

B.E. Computer Science & Engineering (Model Curriculum) Semester-VI
TEE2043CS - Neural Network and Deep Learning

P. Pages : 3

Time : Three Hours



GUG/W/24/13829

Max. Marks : 80

- Notes :
1. All questions are compulsory.
 2. All questions carry equal marks.
 3. Assume suitable data wherever necessary.
 4. Illustrate your answers wherever necessary with the help of neat sketches.
 5. Due credit will be given to neatness and adequate dimensions.

1. a) Draw a neat diagram of a biological neuron and define the following terms: 8
- i) Synapse ii) Axon
- iii) Dendrite iv) Soma
- b) Differentiate between Supervised, Unsupervised and Reinforcement Learning with suitable examples. Also state how Deep learning is resembles and differs from the machine learning. 8

OR

2. a) What are Artificial Neural Networks (ANNs)? Draw the mathematical model of the neuron and explain the concept of an ANN with an example. 8
- b) Diagrammatically illustrate and discuss McCulloch-Pitts Neuron Model. Also give the mathematical model of it by considering input X_i can be excitatory or inhibitory. Implement 3 inputs binary OR function using MP-Neuron and draw its geometric representation to show how it solves the binary classification problem. 8
3. a) Why it is not possible to use single-layer Perceptron to solve non-linearly separable problems? Prove with an example. 8
- b) Consider 4 data points with 3 dimensions that are divided into two classes, Class-1 and Class-2. 8

Sample	Data Point (x)	Class
S1	[1, 0, 1]	1
S2	[0, 1, 1]	0
S3	[1, 1, 0]	1
S4	[0, 0, 1]	0

Let the initial weight vector be $[-0.5, 1, 0.2]$. Apply the perceptron learning algorithm to the sample data in the same order. Find the value of weight vector at the end of sample S4. (Hint : If $x \in 1$, perform $w = w + x$, else perform $w = w - x$)

OR

4. a) Explain the intuition behind gradient descent. Explain the steps involved in the Back Propagation Algorithm. **8**
- b) Draw a Computation graph for the following function: **8**
 $J(a, b, c) = 3(a + bc)$
 Consider the following values, $a = 5, b = 3, c = 2$
- a) Find the corresponding intermediate values in your computation graph during first forward pass.
- b) Find $dJ/da, dJ/db, dJ/dc$ during first backward pass.
5. a) What is under fitting and overfitting of a model? Give the reasons and ways to tackle it. How Bias and Variance plays the role for Under and Overfitting of a Model? Give the approach to find the Best fit Model. **8**
- b) Give the typical machine learning setup and illustrate it with movie like/dislike example with respect to following components: **8**
 Data, Model, Parameters, Learning Algorithm, Loss/Error function

OR

6. a) What is the Exponential BAM model? How does it differ from other associative memory models? **8**
- b) What is Adaptive Resonance Theory (ART)? Explain the difference between ART1 and ART2. **8**
7. a) Consider the following test cases of a binary classifier with Actual Class (Ground Truth) and Predicted output. Find the corresponding predicted class for each test case by considering the error threshold = 0.6 (i.e. if predicted output is greater than threshold then classified as class-1 otherwise class-0) **8**

Actual Class	Predicted Output
0	0.5
1	0.9
0	0.7
1	0.7
1	0.3
0	0.4
1	0.5

- 1) Construct the Confusion Matrix
- 2) Find the Accuracy
- 3) Find the Error Rate
- 4) Find the Precision
- 5) Find the Recall

- b) What is the exploding gradient problem? How does it affect deep neural networks? What are the strategies to mitigate the exploding gradient problem? **8**

OR

- 8.** a) What are the different measures of performance of a classification algorithm? Explain each of the measures in context of a sample confusion matrix. **8**
- b) Compare and Contrast Batch, Mini-Batch and Stochastic Gradient Descent. **8**
- 9.** a) What are the basic building blocks of CNN architecture? Explain the process of convolution with a very simple image data of size 6×6 and a filter 3×3 . **8**
- b) What is pooling layer and why it is used in CNN? What are the different types of pooling? Explain any one type of pooling with an example. **8**

OR

- 10.** a) Suppose you are given a dataset of 10,000 grayscale images, each with dimensions of 28×28 pixels. You want to use a convolutional neural network (CNN) to classify these images into one of 10 possible categories. **12**
Assume you decide to use the following CNN architecture:
- * Input layer with $28 \times 28 \times 1$ dimensions.
 - * Convolutional layer with 32 filters of size 3×3 , using ReLU activation
 - * Max pooling layer with pool size of 2×2 .
 - * Convolutional layer with 64 filters of size 3×3 , using ReLU activation.
 - * Max pooling layer with pool size of 2×2 .
 - * Flatten layer
 - * Dense layer with 128 neurons, using ReLU activation
 - * Dropout layer with a rate of 0.5
 - * Output layer with 10 neurons, using softmax activation
- Assume you train this CNN on the dataset using a cross-entropy loss function and the Adam optimizer for 10 epochs. After training, you evaluate the performance of the CNN on a separate test set of 2,000 images. Find the total number of Trainable Parameters.
- b) What will be the shape of the output matrix for an image of size 15×15 if padding size is 1, stride size is 2 and 3×3 filter used for convolution. **4**
