

**Birla Institute of Technology & Science, Pilani**  
**Work-Integrated Learning Programmes Division**  
**Second Semester 2018-19**  
**Mid Semester Examination( Makeup )**

Course No. : DSECL ZG557  
Course Title : Artificial & Computational Intelligence  
Nature of Exam : Closed Book  
Weightage : 30%  
Duration : 1.5 Hours  
Date of Exam : 05 / 01 / 2020, AN  
PM

No. of Pages	= 4
No. of Questions	= 4

Time of Exam: 2:00 PM to 3:30

**Note:**

1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. **Questions must be answered only in the page numbers mentioned against each question. In case you require more pages to answer a question, you can continue from page #21**
4. Assumptions made if any, should be stated clearly at the beginning of your answer.

**Answer all the questions**

**Question -1 [1.5 + 1.5 + 1.5 + 2 + 1.5 = 8 M]**

**[ Page 03 - 09 ]**

(1-a) Provide one point for and against Turing Test to determine if a software piece is intelligent

For questions (1-b) and (1-c), answer if forward search (data driven search) or backward search (goal driven search) will be more appropriate with one good reason for the scenarios given:

(1-b) You have met a person Dr. Rajiv who claims to be your distant cousin. You need to verify his claim by finding some common ancestor who is a few generations older.

(1-c) A system that will help human to classify plants by species

For questions (1-d) and (1-e) consider the following scenario:

*A farmer with his wolf, goat, and cabbage come to the edge of a river they wish to cross. There is a boat at the river's edge, but, of course, only the farmer can row. The boat also can carry only two things (including the rower) at a time. If the wolf is ever left alone with the goat, the wolf will eat the goat; similarly, if the goat is left alone with the cabbage, the goat will eat the cabbage. Devise a sequence of crossings of the river so that all four characters arrive safely on the other side of the river.*

(1-d) Devise a concise representation of a state (considering all possible uses of this in search algorithms taught to you). As per the representation devised provide write down the representation of a start state and the goal state.

Provide the data structure description of a state. Specify the fields (with details of what goes into), pointers to be kept in the node.

Answers both in pseudo code, pictorial rep, in description are all allowed. [1.5 M]

State diagram, solution to the problem are not expected here

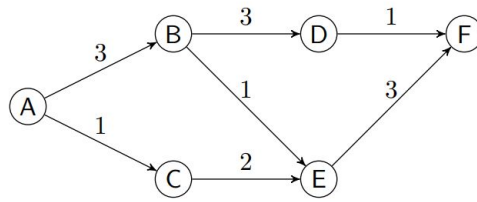
(1-e) Which of DFS or BFS is most preferred for this problem? Why.

DFS is recommended. This will lead to the least number of nodes being expanded. This will become obvious when the state diagram is drawn.

**Question -2 [ 4 + 2 + 1 = 7 M]**

**[ Page 10 - 15 ]**

(2-a) Consider the following state space and the heuristic function associated. The initial state is A and the goal state is F.



Show the result of Uniform cost search algorithm on this search tree.

(2-b) Is the uniform cost search (as presented in class and Text Book) a tree search or a graph search? Explain why should it be this way?

(2-c) When the heuristic function  $h(n) \geq \epsilon$  ( where  $\epsilon$  is a small positive constant) the states expanded by A\* algorithm will be a subset of uniform cost search. Why or why not?

**Question -3 [3+2+ 3 +2 + 1 = 11 M]**

**[ Page 16 - 22 ]**

The *sliding-tile puzzle* consists of three black tiles, three white tiles, and an empty space in some order. The goal is to arrive at the goal configuration shown below by legal moves [B- Black tile, W-White tile].

B	B	B		W	W	W
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The puzzle has two legal moves with associated costs

Move #1: A tile may move into an adjacent empty location. This has a cost of 1.

Move #2: A tile can hopover one or two other tiles into the empty position. This has a cost equal to the number of tiles jumped over

(2-a) What are measures using which the complexity of a state space can be measured. List each of them and provide the corresponding expression / value for this problem.

Listing of space, branching ,- 1Mark, Corresponding values for this problem - 2M

(2-b) Write down an admissible heuristic function  $h(n)$  for this problem with a formal description. Explain why this proposed heuristic is admissible.

1Mark for heuristic function and 1Mark for explaining

$h(n)$  = # of white tiles on the wrong side of each black tile

- Breadth-first search is admissible, monotonic and very uninformed.
- Counting tiles out of the goal position is a simple useful heuristic that is admissible.
- A form of this heuristic would be to count all white tiles on the wrong side of each black tile.
- For example for the following configuration, there are 3 Ws on the right side of 1st B, and 2 Ws on the right side of both the 2nd and 3rd Bs.
- Therefore  $h(n) = 3+2+2 = 7$  B\_WBBWW
- Counting tiles out of place is not monotonic, but is more informed than breadth-first search. An easy way to prove that a heuristic is non-monotonic is to watch its value change as it goes along a search path.

(2-c) Generate the A\* search tree (using tree search) starting with the following start state for depth up to 3 or until the goal state is reached, whichever is earlier.

W	B	W	B	B	W	
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3Marks for : Annotate each node and edges with appropriate values  $f(n)$ ,  $h(n)$  and  $g(n)$  for better understanding. A search tree without such annotations will not get full credit here.

(2-d) Argue formally the optimality of the solution obtained.

Valid argument - 2M, Good attempt in right direction - 1M

(2-e) Will the solution obtained be different if the heuristic is also consistent in addition to being admissible. Why or why not?

0.5 , 0.5 for reasoning.

#### Question -4 [ 4M]

[ Page 22 - end ]

You have been asked to solve below linear equation problem with multiple variables:

$$2a + 7b - 5c + d = 0$$

where a, b,c, and d are integers in the range [-20,20] (equation can have more than one solution)

You have decided to solve this question using genetic algorithm. Show all the steps involved in solving this using Genetic Algorithm.

Number each of your steps, and provide appropriate title to those steps. (No need to get the final solution, just the first iteration of each step involved in the algorithm)

Most likely representation of chromosome could be a list with 4 integers with each integer representing variables a,b,c or d. For example [3,2,3,1] would imply  $a=3, b=2, c=3, d=1$ .

Generate random population (list of lists)

Fitness function - use a fitness function (most likely  $f(x) = 2a + 7b - 5c + d$ ) and calculate the fitness of each individual

Apply some selection criteria based on fitness value (could be roulette or the best fit etc.) to come up with initial population

Apply crossover and mutation (how students chose to incorporate crossover and mutation may differ but it should be consistent)