National University

of Computer & Emerging Sciences Peshawar Campus

Student Name: _____ Roll No: _____

Program: BS (CS-17)
Semester: SPRING – 2020
Time Allowed: 3:00 hours
Course: **Artificial Intelligence (AI)**

Examination: **Final**
Total Marks**: 100** Weightage**: 60**
Date: **29-06-2020**
Instructor: **Dr. Hafeez Ur Rehman**

NOTE: Attempt all questions.

Question # 01: **[Marks: 10+5+10]**

A. Artificial intelligence may be defined as a discipline that systematizes and automates reasoning processes to create machines that **think/act like humans**, **think/act rationally**. Explain each approach using the **example of an automated vehicle**. List the relative **advantages** and **disadvantages** of each approach.

B. Explain **with example** the following statement in the context of rational agents: "**A lot of rational behavior has nothing to do with logic**"?

C. 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 Professor				
Self-driving car				
Aerial Drone				
Chess with a clock				

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

A. Consider an unbounded search tree with branching factor of 35 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.

C. The **heuristic path algorithm** is a best-first search in which the evaluation function is:

$$f(n) = (2 - w) * g(n) + w * h(n).$$

a. For what values of *w* is this complete?

b. For what values is it optimal, assuming that *h* is admissible?

c. What kind of search does this perform for *w = 0*, *w = 1*, and *w = 2*?

Question # 03: **[Marks: 10]**

Consider an artificially intelligent agent that plays the **15-puzzle game** with one of the following goal states G1 or G2:

G1 =

	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

G2 =

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	

Which of the following initial states (S1, S2) are reachable to goal G1 and which are reachable to goal G2? **Also give reason to support your answer**?

S1 =

15	10	13	12
1	9	2	3
4	5	6	7
14	11		8

S2 =

15	12	7	14
13		6	11
8	9	10	5
4	1	2	3

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. Consider a very large state space with a search failure probability *p=0.20. Considering a Random Restart Hill Climbing;* what is the **expected number of restarts** (number of success? number of failures?) and **average number of steps** (if avg. of success is 60 and avg. of failure is 20)?
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.

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