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ASSIGNMENT # 01

Scenario Given:

⊙ 10x10 grid

	0	1	2	3	4	5	6	7	8	9
0	13 S	12	11	10	9 X	8	7	6	5	4
1	12 X	11 X	10	9 X	8 X	7	6 X	5 X	4 X	3
2	11	10	9	8	7	6	5	4 X	3	2
3	10	9 X	8 X	7 X	6	5 X	4 X	3 X	2	1
4	9	8	7	6 X	5	4	3	2 X	1	0 G
5	10 X	9 X	8	7 X	6 X	5	4 X	3 X	2	1
6	17	10	9	8	7 X	6	5	4	3	2
7	18	11 X	10 X	9	8	7	6 X	5 X	4 X	3
8	13	12	11	10	9 X	8	7	6	5	4
9	14 X	13 X	12 X	11 X	10 X	9	8 X	7 X	6 X	5

S = Start State (0,0)

G = Goal State (4,9)

X = Represent walls or obstacles

Dot (.) = represent path

(1) Implement A* Search to find most cost-efficient path, considering distance & obstacles

→ The A* Search is the informed Search Algo so; heuristic function used will be Manhattan Distance;

$$MD = |x_2 - x_1| + |y_2 - y_1|$$

$\therefore (x_2, y_2) = (4, 9)$

e.g# Calculate all the Distances :-

$\therefore$ for $S(x_1, y_1) = (|(4-0)| + |9-0|)$

$= 13$

Now; A* Search Algo states

$$f(n) = g(n) + h(n)$$

$h(n)$: from (n) to Goal

$g(n)$: Steps from S → n

Explanation :

S(0,0) starts moving to n (0,1) to (0,2)

Here it has 2 options

$\therefore g(n) = 2$ and $h_1(n) = 10$, $h_2(n) = 10$] $f(n) = 12$ Same for both!

If it move to (0,3) it face wall so

It moves to (1,2) then to (2,2) → Decision making

$\therefore g(n) = 4$; $h_1(n) = 10 \rightarrow f(n) = 14$

$h_2(n) = 8 \rightarrow f(n) = 12$ least

moves to $f(n) = 12$ which is (2,3) then keeps on moving till (2,5) where again it has 2 options;

$\therefore g(n) = 7$; $h_1(n) = 7 \rightarrow f(n) = 14$

$h_2(n) = 5 \rightarrow f(n) = 12$

If it chooes $f(n) = 12$ it faces wall so it chooes and backtracks to $\boxed{f(n) = 14}$ and moves to (0,5) where it again decides and chooes least distance, (0,6)

It keeps moving till it gets it's goal (4,9)

Hence;

$\boxed{\text{Total cost (no. of steps)} = 17}$

③

* **efficient path / optimal path :**

$\boxed{(0,0)} \rightarrow (0,1) \rightarrow (0,2) \rightarrow (1,2) \rightarrow (2,2) \rightarrow (2,3) \leftarrow (2,4) \leftarrow (2,5) \leftarrow (1,5) \leftarrow (0,5) \rightarrow (0,6) \rightarrow (0,7) \rightarrow (0,8) \rightarrow (0,9) \rightarrow (1,9) \rightarrow (2,9) \rightarrow (3,9) \leftarrow \text{goal } \boxed{(4,9)}$

② Calculate h(n), make sure it is admissible and consistent

- h(n) → manhattan Distance to goal calculated.

⊙ **Admissibility:**

A heuristic is admissible if for every node n,

$$h(n) \leq \text{true minimal cost from } (n) \text{ to goal}$$

→ In a 4-connected grid where each move costs 1, the smallest possible # of moves from cell (x,y) to $(4,9)$ equals to Manhattan Distance $|x-4|+|y-9|$

→ Therefore h(n) (Manhattan) **never overestimates** the true cost

Hence admissible.

⊙ **Consistency (monotonicity)** → Why(h) is consistent?

A heuristic is consistent if for every node (x) and every successor (y) neighbour.

$$h(x) \leq \text{cost}(x,y) + h(y)$$

Since each move in the grid costs 1, and the MD b/w 2 adjacent cells changes by at most 1, → $|h(x)-h(y)| \leq 1$ → $h(x) \leq 1 + h(y)$