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**PRESIDENCY UNIVERSITY
BENGALURU**

**SCHOOL OF ENGINEERING
END TERM EXAMINATION - JUN 2023**

Semester : Semester IV - 2021

Course Code : ECE3020

Course Name : Sem IV - ECE3020 - Computational Intelligence and Machine Learning

Program : ECE

Date : 14-JUN-2023

Time : 9.30AM -12.30PM

Max Marks : 100

Weightage : 50%

Instructions:

- (i) Read all questions carefully and answer accordingly.
 - (ii) Question paper consists of 3 parts.
 - (iii) Scientific and non-programmable calculator are permitted.
 - (iv) Do not write any information on the question paper other than Roll Number.
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PART A

ANSWER ALL THE QUESTIONS

(5 X 2 = 10M)

1. The bias–variance decomposition is a way of analyzing a learning algorithm's expected generalization error with respect to a particular problem. Write the relation among bias, variance, and noise.
(CO1) [Knowledge]
2. To avoid overfitting or underfitting, regularization is used to calibrate machine learning models by minimizing the adjusted loss function. With suitable equation, explain how regularized least squares are used to control error.
(CO1) [Knowledge]
3. One of the examples of a linear discriminant model is the perceptron of Rosenblatt, which occupies an important place in the history of pattern recognition algorithms. Explain perceptron convergence theorem.
(CO1) [Knowledge]
4. In the field of machine learning, sequence models are those that take in or produce data in the form of a sequence. Sequential data includes but is not limited to text streams, audio snippets, video clips, time series data, and so on. With suitable equation, explain sequential learning.
(CO1) [Knowledge]
5. Hyper-planes are decision boundaries that helps to classify the data points. Data points falling on either side of the hyper-plane can be attributed to different classes. Also, the dimension of the hyper-plane depends upon the number of features. How hyper-plane will be used in classification of data?
(CO2) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS

(2 X 15 = 30M)

6. i) Probabilistic discriminative models are majorly divided into two types a) generative model b) discriminative models. Consider a data set $C = \{(0,1), (1,1), (1,0), (1,1), (1,0), (0,1), (1,0), (1,1), (0,1)\}$, find the relation between generative and discriminant models for the given data set. (7M)
- ii) Perceptron models are the simplest type of artificial neural network which carries input and their weights, the sum of all weighted input, and an activation function. Perceptron models are continuously contributing to Artificial Intelligence and Machine Learning, and these models are becoming more advanced. Perceptron enables the computer to work more efficiently on complex problems using various Machine Learning technologies. With suitable diagrams explain perceptron algorithm. (8M)
- (CO3, CO2) [Comprehension]
7. In computational science, particle swarm optimization (PSO) is a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. PSO has a main advantage of having fewer parameters to tune. PSO obtains the best solution from particles' interaction, but through high-dimensional search space, it converges at a very slow speed towards the global optimum.
- i) Consider a scenario that, five particles (Say P1, P2, P3, P4 and P5) are moving around the solution space (Say Z). Each particle moves around the solution space randomly but at the same time attracted by other poles, its past best position (solution) and the best position (solution) of the whole swarm (collection of particles). These poles modify the velocity vector of the particles at each iteration. (7M)
- ii) How these swarms (Say P1, P2, P3, P4 and P5) modify their velocity vectors in the form of their position and reaches their destination (Say Z). Form an algorithm with suitable equations. (8M)
- (CO3) [Comprehension]

PART C

ANSWER ALL THE QUESTIONS

(3 X 20 = 60M)

8. Logistic Regression is one of the most popular linear classification models that perform well for binary classification but falls short in the case of multiple classification problems with well-separated classes. While Linear Discriminant Analysis (LDA) handles these quite efficiently. LDA can also be used in data preprocessing to reduce the number of features just as Principle component analysis which reduces the computing cost significantly
- Consider two data sets as mentioned below, what will be suitable weight vector which will be used to perform classification as well as dimensionality reduction.
- $X_1 = \{(4,1), (2,4), (2,3), (3,6), (4,4)\}$
- $X_2 = \{(9,10), (6,8), (9,5), (8,7), (10,8)\}$

(CO2) [Application]

9. K-Means clustering is an unsupervised learning algorithm. There is no labeled data for this clustering, unlike in supervised learning. K-Means performs the division of objects into clusters that share similarities and are dissimilar to the objects belonging to another cluster
- Consider data sets X and Y as given below. Show the steps of calculation for data points until final clustering is done where no data points are changing clusters.

X	1	2	2	3	4	5
Y	1	1	3	2	3	5

(CO3) [Application]

10. Ant colony optimization (ACO) is an optimization algorithm which employs the probabilistic technique and is used for solving computational problems and finding the optimal path with the help of graphs. ACO has a good performance in solving discrete problems, but it inevitably has some disadvantages. Although it has good stability, it has some shortcomings in the convergence speed and solution accuracy when dealing with a large amount of data.

Consider the problem of finding the optimum order in which the numbers from 1 to 9 are arranged so that the cost of order is maximum. Assume that six ants have the cost functions (C1, C2, C3, C4, C5, and C6). Consider the following are the orders selected by the six ants along with the corresponding Cost as given below. With help of pheromone matrix explain optimization steps in ACO.

ANT Number	ORDER									COST
ANT1	3	4	1	9	2	8	5	6	7	C1
ANT2	8	4	9	6	3	1	2	7	5	C2
ANT3	3	2	4	1	7	5	8	6	9	C3
ANT4	5	8	9	2	7	3	6	4	1	C4
ANT5	5	6	8	2	3	9	7	1	4	C5
ANT6	4	6	7	8	1	2	5	9	3	C6

(CO3) [Application]