CENG 407: Robotics and Robot Autonomy
OSTIM Technical University
Fall 2024
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Take Home Exam 3
Graph Search Algorithms

Due Date: 06.01.2025 23:59

In this assignment, you will implement the **Depth First Search, Dijkstra and A* Algorithms** for a robot. You will also implement a stack, a queue and a priority queue structure by using arrays and array operations only. You will upload **a single report** named *your_student_id_THE3.pdf*.

Important Notes: This assignment will be evaluated on a scale of 120 points. Pay attention to the name of the uploaded file. Make sure it is in pdf format. Your report should have a title, date, and name section. In the report, you have to add a heading for each of the following main items, and for each sub-item, add a subheading. Fill in the headings with the requested information. Use captions for the tables and figures. In the captions, clearly state the used algorithm and the environment names.

1. **Introduction** (6 Pts)

   What is the main goal of this report, and what are you hoping to achieve with it? Download the **the3.py**. Describe the node class and the given grid environment and how the graph is generated.

2. **Breadth First Search** (6 Pts)

   2.1) **Breath First Search** function is implemented already. Explain the code. Provide pseudocode of BFS algorithm. (2 Pts)

   2.2) Run the BFS algorithm. Provide figures for each 3 environments. Add the screenshots of the terminal for each environment. You will need the solution time, number of visited grids and the path length to fill the table in part 6. (4 Pts)

3. **Depth First Search** (15 Pts)

   3.1) Explain the DFS algorithm. Provide pseudocode of the algorithm. (3 Pts)

   3.2) Implement DFS function in the the3.py. Put the screenshot of your code. Explain the DFS function and the stack structure that you implemented. (6 Pts)

   3.3) Run the DFS algorithm. Provide figures for each 3 environments. Add the screenshots of the terminal for each environment. You will need the solution time, number of visited grids and the path length to fill the table in part 6. (6 Pts)

4. **Dijkstra** (23 Pts)

   4.1) Explain the Dijkstra algorithm. Provide pseudocode of the algorithm. (5 Pts)

   4.2) Implement Dijkstra function in the the3.py. Put the screenshot of your code. Explain the Dijkstra function and the priority queue structure that you implemented. (9 Pts)

   4.3) Run the Dijkstra algorithm. Provide figures for each 3 environments. Add the screenshots of the terminal for each environment. You will need the solution time, number of visited grids and the path length to fill the table in part 6. (9 Pts)

5. **A*** (25 Pts)

   5.1) Explain the A* algorithm. Provide pseudocode of the algorithm. (5 Pts)

   5.2) Implement A* function in the the3.py. Put the screenshot of your code. Explain the A* function. (11 Pts)

   5.3) Run the A* algorithm. Provide figures for each 3 environments. Add the screenshots of the terminal for each environment. You will need the solution time, number of visited grids and the path length to fill the table in part 6. (9 Pts)

6. **Comparison** (30 Pts)

   Compare the algorithms in general. Evaluate whether each algorithm is optimal and complete. Fill the table 1 with 'YES' and 'NO'. Describe how the optimality is changed when the graph is uniform or weighted. Indicate whether the given grid world is a uniform or weighted graph. (15 Pts)

	Complete	**Optimal (Uniform Cost Graph)**	**Optimal (Weighted Graph)**
BFS			
DFS			
Djikstra			
A*			

Table 1: Completeness and Optimality of the Algorithms

   Create 3 copies of the table 2 for each environment and change the caption accordingly. Fill all 3 tables for each algorithm based on the terminal screenshots. Give an explanation about the performance metrics i.e. solution time and path length. Which algorithm has better solution time and why? Which algorithm(s) provide the shortest path? (15 Pts)

	Solution Time	Num. of Visited Nodes	Path Length
BFS			
DFS			
Djikstra			
A*			

Table 2: solution time and calculated path length of each algorithm for environment 1

7. **Conclusion** (10 Pts + 5 Pts Report Style)

   Provide detailed description of what you achieved in this assignment.