M.TECH/CSE/1ST SEM/CSEN 5131/2021

MACHINE LEARNING
(CSEN 5131)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Which of the following refers to the problem of finding abstracted patterns (or structures) in the unlabeled data?
(a) Supervised learning (b) Un-supervised learning
(b) Hybrid learning (d) Reinforcement learning.

(ii) Which of the following is an essential process in which the intelligent methods are applied to extract data patterns?
(a) Warehousing (b) Data Selection
(c) Data Mining (d) Text Mining.

(iii) Which of the following is not a decision tree node?
(a) Root node (b) Internal node (c) predicted node (d) Leaf node

(iv) k-means algorithm can:
(a) Create convex shaped cluster spaces.
(b) Automatically determine total number of clusters.
(c) Generate soft clustering of data points.
(d) Both option (a) and (b).

(v) In the example predicting the number of newborns, the final number of total newborns can be considered as the _____
(a) Features (b) Observation (c) Attribute (d) Outcome.

(vi) The growth function h(N) for positive rays (h(X) = 1 when X > a and h(X) = -1 otherwise) is
(a) N+1 (b) N (c) 2^N (d) ∞ (Infinity)

(vii) Dimensionality reduction reduces the data set size by removing _____
(a) composite attributes (b) derived attributes
(c) relevant attributes (d) irrelevant attributes

(viii) Using the hypothesis H, we can shatter n points. This implies that
(a) $d_{VC} = n$ (b) $d_{VC} \geq n$ (c) $d_{VC} \leq n$ (d) No conclusion
(*d_{VC} being the VC-dimension of H.*)

(ix) Multilayered Perception model can learn
(a) AND (b) XOR (c) OR (d) All of these.

(x) In a 3 layered MLP, the number of nodes in the input layer is 6 and the hidden layer is 3 excluding the bias node in the hidden layer). The maximum number of connections from the input layer to the hidden layer are
(a) Less than 18 (b) 18
(c) More than 18 (d) It is an arbitrary value.

Group- B

2. (a) Define Information gain and gain in Gini Index in the context of decision tree learning.

(b) Consider the following data set for a binary class problem.
Calculate the information gain when splitting on three attributes 'Over 170CM', 'Eye' and 'Hair length'. Which attribute would the decision tree induction algorithm choose?

Sl No	Over 170CM	Eye	Hair length	Gender
1	No	Blue	Short	Male
2	Yes	Brown	Long	Female
3	No	Blue	Long	Female
4	No	Blue	Long	Female
5	Yes	Brown	Short	Male
6	No	Blue	Long	Female
7	Yes	Brown	Short	Female
8	Yes	Blue	Long	Male

[(CO1, CO4, CO5) [Remember/LOCQ][Understand/IOCQ] and [Apply/HOCQ]]
4 + 8 = 12

3. (a) Explain the Linear regression technique with appropriate example.

(b) Consider the following data with one input (X) and one output (Y):

X	30	10	22	34	34	18	16	43	25
Y	41	24	36	38	50	35	24	34	34

Using the method of linear regression, predict the output Y for an input data X=36. [(CO1, CO4,CO6) [Remember/LOCQ][Apply/IOCQ]]
6 + 6 = 12

Group - C

4. (a) Derive the growth function of n input data points for the following hypotheses:
(i) Positive intervals
$f(x) = +1$ for $a \leq x \leq b$;
Otherwise, $f(x) = -1$
(ii) Positive ray $f(x) = +1$ for $x >= a$

Otherwise, f(x) = -1

(b) Suppose 4 input data points X_1, X_2, X_3, and X_4 need to be classified into two classes +1 and -1. Determine a set or list of maximum possible dichotomies for these 4 data points, which can be obtained under the following three conditions: (i) break point is 2. (ii) break point is 3. (iii) break point is 4.

[(CO2, CO4) [Remember/LOCQ] [Analyze/HOCQ]]

6 + 6 = 12

5. (a) Define VC dimension. Explain the importance of VC dimension in machine learning?

(b) Prove that the VC dimension of perceptron in d-dimension is d+1.

(CO1, CO3, CO4) [Remember/LOCQ][Evaluate/IOCQ][Analyze/HOCQ]]

4 + 8 = 12

Group - D

6. Suppose we have 5 1D data points x_1=1, x_2=2, x_3=4, x_4=5, x_5=6, with 1, 2, 6 as class 1 and 4, 5 as class 2 Þ y_1=1, y_2=1, y_3=-1, y_4=-1, y_5=1.
When a polynomial kernel of degree 2 ($K(x,y) = (xy+1)^2$) is used and C is set to 100, we get the Lagrange multipliers as follows:
α_1=0, α_2=2.5, α_3=0, α_4=7.333, α_5=4.833
Identify the support vectors and derive the discrimination function.

[(CO1, CO2, CO5)[Understand/LOCQ][Apply/IOCQ][Evaluate/HOCQ]

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7. (a) Derive the weight update equation of a feed forward Multi Layered Perceptron network using back propagation learning.

(b) Justify the statement "Back propagation learning using gradient descent algorithm may find some local optima."

[CO1, CO2, CO5) [Understand/LOCQ][Apply/IOCQ][Evaluate/HOCQ]]

10 + 2 = 12

Group - E

8. Deduce all the equations needed to solve the problem of Linear SVM (Linearly separable case). Derive the Lagrangian for the optimization problem as defined by linear SVM and write its Dual. [(CO2, CO3, CO4) [Remember/LOCQ][Understand/IOCQ]]

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9. (a) Briefly discuss about the pre-defined parameters required in db-scan clustering algorithm.

(b) Apply DBSCAN on the following set of data points, to determine the clusters. Show all steps in detail, assuming eps = 1 and minPts = 2.
Data Points: (3,0), (3,1), (3,2), (4,1), (4,2), (10,11), (10,10), (20,21), (20,22), (21,21), (21,22). [(CO4, CO5, CO6) [Remember/LOCQ][Apply/IOCQ]]

3 + 9 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	41.67%	41.67%	16.66%

Course Outcome (CO):

After the completion of the course students will be able to

1. Learn and understand various machine learning algorithms;
2. Understand complexity of Machine Learning algorithms and their limitations;
3. Compare and contrast various machine learning techniques and to get an insight of when to apply a particular machine learning approach;
4. Mathematically analyze various machine learning approaches and paradigms;
5. Apply common Machine Learning algorithms in practice and implementing their own;
6. Perform experiments in Machine Learning using real-world data

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
CSE	https://classroom.google.com/c/NDEwMjU4NTM5MzU1/a/NDc0ODI5Mjg3NjYw/details