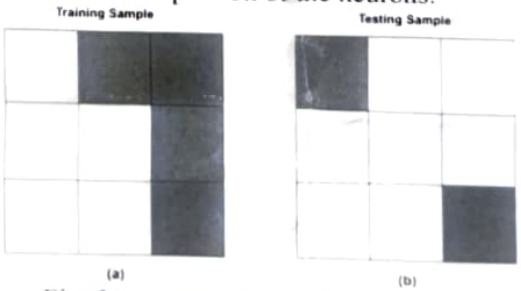
CURRICULUM: IIITUGECE22

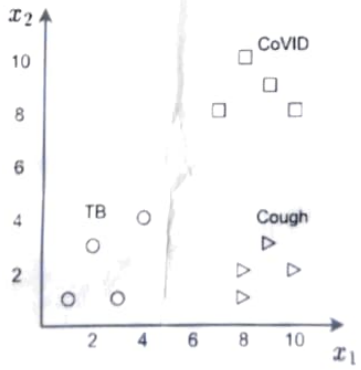
End Semester Examination

05, Dec.'22

Degree	B. Tech.	**Branch**	ECE
Semester	V		
Subject Code & Name	ECPE12 / Artificial Neural Networks		
Time: 180 Minutes	**Answer All Questions**		**Maximum: 100 Marks**

S. No.	Question	Marks
1.a	Answer the following with respect to the artificial neural networks: i. Discuss the significance of the activation function? ii. What advantages does ANN offers over classical computational methods? iii. What is the significance of bias? If the bias is considered as '0', then how will it impact the performance of the network? iv. Briefly discuss the significance of the learning rate and how it can impact the training phase of the neural network? v. How are the weights initialized in ANNs?	5
1.b	A single-layer neural network is to have six inputs and two outputs. The outputs are to be limited to and continuous over the range 0 to 1. Determine the following: i. How many neurons are required? ii. What are the dimensions of the weight matrix? iii. What kind of activation functions could be used? iv. Is a bias required? v. Determine the outputs if the input vector is [0.1, 0.2, 0.5, 1, 0.3, 0.5] and all the weights and bias are initialized at 0.5 each.	5
1.c	A single layer ANN has been trained to recognise between cats and dogs. The ANN will generate an output in the form of probabilities in between 0 and 1 for both the classes. Based upon the given statement, answer the following: i. Draw the architecture of the ANN architecture. ii. What will be the type of the activation function in this neuron? iii. Which learning rules can be used to train this network? iv. If the NN is not able to recognise the dog correctly. What could be the cause? v. What remedial actions can be taken in this regard?	5
1.d	Realize the following functions using McCulloch-Pitt neuron model, consider 2 inputs (x_1, x_2): i. x_1 OR x_2 ii. x_1 AND x_2 iii. x_1 NOR x_2 iv. x_1 AND (NOT x_2) v. NOT x_1	5

2.a	Briefly answer the following: i. If the categories to be recognized are not linearly separable, can we extend the standard perceptron to solve the problem? ii. How increasing the number of hidden layers impacts the efficacy of the neural network? iii. What is the condition of overfitting in ANNs? iv. What are the problems associated with the non-linear activation functions and how can we overcome them? v. How learning rule used for training the perceptron NN is different from Adaline NN?	5
2.b	Design a Hebb net that can classify between horizontal and vertical lines.  Fig. 1: A classification problem.	5
2.c	Consider the classification problem given in Fig. 2. Design a perceptron network to solve it and also sketch the decision boundary. Consider the targets as +1 of white circles and -1 for dark circles. Consider the learning rate as 0.5. (Perform 2 epochs).  Fig. 2: A classification problem.	5
2.d	Design an MADALINE (MRI rule) that can perform XOR operation. Consider bipolar training and testing data, learning rate as 0.1 and the initial weights as $w_{11} = 0.5$, $w_{21} = 0.1$, $b_1 = 1.5$, $w_{12} = 0.1$, $w_{22} = 1.5$ and $b_2 = -0.5$. Perform 1 epoch.	5
3.a	Design a Hopfield network that can store the pattern given in Fig. 3(a). Also check whether it is able to recall the original pattern when pattern shown in Fig. 3(b) is presented to it. Consider random updation of the neurons.  Fig. 3: A pattern association problem.	5
3.b	Briefly answer the following: i. How Hebb rule can be used in unsupervised learning? ii. How are the ANNs used for the pattern association different from the ones used for classification?	5

	iii. If the output y_i of a Hopfield network is positive, under which condition it will converge to zero. iv. How can Hebb rule be used for initializing the weights in bidirectional associative memory networks? v. How can we estimate the performance of a memory network?	
3.c	Design a 5-neuron full counter propagation network that can learn the following function for the interval [0.1, 0.5, 1, 2, 4]: $$y = \frac{2x}{x+2}$$ i. Design the architecture of the network, assign appropriate weights to it. ii. Test the network when whether it is able to generate the correct output for the function, when both inputs are present. Consider $x = 2.5$ and $y = 1$. iii. Test the network whether it is able to generate the correct output for the function when only one input is present consider $x = 1.5$. iv. In (iii), if the designed full CPN is not able to correctly estimate the function, what remedial action can be performed?	5
3.d	Consider the patterns p_1 and p_2 as shown in figure 4 as:  Fig. 4: A pattern association problem. i. Determine whether these patterns are orthogonal? ii. Design an auto-associative memory network that can store these patterns. iii. Determine the response of the network if a test vector p_t, as shown in figure above, is presented to the network.	5
4.a	i. How the multi-layer feedforward networks, Madaline and LVQ neural networks are different from each other? Justify your answer with respect the architecture, training algorithms and applications of the each. ii. Analytically obtain the derivative of *tanh* activation function.	5
4.b	Let us assume x_1 and x_2 are the two biomarkers that can be used to classify between three types of respiratory diseases viz., tuberculosis (TB), COVID and seasonal cough. Design an LVQ based neural networks that is able to diagnose the patient with respective disease. Consider the $\alpha = 0.5$.  Fig. 5: A classification problem.	5
4.c	Briefly answer the following with respect to ART networks: i. How does the learning happen in ART networks? ii. How do they address the stability-plasticity dilemma?	5

	iii. What will happen is the input provided doesn't belong to any of the present clusters? iv. What is the role of the various layers in the ART-1 networks? v. Discuss the role of vigilance parameter in ART networks and how does it impact the training?	
4.d	Design an ART-1 NN that can cluster the vectors (1, 1, 0, 0, 0), (0, 0, 0, 1, 1) and (0, 1, 1, 1, 0) into almost 2 clusters. Considerations $\rho = 0.7$, $t_{ji} = 1$ and $L = 2.5$.	5
5.a	Answer the following with respect the back-propagation algorithm i. Why do we use the chain rule while computing the partial derivatives of the error? ii. Why the weights are not updated during the error estimation phase of the back-propagation algorithm? If the weights are updated in this phase, what will be its consequences. iii. How do we obtain the weight correction terms? Give the analytical expression. iv. What do we mean by memorization and generalization? v. How the calculation of errors in BPNN is different from that of Adaline?	5
5.b	Chest computed tomography (CT) scan is an important method for the diagnosis of COVID-19 pneumonia. Design a neural network-based system that can classify that the patient has been infected by COVID or not. i. Discuss the functioning of the proposed system using block diagram/flow charts. ii. Justify, the choice of the following: a. The choice of inputs of the neural network. b. The choice of the neural network architecture. c. The choice of training algorithm. d. The performance of the network?	5
5.c	Neural networks are being widely used in intelligent control applications. The UAV's/drone are finding their applications in our daily lives and have very complex dynamics. Based upon the above statement answer the following: i. Using block diagram, explain how by using the neural networks, the dynamics of the UAV can be estimated. a. What information about the system can be used to estimate the dynamics of the UAV? b. What architecture and training algorithms can be used to obtain the equivalent neural network model of the UAV? ii. Now, once we have estimated the dynamics of the UAV, we want our UAV to attain a certain vertical height. Illustrate with the help of a block diagram, how we can design an intelligent controller for the same? a. What will be the choice of the feedback control architecture? b. Can we comment that this architecture, chosen in (ii.a), will be immune to wind disturbances? Justify the answer.	5
5.d	The pilot of an airplane is talking into a microphone in his cockpit. The sound received by the air traffic controller in the tower is garbled because the pilot's voice signal has been contaminated by engine noise that reaches his microphone. Design an ANN based noise filtering that can solve this problem. i. Design a functional block diagram of the proposed system? ii. Illustrate the characteristics of the various input/output parameters and the ANN models that can be used to solve such problems. iii. What training strategy can be employed to train such ANNs? iv. How will this type of ANN based noise filtering system will also be able to reject the real-time noise and adapt to such variations?	5

***** **GOOD LUCK** *****