National University

of Computer & Emerging Sciences Peshawar Campus

Student Name: ____________________ Roll No: __________________

Program: BS (CS-18)
Semester: SPRING – 2021
Time Allowed: 3:00 hours
Course: **Artificial Intelligence (CS-461)**

Examination: **Final**
Total Marks**: 100** Weightage**: 60**
Date: **08-07-2021**
Instructor: **Dr. Hafeez Ur Rehman**

NOTE: Attempt all questions.

Question # 01: **[Marks: 10]**

A. Characterize the following agents into their respective task environments (answer in tabular format):

Agents / Environment Types	**Deterministic/ Stochastic**	**Static/Dynamic/ Semi-dynamic**	**Episodic/Sequential**	**Discrete/ Continuous**
GO game				
Agent Playing Cricket				
Lecturing Robot				
Self-driving car				
Aerial Drone				
Chess with a clock				
Crossword				

Question # 02: **[Marks: 5+10]**

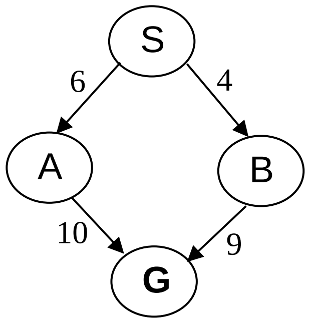
A. Consider an unbounded search tree with branching factor of 40 and depth of the shallowest goal state at 20th level (assuming the worst case). What is Time and Space complexity (in terms of number of nodes) of BFS, DFS and Iterative deepening search strategies for this tree (don't write asymptotic notation but actual number of nodes)?

B. Draw an example **state space graph** with path costs and heuristic function values in which the heuristic is admissible but A* is not optimal.

Question # 03: **[Marks: 2+2+5+6]**

Consider the following search space (S is the initial state and G is the goal state) with actual path costs *g(n)* along the edges and relative heuristic function *h(n)* values as shown in the table below:

Heuristic	value
h(S)	21
h(A)	04
h(B)	08
h(G)	00



Now, answer the following questions:

a. Is *h(x)* admissible?
b. Is *h(x)* consistent?
c. Will **Uniform Cost Search (UCS) algorithm** give an optimal solution for this problem? If yes, give the order of node expansion. If no, then suggest changes (in **search space**) such that **UCS becomes optimal**.
d. Will **A* search algorithm** give an optimal solution using this heuristic? If yes, give the order of node expansion. If no, then suggest changes (in **heuristic or search space**) such that **A* becomes optimal**.

Question # 04: [**Marks: 5+5+10**]

1. What are the **three reasons** for *Hill Climbing* algorithm to be incomplete in a larger search space?
2. In **simulated annealing**, what is the effect of **temperature** and **worst move (ΔE)** on probability of accepting locally bad move?
3. Consider the 5-Queen problem that you would like to solve using Genetic Algorithms. Each queen can only move in its column. The idea is to find a configuration in which no queen attacks the other. A random configuration of the problem is shown below:

[**Marks Distribution: 2+2+4+1+1**]

Q1			**Q4**	
	Q2			
				Q5
		Q3		

In the above context answer the following:

a. How will you turn it into a maximization problem? Write objective function.
b. What will be the maximum fitness value that your algorithm will try to achieve?
c. Start with a random population of **four individuals** and list the steps involved using Genetic Algorithm (allowed modification operators are crossover and mutation) in generating the first generation of states?
d. What will happen if the mutation probability is set to 0?
e. What will happen if we avoid doing crossover?

Question # 05: **[Marks: 5+5+5+5]**

Consider the following training data:

Example	**A1**	**A2**	**A3**	**A4**	***y* (label)**
X_1	0	0	0	0	**1**
X_2	0	0	0	1	**1**
X_3	0	1	1	0	**0**
X_4	0	1	1	1	**0**
X_5	1	0	0	0	**0**
X_6	0	1	0	1	**1**
X_7	1	1	0	0	**0**
X_8	1	1	0	1	**1**

In the context of the above, answer the following questions:

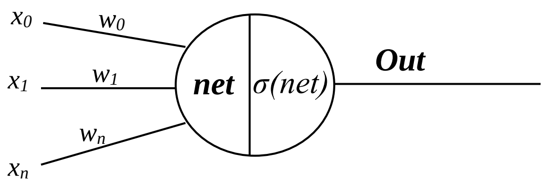
A. If we want to search for a hypothesis for the above data. What will be the size of the hypothesis space? And why? Elaborate your answer.
B. Explain how a new example, say X = [1, 1, 1, 0] will be classified using KNN with the value of k=3.
C. How the value of k is related to overfitting/underfitting? Explain each case with an example.
D. In your opinion, for which type of problems you will prefer KNN classification and for which type you will not prefer? And why? Elaborate your answer with an example.

Question # 06: **[Marks: 10 + 10]**

a. Let us consider a perceptron that you want to train for the **NAND function**. Initialize the weights of the perceptron with values (0.0, 0.0, 0.0). You have to train the perceptron to learn the NAND function. **Give values after the first two training iterations** of the perceptron learning algorithm. Assume learning rate η=0.1, and incremental weight updates.

b. **Derive** the formula for $\Delta \mathbf{W}_i$ using ***gradient descent training rule*** for the following unit with inputs $x_0, x_1, ..., x_n$ (including bias) as well as output ***Out*** which is a **sigmoid** function $\sigma(x)$.

Whereas, $\sigma'(x) = \sigma(x)(1-\sigma(x))$ and ***net*** = $w_0x_0+w_0x_0^2+w_1x_1+w_1x_1^2+\ldots\ldots.+ w_nx_n+w_nx_n^2$



----- Good Luck! -----