Set B

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BRAC UNIVERSITY
Department of Computer Science and Engineering
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Examination: Semester Final   Semester :Spring 2024
Duration: 1 Hour 50 Minutes   Full Marks: 40

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CSE 422: Artificial Intelligence
Answer the following questions.
Figures in the right margin indicate marks.
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Name:	ID:	Section:

1. CO4

SL no.	unique_ID	Age	Income	Student?	Credit Rating	Buys_Computer ?
1	#5	30	High	NO	Fair	NO
2	#19	30	High	NO	Excellent	NO
3	#24	32	High	NO	Fair	YES
4	#2	41	Medium	NO	Fair	YES
5	#10	42	Low	YES	Fair	YES
6	#32	44	Low	YES	Excellent	NO
7	#4	37	Low	YES	Excellent	YES
8	#8	28	Medium	NO	Fair	NO
9	#6	31	Low	YES	Fair	YES
10	#7	36	Medium	YES	Fair	YES
11	#9	22	Medium	YES	Excellent	YES
12	#14	35	Medium	NO	Excellent	YES
13	#13	37	High	YES	Fair	YES
14	#21	42	Medium	NO	Excellent	NO

a. Among the features **"Student"** and **"Credit Rating"**, which one do you think would be more suited for classifying if a person would buy a computer or not? **Provide** answer using ID3.   4

b. Do you think **"unique_ID"** would be a good feature for classification here? **Provide** a brief explanation to support your claim.   2

c. Can we use **"Age"** as a building node for the decision tree? If not, then what must we do beforehand?   2

d. For row number 4,10 and 11 if the value of **"Buys_Computer"** becomes **"Soon"**, then **compute** the Information Gain for feature **"Income"**.   2

2. CO2   CARB University (CARBU) wants to start a new degree program which is B.A. in Social Media Influencing (SMI).
Suppose the degree program is associated with the following courses:

SMI101: Fundamentals of Social Media Influencing	SMI251: Increasing Engagements
SMI111: Principles of Shorts	SMI360: Finance, Advertisement and Boosting
SMI422: Representation and Problem-Solving	SMI321: TikTok
SMI421: Media Networking	SMI320: Instagram
SMI220: Reels	

In order to graduate from the degree program, one must complete the following four requirements:
Requirement 1: SMI422 OR SMI320.
Requirement 2: SMI251 OR SMI321 OR SMI360.
Requirement 3: SMI422 OR SMI421 OR SMI220.
Requirement 4: (SMI101 AND SMI111) OR (SMI101 AND SMI422) OR (SMI421 AND SMI251).
In addition, the department imposes the following restrictions:
Restriction 1: Students can't take both SMI101 and SMI360.

Restriction 2: Students can't take both SMI251 and SMI321.
Restriction 3: Students can take only one class from the set SMI422, SMI421, and SMI320.
In addition, courses cannot be used to count towards multiple graduation requirements - so if you use SMI422 to fulfill part of the Requirement 1 it can't count towards either the Requirement 3 or Requirement 4. Answer the following,

a. X just started his junior year at CARBU, and needs to graduate as soon as possible. Suppose all he has left to take are SMI required classes. **Determine** the initial domains and at least 4 constraints of his trying to find a set of classes to satisfy all requirements as a CSP (Hint: the requirements should be variables).   5

b. Suppose X has already taken SMI422 towards his Requirement 1 and SMI101 towards Requirement 4. **Determine** other classes he must take to graduate using forward checking and explain how the forward checking help.   5

3. CO3 a. A patient went to the hospital for a malaria test. The doctors informed him that their test can successfully diagnose malarial positive given the patient is actually malaria positive 94% of the time. Also, the probability of having no malaria and getting a malaria negative test result is 4%. Meanwhile, 27% of people in general who come for tests are malaria positive. Now if the patient is already diagnosed malaria negative, then **calculate** the probability of the patient actually being malaria negative.   6

b. Is being malaria positive and having a positive test result independent of each other? **Show** calculation and figure out using the information from question A. (Keep two digits after the decimal point of the final score).   4

4.CO4

Vehicle ID	Engine Size (liters)	Fuel Efficiency (mpg)
1	1.6	30
2	2.0	27
3	2.5	24
4	3.0	22
5	3.5	20

Let Engine Size be the input variable (also known as predictor), x and the Fuel Efficiency the output variable (also known as response), y. To predict the value of y, we establish a linear relationship $h_w(x) = w_1 x + w_0$.

a. **Interpret** the meaning of the weights, w_1 and w_0 in terms of linear regression   1

b. Let us define the Loss-function, $Loss(h_w) = \sum_{j=1}^{N} y_j - (w_1 x_j + w_0))^2$ and the [partial-derivative of this Loss-function with respect to each weight is given by $\frac{d(Loss(h_w))}{dw_0} = -2(y - h_w(x))$ and $\frac{d(Loss(h_w))}{dw_1} = -2x(y - h_w(x))$.   4.5

Tahia uses her special calculation and estimates the weights as $w_1 = 15$ and $w_0 = 0$. Using Gradient-descent algorithm upto 2 iteration, improve these estimates. You may consider the value of learning parameter $\alpha = 1$. **Show** all steps of calculation.

No. of iteration	$h(w)$	$Loss(h_w)$	$\frac{d(Loss(h_w))}{dw_0}$	$\frac{d(Loss(h_w))}{dw_1}$	w_0	w_1

c. Using the updated estimates of weights w_0 and w_1 from question 2, predict the fuel efficiency of a car with engine size of 3 liters. Then, **compare** this prediction with the actual selling price from the dataset to evaluate the accuracy of the model.   1.5

d. For a large data set **discuss** the effect of a decaying learning rate (Reducing learning rate over time), a on the efficiency of the learning process.   1.5

e. **Discuss** the impact on the gradient descent algorithm when the learning rate is too small.   1.5