ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **WINTER SEMESTER, 2017-2018**

DURATION: 1 Hour 30 Minutes **FULL MARKS: 75**

CSE 4701: Artificial Intelligence

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **4 (four)** questions. Answer any **3 (three)** of them.

Figures in the right margin indicate marks.

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1. a) Consider the following generic search pseudo-code: 5

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Procedure Search(G,S,goal)
          Inputs
                    G: graph with nodes N and arcs A
                    S: set of start nodes
                    goal: Boolean function of states
          Output
                    path from a member of S to a node for
which goal is true
                    or ⊥ if there are no solution paths
          Local
                    Frontier: set of paths
          Frontier ←{⟨s⟩: s∈S}
          while (Frontier ≠{})
                    select and remove ⟨s0,...,sk⟩ from Frontier
                    if ( goal(sk)) then
                              return ⟨s0,...,sk⟩
                    Frontier ←Frontier ∪{⟨s0,...,sk,s⟩: ⟨sk,s⟩∈A}
          return ⊥
```

Figure 1: Code listing 1

Imagine that this generic algorithm was used as the basis for an implementation of depth-first search and of breadth-first search. Which line or lines of the pseudocode above must have different implementations? Briefly, how would those implementations differ?

b) IUT has been expanding for the last couple of years. Assume that IUT has acquired a new site in BoardBazar as part of the expansion project. You have to place a dormatory, a new academic building, a recreational area and an administration building. The area for development can be represented as 3x3 grid (three rows 0,1,2 and three columns 0,1,2) and you need to place each development in one cell of the grid. Unfortunately, there are some practical constraints on the problem that you need to take into account. In the following, A is close to B if A is in a cell that shares an edge with B (sharing a corner does not make two objects close). The constraints are as follows: 12

- There is a garbage dump in cell 0,0.
- There is a lake in cell 1,2.

- The dormatory and the new academic building should not be close to the garbage dump.
- The recreational area should be close to the lake.
- The dormatory and the new academic building should be close to the recreational area.
- The dormatory and the new academic building should not be close to the administration building.

Represent this problem as a CSP. Do not forget some basic constraints that are inherent in allocating objects in space but are not listed above.

c) Draw a constraint graph for this problem. If a constraint/domain is too long to fit easily in the graph, use a label in the graph instead, and indicate which constraint/domain the label refers to. 8

2. a) Consider a scenario in which there are: two block X and Y and a flat surface. The two blocks can be both on the surface, the top of the box is clear (i.e. clearX and clearY is true). When X is stacked on Y, clearX is true and clearY is false and vise versa when Y is stacked on X. Assume there is a robot that can perform 3 actions, stack X on top of Y, Stack Y on top of X, unstack the two blocks. A block can be stocked on the other if and only if both blocks are clear [i.e. nothing stacked on them]. Notice that unstack can be executed at any state. If unstack is performed, when the two blocks are already on the surface, nothing happens. 9

Provide a STRIPS representation for the actionsin this planning scenario. Please use sensible names for the actions.

b) If the robot is in a state in which clear Y is true and clearX is false, find a plan by forward planning for achieving the goal state in which clearY is false and clearX is true. Show your work i.e. draw the search space from source to desired destination 6

c) Prove that if A* selects a path to the goal, it selects the optimal i.e. lowest cost path. 10

3 a) Peg Solitaire is a board game for one player involving movement of pegs on a board with holes. The standard game fills the entire board with pegs except for the central hole. The objective is to empty the entire board except for a solitary peg in the central hole, by making valid moves. A valid move is to jump a peg orthogonally [up, down, left and right] over an adjacent peg into a hole two positions away and then to remove the jumped peg. Let the Figure 2 be a representation of a standard peg solitaire board where letters of the english alphabet represent pegs on the board and x in the middle is the initial blank spot from which the game begins. 16

Represent peg solitaire as a search problem.

i. How would you represent a node/state?
ii. What is the goal node?
iii. What are the arcs?
iv. How many possible board states are there? [Note: this is not the same as the number of "valid" or "reachable" game states, which is a much more challenging problem.]

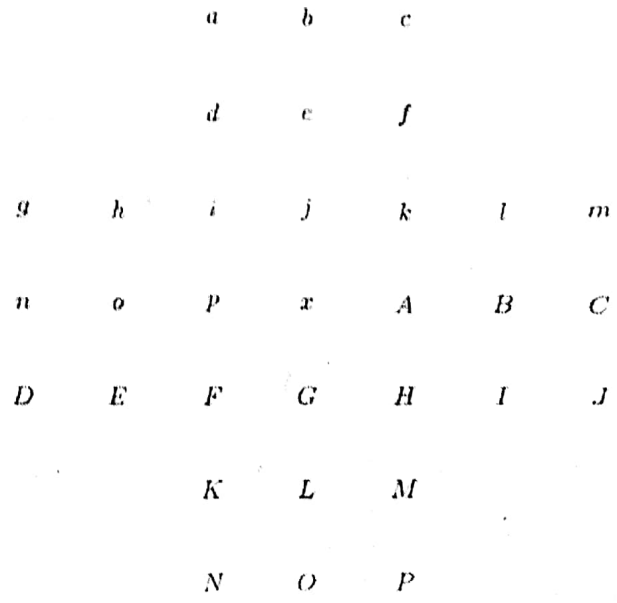

Figure 2: Representation of a peg solitaire board

b) Write out the first three levels (counting the root as level 1) of the search tree based on the labels in Figure 2. (Only label the arcs; not the nodes). What can you say about the length of the solution(s)? 9

4. a) What is a key limitation of stochastic local search and what is a key advantage? Consider two local search algorithms, A and B. A solves 25% of a given problem if it is given upto 100 minutes. B solves 35% of the problems it is given upto 55 minutes. Is one algorithm always better than the other? If not, which algorithm would you use in which conditions? 6

b) Prove that the run-time complexity of IDS is the same as DFS or BFS. 9

c) Consider the directed graph at figure 4(c)where a is the start node and k and n are both goal nodes, the true cost function is given by the edge labels, and h is an admissible heuristic function, the values for each node are shown in Table 1. 10

Table 1: Heuristic values for the graph at 4(c)

node	h(node)
a	16
b	16
c	11
d	20
e	18
k	0
m	2
n	0

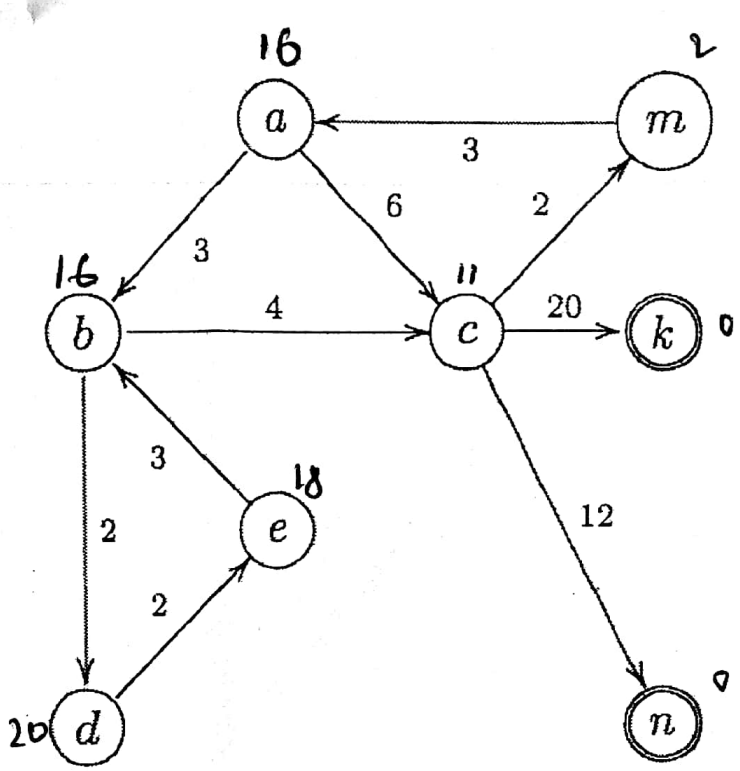

Figure 3: Directed graph for 4.(c)

Answer the following question for a case where you use Branch-and-bound search with cycle checking, in which neighbors are expanded according to f [evaluation function]. Assume that ties are broken alphabetically.

i. What sequence of paths are expanded (or considered for expansion) by branch-and-bound? (If you like, you can describe each path just by giving the last node in the path.
ii. What path is returned?
iii. What is the cost of the path?
iv. If you have to use either DFS or BFS for this problem, which one would you use and why?