**Heuristic Search: Report**

**Optimizations:**

The purpose of optimization is to achieve the best, most efficient design. Adhering to the criteria and constraints outlined by the assignment, we optimized our algorithms by using various data structures, calculating h, g, and ƒ values, and testing our project as we worked on it. We considered factors such as productivity, runtime, efficacy, space, and more.

**Proposed Heuristics:**

Admissible/consistent heuristic: Manhattan Distance

The manhattan distance is the safest option to calculate the heuristic value. If the value was overestimated, it would pose a problem in accuracy. Since it is counted block by block, the value will not be overestimated.

Inadmissible heuristics:

1. Euclidean Distance- Can be underestimated, but is still a good measurement.

2. Chebyshev distance- Provides a maximum distance.

3. Average of Euclidean and Manhattan Distance- Manhattan can potentially overestimate, and euclidean can underestimate. If we average them, a more accurate heuristic value can be found.

4. Manhattan/2 - Rough estimate which is an okay starting place.

**Experimental Results:**

**(5)**

**Average of Euclidean and Manhattan**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Runtime** | **Path Length** | **Nodes Expanded** | **Memory** |
| **A Star** | 3479.92 | 180.51632813814905 | 435.44 | 2054.08 |
| **Uniform Cost** | 85339.1 | 100.66393466243366 | 10765.74 | 32934.04 |
| **Weighted AStar(1.25)** | 1440.4 | 199.33486726142996 | 180.56 | 1222.34 |
| **Weighted AStar(2.0)** | **984.3** | **208.6058414570998** | **123.54** | **1032.8** |

**Chebyshev**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Runtime** | **Path Length** | **Nodes Expanded** | **Memory** |
| **A Star** | **22623.6** | **110.2950094990893** | **2839.18** | **9460.38** |
| **Uniform Cost** | **85339.1** | **100.66393466243366** | **10765.74** | **32934.04** |
| **Weighted AStar(1.25)** | **16443.88** | **125.20607604191908** | **2061.54** | **7131.88** |
| **Weighted AStar(2.0)** | **3724.7** | **178.29328414370298** | **466.72** | **2112.56** |

**Euclidian**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Runtime** | **Path Length** | **Nodes Expanded** | **Memory** |
| **A Star** | **13961.82** | **112.98029483439484** | **1752.2** | **6212.88** |
| **Uniform Cost** | **85339.1** | **100.66393466243366** | **10765.74** | **32934.04** |
| **Weighted AStar(1.25)** | **7333.44** | **129.83744525108995** | **918.42** | **3665.18** |
| **Weighted AStar(2.0)** | **1286.4** | **179.77895350665239** | **160.86** | **1157.32** |

**Manhattan**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Runtime** | **Path Length** | **Nodes Expanded** | **Memory** |
| **A Star** | **9230.88** | **133.43162489477584** | **1157.94** | **4402.28** |
| **Uniform Cost** | **85339.1** | **100.66393466243366** | **10765.74** | **32934.04** |
| **Weighted AStar(1.25)** | **6333.02** | **165.35989975712164** | **793.6** | **3200.14** |
| **Weighted AStar(2.0)** | **1317.5** | **207.6181998726367** | **165.4** | **1169.96** |

**Manhattan/2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Runtime** | **Path Length** | **Nodes Expanded** | **Memory** |
| **A Star** | **35739.58** | **112.0009925142368** | **4495.24** | **14433.5** |
| **Uniform Cost** | **85339.1** | **100.66393466243366** | **10765.74** | **32934.04** |
| **Weighted AStar(1.25)** | **24924.38** | **116.01451415252235** | **3133.52** | **10376.5** |
| **Weighted AStar(2.0)** | **10096.74** | **132.01942845846065** | **1267.68** | **4798.64** |

**(6)** Different heuristic functions affect the behavior of each algorithm in terms of all four presented measurements. Uniform Cost Search has the shortest path length, and all categories are constant for all heuristics. Manhattan/2 has the shortest path lengths, but the largest memories. Chebyshev has the second shortest path lengths, and the second largest memory stats. The other three have relatively similar path lengths, and proportional memories. Each algorithm performs relative to the heuristics used.

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