Module 2: Portfolio Milestone

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Portfolio Milestone

For this portfolio project, I have selected the Shortest Path Tool because of its relevance to my goal of pursuing a career in AI and ML within the robotics field. Developing and analyzing both Dijkstra's and Bellman-Ford algorithms will allow me to explore their efficiency in various scenarios, providing valuable insights into algorithmic optimization and problem-solving—key skills in robotics and artificial intelligence.

The Shortest Path Tool will compute the shortest path between two points in a weighted graph using Dijkstra's and Bellman-Ford algorithms. The programs will visualize paths and compare the efficiencies.

Project Plan

Figure 1 shows the project plan that will act as a guideline for the portfolio project. The project will consist of 4 phases over 7 weeks - the remainder of this course.

Figure 1: Project plan including phase, duration, tasks, and deliverables.

Phase	Duration (week)	Tasks	Deliverables
1	1	- Choose project idea. - Research shortest path algorithms.	Project Plan. Algorithm choices.
2	2	- Implement chosen algorithms. - Develop necessary input generations to test algorithms. - Gather empirical data.	2 page paper outlining: - Purpose, obstacles, skills acquired. - Screenshots of successful execution
3	2	- Analyze data for time and space complexity trends. - Compare algorithm performances and identify strengths and weaknesses. - Implement optimizations.	- Time and space complexity trends - Algorithm comparisons - Report summarizing the analysis and optimizations
4	2	- Presentation or paper highlighting project goals, methodology, analysis, and outcomes - Including visuals, graphs and code	- 8 Slide presentation or a 2 page paper - Source code

Algorithm Choices

The two algorithms that we are going to focus on in this project are Dijkstra and Bellman-Ford's algorithms. Both these algorithms accomplish the same task but each have their pros and cons (Sryheni, S., 2024, March 18th).

Dijkstra's Algorithm: This algorithm calculates the shortest path from a source node to all nodes inside the weighted graph. It does this by repeatedly selecting the nearest unvisited node and calculating the distance to all the unvisited, neighboring nodes (W3Schools, 2024). This algorithm is efficient for graphs without negative weights.

Bellman-Ford's Algorithm: Like Dijkstra's algorithm, this algorithm calculates the shortest path from a source node to all nodes inside the weighted graph. However, the concept behind this algorithm is different. This algorithm will repeatedly check all edges in the graph for shorter paths (W3Schools, 2024). In addition, this algorithm is suitable for graphs with negative weights.

Purpose and Skill Acquired

The purpose of this project is to analyze and compare the performance and efficiency of Dijkstra and Bellman-Ford's algorithms throughout this portfolio project. This will serve as a strong introduction to graph theory and aid in solving real world shortest path problems such as finding the shortest route to reach a destination.

Potential Obstacles

A potential obstacle that will have to be considered would be edge case handling. This includes disconnected nodes, invalid inputs, or negative weights if working with Dijkstra's algorithm. Furthermore, handling large datasets could prove challenging with Bellman-Ford's algorithm.

Conclusion

The Shortest Path Tool project is an excellent opportunity to deepen my understanding of algorithm design while building practical skills essential for AI and robotics. By implementing and comparing Dijkstra's and Bellman-Ford algorithms, I can better understand their efficiency and usability in solving real-world problems.

References

Sryheni, S., (2024, March 18), *Dijkstra's vs Bellman-Ford Algorithm.* Baeldung. https://www.baeldung.com/cs/dijkstra-vs-bellman-ford

W3Schools (2024), *DSA Bellman-Ford Algorithm.* https://www.w3schools.com/dsa/dsa_algo_graphs_bellmanford.php

W3Schools (2024), *DSA Dijkstra's Algorithm.* https://www.w3schools.com/dsa/dsa_algo_graphs_dijkstra.php