Assignment 2

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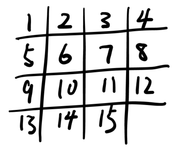


Q1: Search Algorithms for the 15-Puzzle

a)	UCS	IDS	A*	IDA*
start10	2565	2407	33	29
start20	Mem	5297410	915	952
start27	Mem	Time	1873	2237
start35	Mem	Time	Mem	215612
start43	Mem	Time	Mem	2884650

b)
For UCS, the time complexity is $O(b^d)$ and its space complexity is the same.
However, although IDS has the same time complexity, it is way more efficient in terms of space O(bd). Therefore, it does not run out of memory but it takes time to solve hard puzzles.

A* is much more efficient than UCS because it has a heuristic to estimate the distance towards the goal. It can have polynomial time complexity if heuristic function is good. However, it has the same issue like UCS, the space complexity is the same.
Therefore, we have IDA* that take advantage of the heuristic and space complexity of O(bd) to become the optimal search.

Q2: Deceptive Starting States

a)

start49(S), showpos(S), h(S,H).
MBDC
LAKH
JFEI
ONG
S = [4/1, 2/2, 1/2, 1/4, 1/3, 3/3, 3/2, 4/4, ... / ...|...],
H = 25.

start51(S), showpos(S), h(S,H).
GKJI
MNC
EOHA
FBLD
S = [2/1, 3/4, 4/2, 2/4, 4/4, 3/1, 4/1, 1/1, ... / ...|...],
H = 43.

b) 551168

c) It cannot find the solution so it goes deeper.

Q3: Heuristic Path Search $f(n) = (2-w)g(n) + wh(n)$

a/c)		start49		start60		start64
IDA*	49	178880187	60	321252368	64	1209086782
1.2	51	988332	62	230861	66	431033
1.4	57	311704	82	3673	94	188917
Greedy	133	5237	166	1617	184	2174

b) F1 is (2 - 1.4) * G1 + 1.4 * H1,

d) If w is closer to 2.0, the search will be super faster but the path is not optimal at all.
However, if w is closer to 1.0, the search will be much slower (I mean SUPER slow) but it gives optimal path.
Therefore, you either have faster speed or better path. According to the table above, when w is 1.2, it seems to be more balanced between speed and quality. It has better speed with slight longer path (2 more in this case but way faster).

Q4: Maze Search Heuristics

a) Manhattan distance. $h(x,y,x_G,y_G) = (x-x_G)+(y-y_G)$

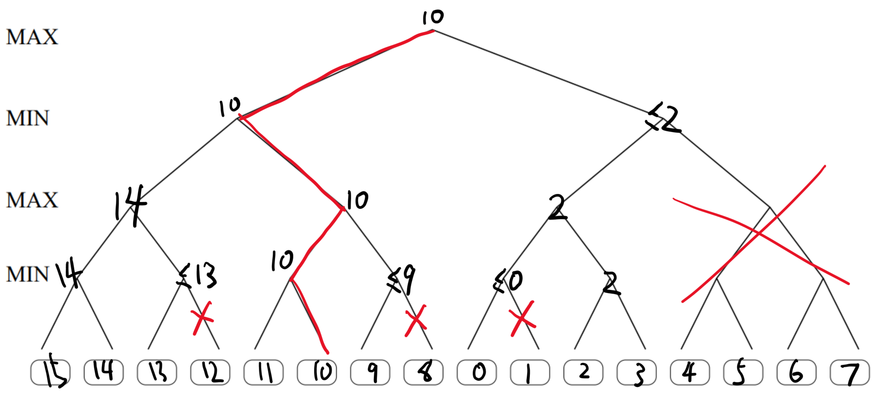
b)
i) Yes, it is still admissible since it simply measures the straight line distance. Moving diagonally does not affect it much and it might even become a better heuristic because of it.

ii) No, it is not admissible anymore because of diagonal move. Manhattan distance does not work diagonally because it is only designed for horizontal and vertical moves.

iii)

Q5: Game Trees and Pruning

a/b)



c) 27 nodes (1/3).

d) It is $O(b^{d/2})$ if optimal move is always chosen first. You will prune that branch so is it simply O(1) 50% of the time so it will be half of the depth.