CMPT 310 (ASSIGNMENT 1)

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This assignment concerns in solving the eight-puzzle problem using three Heuristics: 1. Misplaced-tiles Heuristic, 2. Manhattan Heuristic, and 3. Gaschnig heuristic. The tables, graphs and reasoning of the required answers to the questions is discussed in this report.

1. TABLE TO COMPARE THREE HEURISTICS

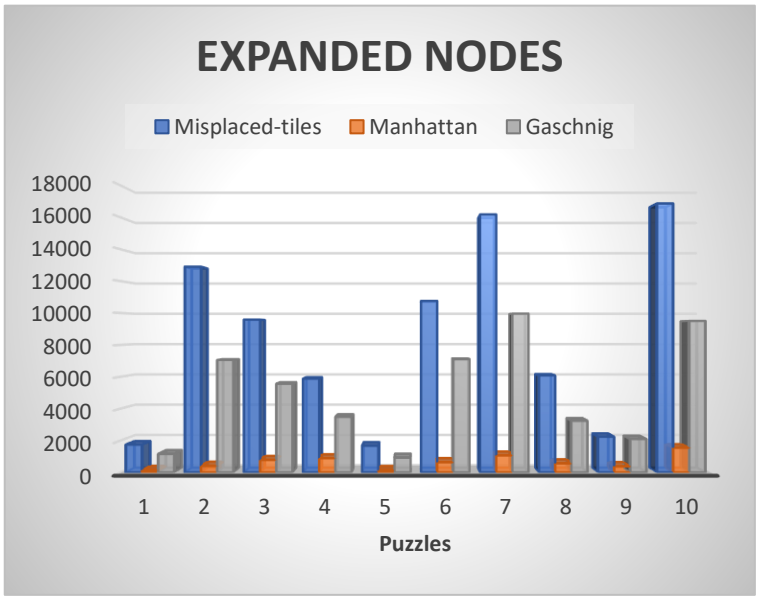
	MISPLACED-TILES HEURISTIC			MANHATTAN HEURISTIC			GASCHNIG HEURISTIC		
	TIME (in sec)	**LENGTH**	**EXPANDED NODES**	**TIME (in sec)**	**LENGTH**	**EXPANDED NODES**	**TIME (in sec)**	**LENGTH**	**EXPANDED NODES**
Puzzle 1	1.122044 (max)	19	1746 (max)	0.015618 (min)	19	138 (min)	0.533255	19	1163
Puzzle 2	66.364974 (max)	24	12906 (max)	0.066418 (min)	24	413 (min)	26.459585	24	7052
Puzzle 3	61.326335 (max)	23	9586 (max)	0.562664 (min)	23	786 (min)	25.048281	23	5562
Puzzle 4	20.034988 (max)	22	5883 (max)	0.306541 (min)	22	896 (min)	4.339649	22	3485
Puzzle 5	0.975824 (max)	19	1682 (max)	0.007996 (min)	19	130 (min)	0.336532	19	932
Puzzle 6	72.659981 (max)	23	10758 (max)	0.380345 (min)	23	643 (min)	39.099675	23	7100
Puzzle 7	187.65955 (max)	24	16181 (max)	0.844635 (min)	24	1074 (min)	83.832747	24	9961
Puzzle 8	24.269112 (max)	22	6084 (max)	0.255837 (min)	22	570 (min)	8.644189	22	3242
Puzzle 9	3.455024 (max)	20	2242 (max)	0.132922 (min)	20	389 (min)	4.451729	20	2098
Puzzle 10	164.92168 (max	24	16870 (max)	1.652184 (min)	24	1550 (min)	63.517573	24	9504

As is evident from the above table, the Misplaced-tiles Heuristic takes maximum amount of time to perform and maximum number of nodes expansion among the other three, and the Manhattan Heuristic takes minimum amount of time along with minimum number of nodes expansion.After calculating the time taken, number of tiles moved and expanded nodes, lets calculate the average of time taken and expanded nodes since number of tiles remained same throughout the Puzzle in all three Heuristics.

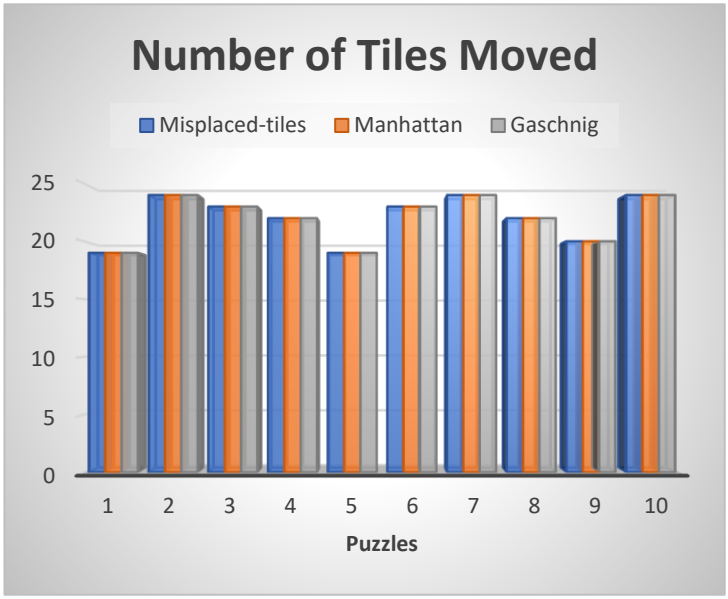
	AVERAGE		
	TIME (in sec)	**EXPANDED NODES**	**NUMBER OF TILES MOVED**
Puzzle 1	0.556972	1015	19
Puzzle 2	30.96366	6790	24
Puzzle 3	28.97909	5311	23
Puzzle 4	8.227059	3421	22
Puzzle 5	0.440117	914	19
Puzzle 6	37.38	6167	23
Puzzle 7	90.77898	9072	24
Puzzle 8	11.05638	3298	22
Puzzle 9	2.679892	1576	20
Puzzle 10	76.69715	9308	24

2. HISTOGRAMS TO COMPARE THE THREE HEURISTICS

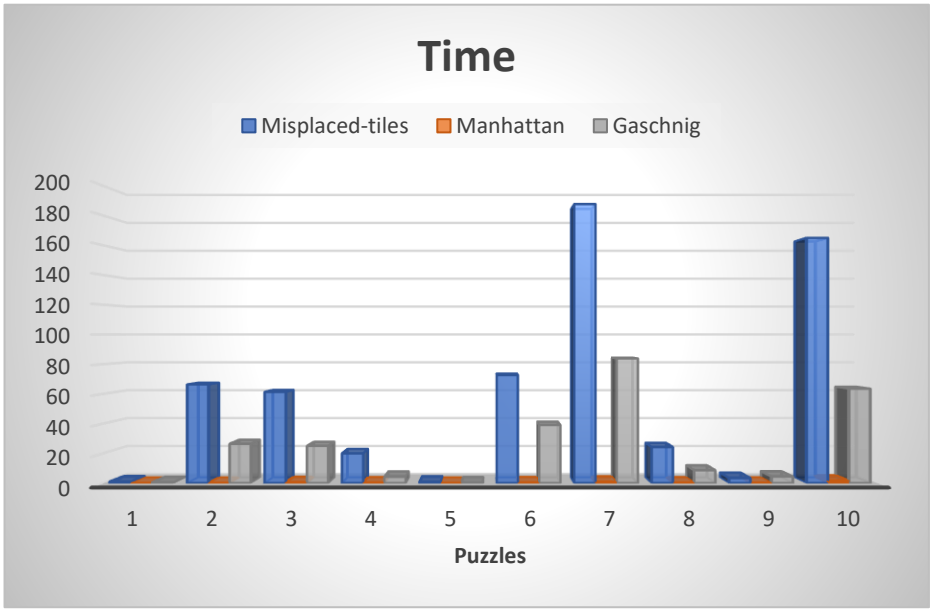
A. EXPANDED NODES



B. NUMBER OF TILES MOVED



C. TIME



3. QUESTIONS OF COMPARISION

ANSWER 1: Based on the calculated data, it can be concluded that Manhattan is the best algorithm because among the three algorithms, the Manhattan takes less amount time to solve the eight puzzle and it takes a smaller number of node expansions, making it faster than the others.

ANSWER 2: Based on theoretical consideration, the Misplaced-tiles Heuristics can be ruled than Manhattan and Gaschnig Heuristics because:

Manhattan Heuristic concerns with calculating the Manhattan distance and then using that distance to solve the eight-puzzle problem. The Manhattan distance is calculated as such that the sum is comprised of individual state of the tiles of how far the tiles are placed. The empty space is moved to the neighboring sites until the goal is reached.

Gaschnig Heuristic solves the eight-puzzle problem by calculating the Gaschnig distance which is the count of how many times the swapping of tiles and the empty spaces occurs, i.e., estimating the number of tiles needs to reach the goal state.

Misplaced-tiles Heuristics solves the eight-puzzle problem by calculating the number of misplaced tiles not concerning itself with how far the tile is to reach the goal state, i.e., each tile is considered as equal distance from the goal state.

Hence, with above reasoning, it can be concluded that Misplaced-tiles Heuristic can be ruled out because for some n, $h_1(n)$ of Misplaced-tiles will be less than that of $h_2(n)$ of Manhattan, or Gaschnig, i.e $h_1(n) \geq h_2(n)$, for all n, is contradicted because of high accuracy of Manhattan and Gaschnig theoretically.

ANSWER 3: The Pattern Databases is the database that is at least as accurate as all three functions discussed here. As discussed in class lecture, the pattern database uses a wild card to replace some of the tiles and use the value as heuristic. When more than one pattern applies, the maximum value is used. Using the reasoning is answer 2, the h values of above 3 functions is less than that of pattern database, hence pattern database will be more accurate (it is better than Manhattan as discussed in lecture).