**COMP 3710 Artificial Intelligence**

Winter 2019

Term test I

Student Name: Student Number:

1. (3 marks) There are two types of searching problems.
2. Explain briefly how they are different.
3. For each type, give an example problem with an algorithm that can be used to solve the problem.

|  |  |  |
| --- | --- | --- |
|  | Type 1 | Type 2 |
| Explanation | A goal is known. A solution is a path to a goal from an initial state. | A goal is not know. A solution is a goal or a goal-like state. |
| Example | n-puzzle game | n-queens, TSP |
| Algorithm | A\* | Genetic algorithm |

1. (3 marks) Give formal representations of states for the two following problems.
2. 8-puzzle game that uses a 3×3 board
* Variables with their domains

9 variables representing 9 tiles.

Their domains are {0, 1, 2, …, 8}

* Data structure

A linear array of 9 variables, i.e., values in the 9 variables

1. 5-queens problem that uses a 5×5 board
* Variables with their domains

5 variables representing the queen’s position in each column

Their domains are {0, 1, 2, 3, 4}.

* Data structure

A linear array of 9 variables, i.e., values in the 9 variables

1. (3 marks) In push\_or\_update\_node\_in\_expandedQ(node) that is used in the A\* algorithm for n-puzzle game, explain how to update the node in the case when the node is already in the expanded queue. You may use pseudo code for the explanation. (You need identify what are updated with what values.)

function push\_or\_update\_node\_in\_expandedQ(node)

{

 // If the node is already in the expanded queue,

 if (expandedQ.isIn(get\_id\_of\_node(node))) {

 ...**You need to explain this part**...

 }

 // Otherwise, push the node into the expandedQ

 else

 expandedQ.push(get\_id\_of\_node(node), get\_fvalue\_of\_node(node), node);

}

Get old\_node from expandedQ, that has the same id as node;

If g-value of node < g-value of old\_node

 Pop the old\_node from expandedQ;

 Push node into expandedQ;

1. (3 marks) We would like to solve the 5-queens problem using the Most-Constrained Variable First heuristic.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 4 |  |  |  |  |  |
| 3 |  |  |  |  |  |
| 2 | Image result for queen  symbol |  |  |  |  |
| 1 |  |  | Image result for queen  symbol |  |  |
| 0 |  |  |  |  |  |

 0 1 2 3 4

Decide the next column and its value with proper explanation.

Answer: 1:4

Reason:

 Column 1 has 1 choice.

 Column 2 has 2 choices.

 Column 3 has 3 choices.

1. (3 marks) We would like to solve the 5-queens problem using a local search algorithm that moves a queen to another position in the same column, so that the next board becomes better.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 4 |  |  |  |  | Image result for queen  symbol |
| 3 |  |  |  |  |  |
| 2 |  |  | Image result for queen  symbol |  |  |
| 1 |  | Image result for queen  symbol |  | Image result for queen  symbol |  |
| 0 | Image result for queen  symbol |  |  |  |  |

 0 1 2 3 4

1. Improve the board by moving the queen in column-0 if possible.
2. After a), improve the board by moving the queen in column-1 if possible.
3. After b), improve the board by moving the queen in column-2 if possible.

 a) b) c)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  |  |  |  | Image result for queen  symbol |  |
|  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  | Image result for queen  symbol |  |  |
|  |  |  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  |  |  |  |  |  |  |  |
|  |  | Image result for queen  symbol |  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  |
|  |  |  |  |  |  |  |  | Image result for queen  symbol |  |  |  |  |  | Image result for queen  symbol |  |  |  |

1. (3 marks) Let’s consider the genetic algorithm. Here are four individuals with their fitness values.
* I1 – [1, 0, 0, 1] 20
* I2 – [0, 0, 1, 1] 10
* I3 – [1, 0, 1, 0] 40
* I4 – [0, 1, 0, 1] 30
1. Decide fitness ratios and the roulette wheel with the fitness ratios.

Fitness ratios: 0.2, 0.1, 04, 0.3

Wheel: [0.2, 0.3, 0.7, 1]

1. Select two individuals with the above roulette wheel and two random numbers 0.45 and 0.7.

0.45 > 0.4 and 0.45 <= 0.7 => select I3

0.7 > 0.4 and 0.7 <= 0.7 => select I3

1. Apply the single point crossover to the above two individuals, with the middle point. List the two new offspring.

[1, 0, 1, 0] and [1, 0, 1, 0]