

Indian Statistical Institute

Mid-Semester Examination: 2021 – 2022

Master of Science in Quality Management Science, Semester II

Compulsory Optional: Neural Networks

Date: 21 March 2022

Maximum Marks: 50

Duration: 2 hours

Attempt all the questions. Credit will be given for precise and brief answers.

1. How data is represented? What is supervised learning and what is unsupervised learning? Give example for one each. What is over fitting and what is under fitting? Describe one instance in design of architecture so that a neural network may result in over fitting and another instance so that a neural network may result in under fitting.
 $2 + 2 + 2 + 2 + 2 = 10$
2. The number of input and output nodes in an artificial neural network (ANN) is fixed, but number of hidden nodes and connection weights are not. They are called free parameters of an ANN. "If there are too few free parameters the network will not be able to learn the training set well enough. If there are too many of them the network will not generalize." Please explain the statement within the double quote. What is associative memory and what is Hebbian learning?
 $6 + 2 + 2 = 10$
3. If you are to design a neural network for hand written character recognition, how you will determine the number of input nodes and the number of output nodes? What features would you choose and how (feel free to be imaginative, you don't need to mug up from the class notes and vomit out on the answer script)? Draw a diagram of your (not necessarily the class note's) architecture of a neural network that will be able to do the classification job (with justification).
 $2 + 1 + 2 + 3 + 4 = 12$
4. You are given n different data sets, where n is a positive integer. The $n \times n$ covariance matrix of the data sets turns out to be a diagonal matrix with a small trace. Mention two important properties of the data sets with justification. How the data components are oriented to each other? Assuming that the variances are all different, prove that the eigenvectors of the covariance matrix are mutually orthogonal.
 $2 + 2 + 1 + 5 = 10$
5. Following is the weight matrix of a Hopfield network:

$$\mathbf{w} = \frac{1}{3} \begin{bmatrix} 0 & -2 & 2 \\ -2 & 0 & -2 \\ 2 & -2 & 0 \end{bmatrix}.$$

Please draw the diagram of the network indicating the nodes, direction and weight of the synapses. What will be the output of the network if the input is $(1, -1, 1)$? From the result what can you infer about the input?

$$4 + 2 + 2 = 8$$