FIT5047 First Theory Assignment

Due date: 2nd April 2022 (23:55).

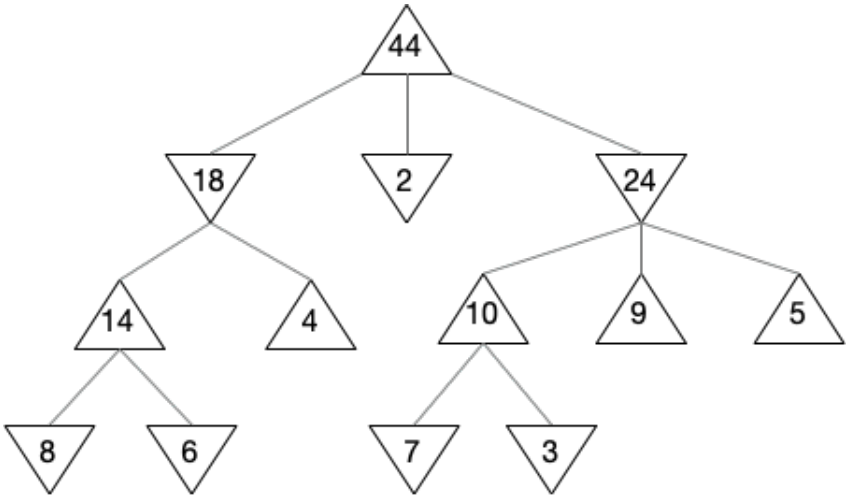
Evaluation: 100 marks = 5%.

Submission: Moodle.

1 Tentative Control Strategies

[12+8 = 20]

Use the following (fully expanded) search tree to indicate the order in which nodes are expanded for different types of search algorithms. Assume that "44" is the start node and "3" is the only goal node.



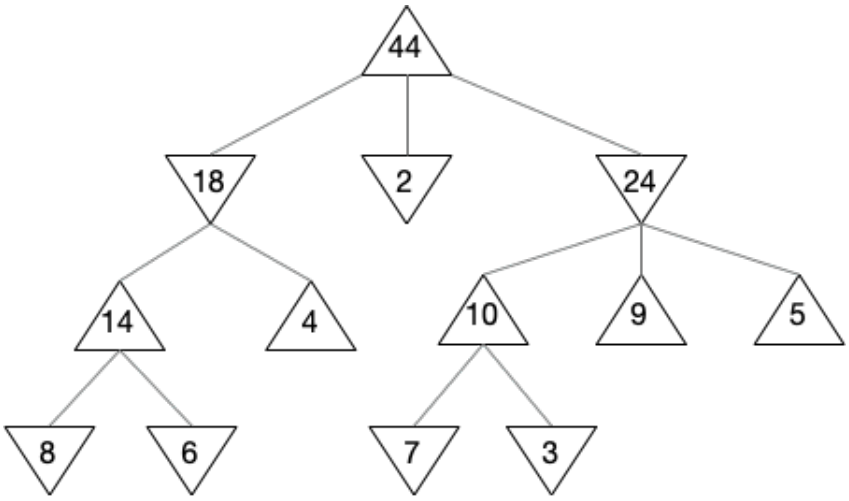
(a) Depth First Search (DFS).
List the nodes according to their order of expansion. Assume that rightmost nodes are expanded first. Moreover, list the nodes in the final search tree – that is, without the nodes deleted by the algorithm. [12]

(b) Breadth First Search (BFS).
List the nodes according to their order of expansion. Assume that rightmost nodes are expanded first. [8]

2 Backtracking

[5+10+5 = 20]

Consider again the tree in Question 1, shown below. Assume, again, that "44" is the start node and "3" is the only goal node. Assume, in addition, that the children of a node can be accessed by three operators: Left, Middle, and Right, with the obvious meaning, that is, "Left" gives access to the child on the left, "Middle" gives access to the child in the middle, and "Right" gives access to the child on the right.



(a) Define which order of operators one should use when exploring a node so that the backtracking algorithm finds a solution exploring the least number of nodes. [5]

(b) List the nodes according to their order of expansion using the order chosen in (a). [10]

(c) List the nodes in the final search tree – that is, without the nodes deleted by the algorithm after backtracking. [5]

3 Algorithm A/A*

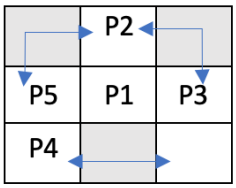
[3+7+10 = 20]

Assume that a group of people (P1, P2, P3, P4, P5) is planning to go for a Summer holiday. However, they have not been able to find accommodation together. Somehow, they have managed to book their accommodation around the city (shown in the final locations table below – on the right). This question asks you to find the minimum cost involved in travelling to the destination locations from their initial locations (shown in the initial location table below, on the left) using the A* algorithm. Based on the information given for this problem, draw the search tree generated by the A* algorithm, and in such a tree:

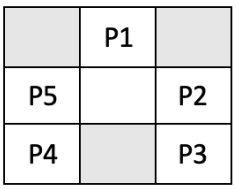
(a) define a heuristic function for this problem better than the constant function to 0; [3]

(b) indicate the values of g, h and f, as seen in the lectures; if you could not find a suitable heuristic function in (a), then use the constant function to 0; [7]

(c) indicate, using Roman numbers, the order in which nodes are expanded. [10]



Initial locations



Final Locations

While computing the cost of g, h, and f, you need to follow these criteria:

- The white squares are the suburbs of the city. Any person can travel only one suburb at a time.
- Travelling from one suburb to another costs $1.
- Each suburb can be occupied for at most one person.
- The center square is the CBD; while leaving the CBD has no extra cost, entering it incurs an additional charge of $2.
- The gray squares are toll roads, not suburbs. Nobody is allowed to stop or stay there. Using a toll road incurs an additional cost of $3. One can then travel from any two suburbs that are connected by a toll road in a single step, but paying the additional cost. Adjacent suburbs of the toll roads (that is, connected by a toll road) are marked using double blue arrowheads in the map grid on the left.
- People can travel horizontally and vertically only in the map grid – thus, no diagonally travel is allowed, unless through one of the two toll roads at the top of the grid map.

4 Irrevocable Control Strategies

[4+8+8 = 20]

This exercise is about genetic algorithms. Consider the following situation. You are packing your bag for a weekend trip. Your flight ticket allows up to 10Kg of carry-on baggage. There are 10 items that seem to be useful for your trip. You have estimated the usefulness of each item as well as measured its weight. Since you have a limited baggage capacity, you want to take the items that yield total highest usefulness within the weight limits.

Item	Weight	Usefulness
0	1	2
1	2	3
2	4	4
3	8	10
4	3	5
5	5	9
6	6	7
7	3	1
8	9	8
9	7	6

Using the information and description of the problem above:

(a) Propose a representation of the genes and chromosomes for the genetic algorithm. [4]

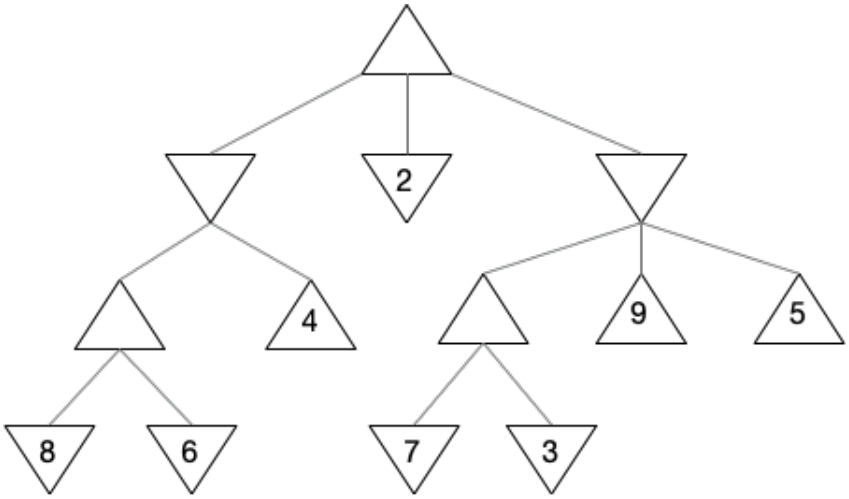
(b) Propose a suitable fitness function for this problem. [8]

(c) Provide an initial population with 4 chromosomes and, using the fitness function you proposed in part (b), calculate the probability of each chromosome to be selected. [8]

5 Adversarial Search

[5+7+8 = 20]

The figure below shows a game tree in which leaf nodes have the stated utility values. Nodes depicted with $\triangle$ belong to player MAX, while nodes depicted with $\triangledown$ belong to MIN.



(a) Using the MINIMAX algorithm, display the computed Minimax values for all nodes in the game tree. [5]

(b) Now, perform the $\alpha - \beta$ search algorithm assuming that the rightmost nodes are expanded first. Then, cross out the branches that will be pruned by the algorithm and in each case indicate whether it is an α cut-off or a β cut-off. [7]

(c) For all non-leaf nodes in the search tree generated by the α–β search algorithm obtained in part (b), display the sequence of α or β values computed by the search algorithm at that node (with the leftmost values in the sequence having been computed first). [8]