Self-Evolving Hierarchical A* Search

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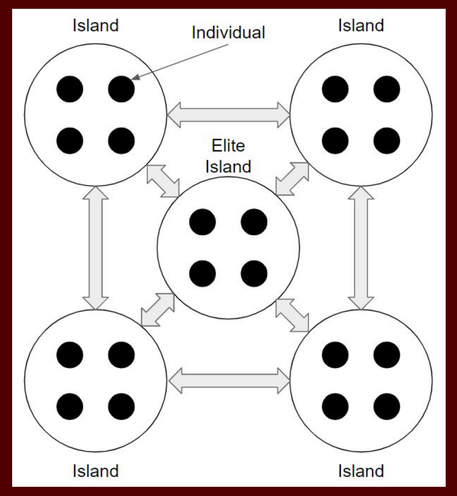
INTRODUCTION

Problem: (I) The performance heuristic-based search algorithms heavily depends on the quality of the heuristic function. (II) Heuristic design is time consuming. (III) Difficult to design a single heuristic to capture all the complexities [1].

Goal: To reduce the difficulty of designing a heuristic function with high performance for A* search algorithm.

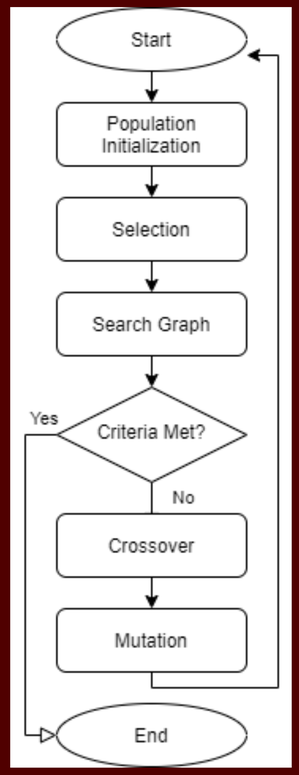
Objectives: Partition the search graph based on the characteristics of each segment. New approach that can be self-evolved to achieve rapid search with high accuracy and low computational cost.

Solution: Our new algorithm aims to (I) reduce the search complexity; (II) boost search performance (III) guarantee completeness and optimality.



METHODOLOGY

- **Preprocesses a grid based map**
  - Partitions graph to multiple segments
  - Generates an abstract graph for hierarchical search
- **Generates heuristic functions for each segment**
  - Heuristic functions are designed and optimized via Genetic Algorithm
- **Graph search with the generated heuristic functions**
  - Searches in abstract space first
  - Parallel search in each segment
  - Applies different heuristics in different segments to boost search performance
  - Refines the solution path



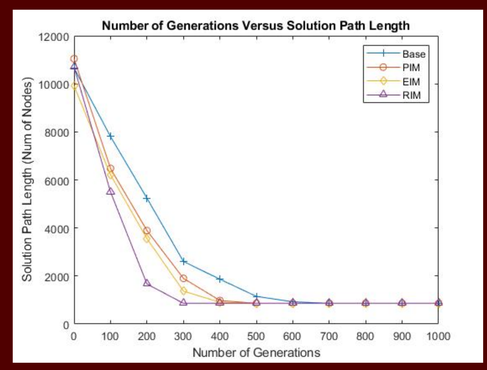
Sample map from a 2D grid based video game. This map is represented in pure text format to simplify the graph search process [2].

```
type octile
height 5
width 10
map
@@@@@@@@@@
TTWW@....@
TTWW@....@
TTSS@....@
TTSS.....@
```

Sample map in pure text format. It shows the height and width of the map. The symbols represent the elements in the map [2].

RESULT

Our preliminary results [3] show that HEHA* is:
(1) capable of developing accurate heuristic functions that provide optimal solutions for different environments
(2) able to design complex heuristic functions with high performance via evolutionary algorithm
(3) able minimizes both the search time and memory consumption



Future Works

The algorithm we used creates too many unnecessary partitions. We are currently developing a graph partitioning algorithm that is efficient and accurate.

[1] Aine, Sandip, et al. "Multi-heuristic a." The International Journal of Robotics Research 35.1-3 (2016): 224-243.
[2] Sturtevant, Nathan R. "Benchmarks for grid-based pathfinding." IEEE Transactions on Computational Intelligence and AI in Games 4.2 (2012): 144-148.
[3] Yiu, Ying Fung, Jing Du, and Rabi Mahapatra. "Evolutionary Heuristic A* Search: Pathfinding Algorithm with Self-Designed and Optimized Heuristic Function." International Journal of Semantic Computing 13.01 (2019): 5-23.

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