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Course: CSE 415 Autumn 2017
Date: 21 Oct2017

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 ----------→

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	--

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

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.