Homework 4 - Step 6 Documentation

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**6A) Describe in words how the number of expanded states compares for UCS and A\* with each of the two different heuristics.**

The average expanded states for UCS are **exponentially** greater than the A\* algorithms with each of the heuristics. A\* misplaced also seems to have a somewhat greater average than A\* Manhattan for the path lengths 6, 8, 10, 12.

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**6B) Explain why the number of expanded states varies among those three searches in the way you observed in your answer to 6A.**

The expanded states vary because it’s always better to use heuristic functions with higher values, which A\* Manhattan is. This shows with its lower average of expanded states. Manhattan distance is also *always* better than A\* Misplaced. Also, Uniformed Cost Search has a higher amount of expanded states because the algorithm has a worst-case runtime that is exponential in the average branching problem. Since A\* are informed algorithms, they will be faster.

**6C) Describe in words how the number of expanded states compares for Iterative Deepening and IDA\* with each of the two different heuristics.**

Iterative Deepening has a **much** higher average of expanded states. IDA\* Misplaced has the second highest averages, with the expanded states of 6, 8, 10, and 12 being much higher than in IDA\* Manhattan.

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**6D) Explain why the number of expanded states varies among those three searches in the way you observed in your answer to 6C.**

Since ID is an uninformed search, it will take longer. Manhattan distance is an admissible heuristic, so it will be optimal, thus the small average for expanded states.

**6E) How do the iterative deepening and IDA\* variations compare to UCS and the A\* variations in number of expanded states?**

ID is the algorithm with the highest average of expanded states, UCS has the second highest, then IDA\* Misplaced, A\* Misplaced, IDA\* Manhattan, and lastly A\* Manhattan. Those with the Manhattan heuristic are shown to have lower averages, showing their optimality.

**6F) Describe the memory usage (max states in memory) that you observed for UCS, and the two variations of A\*.**

The memory usage for UCS is much higher than the other algorithms. A\* can use a lot of memory, however, we can see UCS uses a greater deal. UCS has proved to be very inefficient and suboptimal. A\* Manhattan has a smaller memory usage than A\* Misplaced.

**6G) Describe the relative memory usage (max states in memory) that you observed for Iterative Deepening and IDA\* with the two different heuristics.**

ID, IDA\* Misplaced, and IDA\* Manhattan all have the same low memory usage averages. They are all shown to be very memory efficient compared to the other algorithms.

**6H) Explain the memory usage that you observed for the three iterative deepening algorithms (IDA\* and ID) versus the others (UCS and A\*).**

The ID algorithms were shown to be very memory efficient compared to UCS and A\*. ID is a depth-first search algorithm. DFS requires smaller amounts of memory because you would simply need to know a single path through the search tree. This is unlike BFS that needs memory proportional to the width of the search tree, storing the current level and all levels before it.