DISCIPLINE OF COMPUTER SCIENCE & ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY INDORE

Autumn Semester, 2021

End Semester Examination

Course Code and Title: CS403/603 Machine Learning

Date (Day): 23/11/2021 (Tuesday) Max. Time Duration: 3 Hrs inclusive scanning & uploading

Max. Marks: 50 No. of Questions: 05

Number of pages in the Question Paper: 03

Instructions:

1. ***All questions are compulsory. Clearly state the assumptions wherever required with proper justification***

2. Answers must be brief and to the point.

3. All answers must be in one pdf file. Only one pdf file is considered.

Q.1

A. For a 2-input XOR problem, form RBFN architecture using Gaussian function. Show all the steps of hidden layer training and output layer training, draw a neat diagram. Assume number of nearest receptors, P=2.

B. How Radial Basis Function Network is different from Multilayer Feed Forward Neural Network?

[7+3]

Q. 2

A. Cluster the following eight points (with (x, y) representing locations) into three clusters:

A1(1, 4), A2(4, 7),
A3(4, 8), A4(3, 4),
A5(1, 2), A6(3, 6),
A7(2, 7), A8(2, 3)
Initial cluster centres are A1(1, 4), A4(3, 4) and A7(2, 7). Use K-Means Algorithm to find the updated three cluster centres after the second iteration.

B. What is the significance of Lagrange multipliers in solving the optimization problem of support vector machine? Explain with proper formulations.

[7+3]

Q. 3

A. Why Autoencoder kind of hidden layers are formed in Convolutional Neural Network (CNN) deep learning model? Discuss in detail by drawing the architecture diagram. Also discuss the broad steps of learning in CNN model.

B. What is meant by 'curse of dimensionality'? Discuss.

[7+3]

Q. 4

A. [Naive Bayes Classifier] Assume that you are given the following dataset of a person having heart disease or not.

CITY	Gender	Income	illness
Dallas	Male	40367	No
Dallas	Female	41524	Yes
Dallas	Male	46373	Yes
New York City	Male	98096	No
New York City	Female	102089	No
New York City	Female	100662	No
New York City	Male	117263	Yes
Dallas	Male	56645	No

Consider the following Income feature drawn from the Normal Distribution & construct a Guassian Naive Bayes Classifier to predict the Illness of the person from the following data ?

CITY	Gender	Income
Dallas	Female	100000

Note : [calculator might be required for computing the values from the gaussian formula for income value.]

B. Describe **two differences** for each between the following:

(i) Discriminative Model vs Generative Model

(ii) Conventional Machine Learning vs Deep Learning

(Please ensure that only differentiative points are mentioned)

[7+3]

Q. 5

A. Consider following data points in 2-D space.

X={(1, 5), (2, 6), (2, 6), (3, 8), (4, 6), (8, 3)}

Total number of data points n=6, total number of clusters k=2, fuzzification parameter p=2.
Initial membership matrix U_{ij} (given in table below)

Data Points	k_1	k_2
x_1	0.3	0.7
x_2	0.8	0.2
x_3	0.5	0.5
x_4	0.4	0.6
x_5	0.1	0.9
x_6	0.6	0.4

1) Calculate initial cluster centers.
2) Calculate distance of each data points from each cluster.
3) Calculate updated membership matrix.
4) Plot the formed clusters on 2D space & comment on 'Cluster Compactness' i.e. within cluster & between clusters. [1+2+2+2]

Note: Calculate cluster centers, distance and membership matrix for one iteration only

B. What is meant by 'Bias' & 'Variance' in context of learning a model for a problem? Does it affect the performance of the learned model? Discuss **briefly** with appropriate diagram or example. [3]