

AI Assignment 1 - Coding

Kaustubh Hiware, 14CS30011

Heuristics used:

- $h_a(n) = 0$
- Manhattan Distance: sum of x and y distances of each tile from its place in the goal state
- Euclidean Distance: square root of sum of squares of the x and y distances of each tile from goal tile
- Misplaced tiles: sum of number of tiles in the same place as in goal state

Input.txt has randomly generated 50 inputs with some unsolvable inputs, which are indicated by -1.

Output: The output is also present in output.txt.

- We see that, in most cases, misplaced tiles heuristic takes the longest time.
- Maximum nodes are explored in misplaced tiles heuristic.
- In few cases, euclidean gives outrageous running time.

A*

Start A*	N0	t0	N1	t1	N2	t2	N3	t3
[3, 1, 2, 4, 0, 5, 6, 7, 8]	2	0.00015483	2	0.00015498	2	0.00019199	10	0.00877069
[1, 2, 0, 4, 8, 3, 7, 6, 5]	20	1.03776334	20	0.06347172	20	0.04733376	28	15.66652274
[1, 3, 5, 7, 2, 6, 8, 0, 4]	28	2.37207187	28	0.10577174	28	0.05886474	30	19.23183269
[1, 2, 3, 4, 6, 5, 7, 8, 0]	-1	-1	-1	-1	-1	-1	-1	-1
[0, 4, 1, 5, 3, 2, 7, 8, 6]	30	2.12184450	30	0.11852891	30	0.10726926	30	15.90167311
[8, 6, 7, 2, 5, 4, 1, 3, 0]	-1	-1	-1	-1	-1	-1	-1	-1
[1, 4, 3, 7, 0, 8, 6, 5, 2]	34	0.73108209	34	0.03989968	34	0.02030717	34	15.29814516
[6, 0, 8, 4, 3, 5, 1, 2, 7]	34	4.46976559	34	0.22015713	34	0.30442352	34	17.70579238
[2, 0, 8, 1, 3, 5, 4, 6, 7]	34	0.13419359	34	0.00799375	34	0.00486309	34	7.51391728
[1, 0, 3, 2, 4, 5, 6, 7, 8]	-1	-1	-1	-1	-1	-1	-1	-1
[8, 7, 2, 1, 5, 0, 4, 6, 3]	34	4.61804560	34	0.21142870	34	0.30260497	34	15.91888786
[6, 3, 8, 5, 4, 1, 7, 2, 0]	39	2.18695434	39	0.08940288	39	0.05587300	39	15.86218707
[4, 1, 2, 3, 0, 6, 5, 7, 8]	39	1.33426040	39	0.08160160	39	0.07370772	39	17.82897775
[1, 2, 3, 4, 5, 6, 7, 8, 0]	39	2.47893124	39	0.13292724	39	0.10812089	39	16.71167520
[1, 3, 6, 5, 2, 8, 4, 0, 7]	39	4.63422823	39	0.27009163	39	0.30075601	39	16.87090056
[1, 8, 5, 0, 2, 4, 3, 6, 7]	39	0.48900347	39	0.02588134	39	0.01774247	39	13.26048517
[5, 3, 6, 4, 0, 7, 1, 8, 2]	39	4.52698905	39	0.14842411	39	0.15836724	39	16.56543868
[1, 2, 3, 4, 5, 0, 7, 8, 6]	39	2.09871019	39	0.10621782	39	0.07325357	39	18.20022833
[7, 0, 2, 8, 5, 3, 6, 4, 1]	-1	-1	-1	-1	-1	-1	-1	-1
[0, 1, 2, 4, 5, 3, 7, 8, 6]	39	2.37415034	39	0.12739910	39	0.10897407	39	17.32334804
[1, 2, 3, 4, 0, 5, 7, 8, 6]	39	1.57134223	39	0.08418459	39	0.05467428	39	16.33954513

[1, 2, 3, 0, 4, 5, 7, 8, 6]	39	1.00657876	39	0.05037304	39	0.02740254	39	14.55579487	
[4, 3, 1, 0, 7, 2, 8, 5, 6]	39	0.83403688	39	0.04529862	39	0.02584738	39	18.45131307	
[1, 6, 4, 0, 3, 5, 8, 2, 7]	39	2.25840040	39	0.10769305	39	0.06390009	39	18.35260730	
[3, 4, 6, 2, 0, 8, 1, 7, 5]	39	4.01919763	39	0.19885041	39	0.22096891	39	17.53456524	
[1, 2, 3, 0, 4, 8, 7, 6, 5]	39	3.54303254	39	0.27940637	39	0.29558696	39	17.27101138	
[0, 4, 3, 2, 1, 6, 7, 5, 8]	39	4.08657905	39	0.20440755	39	0.19110454	39	17.99183410	
[8, 1, 2, 0, 4, 3, 7, 6, 5]	-1	-1	-1	-1	-1	-1	-1	-1	
[1, 0, 2, 4, 6, 3, 7, 5, 8]	39	0.36497568	39	0.02270967	39	0.01631466	39	11.96063456	
[6, 5, 3, 4, 1, 7, 0, 2, 8]	39	5.01016218	39	0.29016297	39	0.41178320	39	20.87122613	
[6, 4, 7, 8, 5, 0, 3, 2, 1]	39	4.44913346	39	0.18190959	39	0.24999777	39	16.41448763	
[5, 2, 1, 4, 8, 3, 7, 6, 0]	39	4.90478548	39	0.39928514	39	0.57297959	39	16.69117055	
[4, 8, 7, 5, 3, 1, 0, 6, 2]	39	3.96656049	39	0.16674004	39	0.14072912	39	18.14270238	
[8, 3, 5, 6, 4, 2, 1, 0, 7]	39	3.10344402	39	0.15007538	39	0.14118152	39	16.87319222	
[7, 4, 3, 2, 8, 6, 0, 5, 1]	39	3.69375211	39	0.09539716	39	0.06510507	39	16.54776787	
[8, 6, 7, 2, 0, 4, 3, 5, 1]	39	4.93745823	39	0.22290780	39	0.40764254	39	14.24332675	
[0, 4, 3, 2, 1, 6, 7, 5, 8]	39	4.09322756	39	0.29620662	39	0.18409950	39	18.97432475	
[1, 2, 3, 4, 5, 0, 7, 8, 6]	39	1.96527501	39	0.10016849	39	0.07475672	39	16.24122037	
[1, 2, 3, 4, 0, 5, 7, 8, 6]	39	1.58071910	39	0.07319126	39	0.05001318	39	16.16284472	
[8, 6, 7, 2, 5, 4, 1, 3, 0]	-1	-1	-1	-1	-1	-1	-1	-1	
[1, 2, 0, 4, 8, 3, 7, 6, 5]	39	1.14398351	39	0.06371826	39	0.04972849	39	15.88866231	
[1, 0, 2, 4, 6, 3, 7, 5, 8]	39	0.32820838	39	0.02033010	39	0.01650575	39	11.73351975	
[1, 2, 3, 4, 6, 5, 7, 8, 0]	-1	-1	-1	-1	-1	-1	-1	-1	
[0, 1, 2, 4, 5, 3, 7, 8, 6]	39	2.17892338	39	0.11925577	39	0.10758060	39	15.70272747	
[1, 2, 3, 4, 5, 6, 7, 8, 0]	39	2.59542697	39	0.12648465	39	0.10154870	39	17.83437242	
[7, 0, 2, 8, 5, 3, 6, 4, 1]	-1	-1	-1	-1	-1	-1	-1	-1	
[8, 1, 2, 0, 4, 3, 7, 6, 5]	-1	-1	-1	-1	-1	-1	-1	-1	
[1, 2, 3, 0, 4, 8, 7, 6, 5]	39	3.41588316	39	0.19684434	39	0.20537008	39	15.72081487	
[1, 2, 3, 0, 4, 5, 7, 8, 6]	39	0.94715350	39	0.04507575	39	0.02909580	39	13.79254703	
[1, 0, 3, 2, 4, 5, 6, 7, 8]	-1	-1	-1	-1	-1	-1	-1	-1	
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+									

IDA*

Start IDA*	N0	t0	N1	t1	N2	t2	N3	t3
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								
[3, 1, 2, 4, 0, 5, 6, 7, 8]	10	0.00022592	10	0.00021800	10	0.00025725	10	0.00117420
[1, 2, 0, 4, 8, 3, 7, 6, 5]	28	1.18621707	28	1.76509812	28	26.63045239	28	0.79611658
[1, 3, 5, 7, 2, 6, 8, 0, 4]	30	1.45959460	30	2.72914703	30	63.31747508	30	0.65905786
[1, 2, 3, 4, 6, 5, 7, 8, 0]	-1	-1	-1	-1	-1	-1	-1	-1
[0, 4, 1, 5, 3, 2, 7, 8, 6]	30	1.64454527	34	5.37690712	34	165.04616852	34	0.90202970
[8, 6, 7, 2, 5, 4, 1, 3, 0]	-1	-1	-1	-1	-1	-1	-1	-1
[1, 4, 3, 7, 0, 8, 6, 5, 2]	34	1.01240193	34	1.43934710	34	6.61842412	34	0.89474859
[6, 0, 8, 4, 3, 5, 1, 2, 7]	34	2.94737913	34	1.73855718	34	29.04872442	34	2.63117403
[2, 0, 8, 1, 3, 5, 4, 6, 7]	34	0.21768334	34	0.08873737	34	0.31426391	34	0.13959156
[1, 0, 3, 2, 4, 5, 6, 7, 8]	-1	-1	-1	-1	-1	-1	-1	-1
[8, 7, 2, 1, 5, 0, 4, 6, 3]	34	3.03257470	39	10.04505874	39	359.84012511	39	15.04397236
[6, 3, 8, 5, 4, 1, 7, 2, 0]	39	1.61184448	39	1.61504128	39	33.38959117	39	2.43032827
[4, 1, 2, 3, 0, 6, 5, 7, 8]	39	1.37640290	39	2.70666649	39	51.69246632	39	4.05774473
[1, 2, 3, 4, 5, 6, 7, 8, 0]	39	1.79246634	39	7.88604425	39	232.78805638	39	1.47507325
[1, 3, 6, 5, 2, 8, 4, 0, 7]	39	2.95919466	39	7.94529886	39	273.79163340	39	0.39802402
[1, 8, 5, 0, 2, 4, 3, 6, 7]	39	0.53886985	39	0.32652876	39	3.02122611	39	0.09736517

[5, 3, 6, 4, 0, 7, 1, 8, 2]	39	2.86084209	39	4.04018089	39	24.31634789	39	0.10116328	
[1, 2, 3, 6, 4, 5, 0, 7, 8, 6]	39	1.68076651	39	6.57481090	39	183.87465976	39	1.09762525	
[7, 0, 2, 8, 5, 3, 6, 4, 1]	-1	-1	-1	-1	-1	-1	-1	-1	
[0, 1, 2, 4, 5, 3, 7, 8, 6]	39	1.91433713	39	10.88588089	39	296.08508099	39	12.29244722	
[1, 2, 3, 4, 0, 5, 7, 8, 6]	39	1.36795751	39	4.85078917	39	124.41268015	39	7.14885411	
[1, 2, 3, 0, 4, 5, 7, 8, 6]	39	0.90215369	39	0.35455519	39	2.07355041	39	0.57225562	
[4, 3, 1, 0, 7, 2, 8, 5, 6]	39	0.72276964	39	1.80561544	39	3.68258140	39	0.06184927	
[1, 6, 4, 0, 3, 5, 8, 2, 7]	39	1.94948593	39	2.45946815	39	37.78323441	39	2.84720888	
[3, 4, 6, 2, 0, 8, 1, 7, 5]	39	2.88921335	39	4.26877734	39	73.13384019	39	4.36466623	
[1, 2, 3, 0, 4, 8, 7, 6, 5]	39	2.36596775	39	1.43187188	39	20.32376594	39	1.92799334	
[0, 4, 3, 2, 1, 6, 7, 5, 8]	39	2.53414340	39	4.00869156	39	102.10481882	39	6.15688130	
[8, 1, 2, 0, 4, 3, 7, 6, 5]	-1	-1	-1	-1	-1	-1	-1	-1	
[1, 0, 2, 4, 6, 3, 7, 5, 8]	39	0.46668315	39	1.89515738	39	33.69497854	39	2.75250115	
[6, 5, 3, 4, 1, 7, 0, 2, 8]	39	4.29567293	39	6.42287127	39	167.10238073	39	7.87676348	
[6, 4, 7, 8, 5, 0, 3, 2, 1]	39	3.04172373	39	5.23823269	39	195.65455071	39	0.27365738	
[5, 2, 1, 4, 8, 3, 7, 6, 0]	39	3.25987760	39	7.77450474	39	265.23596379	39	1.32458905	
[4, 8, 7, 5, 3, 1, 0, 6, 2]	39	2.33121600	39	1.40017213	39	39.56823937	39	0.05670114	
[8, 3, 5, 6, 4, 2, 1, 0, 7]	39	2.21527330	39	5.45081104	39	149.34345633	39	7.93359656	
[7, 4, 3, 2, 8, 6, 0, 5, 1]	39	2.64620719	39	6.15746936	39	235.94325016	39	0.92651821	
[8, 6, 7, 2, 0, 4, 3, 5, 1]	39	3.34223387	39	9.97582106	39	382.20616752	39	0.84931198	
[0, 4, 3, 2, 1, 6, 7, 5, 8]	39	2.66662816	39	4.12810618	39	108.52898368	39	6.04419354	
[1, 2, 3, 4, 5, 0, 7, 8, 6]	39	1.67587210	39	6.08372335	39	179.65024711	39	1.08590094	
[1, 2, 3, 4, 0, 5, 7, 8, 6]	39	1.23066501	39	4.63301563	39	121.48032202	39	7.09913538	
[8, 6, 7, 2, 5, 4, 1, 3, 0]	-1	-1	-1	-1	-1	-1	-1	-1	
[1, 2, 0, 4, 8, 3, 7, 6, 5]	39	1.13844423	39	1.75628105	39	25.69064542	39	0.62895389	
[1, 0, 2, 4, 6, 3, 7, 5, 8]	39	0.55487725	39	1.90937736	39	33.48617017	39	2.77442414	
[1, 2, 3, 4, 6, 5, 7, 8, 0]	-1	-1	-1	-1	-1	-1	-1	-1	
[0, 1, 2, 4, 5, 3, 7, 8, 6]	39	1.85357404	39	10.21510852	39	373.50664764	39	14.53592644	
[1, 2, 3, 4, 5, 6, 7, 8, 0]	39	1.73513545	39	7.97322167	39	226.76123054	39	1.36926909	
[7, 0, 2, 8, 5, 3, 6, 4, 1]	-1	-1	-1	-1	-1	-1	-1	-1	
[8, 1, 2, 0, 4, 3, 7, 6, 5]	-1	-1	-1	-1	-1	-1	-1	-1	
[1, 2, 3, 0, 4, 8, 7, 6, 5]	39	2.19080933	39	1.38792584	39	19.77927678			