CS3612 - Intelligent Systems

Assignment Report

Search: Modified n-puzzle

Index number: 190290U

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Introduction

The assignment required students to implemented A-star algorithm to solve modified N-puzzle problem. The traditional N-puzzle is such that there is a n-by-n board with numbered tiles. One such tile is a blank tile and other are numbered with different integers. The problem gives a starting state of the board and an ending state. The solver must find sequence of tile moves (by moving around the blank tile) that the starting state reaches the ending state after applying the found moves. The assignment is slightly modified N-puzzle where the board has exactly two blank tiles instead of one. Students must implement the A-star algorithm using tile difference heuristic and Manhattan distance heuristic functions, which were discussed in the class, to solve the modified N-puzzle problem. After implementing the algorithm, the student should use t-paired testing to compare the two heuristic functions.

Comparing the two heuristic functions

The code related to this part is implemented in the 'experimentPart.py' python file. In this file, 110 (sample size) number of start states are randomly produced. For each start state, the goal state is obtained by altering the two blank tiles in the state randomly by some number of times. In the code, it is implemented as (These decisions were carefully taken to avoid the code running for very long time before giving the result):

- 20 for 16 <= n <= 12
- 22 for 11 <= n <= 14
- 24 for 5<= n <= 16 where n is the length or width of the puzzle board

Then for each start state & goal state pair, I ran the A-star algorithm with tile difference heuristic and then with Manhattan distance heuristic. Then I considered the number of total states that was considered in the start-to-goal path by the two heuristics respectively and obtained the difference.

- The difference = (Total states or nodes that expanded by tile difference heuristic) – (Total states or nodes that expanded by Manhattan distance heuristic)

Therefore, I get 110 number of values for the 'difference'. Then from these values the mean, standard deviation, and the statistic value (or T-value) calculated to carry out the t-paired test. The **null hypothesis (H0)**, and the **alternative hypothesis (H1)** can be defined as:

- H0: the actual or population mean (say 'u') = 0
- H1: u > 0

Then **5% level of significance is assumed,** and the critical value can be obtained from the student-t distribution table as **1.64**

- Then the rejection criteria can be obtained as:

If **statistic value (T-value) > critical value** ⟶ We have enough evidence to **reject** H0 at 5% level of significance

Then based on the value we get to the T-value variable in the code, we can determine whether the Manhattan distance heuristic is better than the tile difference or not.

Conclusion

The difference-values got for 110 random start-goal pairs are as follows (copied from the code output):

test num.	n	Tile diff.	Manhattan dis.	difference
1	5	33	33	0
2	5	3527	223	3304
3	5	857	274	583
4	5	939	109	830
5	6	39	32	7
6	6	104	104	0
7	6	171	44	127
8	6	32	32	0
9	6	64	64	0
10	7	59	59	0
11	7	50	50	0
12	7	6228	2305	3923
13	7	176	176	0
14	7	852	200	652
15	7	59	59	0
16	7	92	92	0
17	8	300	105	195
18	8	241	241	0
19	8	112	112	0
20	8	60	60	0
21	8	253	253	0
22	8	727	186	541
23	8	571	239	332
24	8	109	109	0
25	9	1679	344	1335
26	9	13	13	0
27	9	14	14	0
28	10	102	102	0
29	10	30	30	0
30	10	664	171	493
31	10	85	85	0

32	10	100	100	0
33	10	105	105	0
34	10	53	53	0
35	11	30	30	0
36	11	311	96	215
37	11	35	35	0
38	11	13	13	0
39	11	93	93	0
40	11	64	64	0
41	11	56	30	26
42	11	27	27	0
43	11	54	54	0
44	11	14	14	0
45	11	24	24	0
46	12	57	57	0
47	12	30	30	0
48	12	12	12	0
49	12	14	14	0
50	12	59	59	0
51	12	163	163	0
52	12	15	15	0
53	12	61	61	0
54	12	31	31	0
55	13	59	59	0
56	13	63	63	0
57	13	86	86	0
58	13	144	62	82
59	13	14	14	0
60	13	141	141	0
61	13	65	65	0
62	13	82	82	0
63	13	9	9	0
64	13	110	110	0
65	14	100	100	0
66	14	46	26	20
67	14	166	166	0
68	14	64	64	0
69	14	164	120	44
70	14	31	31	0
71	15	31	31	0
72	15	15	15	0
73	15	104	104	0
74	15	169	169	0
75	15	103	103	0
76	15	173	173	0
77	15	63	63	0
78	16	567	256	311
79	16	4	4	0

80	16	32	32	0
81	16	13	13	0
82	16	59	59	0
83	16	167	167	0
84	16	94	94	0
85	16	12	12	0
86	17	103	103	0
87	17	30	30	0
88	17	32	32	0
89	17	43	43	0
90	17	34	34	0
91	17	15	15	0
92	17	9	9	0
93	17	33	33	0
94	18	64	64	0
95	18	47	26	21
96	18	12	12	0
97	19	64	64	0
98	19	50	50	0
99	19	29	29	0
100	19	319	103	216
101	19	104	104	0
102	20	13	13	0
103	20	28	28	0
104	20	136	65	71
105	20	169	169	0
106	20	62	62	0
107	20	60	60	0
108	20	24	24	0
109	20	13	13	0
110	20	31	31	0

The program also outputs these parameters:

```
sample mean:  121.16363636363636
sample standard deviation:  514.3141068456288
Statistic value (T-value):  2.4708148620312844
Critical value:  1.64
CRITICAL VALUE is less than T_value => Null hypothesis can be rejected
with 5 percent level of significance
```

Since **T-Value > critical value** ➔ we have enough evidence to reject H0 at 5% level of significance.

Therefore, ‘u’ (the actual or population mean) > 0 ➔ which means total moves required for tile difference heuristics is greater than the requirements of Manhattan heuristic.

Therefore, the conclusion is: **Manhattan distance is better than tile difference heuristic**