FIT5047 First Theory Assignment

Due date: 1st April 2021 (23:59).

Evaluation: 100 marks = 5%.

Submission: Moodle.

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Backtracking

[5+10+5 = 20]

Consider the following problem description. Two missionaries and two cannibals come to a river that goes from north to south. There is a boat on a side of the river that can be used either by one or two persons. How should they use this boat to cross the river in such a way that cannibals never outnumber missionaries on either side of the river? Assume that the boat, missionaries and cannibals are all initially on the west side of the river and the goal is to have all missionaries and cannibals on the east side of the river.

Assume that a node in this problem is represented by a pair consisting of a 2x2 matrix and a letter 'W' or 'E', such that the matrix is used to indicate the number of missionaries and cannibals at each side of the river and the letter is used to indicate where the boat is in that particular node. Given the description of the problem, the initial (left pair) and goal (right pair) nodes of this problem are as shown below, where the number of missionaries is in the top row and the number of cannibals is in the bottom row of the matrix; moreover, the number of missionaries on the west side of the river is on the left column and the number of cannibals on the east side of the river is on the right:

$$\left(\begin{bmatrix} 2 & 0 \\ 2 & 0 \end{bmatrix}, \mathrm{W}\right) \qquad \left(\begin{bmatrix} 0 & 2 \\ 0 & 2 \end{bmatrix}, \mathrm{E}\right)$$

(a) Specify the operators and a goal test to solve the above missionaries and cannibals

~~two Missionaries~~ $\left(\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}, w\right)$ $\left(\begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}, E\right)$

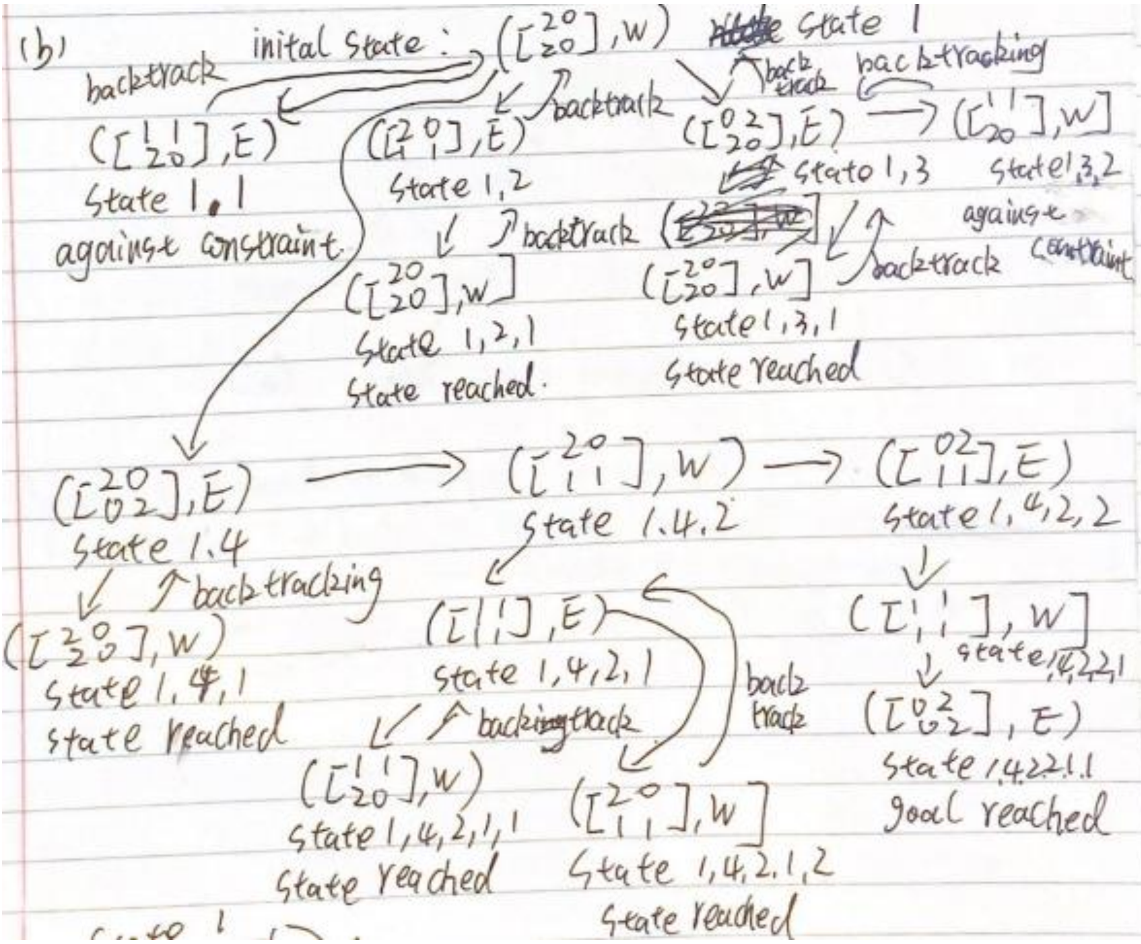
$\left(\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}, w\right)$

Operators:

Goal test: Do all people move ti the other side?

Metrix should same as $\left(\begin{bmatrix} 0 & 2 \\ 0 & 2 \end{bmatrix}, E\right)$

(b) problem using the backtracking algorithm studied in the lectures. [5] (b) Draw the complete search tree generated by the backtracking algorithm. [10]



(c) In the search tree of part (b), clearly indicate the search order according to the backtracking algorithm. [5]

State 1-> state 1.1 -> backtracking->state1.2->state1.2.1->backtracking->state1.3->state 1.3.1 -> backtrack->state 1.3.2->backtrack->state 1.4 ->state 1.4.1->backtracking->state 1.4.2->state1.4.2.1->state 1.4.2.1.1 ->backtracking->state1.4.2.1.2->backtracking->state1.4.2.2->state1.4.2.2.1 ->state1.4.2.2.1.1(goal)

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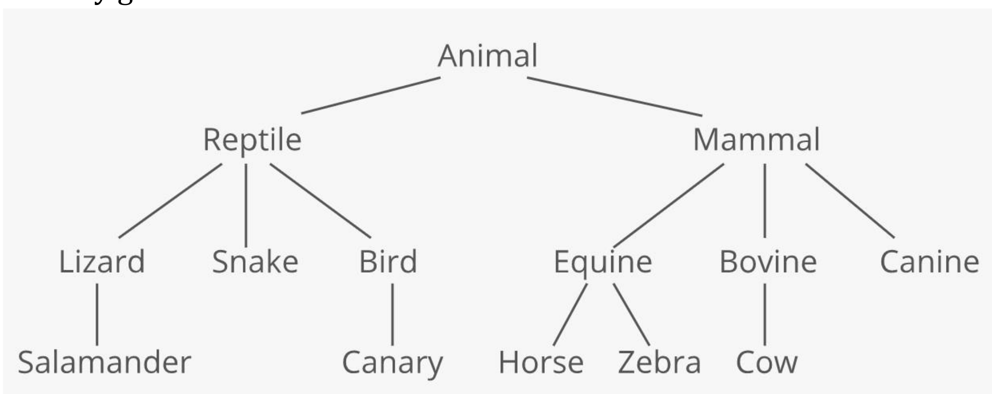
Tentative Control Strategies

[10+10 = 20]

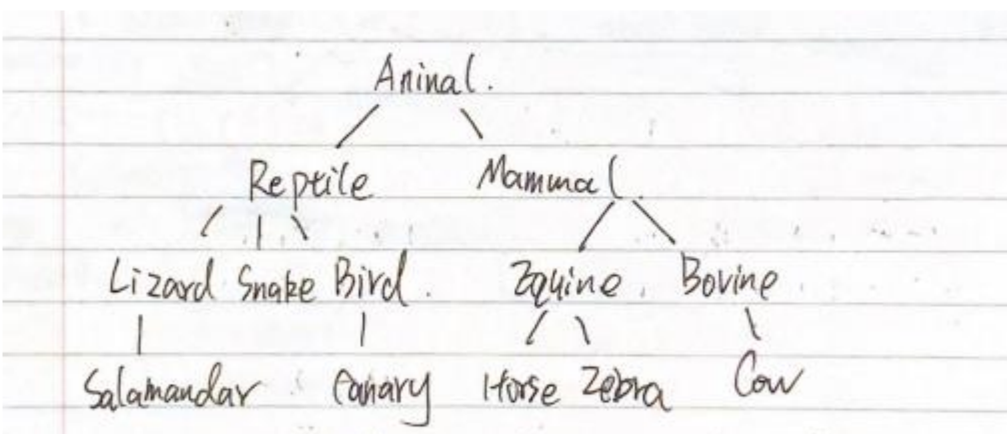
Use the following (fully expanded) search tree to indicate the order in which nodes are expanded for different types of search algorithms. Assume that “Animal” is the start node and “Cow” is the only goal node.



(a) Depth First Search (DFS).

List the nodes according to their order of expansion. Moreover, list the nodes in the final search tree (that is, without the nodes deleted by the algorithm). [10]

Animal->Reptile->Lizard->Salamander->Snake->Bird->Canary->Mammal->Equine->Hourse-> Zebra - > Bovine->Cow



(b) Breadth First Search (BFS).

List the nodes according to their order of expansion. [10]

Animal->Reptile-> Mammal->Lizard-> Snake->Bird-> Equine-> Bovine-> canine->Salamander->Canary-> Horse -> Zebra - > Cow

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Algorithm A/A*

[10+6+4 = 20]

Consider a grid of size 3 by 3 that represents a map. In each tile of the grid, there is a letter representing a kind of terrain. There are two types of terrains in the map: A and B. Currently, a robot is at the top right corner. We use the "∗" symbol to represent the current location of the robot.

	1	2	3
1	A	B	A*
2	A	A	A
3	B	B	B

Assume that the **X** axis is the horizontal direction while the **Y** axis is the vertical direction – so the current location of the robot is (3,1). The robot needs to do some tasks at position (1,3), depicted in red. It takes 1 minute for the robot to move from one tile to another. However, when the robot is moving from one type of terrain to another type, it has to change its wheels before the moving, which takes two extra minutes. The robot can only move horizontally or vertically (thus, the robot cannot move diagonally).

Using the A* algorithm, suppose that we want to find a path that takes the least time to make the robot move from position (3,1) to position (1,3). Based on this information:

(a) Using the Manhattan distance as a heuristic function for this problem, perform the A*algorithm to search for the path and draw the search tree. [10]

(b) In such a search tree, indicate the values of *g*, *h* and *f*, as seen in the lectures. [6] (c)

Use Roman numbers to indicate the order in which nodes are expanded. [4]

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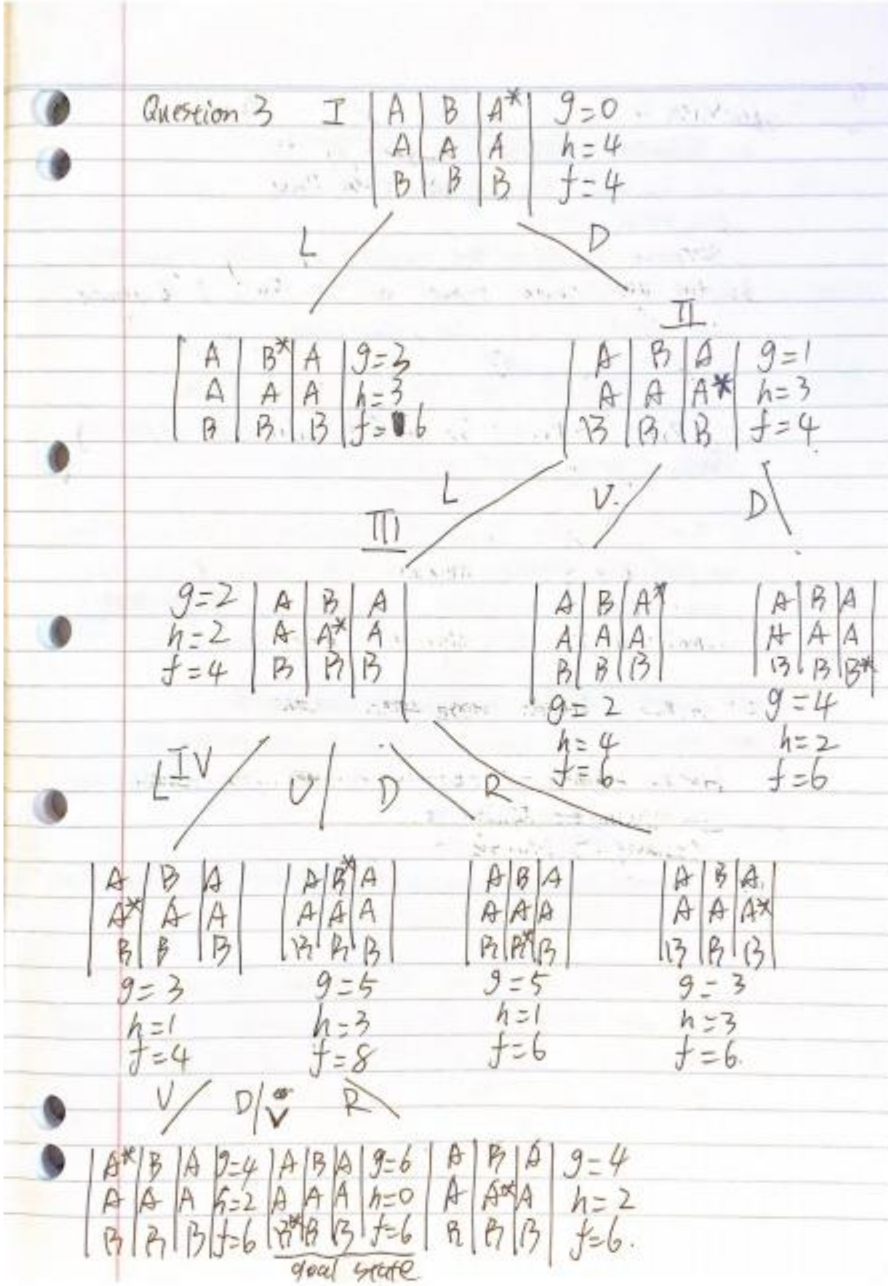
Question 3
I
g=0
h=4
f=4
L
D
II
g=3
h=3
f=6
g=1
h=3
f=4
L
V
D
III
g=2
h=2
f=4
g=2
h=4
f=6
g=4
h=2
f=6
L IV
V
D
R
g=3
h=1
f=4
g=5
h=3
f=8
g=5
h=1
f=6
g=3
h=3
f=6
V
D
R
g=4
h=2
f=6
g=6
h=0
f=6
goal state
g=4
h=2
f=6

4

Irrevocable Control Strategies

[5+5+10 = 20]

The following exercises are about Simulated Annealing and Genetic Algorithms.

(a) In Simulated Annealing, if T2 > T1, is the probability of adopting a new worse state higher in T2 or in T1? Why?
(No marks will be given for absent or incorrect explanations.)

In T2 will get higher probability to adopt a new worse state.

Because according to the Simulate annealing algorithms, adopting worse state means $\triangle E > 0$ and already know that T1<T2, So I can Know Pr(T1)>Pr(T2)(Pr= $e^{-\triangle E/T}$),so in T2 will have higher probability to adopt a worse state.

(b) Does the Simulated Annealing algorithm always terminate? Why or why not?
(No marks will be given for absent or incorrect explanations.)

Yes. Because simulated annealing is and algorithms to find the global maximum value, when T = 0 or find all state, the algorithms will stop. But when the temperature remains at infinity, this algorithm may won't stop.

(c) A Genetic Algorithm is used to evolve a binary string of length *n* to one where the sum (from left to right) of the last four genes is equal to 1. The initial population is a randomly generated set of binary strings of length *n*, such as those shown here:

00110001

01011101

11101111

Give a suitable fitness function for this problem.

Fitness Function: Sum(genes $\wedge$ 00001111)
Sum the result of logical conjunction of genes and "00001111" if result equal to 4, the last four genes will equal to 1.

5

Adversarial Search

[4+6+4+6 = 20]

The figure below shows a game tree in which leaf nodes, which belong to MIN (5), have the stated utility values; the player at the root of the tree is MAX (4).

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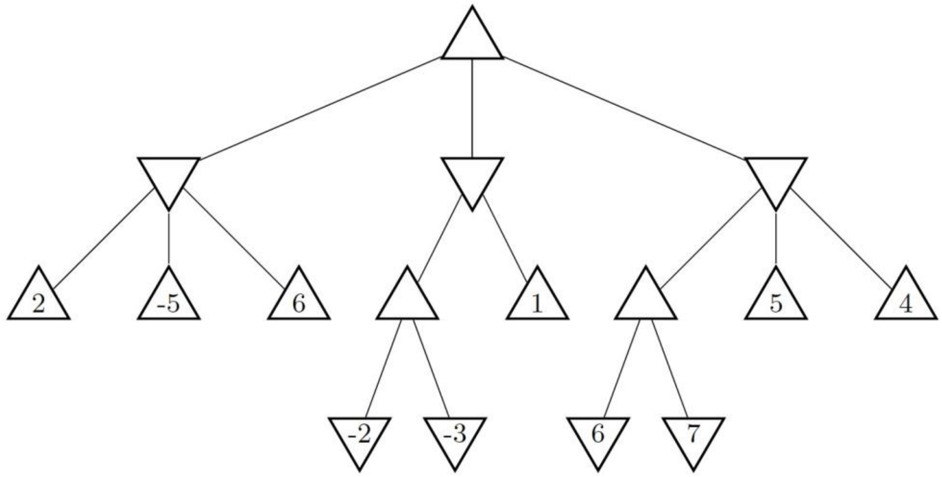
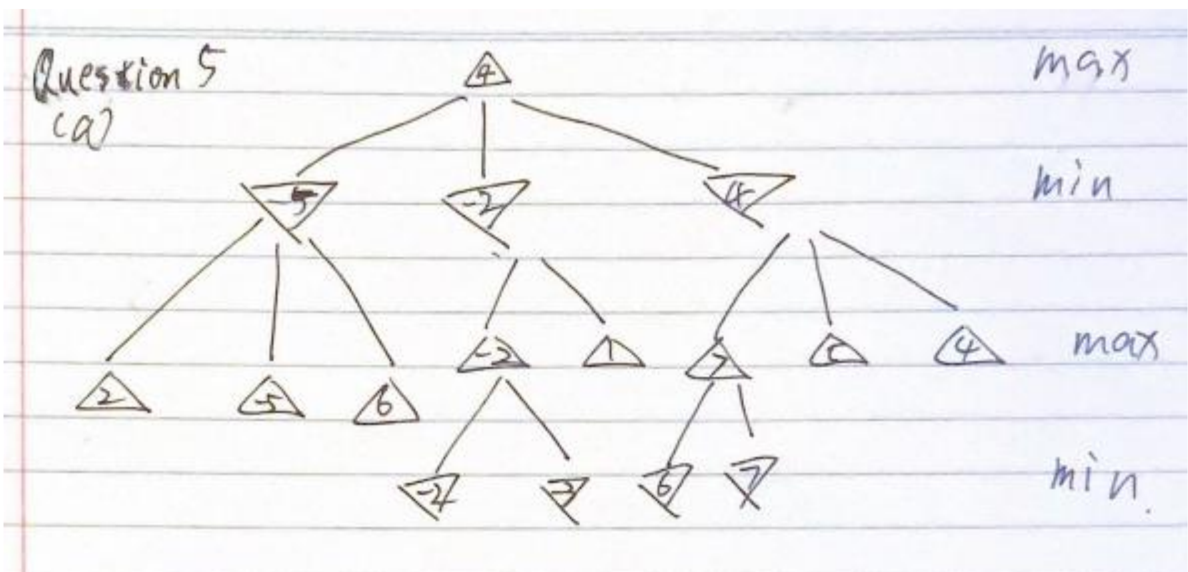


(a) Using the MINIMAX algorithm, display the computed Minimax values for all nodesin the game tree. [4]



(b) Draw a game tree obtained from the one in the figure above by reordering the actions ina way that, assuming left-to-right evaluation, maximises the number of nodes pruned if you were to use the α–β algorithm. [6]

(c) In such a new game tree, cross out the branches that will be pruned by the α–β search algorithm. [4]

(d) For all non-leaf nodes that are not pruned, 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). [6]

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