

MACHINE LEARNING TECHNIQUES
(AEIE 4233)

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) Identify the type of learning in which labeled training data is used
(a) Semi Supervised learning (b) Supervised learning
(c) Reinforcement learning (d) Unsupervised learning.
- (ii) What is called the average squared difference between classifier predicted output and actual output?
(a) Mean squared relative error (b) Mean squared error
(c) Mean absolute error (d) Root mean squared error.
- (iii) _____ computes the difference between entropy before the split and average entropy after the split of the dataset based on given attribute values.
(a) Information gain (b) Gini ratio
(c) Pruning (d) Cost function
- (iv) In Hyper plane, $f(x)=\text{sign}(w*x+b)$ where 'w' is a _____.
(a) Constant (b) Vector (c) Distance (d) None of these
- (v) Assume a simple MLP model with 3 neurons and inputs =1, 2, 3. The weights to the input neurons are 4, 5 and 6. Assume the activation function is a linear constant value of 3. What will be the output?
(a) 32 (b) 64 (c) 96 (d) 128.
- (vi) In a simple MLP model with 8 neurons in the input layer, 5 neurons in the hidden layer and 1 neuron in the output layer. What is the size of the weight matrices between hidden output layer and input hidden layer?
(a) [1×5], [5×8] (b) [5×1], [8×5] (c) [8×5], [5×1] (d) [8×5], [1×5].
- (vii) The Bayes rule can be used in
(a) Solving queries (b) Increasing complexity
(c) Decreasing complexity (d) Answering probabilistic queries.

- (viii) What is the meaning of hard margin in SVM?
(a) It allows very low error in classification.
(b) It allows high amount of error in classification.
(c) It underfits data.
(d) Its margin is highly flexible.
- (ix) What is adaline in neural networks?
(a) Adaptive linear element. (b) Automatic linear element.
(c) Adaptive line element. (d) None of the mentioned.
- (x) CNN is mostly used when there is an _____.
(a) Structured data (b) Unstructured data
(c) Both (a) and (b) (d) None of the above

Group – B

2. (a) State the Unsupervised Learning method with proper diagram. Give one real life example of both Supervised Learning and Unsupervised Learning. [(CO1)(Understand/LOCQ)]
- (b) Explain the concept of different skewness in data distribution with diagram. Given a left-skewed distribution that has a median of 60, what conclusions can you draw about the mean and the mode of the data? [(CO1)(Understand/LOCQ)]
- (c) A company wants to improve its sales. The previous sales data indicated that the average sale of 25 salesmen was Rs. 50 per transaction. After training, the recent data showed an average sale of Rs. 80 per transaction. If the standard deviation is Rs.15, find the t-score. [(CO6)(Analyze/IOCQ)]
(3 + 2) + (2 + 2) + 3 = 12
3. (a) Explain inductive learning with example. [(CO1)(Understand/LOCQ)]
- (b) Calculate the Quartiles of the following dataset: 37, 16, 35, 13, 26, 35, 23, 26. Also determine the 60th Percentile of the above dataset. [(CO1)(Apply/IOCQ)]
- (c) Determine the median, mode and interquartile Range (IQR) of the given dataset {1, 2, 3, 5, 5, 6, 7, 7, 7, 9, 12} [(CO1)(Apply/IOCQ)]
2 + (3 + 2) + (1 + 1 + 3) = 12

Group – C

4. (a) State the Least Square regression problem. Explain how this problem is solved. [(CO2)(Remember/LOCQ)]
- (b) Given the set of values $X = (3, 9, 11, 5, 2)^T$ and $Y = (1, 8, 11, 4, 3)^T$. Evaluate the regression coefficients. [(CO2)(Evaluate/HOCQ)]
- (c) Find the correlation coefficient between the variable X and Y in the above problem. [(CO2)(Analyze/IOCQ)]
(2 + 4) + 4 + 2 = 12
5. (a) Illustrate Principal Component Regression (PCR) method. [(CO2)(Analyze/IOCQ)]

- (b) What is over fitting? How this is reduced by regularization? [[CO2](Understand/LOCQ)]
- (c) State the Ridge regression problem. Find the solution of this problem. How the Ridge formulation differs from the least square regression problem? [[CO2](Understand/LOCQ),(Analyze/IOCQ)]
- 3 + 2 + (2 + 4 + 1) = 12**

Group - D

6. (a) Explain the Fisher’s Linear Discriminant Analysis (LDA) criterion between two classes and hence derive a solution of this problem. [[CO3](Analyze/IOCQ)]
- (b) State the limitations of LDA. [[CO3](Remember/LOCQ)]
- (c) Use K Means clustering to cluster the following data into two groups:
 $\{ 2, 4, 10, 12, 3, 20, 30, 11, 25 \}$.
 Assume cluster centroid are $m_1=2$ and $m_2=4$. The distance function used is Euclidean distance. [[CO4](Analyze/IOCQ)]
- 5 + 2 + 5 = 12**
7. (a) Give the significance of kernel trick in the context of support vector machine. Describe different types of standard kernel functions. [[CO3](Understand/LOCQ)]
- (b) The following table consists of a training data that contains the factors that determines whether golf is played or not. For a given row entry, count represents the number of data tuples having the values for outlook, temperature, humidity and windy or not in that row.

Outlook	Temperature	Humidity	Windy	Play Golf
Rainy	Hot	High	False	No
Rainy	Hot	High	True	No
Overcast	Hot	High	False	Yes
Sunny	Mild	High	False	Yes
Sunny	Cool	Normal	False	Yes
Sunny	Cool	Normal	True	No
Overcast	cool	Normal	True	Yes
Rainy	Mild	High	False	No
Rainy	Cool	Normal	False	Yes
Sunny	Mild	Normal	False	Yes
Rainy	Mild	Normal	True	Yes
Overcast	Mild	High	True	Yes
Overcast	Hot	Normal	False	Yes
Sunny	Mild	High	True	No

Using Naive Bayes classifier determine the play prediction for the day $x'=(\text{Outlook}=\text{Sunny}, \text{Temperature}=\text{Cool}, \text{Humidity}=\text{High}, \text{Wind}=\text{False})$.

[[CO3](Evaluate/HOCQ)]
4 + 8 = 12

Group - E

8. (a) Draw a basic architecture of a ADALINE network, and demonstrate the training algorithm based on that architecture. How MADALINE is different from ADALINE? [(CO6)(Remember/LOCQ)]
- (b) Draw a Perceptron network with 3 inputs, 1 output and 1 bias input. State the training algorithm for this Perceptron network. [(CO6)(Understand/LOCQ)]
- (c) Why do we use a Pooling Layer in a CNN? [(CO5)(Understand/LOCQ)]
- (2 + 3 + 1) + (2 + 3) + 1 = 12**
9. (a) How would you tune the Network Structure (Model Design) Hyperparameters to get the highest accuracy in a Deep Neural Network? [(CO5)(Analyze/IOCQ)]
- (b) What is MLP? How it is different from single layer neural network? [(CO5)(Remember/LOCQ)]
- (c) Evaluate the output after convolution between the 6 × 6 image and the 3 × 3 filter provided below: for (i) Stride = 1 and (ii) Stride = 2.

1	0	0	0	0	1
0	1	0	0	1	0
0	0	1	1	0	0
1	0	0	0	1	0
0	1	0	0	1	0
0	0	1	0	1	0

6×6 image

1	-1	-1
-1	1	-1
-1	-1	1

Filter

[(CO5)(Evaluate/HOCQ)]
3 + (1 + 2) + (3 + 3) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	41.67	39.58	18.75

Course Outcome (CO):

After the completion of the course students will be able to:

1. Familiarize with the basic concepts and techniques of machine learning and integrate multiple facets of practical machine learning in a single system: data pre-processing, learning, regularization, model selection, data analysis, and hypothesis testing.
2. Develop linear and multivariate regression models on given data and analyze their performance by calculation of R-square and goodness of fit.
3. Implement and analyze existing learning algorithms, including well-studied methods for development of classifier models such as LDA, Bayes, KNN, SVM and logistic regression.
4. Learn data clustering techniques and dimensionality reduction of data by principal component analysis method and apply them on practical problems.
5. Gain knowledge on artificial neural network, convolution neural network and deep learning and implement them with python.
6. Apply basic principles of AI in real world problems that require solving, inference, perception, knowledge representation, and learning

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