National University of Computer and Emerging Sciences

Karachi Campus

Artificial Intelligence (AI2002)

Final Exam

Total Time (Hrs): 3
Total Marks: 50
Total Questions: 7

Date: May 27th 2024

Course Instructor(s)

Dr. Fahad Sherwani, Dr. Farrukh Hassan Syed,
Mr. Syed Faisal Ali, Miss. Fizza Aqeel,
Miss. Mafaza Mohi, Mr. Sandesh Kumar

[redacted] Roll No

[redacted] Section

[redacted] Student Signature

Do not write below this line

Attempt all the questions.

CLO#1: To grasp the concepts of rational behavior and intelligent agents

Q1: Answer the following brief questions

1. What are the primary characteristics that define a rational agent in Artificial Intelligence?
2. Why CSPs use factored state representation? Give justification.
3. An autonomous drone delivery system operates in a complex environment where it must deliver packages to various locations within a city. Explain whether the environment for the agent is episodic or sequential. Justify your answer.
4. How does local beam search differ from standard hill-climbing algorithms in terms of handling multiple states simultaneously during search?
5. What are the key differences between depth-first search (DFS) and breadth-first search (BFS) in terms of space and time complexity?
6. Assume that a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves. (T/F). Justify.
7. Minimax algorithm leads to outcomes at least as good as any other strategy only when the opponent is also optimal. Give Justification.
8. Write any two limitations of hill climbing algorithm in optimization problems
9. Given a CSP with n variables of domain size d, what would be the size of the search tree: (i) with commutativity (ii) Without commutativity.
10. Iterative deepening search can also be applied to adversarial search. Give Justification. **[10 Marks]**

CLO#3: To showcase comprehension and capability in implementing key concepts and methodologies in probabilistic reasoning, machine learning algorithms, and neural networks

Q2: (A). Consider a population in which 30% of individuals have a certain genetic trait, denoted as Trait A. Among those with Trait A, 70% also have Trait B, while among those without Trait A, 20% have Trait B.

1. What is the conditional probability that an individual has Trait B given that they have Trait A?
2. What is the unconditional probability that a randomly selected individual from the population has Trait B?

(B). Calculate the Joint Probability Distribution of the following figure 1.

T(B|A) = 0.7

T(A) = 0.3

Temperature in C° (x)	0	25	50	75	100	125
Yield in Grams (y)	10	25	40	55	70	?

Table 3: Training Data

Find the estimated yield in grams using regression, if the temperature is raised to 125 C°

[1 + 3 = 4 Marks]

Q5: (A). You are a data analyst at a healthcare organization. Your task is to predict whether a patient is likely to have diabetes based on historical patient data. The dataset includes the following features for each patient:

- Age - BMI (Body Mass Index) - Blood Pressure - Insulin Level - Glucose Level
- Diabetes status (1 for diabetes, 0 for no diabetes)

Given the following data in table 4, use the K-Nearest Neighbors (KNN) algorithm to classify whether a new patient with the following characteristics will have diabetes, use k=3:

Age:	BMI:	Blood Pressure	Insulin Level	Glucose Level
45	28	80	100	140

Table 4: Test Data

The historical data is in table 5 as follows:

Age	BMI	Blood Pressure	Insulin Level	Glucose Level	Diabetes
25	22	70	85	130	0
30	30	85	90	150	1
35	28	80	105	160	1
40	25	75	100	140	0
50	27	78	95	145	0
55	31	90	110	155	1
60	26	85	108	148	0
65	29	88	115	165	1
70	32	92	120	170	1

Table 5: Training Data

Tasks:

1. Calculate the Euclidean distance between the new patient and all patients in the dataset.
2. Identify the K-nearest neighbors based on the distances calculated.
3. Predict whether the new patient will have diabetes using majority voting.
4. Discuss how the choice of k affects the classification result and how you might select an optimal k.

[1.5 + 1 + 1 + 0.5 = 4 Marks]

Q5: (B). Construct a complete decision tree using the ID3 algorithm on the provided data. Display the entire tree from the root node to leaf nodes as indicated in the set. Dataset of animal classification have the following attributes:

- Habitat (Forest, Desert, Grassland)
- Diet (Herbivore, Carnivore, Omnivore)
- Activity (Diurnal, Nocturnal)

National University of Computer and Emerging Sciences
Karachi Campus

Animal Type (Mammal, Bird, Reptile) - this is the target variable. **[8 Marks]**

Habitat	Diet	Activity	Animal Type	
Forest	Herbivore	Diurnal	Mammal	1
Forest	Carnivore	Nocturnal	Mammal	2
Desert	Carnivore	Nocturnal	Reptile	1
Grassland	Herbivore	Diurnal	Bird	1
Forest	Omnivore	Nocturnal	Mammal	3
Grassland	Omnivore	Diurnal	Bird	2
Desert	Omnivore	Nocturnal	Reptile	2
Grassland	Herbivore	Diurnal	Bird	3
Forest	Herbivore	Nocturnal	Mammal	4
Desert	Herbivore	Diurnal	Reptile	3

Table 6: Training Data

Q6: Use the k-means algorithm and Euclidean distance to cluster the following 8 examples into 3 clusters:

Data Points	A1	A2	A3	A4	A5	A6	A7	A8
x	2	2	8	5	7	6	1	4

Suppose that the initial seeds (centers of each cluster) are A1, A4 and A7. Initially, run the k-means algorithm for 2 epochs. After the 2nd epoch, please give the following:

a) New Centroid Values
b) Newly formed cluster sets.
c) How many more iterations are needed to converge? Please Justify. **[2+2+2= 6 Marks]**

Q7: Consider a feedforward neural network with one input layer consisting of two input neurons, two hidden layers with three neurons each, and one output layer with one neuron. The activation function used in all layers is the sigmoid function. Draw the neural network and compute the output.

Input Layer to First Hidden Layer (Layer 1):	First Hidden Layer to Second Hidden Layer (Layer 2):	Second Hidden Layer to Output Layer (Layer 3):
Neuron 1: Weight 1: 0.1, Bias: -0.2 Weight 2: -0.3, Bias: 0.4 Neuron 2: Weight 1: 0.5, Bias: -0.1 Weight 2: -0.2, Bias: 0.3 Neuron 3: Weight 1: 0.4, Bias: 0.2 Weight 2: -0.1, Bias: -0.5	Neuron 1: Weight 1: 0.2, Bias: 0.1 Weight 2: -0.4, Bias: 0.3 Weight 3: 0.5, Bias: -0.2 Neuron 2: Weight 1: 0.3, Bias: -0.4 Weight 2: -0.2, Bias: 0.2 Weight 3: 0.1, Bias: 0.3 Neuron 3: Weight 1: -0.1, Bias: 0.2 Weight 2: 0.4, Bias: -0.3 Weight 3: -0.2, Bias: 0.1	Neuron 1: Weight 1: -0.3, Bias: 0.5 Weight 2: 0.2, Bias: -0.1 Weight 3: 0.4, Bias: 0.3

Given an input vector [0.6, -0.1], calculate the output value of the neural network. Assume the sigmoid activation function for all neurons. **[6 Marks]**