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MST-026

M. SC. (APPLIED STATISTICS)

(MSCAST)

Term-End Examination

June, 2025

MST-026 : INTRODUCTION TO MACHINE LEARNING

Time : 3 Hours *Maximum Marks : 50*

Note : *Question No.* ***1*** *is compulsory. Attempt any* ***four*** *questions from question numbers 2 to 6. Use of scientific (non-programmable) calculator in allowed. Symbols have their usual meanings.*

1. (a) Consider the following code :

```
set.seed (2017)
#line of code
test < – iris [test_index,]
train < – iris [–test_index,]
```

Here our objective is to split the iris data into train and test as 80 : 20 using a function of caret package. Then what code should be written in place of #line of code ? 3

(b) Given a list of 10 examples including 5 positive, 3 negative and 2 neutral examples. Find the entropy of the dataset with respect to this classification. 2

(c) Which of the following is not a type of supervised learning ? Give reason in support of your answer : 2

(i) Classification

(ii) Clustering

(iii) Regression

(iv) None of the above

(d) Differentiate between the biological neural network and the artificial neural networks. 3

2. (a) Suppose there are 10,000 e-mails in a mailbox out of which 300 are spams. The spam detection system detects 150 mails as spams, out of which 50 are actually spams. What is the precision and recall of spam detection system ? 5

(b) In linear regression, our hypothesis is $h_\theta(x) = \theta_0 + \theta_1 x$, the training data is given in the table :

x	y
10	5
3	3
6	7
8	6

If the cost function is

$$J(\theta) = \frac{1}{2m} \sum_{i=1}^{m} (h_\theta(x) - y_i)^2$$

where m is number of training data points, what is the value of $J(\theta)$ when $\theta = (1, 1)$? 5

3. In the following datasets x_1 and x_2 are the two input variables and class is the dependent variable : 10

x_1	x_2	Class
–1	1	–
0	1	+
0	2	–
1	–1	–
1	0	+
1	2	+
2	2	–
2	3	+

What will be the class of a new data point $x_1 = 1$ and $x_2 = 1$ in 5-NN (k-nearest neighbour with $k = 5$) using Euclidean distance measure ?

4. If the input vectors are $I_1 = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$, $I_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ and $I_3 = \begin{bmatrix} \sqrt{2} \\ 1/\sqrt{2} \end{bmatrix}$ and initial values of three weight vectors are $\begin{bmatrix} 0 \\ -1 \end{bmatrix}, \begin{bmatrix} -2/\sqrt{5} \\ 1/\sqrt{5} \end{bmatrix}, \begin{bmatrix} -1/\sqrt{5} \\ 2/\sqrt{5} \end{bmatrix}$, then calculate the resulting weight found after training the competitive layer with Kohonen's rule and a learning rate α of 0.5 on the input-series in order I_1, I_2 and I_3. 10

5. Find the modified weights for the training set having input $I_1 = 0.3$, $I_2 = -0.5$ and output = 0.1 with $[V]^o = \begin{bmatrix} 0.1 & 0.4 \\ -0.2 & 0.2 \end{bmatrix}$ and $W^o = \begin{bmatrix} 0.2 \\ -0.5 \end{bmatrix}$. 10

6. Solve the network to approximate the function $f(x) = 1 + \sin \pi x$ for $-1 \leq x \leq 1$, choosing initial weights and bias as the random numbers, using backpropagation algorithm. 10

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