Missionaries and Cannibals AI Game

This project presents an AI-powered solution to the classic Missionaries and Cannibals puzzle. The goal is to develop an intelligent system that safely transports all characters across a river under strict constraints. The challenge combines problem-solving, search algorithms, and state validation to efficiently find a correct sequence of moves. Through this game, we demonstrate AI's capability to solve logic puzzles automatically, offering an engaging and educational experience.

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Problem Statement

Classic Puzzle Setup

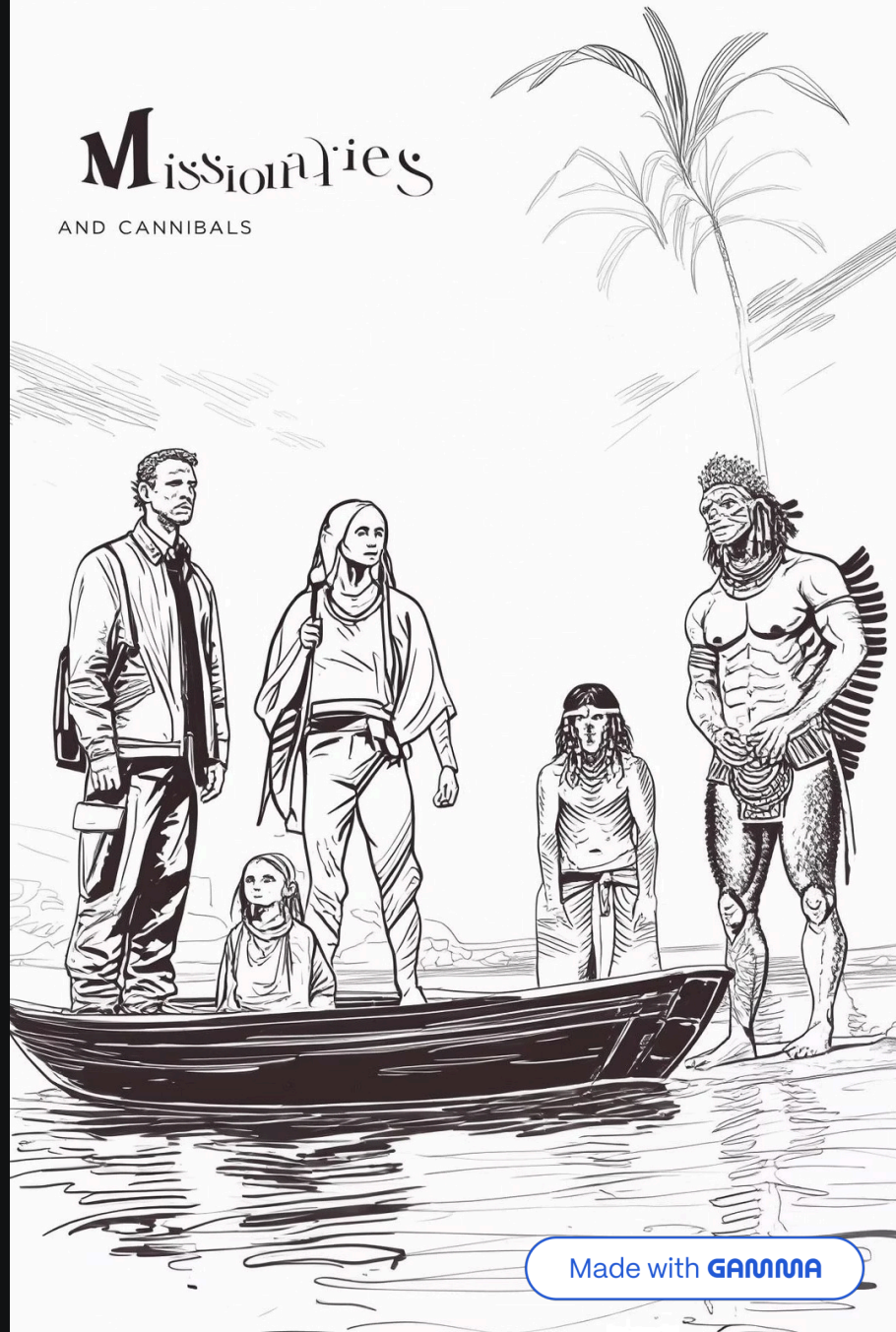
Three missionaries and three cannibals must cross a river using a single boat.

Constraints

Cannibals can never outnumber missionaries on either riverbank to avoid danger.

Challenge

Develop an AI that models the problem effectively and solves it efficiently with valid moves.



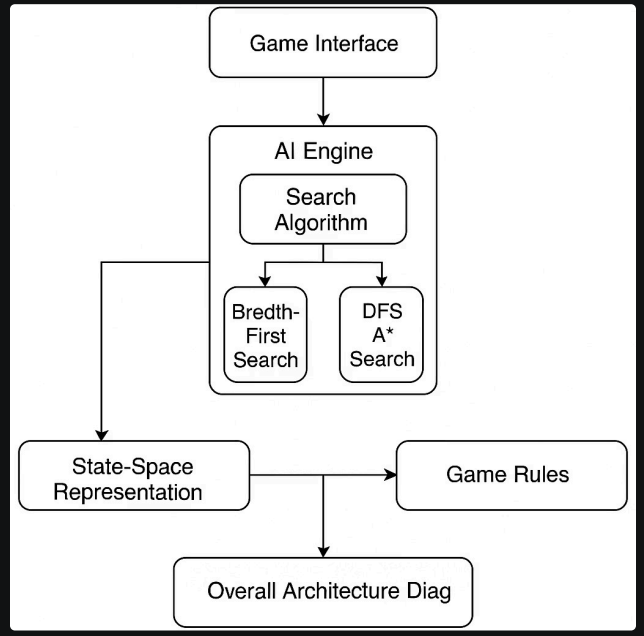
Overall Architecture

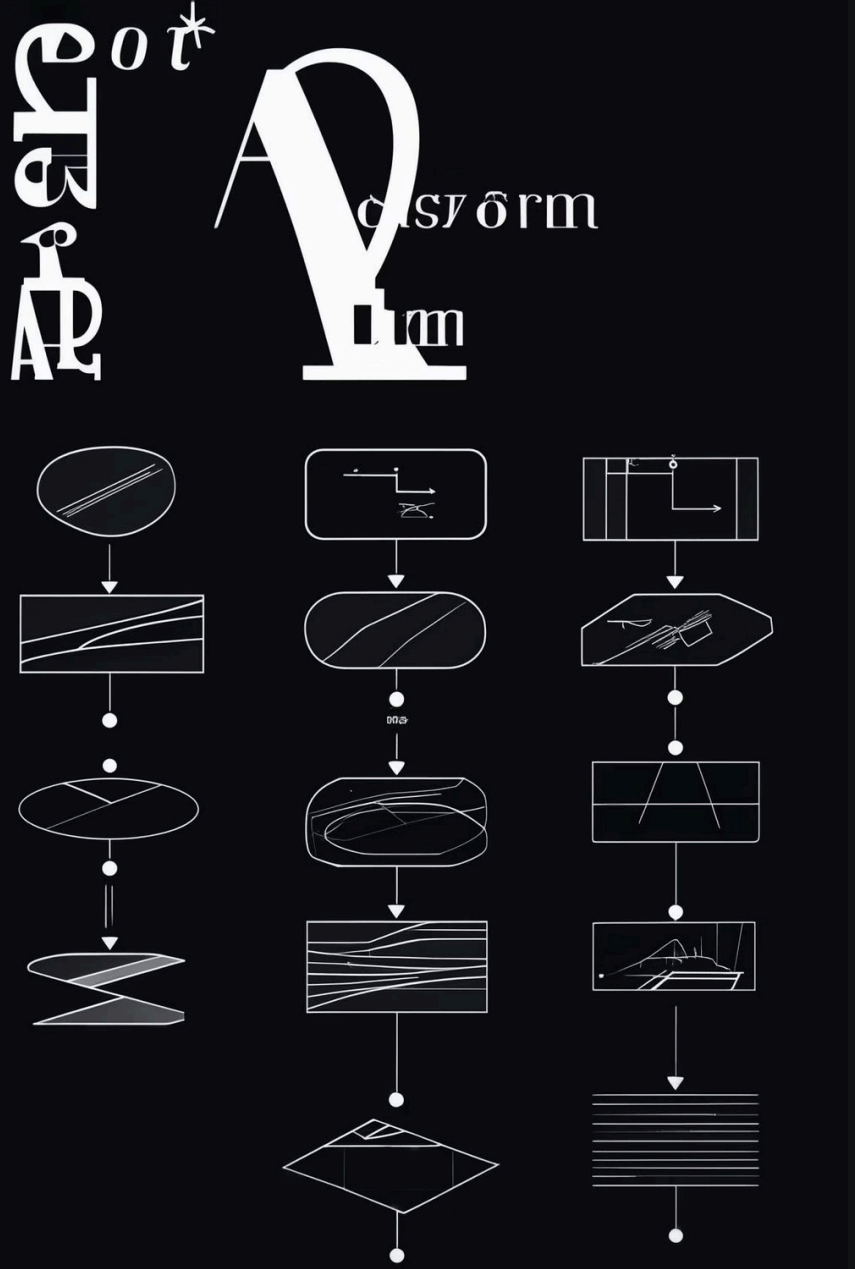
Data Flow

- Initial State: Represents starting positions of missionaries, cannibals, and boat
- AI Algorithm: Search method explores possible states
- Actions: Valid moves generating new states
- Goal Test: Checks if all characters reached the opposite bank
- Solution: Sequence of actions found through the search

AI Algorithms Used

- Breadth-First Search for exhaustive search
- Depth-First Search for simpler exploration
- A* Search with heuristics for efficient pathfinding





AI Algorithm Choice

1 Selected Algorithm: A* Search

Chosen for its optimal and efficient pathfinding in complex state spaces.

2 Heuristic Function

Estimates remaining steps by calculating a simplified distance to goal (e.g., number of people left to cross).

3 Pseudocode Overview

Maintains open and closed lists, selects state with lowest cost plus heuristic, expands valid moves, repeats until goal found.

Implementation Details: State Representation

Data Structures

Each state is a tuple containing missionaries left, cannibals left, and boat position (0 or 1).

This simple structure allows quick comparison and hashing for efficient search.

Validity Checks

- No bank has more cannibals than missionaries unless no missionaries present.
- Boat must carry one or two people only.
- States violating constraints are pruned early.

Implementation Details: Action Generation

Possible Actions

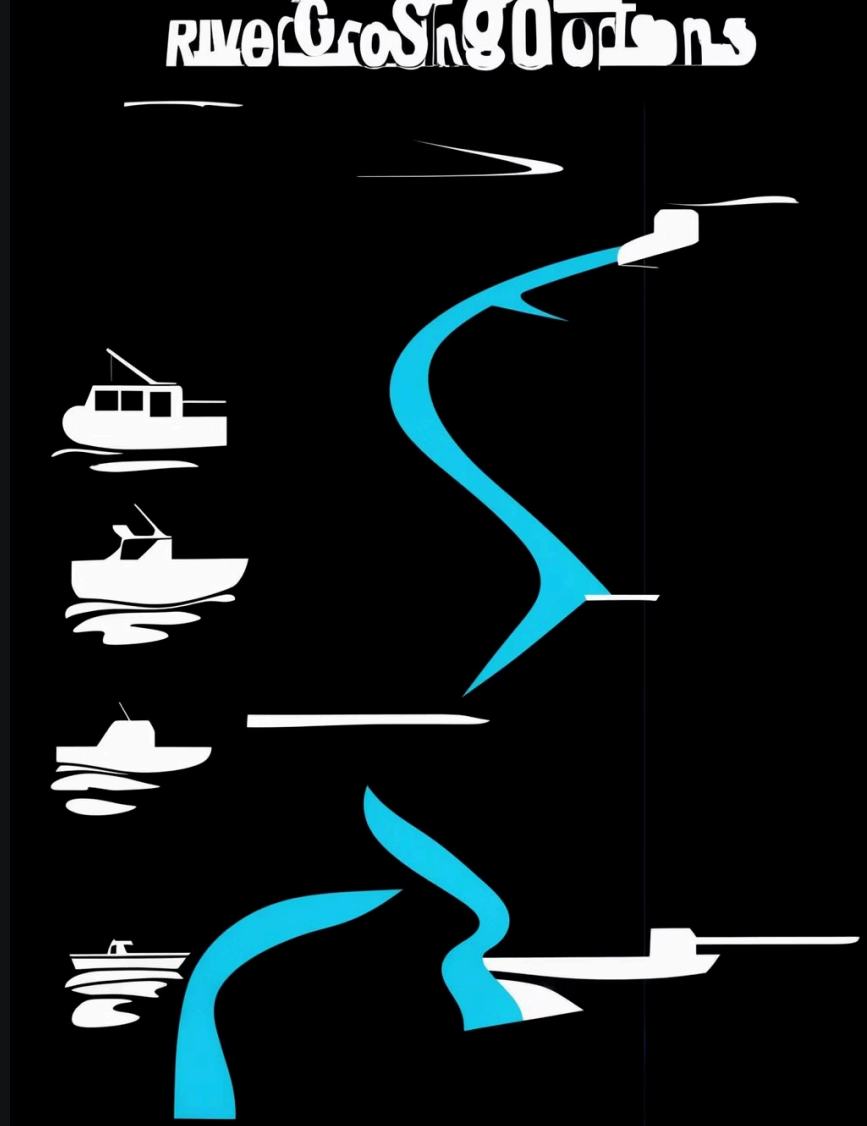
Boat can carry one or two people: missionaries, cannibals, or both.

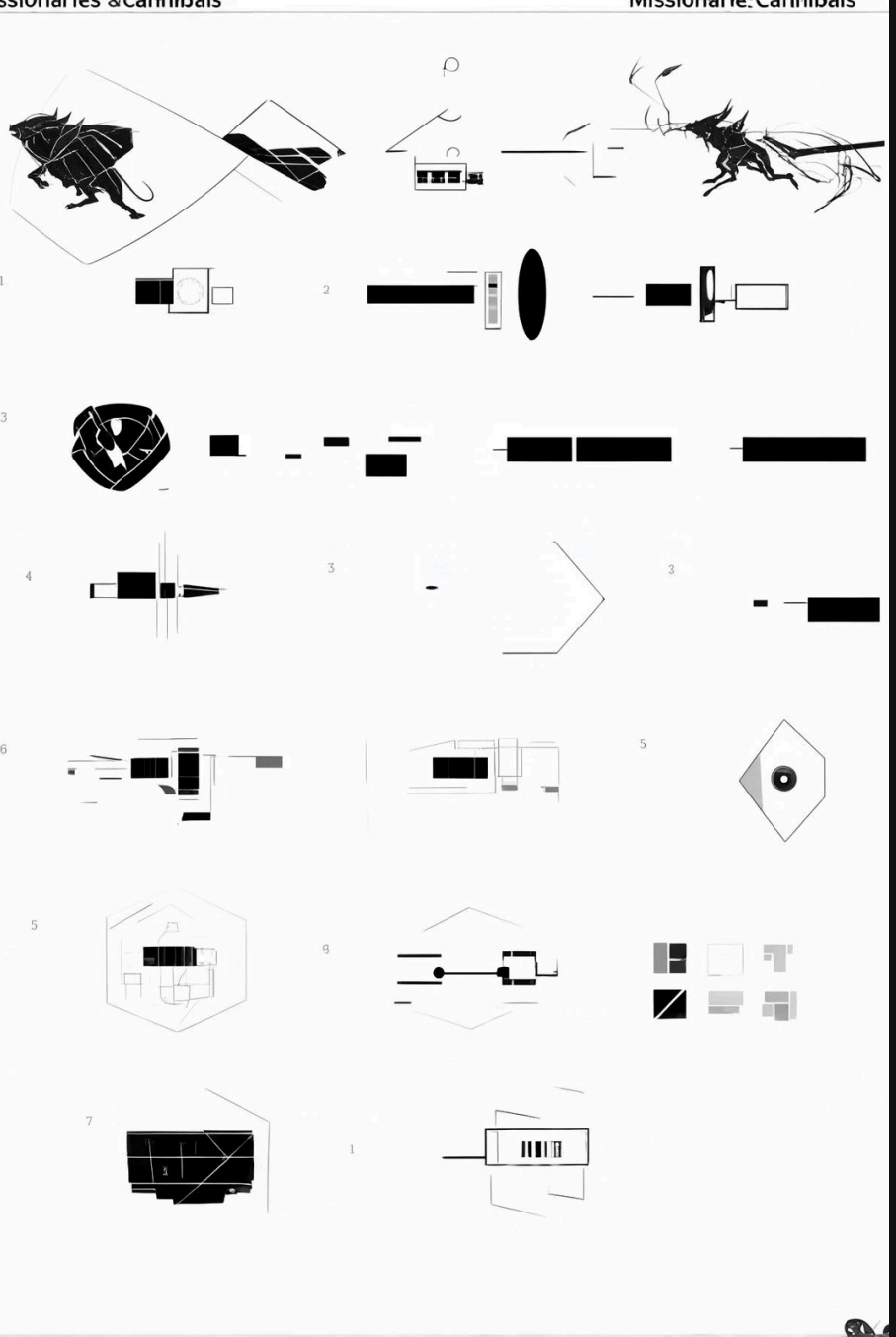
Valid Moves Determination

Each action generates a potential next state checked for legality.

Preventing Illegal States

Reject moves that cause cannibals to outnumber missionaries or other invalid conditions.





Results and Performance

Solution Efficiency

The AI found the shortest sequence in 11 steps, demonstrating effective state pruning.

Execution Time

A* Search completed within milliseconds, outperforming uninformed methods.

Comparison

Breadth-First Search explored more states but found similar solution length; DFS risked getting stuck.

Code Snippet

Below is a key snippet implementing the heuristic. It estimates remaining crossings by counting people left on the starting bank. This guides the A* search toward promising states. The function is concise yet critical to efficient problem solving.

// [Insert heuristic function or state transition function code here]

Full source code is available at: GitHub Repository

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        return
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Conclusion and Future Work

Summary

We successfully implemented an AI solution for the Missionaries and Cannibals problem using A* Search with heuristic guidance, efficiently finding valid solutions.

Future Improvements

Plans include developing a user-friendly GUI, experimenting with alternative search algorithms like IDA*, and scaling to more complex puzzle variations.

Acknowledgements

Thanks to the team and open-source communities for valuable resources and inspiration.