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B. Sc. (Engg.) in Computer Science and Engineering
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Level 4 Semester I, Credit: 3.0
Course Code: CSE 403, Course Title: Machine Learning

me: 03 Hours | Total Marks: 90

[N.B. The figure in the right margin indicates the marks allocated for respective question. Split answer of any question will not be accepted.]

SECTION-A

(Answer any three from the following questions.)

1. (a) What is machine learning? How can machine learning tools be used to develop an artificial intelligent agent? 4

   (b) Define training sample, data mining, supervised learning and semi-supervised learning. 4

   (c) When and why will you use the following machine learning algorithms? 7

   i. Find-S
   ii. Candidate-Elimination
   iii. List-Then-Eliminate
   iv. Decision Tree Learning algorithm such as ID3
   v. Gradient Descent and Delta Perceptron Training Rule

2. (a) Which issues should be retained to design a learning system? Mention the three features for the *Spam-nonspam E-mail classification* learning task. 4

   (b) Define restriction bias and preference bias. Why does *over-fitting the data problem* occur in decision tree learning? 4

   (c) Consider the multivariate linear regression learning problem: *House Price Prediction*. Now, represent a typical format of training sample and use Gradient Descent algorithm to derive the general solution. 7

3. (a) A 4-input perceptron has weights 1, 2, 3, and 4. The transfer function is: if the output value is 100 or less call it 0; call it 1, otherwise. The inputs are 20, 10, 5 and 25 respectively. What is the classifying output? Draw the decision trees to represent the following Boolean functions: 4

   i. $A \vee \neg B$
   ii. $A \wedge [B \vee C]$

   (b) Discuss maximum-a-posteriori and maximum-likelihood hypothesis considering a suitable learning task. 4

   (c) Consider the following **EnjoySport** artificial intelligent agent. Suppose that the learning agent has the following dataset given by the supervisor: 7

Example	Sex	Color	Height	Nationality	EnjoySport
1	*Female*	*Brown*	*Tall*	*Bangladesh*	+
2	*Male*	*Brown*	*Short*	*Bangladesh*	-
3	*Female*	*Black*	*Tall*	*Bangladesh*	+
4	*Female*	*Black*	*Tall*	*India*	+
5	*Male*	*Black*	*Short*	*India*	-

The aim is to learn the concept of **EnjoySport**. Use Candidate-Elimination algorithm to find the final version space.

4. (a) When should you use gradient descent and when normal equation method to solve a linear regression problem? Discuss in detail. 4

   (b) A hypothesis space contains three hypotheses, *h1*, *h2* and *h3*. The posteriori probabilities of these hypotheses given the training data are 0.6, 0.3 and 0.2 respectively. Suppose a new instance x is encountered, which is classified positive by *h1*, but negative by *h2* and *h3*. Using Bayes optimal classifier, find out the most probable classification of x. 4

   (c) Consider the following **EnjoySport** artificial intelligent agent trying to infer which person will enjoy the sport based on the following supplied data. 7

Example	Sky	AirTemp	Humidity	Wind	Water	Forecast	EnjoySport
1	*Sunny*	*Warm*	*Normal*	*Strong*	*Warm*	*Same*	*Yes*
2	*Sunny*	*Warm*	*High*	*Strong*	*Warm*	*Same*	*Yes*
3	*Rainy*	*Cold*	*High*	*Strong*	*Warm*	*Change*	*No*
4	*Sunny*	*Warm*	*High*	*Strong*	*Cool*	*Change*	*Yes*
5	*Sunny*	*Warm*	*High*	*Weak*	*Warm*	*Same*	*No*

Your task is to build a decision tree using any suitable algorithm that predicts whether a person will enjoy the sport or not.

SECTION-A

(Answer any three from the following questions.)

1. (a) Compare between biological neural network and artificial neural network (ANN). 4

   (b) Mention the role(s) of weights and activation functions in ANN. Draw various types of activation functions used in ANN. 4

   (c) Design a two-input (*x1* and *x2*) perceptron that implements the Boolean function *AND* using gradient descent algorithm where the following initial conditions are given: 7

   i. Initial weights: $w1=0.1$, and $w2=0.3$ associated with *x1* and *x2* respectively
   ii. Learning rate=0.2
   iii. Threshold function: if the output value is 0.5 or less call it 0; call it 1, otherwise.

2. (a) Mention the purposes of using the following machine learning algorithms: 4

   i. Bayes optimal classifier
   ii. GIBBS
   iii. Naïve Bayes classifier
   iv. Backpropagation

   (b) Which kind of problems cannot be solved by a single layer perceptron? Discuss in detail. 4

   (c) Consider the following training data and predict the target value (yes/no) of the target concept PlayTennis for the new instance (Outlook=*Rain*, Temperature=*Hot*, Humidity=*Normal*, Wind=*Strong*). Apply Naïve-Bayes learner for the same. 7

Day	Outlook	Temperature	Humidity	Wind	PlayTennis
D1	*Sunny*	*Hot*	*High*	*Weak*	*No*
D2	*Sunny*	*Hot*	*High*	*Strong*	*No*
D3	*Overcast*	*Hot*	*High*	*Weak*	*Yes*
D4	*Rain*	*Mild*	*High*	*Weak*	*Yes*
D5	*Rain*	*Cool*	*Normal*	*Weak*	*Yes*
D6	*Rain*	*Cool*	*Normal*	*Strong*	*No*
D7	*Overcast*	*Cool*	*Normal*	*Strong*	*Yes*
D8	*Sunny*	*Mild*	*High*	*Weak*	*No*
D9	*Sunny*	*Cool*	*Normal*	*Weak*	*Yes*
D10	*Rain*	*Mild*	*Normal*	*Weak*	*Yes*
D11	*Sunny*	*Mild*	*Normal*	*Strong*	*Yes*
D12	*Overcast*	*Mild*	*High*	*Strong*	*Yes*
D13	*Overcast*	*Hot*	*Normal*	*Weak*	*Yes*
D14	*Rain*	*Mild*	*High*	*Strong*	*No*

3. (a) Consider a medical diagnosis problem in which there are two alternative hypotheses: (i) that the patient has a particular form of cancer, and (ii) that the patient does not. The available data is from a particular laboratory test with two possible outcomes positive and negative. You have prior knowledge that over the entire population of people only 0.008 have this disease. Furthermore, the lab test is only an imperfect indicator of the disease. The test returns a correct result in only 98% of the cases in which the disease is actually present and a correct negative result in only 97% of the cases in which the disease is not present. In other case, the test returns the opposite result. Determine the MAP hypothesis. 4

   (b) Describe why sigmoid functions are used in the classical Backpropagation algorithm. Mention the remarks on Decision Tree Learning. 4

   (c) Describe briefly the face recognition procedure applying feed-forward Backpropagation ANN concept. 7

4. (a) Mention the roles of support vector machine and *k*-nearest neighbor in machine learning. 4

   (b) Explain various types of ANNs. Also, mention the name of respective algorithm(s) used to train each type of ANN. 4

   (c) Discuss and design a learning system for *tic-tac-toe* game playing problem. 7