National University of Computer & Emerging Sciences, Karachi
Spring-2021 Department of Computer Science
Final Exam
23rd June 2021, 09:00 AM – 12:00 PM

Course Code: CS461/401	**Course Name:** Artificial Intelligence
Instructor Name / Names: Dr. Fahad Sherwani, Dr. Rauf Shams Malick, Ms. Saeeda Kanwal	
Student Roll No:	**Section:**

Instructions:

- Return the question paper.
- Read each question completely before answering it. There are 6 **questions** on **3 pages.**
- In case of any ambiguity, you may make assumption. But your assumption should not contradict any statement in the question paper.

Time: 180 minutes **Max Marks: 50**

Question No. 1 **[Marks: 2+2+2]**

Sudoku is a logic-based number placement puzzle. The objective is to fill a 9x9 grid so that each column, each row, and each of the nine 3x3 boxes contains the digits from 1 to 9. Each digit can only appear once per column, row, and 3x3 box. A sample Sudoku puzzle to use for this question is given in the figure below.

	6							1
			7	9	3			
								5
		9			1	3	2	
		2				7		
	3	5	8			4		
4								
			5	2	6			
1							8	

a) Classify the characteristics of the environment for Sudoku according to the following properties and explain the analyzed reason for each of your five choices.
- Fully observable/partially observable
- Deterministic/stochastic
- Episodic/sequential
- Static/dynamic/semi-dynamic
- Discrete/continuous

b) Specify the task environment of Sudoku puzzle?
c) Are Game theoretic problems necessarily multi agent problems? Give an example of a non-zero-sum game.

Question No. 2 **[Marks: 5+1.5+1.5]**

Consider a fictitious Feedback document collection of Physical and online classes. There are 8 documents in this collection represented as 8 points in two-dimensional vector space.
Cluster the following eight points into three clusters: A1(2, 10), A2(2, 5), A3(8, 4), A4(5, 8), A5(7, 5), A6(6, 4), A7(1, 2), A8(4, 9). Initial cluster centers are A1(2, 10), A4(5, 8) and A7(1, 2).
The distance between a pair of documents is measured by the Euclidean distance between their corresponding points.

a) Use K-Means Algorithm to find the three cluster centers after the second iteration.
b) For two runs of K-Mean clustering is it expected to get same clustering results?
c) How can Clustering (Unsupervised Learning) be used to improve the accuracy of Linear Regression model (Supervised Learning)?

Question No. 3 **[Marks: 5+1+1+1]**

A University bookstore must order books two months before each semester starts. They believe that the number of books that will ultimately be sold for any particular course is related to the number of students registered for the course when the books are ordered. They would like to develop a linear regression equation to help, plan how many books to order. From

past records, the bookstore obtains the number of students registered, X, and the number of books actually sold for a course, Y, for 12 different semesters as shown below.

Semester	Students	Books
1	36	31
2	28	29
3	35	34
4	39	35
5	30	29
6	30	30
7	31	30
8	38	38
9	36	34
10	38	33
11	29	29
12	26	26

a) Obtain a scatter plot of the number of books sold versus the number of registered students.
b) Give the regression equation and interpret the coefficients in terms of this problem.
c) If appropriate, estimate the average number of books that would be sold in a semester for all courses with 30 students registered. Use 95% confidence.
d) What do we learn while 'learning the regression model'? is it the slope, y-intercept or any other coefficients?

Question No. 4 **[Marks: 2+2+4+2]**

Table given below is basically showing results on a specific model results for different classes. It shows the value of how many labels have been predicted correctly and incorrectly.

a) Define Precision and Recall.
b) Why Regression models are suitable for continuous variables? Explain.
c) Calculate precision and recall for each class separately from the given data.
d) Calculate accuracy of this model using the values mentioned in the table given below.

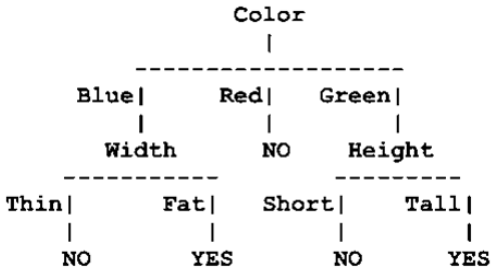
Docs in test set	Assigned UK	Assigned poultry	Assigned wheat	Assigned coffee	Assigned interest	Assigned trade
True UK	95	1	13	0	1	0
True poultry	0	1	0	0	0	0
True wheat	10	90	0	1	0	0
True coffee	0	0	0	34	3	7
True interest	-	1	2	13	26	5
True trade	0	0	2	14	5	10

Question No. 5 **[Marks: 1+2+2+5]**

a) Why do we calculate Entropy and Information Gain? Explain briefly.
b) Using the dataset below, we want to build a decision tree which classifies Y as T=F given the binary variables A; B; C. Draw the tree that would be learned by the greedy algorithm. You do not need to show any computation.

A	B	C	Y
F	F	F	F
T	F	T	T
T	T	F	T
T	T	T	F

c) Given the following decision tree, show how the new examples in the table would be classified by filling in the last column in the table.



Example	Color	Height	Width	Class
A	Red	Short	Thin	
B	Blue	Tall	Fat	
C	Green	Short	Fat	
D	Green	Tall	Thin	
E	Blue	Short	Thin	

d) Using the dataset below, design a decision tree which predicts if Students pass the Machine Learning course (Yes or No), based on their previous GPA (High, Medium, or Low) and whether or not they studied. Also show the calculations for Entropy and Information Gain.

GPA	Studied	Passed
L	F	F
L	T	T
M	F	F
M	T	T
H	F	T
H	T	T

Question No. 6 **[Marks: 2+2+4]**

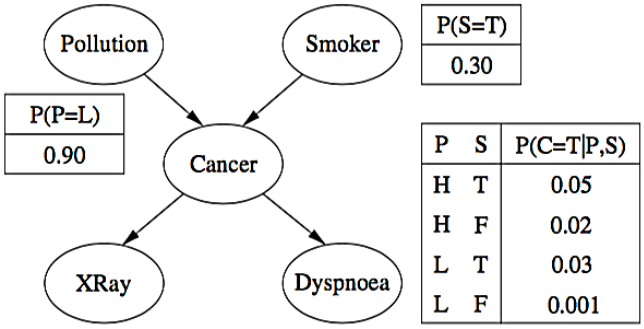
a) Draw the Bayesian Network that corresponds to the following conditional probability:

P (A | B,C,E) P(B | D,G) P(C | E,F,H) P(D | G) P(E| G,H) P(F | I) P(G | H) P(H | I) P(I)

b) Suppose we have a robot on a grid world with a noisy sensor and we know the distribution for P(Observation|Location) of sensor readings given the robot's grid square. We also have knowledge about the locations in the form of a prior, P(Location). However, we are really interested in the probability of being in a grid square given the sensor reading, P(Location|Observation). How could you compute this probability? Short answer.

c) Consider the Bayesian Network given below.

1. Calculate P(Cancer)
2. Calculate P(Pollution|Cancer)
3. Calculate P(Xray|Cancer)
4. Calculate P(Dyspnoea|Cancer)



P(P=L)
0.90

P(S=T)
0.30

P	S	P(C=T|P,S)
H	T	0.05
H	F	0.02
L	T	0.03
L	F	0.001

C	P(X=pos|C)
T	0.90
F	0.20

C	P(D=T|C)
T	0.65
F	0.30

$$precision = \frac{TP}{TP + FP}$$

$$recall = \frac{TP}{TP + FN}$$

$$F1 = \frac{2 \times precision \times recall}{precision + recall}$$

$$accuracy = \frac{TP + TN}{TP + FN + TN + FP}$$

$$specificity = \frac{TN}{TN + FP}$$

$$Entropy(S) = \sum_{i=1}^{c} -p_i \log_2 p_i$$

$$Gain(S, A) = Entropy(S) - \sum_{v \in Values(A)} \frac{|S_v|}{|S|} Entropy(S_v)$$