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A Comparative Study of Pathfinder Algorithms with 3D Visualization

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Problem

Path Algorithms which are normally used are Depth-First Search (DFS), Breadth-First Search (BFS) and A-star (A*) which we focus on.

A* DFS BFS

What is the most suitable algorithm for different specific uses?

Create measurement and visualize the results by designing mazes and compare all results.

Framework

1. Implement algorithms A*, DFS, and BFS
2. Generates maze with Unity
3. Test all algorithms
4. Measure time and path taken
5. Analyze Results
6. Visualize Results

Fig. 1 Framework

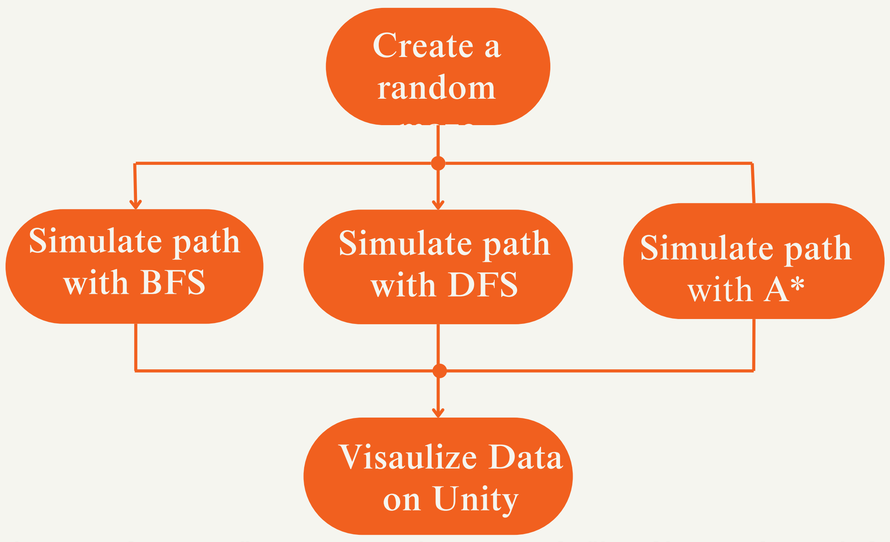


Fig. 2 Flow of comparing pathfinding algorithms

Fig. 3 Pathfinding Simulation in Unity.

We developed a tool to demonstrate these algorithms, focusing on how each algorithm navigates from the start to the goal while avoiding obstacles, comparing their time and space.

- Using 3D animation in Unity, we generate 32×32 random maps.
- Enables users to observe the algorithms in action.
- Enhances understanding of their decision-making processes.
- Highlights benefits such as improved efficiency, scalability, and decision-making in AI systems.

Finding

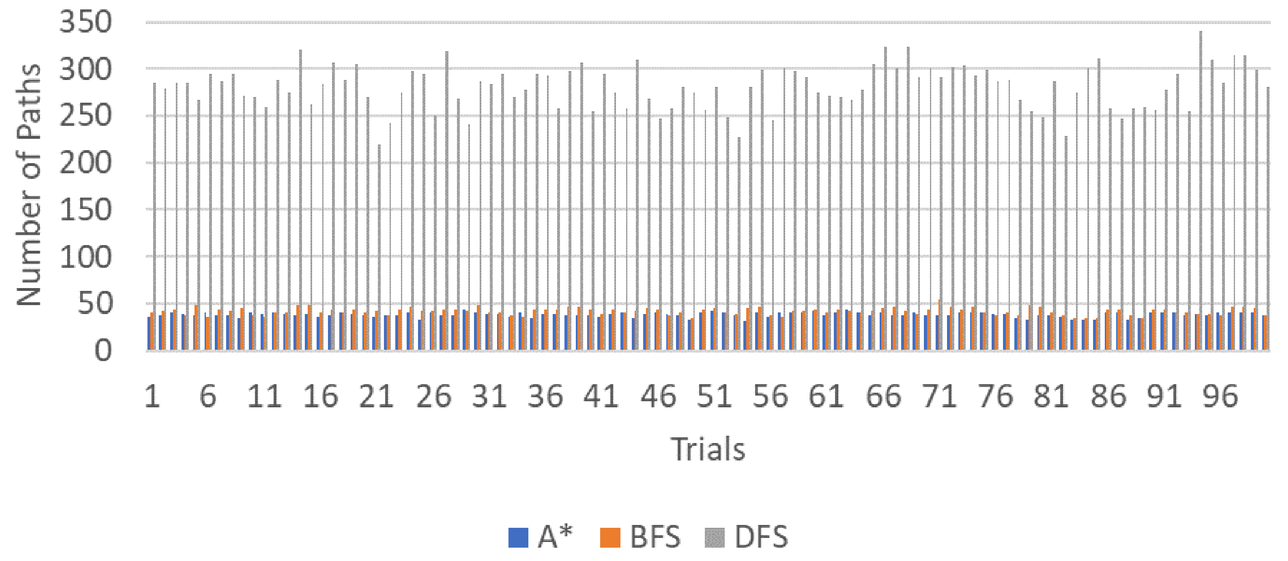


Fig. 4 Comparison of the number of paths.

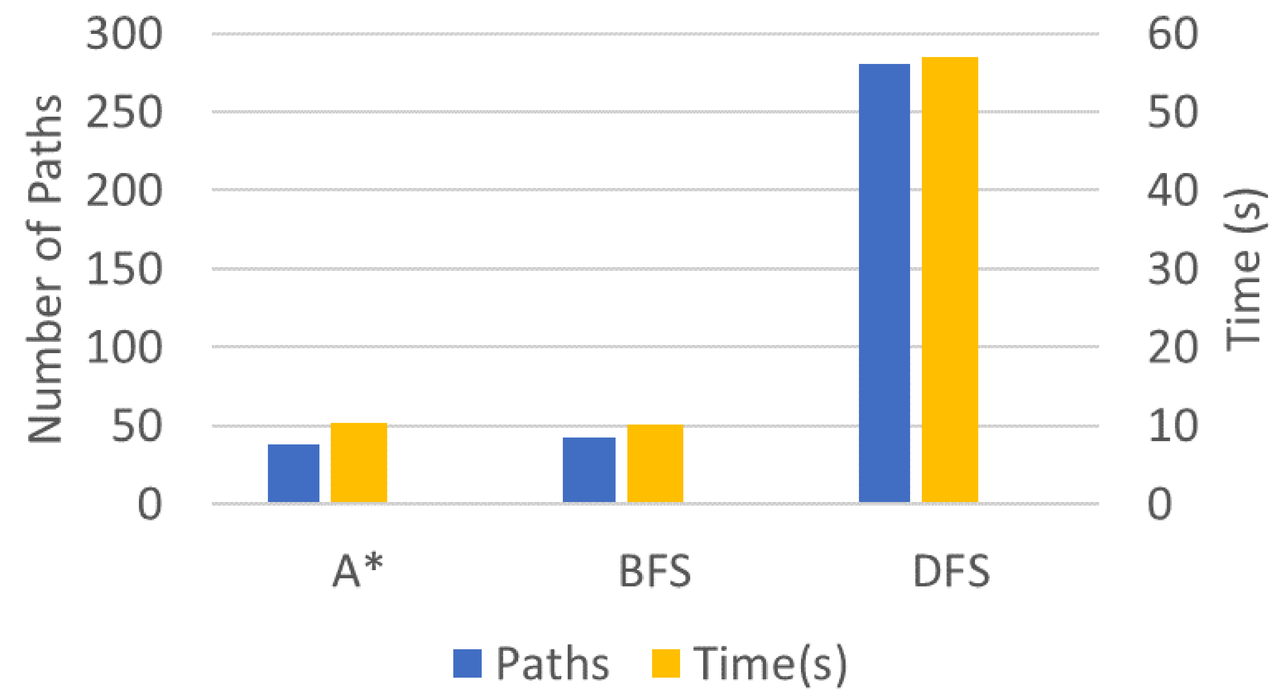
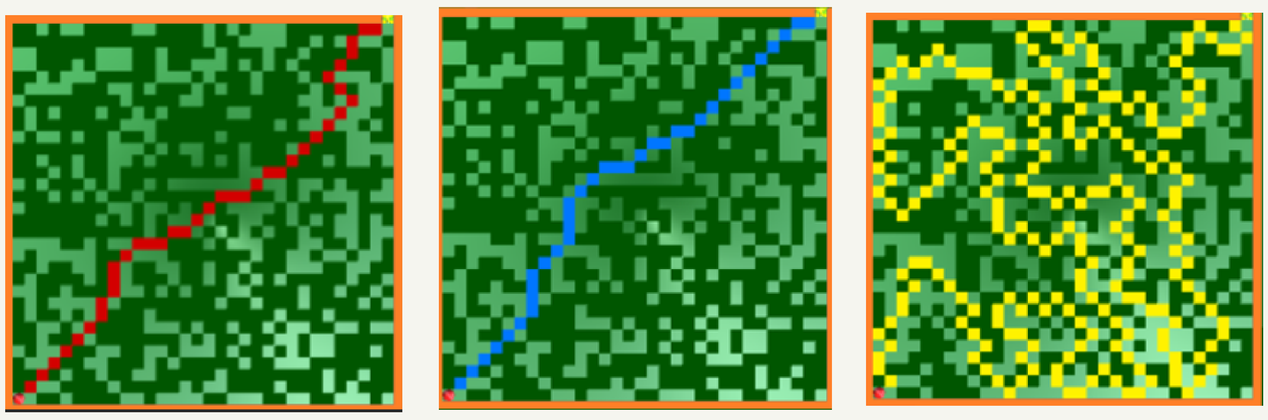


Fig. 5 Comparison of paths and time among algorithms. (in average)



(a) A* (b) BFS (c) DFS

Fig. 6 Simulation results.

Concludsion

A* consistently emerged as the most efficient, providing optimal paths by balancing speed and accuracy, making it highly suitable for applications like robotics and gaming that require precise navigation.

- BFS reliably located the shortest paths by exploring level-by-level but consumed significantly more memory.
- DFS used less memory, yet often produced longer, less direct paths due to its deep, branch-first approach.
- These findings underscore important trade-offs in memory efficiency and path accuracy across different algorithms.
- Future research could expand this analysis to dynamic, complex environments, broadening their applicability in real-world navigation, autonomous systems, and logistics.