David Lim

A16398479

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MAE 242

Homework 1 Programming

1. Depth first search (DFS) algorithm

A maze with a green and yellow center

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Figure 1. DFS algorithm applied to the medium maze.

Figure 1 shows a plot of the path returned by a depth first search (DFS) algorithm. Table 1 shows the performance of the algorithm. The algorithm was implemented with the preferred order of directions being north, south, east, and west. Given this preference, this path was expected for DFS. For example, at nodes (15, 2) and (17, 12), the algorithm decided to expand a path to the north instead of to the east, which could have led to a shorter path to the goal.

Table 1. DFS algorithm performance

|  |  |
| --- | --- |
| Basic cost: | 232 nodes |
| Explored (expanded): | 247 nodes |
| Remaining in queue: | 11 nodes |

This was not the least-cost solution. Rather, it was nearly the greatest-cost solution (without self-intersection) since the preferred directions happened to be “unlucky” for this maze. The DFS algorithm prefers exploring in arbitrarily defined directions and ignores other directions which could be more optimal.

2. Breadth first search (BFS) algorithm

A maze with a yellow and green center

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Figure 2. BFS algorithm applied to the medium maze.

Figure 2 shows a plot of the path returned by a breadth first search (BFS) algorithm. Table 2 shows the performance of the algorithm. The path obtained was the least-cost path of 68 nodes as expected. However, the BFS algorithm explored 225 nodes before finding the goal.

Table 2. BFS algorithm performance

|  |  |
| --- | --- |
| Basic cost: | 68 nodes |
| Explored (expanded): | 225 nodes |
| Remaining in queue: | 3 nodes |

3. Dijkstra search algorithm

A maze with a yellow and black rectangle

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Figure 3. Dijkstra search algorithm applied to the medium maze with a cost function favoring the west.

Figure 3 shows a plot of the path retuned by the Dijkstra search algorithm with the “stay west” cost function. Table 3 shows the performance of the algorithm. The cost function forces the algorithm to find a path that “dwells” in the west, which was the most optimal in the “stay west” cost sense rather than the basic cost sense.

Table 3. Dijkstra search algorithm performance with “stay west” cost

|  |  |
| --- | --- |
| Basic cost: | 152 nodes |
| Stay west cost: | 25875 |
| Explored (expanded): | 246 nodes |
| Remaining in queue: | 1 node |

A maze with a yellow green and blue line

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Figure 4. Dijkstra search algorithm applied to the medium maze with a cost function favoring the east.

Figure 4 shows a plot of the path retuned by the Dijkstra search algorithm with the “stay east” cost function. Table 4 shows the performance of the algorithm. The cost function forces the algorithm to find a path that “dwells” in the east, which was the most optimal in the “stay east” cost sense rather than the basic cost sense.

Table 4. Dijkstra search algorithm performance with “stay east” cost

|  |  |
| --- | --- |
| Basic cost: | 74 nodes |
| Stay east cost: | 13629 |
| Explored (expanded): | 101 nodes |
| Remaining in queue: | 4 nodes |

4. A\* search algorithm

A maze with a yellow and green center

AI-generated content may be incorrect.

Figure 5. A\* search algorithm applied to the medium maze with the Manhattan or Euclidean heuristic.

Figure 5 shows a plot of the path retuned by the A\* search algorithm using either the Manhattan or Euclidean heuristic. Table 5 shows the performance of the algorithm using the Manhattan heuristic, and Table 6 shows the performance using the Euclidean heuristic. The path obtained using either heuristic was the optimal path with a basic cost of 68 as expected, since either heuristic was admissible and guaranteed optimality. However, the algorithm was slightly more efficient with the Manhattan heuristic by exploring 146 nodes instead of 152 nodes with the Euclidean heuristic.

Table 5. A\* search algorithm performance with a Manhattan heuristic

|  |  |
| --- | --- |
| Basic cost: | 68 nodes |
| Explored (expanded): | 146 nodes |
| Remaining in queue: | 5 nodes |

Table 6. A\* search algorithm performance with a Euclidean heuristic

|  |  |
| --- | --- |
| Basic cost: | 68 nodes |
| Explored (expanded): | 152 nodes |
| Remaining in queue: | 5 nodes |

The Manhattan heuristic led to a more efficient result for the maze because it was a better estimate of the cost to the goal. The Euclidean heuristic underestimates the cost to the goal by measuring the straight-line distance to the goal rather than the rectilinear distance that the agent would travel in the discretized space.