Set B

BRAC UNIVERSITY

Department of Computer Science and Engineering

Examination: Semester Final | Semester: Fall 2024

Duration: 2 Hours | Full Marks: 40

CSE 422: Artificial Intelligence

Answer all the following questions. (**Keep your answers precise and to the point**)

Figures in the right margin indicate marks.

Name:	ID:	Section:

1. CO3 a. You are provided with the following data collected from a survey done on a single day at a smart-phone sales center. 14 young men, 8 young women, 7 old men and 1 old woman bought Nokia phones. 8 young men, 12 young women, 5 old men and 3 old women bought Samsung phones. 14 young men, 9 young women, 11 old men and 8 old women bought Apple phones. Considering that an individual can like only one type of phone brand, answer the following.

i. **Construct** a Full Joint Probability Distribution table, defining three random variables: A(Age), G(Gender), and S(Smartphone bought). 2

ii. **Calculate** the (conditional) probability of an individual uniformly selected from this population not to buy an Apple phone if he / she is of old age. 2

iii. Please **justify** if the following is true or false, $S \perp A \mid G=\text{female}$, which is Smartphone bought (S) is conditionally independent of Age (A) given G=female. [P.S. You'll need to make sure all possible scenarios satisfy the condition] 2

iv. What is the expected number of Samsung users among 30 randomly selected old persons from this population? 2

b. **Prove** that if $P(A|B,C) = P(B|A,C)$, then $P(A|C) = P(B|C)$ 2

2. CO3 After having fever and feeling sore throat, Mr. X went to the hospital for HMPV virus check and the test result was negative. Upon asking the legitimacy of the results, the doctors revealed that within last few weeks, 7% of the HMPV positive patients were diagnosed negative and 88% of the HMPV negative patients were diagnosed negative. They also notified that 86% of all visiting patients were actually HMPV negative.

a. Given such information, **find** out the probability of Mr. X being actually HMPV positive. 6

b. Mr. X did a second, third, and fourth test with the same machine, where all the three test results were positive. Assuming that the individual test results are conditionally independent of each other given being actually HMPV positive or actually HMPV negative, **find** out the more likely scenario, HMPV positive or negative? [P.S. you have to take all the four test results into consideration] 4

3. CO4 BRAC University is evaluating student success in the "Artificial Intelligence" course by analyzing various factors such as "Lecture Attendance," "Assignment Completion," and "Exam Scores." Students are classified as "Pass" or "Fail" based on their final grades.

The dataset has the following distribution based on the attribute "Exam Scores":

-Above 80%: 8 Pass, 2 Fail

-Between 50% and 80%: 5 Pass, 5 Fail

-Below 50%: 1 Pass, 9 Fail

a. If the total entropy of the dataset is 0.918, **Calculate** the information gain when splitting based on "Exam Scores." 3

Assume that after splitting the "Below 50%" subset based on "Lecture Attendance," the distribution is as follows:

-High Attendance: 1 Pass, 2 Fail

-Moderate Attendance: 0 Pass, 7 Fail

b. **Calculate** the conditional entropy after splitting based on the attribute "Lecture Attendance" for the subset "Below 50%". 2

c. **Compute** information gain after splitting based on the attribute "Lecture Attendance" for the subset "Below 50%". 2

d. **Identify** whether the following statements are True/False.

i. A Decision Tree is a supervised learning algorithm that can be used only for classification tasks. 1

ii. The attribute with the highest information gain is selected as the root node in a Decision Tree. 1

iii. Entropy does not measure the impurity or disorder of a dataset. 1

4. CO4

Sl	Age (x1)	Height (x2)	Weight (y_i)
1.	2	3	4
2.	3	4	5
3.	4	5	6

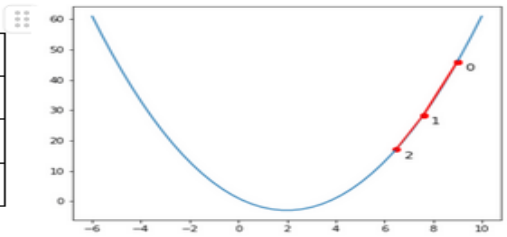

Fig A

Suppose you are asked to predict weight based on a person's height and age. And you notice that these three variables have more or less a linear relationship and so you choose linear regression to address this. Based on this answer the following questions.

The loss function for your regression model will be:

$$1/N \sum_{i=1}^{N} (y_i - y'_i)^2. \quad \textbf{Where } \mathbf{y_i' = m_1 x1_i + m_2 x2_i + c}$$

a. "The given problem can be treated as a classification problem" - **explain** in brief if this statement is true or not. 1

b. What do you think would be the effect of a learning rate which decreases over time? **Explain**. 2

c. Suppose fig A represents a **Loss function** (y axis) vs **coefficient** (x axis) curve which showcases how gradient descent slowly optimizes the coefficient and takes it to the point of global minima. Now suppose at some iteration n, you are at point 1, in the next iteration gradient descent would take you to point 2 and not point 0. How does gradient descent do this, **explain** mathematically. 3

d. Assuming learning rate = 0.1, m1 = 0.4 (age), m2 = 0.5 (height) and c = 0.6 use a single iteration of gradient descent to **estimate** the new values of **m1** , **m2** and **c**. 4

∀(A. B. C): P(A^B|C) = P(A|C) P(B|C), where A and B conditionally independent given C

$P(A) = \Sigma_b P(A \wedge b)$

Entropy = $\Sigma_i p_i \log_2 p_i$

Information Gain, I (X,Y) = H (X) - Σ_i P(Y=y) H(X | Y=y)