Jose Marquez and Gabriel Gacovicaj

Repo - 3013 Advance Structures

Presentation 1 - A* Search Algorithm

1. Introduction

- **Topic**: A* Search Algorithm
- **Description**: A* is a popular informed search algorithm widely used in pathfinding and graph traversal, known for finding the shortest path efficiently.
- **Why is it interesting?**: It combines features of uniform-cost search and greedy best-first search, providing optimality and efficiency. It is widely implemented in real-world scenarios like GPS navigation, game AI, and robotics.

2. Core Mechanics

- **High-Level Overview:**
    - Uses heuristics to guide the search towards the most promising path.
    - Evaluates nodes based on **f(n) = g(n) + h(n):**
        - **g(n):** Cost from start node to current node.
        - **h(n):** Estimated cost from current node to goal.
- **Edge Cases & Design Tradeoffs:**
    - Works optimally if heuristics are admissible (never overestimate the true cost).
    - Performance can degrade significantly if heuristics are poorly chosen.
    - Tradeoff between heuristic complexity and computational overhead.

3. Use Cases & Impact

- **Real-World Applications:**
    - GPS navigation and route finding.
    - Game development for NPC pathfinding.
    - Autonomous vehicle navigation systems.
- **Theoretical Significance:**
    - Benchmark for development and testing heuristic-based search algorithms.
    - Basis for numerous advanced search strategies.
- **Comparison to Alternatives:**
    - Better performance compared to uninformed search (BFS, DFS).
    - More optimal than greedy algorithms due to comprehensive evaluation.

4. Conclusion

- **Key Points:**
  - A* efficiently combines path cost and heuristic to find optimal paths.
  - Proper heuristic selection is crucial for performance.