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**PART B Q2: Solving Basic Eight Puzzle Problem with BFS**

**Note:** All reported counts of examined states exclude the Initial State.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Example File** | **Initial State** | **Solution**  **Path Length** | **States Explored by BFS** | **Reported Solution Path** |
| puzzle0 | [0, 1, 2, 3, 4, 5, 6, 7, 8] | 0 | 0 | [0 ,1 ,2 ,3 ,4 ,5 ,6 ,7 ,8] |
| puzzle1a | [1, 0, 2, 3, 4, 5, 6, 7, 8] | 1 | 2 | [1 ,0 ,2 ,3 ,4 ,5 ,6 ,7 ,8]  [0 ,1 ,2 ,3 ,4 ,5 ,6 ,7 ,8] |
| puzzle2a | [3, 1, 2, 4, 0, 5, 6, 7, 8] | 2 | 9 | [3 ,1 ,2 ,4 ,0 ,5 ,6 ,7 ,8]  [3 ,1 ,2 ,0 ,4 ,5 ,6 ,7 ,8]  [0 ,1 ,2 ,3 ,4 ,5 ,6 ,7 ,8] |
| puzzle4a | [1, 4, 2, 3, 7, 0, 6, 8, 5] | 5 | 161 | [1 ,4 ,2 ,3 ,7 ,0 ,6 ,8 ,5]  [1 ,4 ,2 ,3 ,7 ,5 ,6 ,8 ,0]  [1 ,4 ,2 ,3 ,7 ,5 ,6 ,0 ,8]  [1 ,4 ,2 ,3 ,0 ,5 ,6 ,7 ,8]  [1 ,0 ,2 ,3 ,4 ,5 ,6 ,7 ,8]  [0 ,1 ,2 ,3 ,4 ,5 ,6 ,7 ,8] |

**Comparison of A\* Heuristics on next page**

**PART B Q4: Comparing A-Star Heuristics for Eight Puzzle with Heuristics**

**Note:** All reported counts of explored states exclude the Initial State.

🡨---------Number of States Explored ------------🡪

*(Legend: Best Heuristic Worst Heuristic Too long to compute)*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Example File** | **Initial State** | **Optimal**  **Path Length** | **AStar Hamming** | **AStar Euclidean** | **AStar Manhattan** | **AStar Custom (Linear Conflict)** | **BFS** |
| puzzle0 | [0, 1, 2, 3, 4, 5, 6, 7, 8] | 0 | 0 | 0 | 0 | 0 | 0 |
| puzzle1a | [1, 0, 2, 3, 4, 5, 6, 7, 8] | 1 | 1 | 1 | 1 | 1 | 2 |
| puzzle2a | [3, 1, 2, 4, 0, 5, 6, 7, 8] | 2 | 2 | 2 | 2 | 2 | 9 |
| puzzle4a | [1, 4, 2, 3, 7, 0, 6, 8, 5] | 5 | 5 | 5 | 5 | 5 | 161 |
| puzzle12a | [4, 5, 0, 1, 2, 3, 6, 7, 8] | 8 | 21 | 29 | 29 | 24 | 946 |
| puzzle10a | [3, 1, 2, 6, 8, 7, 5, 4, 0] | 10 | 80 | 30 | 21 | 16 | 3375 |
| puzzle14a | [4, 5, 0, 1, 2, 8, 3, 7, 6] | 14 | 524 | 144 | 209 | 194 | -- |
| puzzle16a | [0, 8, 2, 1, 7, 4, 3, 6, 5] | 16 | 1552 | 778 | 421 | 285 | -- |

**Discussion:** We can see that with simpler searches (fewer optimal moves), all heuristics perform similarly.Even Hamming distance is an effective measure in those circumstances.

However, with starting states that have longer solution paths, the dominance of heuristics is easy to see.

In case of longer solution paths, h\_custom >= h\_manhattan >= h\_euclidean >=h\_hamming

i.e. Linear Conflict Custom Metric outperforms Manhattan which outperforms Euclidean which outperforms Hamming.

The **Custom Metric** (Linear Conflict Based) adds performs close enough in efficiency to Manhattan, and outperforms all heuristics in more complex solution paths.

An interesting contrast is **BFS**, which struggles to find the optimal path quickly, and shows how much faster AStar with a decent admissible heuristic is in comparison. BFS was unable to compute the solution paths for the last two example files.