Applied Artificial Intelligence

Assignment - 1

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1. Introduction

The Word Ladder Adventure Game is an interactive puzzle-solving application where players transform a starting word into a target word by changing one letter at a time. Each intermediate word must be a valid word from a predefined dictionary. The game includes AI-powered hints utilizing search algorithms to assist players in finding the shortest transformation path. This project implements a graph-based word transformation system and introduces various difficulty modes, game constraints, and a console-based user interface.

2. Game Mechanics

a) Word Selection

- The game randomly selects a valid starting word based on the chosen difficulty level.
- A target word is determined, ensuring a valid transformation path exists.

b) Gameplay Features

- Players can manually change a letter at a specified index to form a valid word.
- AI assistance is available using three different search algorithms (BFS, UCS, A*).
- Constraints such as banned words and restricted letters are introduced in Challenge Mode.
- Turn and hint limits are enforced based on difficulty levels.
- Players can visualize the word dictionary graph at any time.

c) Scoring System

- Score is determined based on the number of turns taken and AI hints used.
- Lesser turns and hints result in higher scores.
- A well-formatted console UI provides real-time game statistics and instructions.

3. Comparison of Implemented Search Algorithms

a) Breadth-First Search (BFS)

- Explores words level by level, ensuring the shortest path in an unweighted graph.
- Suitable for finding the shortest transformation sequence but may explore unnecessary paths.

b) Uniform Cost Search (UCS)

- Expands nodes based on cost, ensuring the lowest cost path is chosen first.
- Efficient for weighted transformations but can be slower than BFS for uniform transformations.

c) A* Search

- Uses a heuristic function (letter differences) to estimate the shortest path efficiently.
- Balances cost (UCS) and estimated distance (heuristic), making it the most efficient for large word ladders.

4. Challenges Faced During Development

a) API Dependency and Performance Issues

- Initially, a dictionary API was used to validate words, but performance and availability issues led to replacing it with a local dictionary text file.
- Managing large word datasets while ensuring efficient search was crucial.

b) AI Algorithm Optimization

- Early implementations of BFS, UCS, and A* had excessive computation times for longer words.
- Restricting the search space and improving heuristic calculations optimized performance.

c) User Interface Design

- Creating a visually engaging console-based UI required careful formatting and color coding.
- Introducing real-time status updates without cluttering the console was a key consideration.

d) Ensuring Valid Transformation Paths

- Selecting words with guaranteed transformation sequences required repeated validation.
- The game now continuously searches for a valid pair instead of terminating on failure.

5. Conclusion

The Word Ladder Adventure Game successfully integrates graph-based AI search techniques into a fun and interactive word puzzle. The game mechanics, difficulty levels, and user-friendly console UI make it engaging while providing educational insights into search algorithms. The implemented optimizations ensure efficiency across various difficulty levels.