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Subject: Artificial Intelligence Laboratory

Assignment 5: Implement A star algorithm for eight puzzle problem

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Assignment Details:

Consider two heuristic functions (h1(n) and h2(n)) along with g(n) and execute the algorithm both the times with h1 and g and then h2 and g.

Compare the result of both the run and write the document.

Things to submit:

1. Algorithm implementation

2. Screenshots of the output

3. Document describing heuristic and output along with the understanding of the outputs for both the cases.

Results and Discussion:

Start state:	4 1 3	Goal state:	1 2 3
	7 6 8		4 5 6
	5 2 0		7 8 0

1. Heuristic function chosen is Manhattan distance, which is given by $|x_1 - x_2| + |y_1 - y_2|$ between two points (x_1, y_1) and (x_2, y_2).

   Output:

```
-------
 4 1 3
 7 6 8
 5 2 0
-------
   |
   |
   V
-------
 4 1 3
 7 6 0
 5 2 8
-------
   |
   |
   V
-------
 4 1 3
 7 0 6
 5 2 8
-------
   |
   |
   V
-------
 4 1 3
 7 2 6
 5 0 8
-------
   |
   |
   V
-------
 4 1 3
```

```
 7 2 6
 0 5 8
-------
   |
   |
   V
-------
 4 1 3
 0 2 6
 7 5 8
-------
   |
   |
   V
-------
 0 1 3
 4 2 6
 7 5 8
-------
   |
   |
   V
-------
 1 0 3
 4 2 6
 7 5 8
-------
   |
   |
   V
-------
 1 2 3
 4 0 6
 7 5 8
```

```
-------
   |
   |
   V
-------
 1 2 3
 4 5 6
 7 0 8
-------
   |
   |
   V
-------
 1 2 3
 4 5 6
 7 8 0
-------
A* Search found Path to goal state
Nos of moves from source to goal: 10
Nos of states explored: 12
```

2. Heuristic function chosen is Hamming distance, which is given by $cnt(A_{ij} \neq B_{ij})$ for given matrices A and B.

Output:

```
-------
 4 1 3
 7 6 8
 5 2 0
-------
   |
   |
   V
```

```
-------
 4 1 3
 7 6 0
 5 2 8
-------
   |
   |
   V
-------
 4 1 3
 7 0 6
 5 2 8
-------
   |
   |
   V
-------
 4 1 3
 7 2 6
 5 0 8
-------
   |
   |
   V
-------
 4 1 3
 7 2 6
 0 5 8
-------
   |
   |
   V
-------
 4 1 3
```

```
 0 2 6
 7 5 8
-------
   |
   |
   V
-------
 0 1 3
 4 2 6
 7 5 8
-------
   |
   |
   V
-------
 1 0 3
 4 2 6
 7 5 8
-------
   |
   |
   V
-------
 1 2 3
 4 0 6
 7 5 8
-------
   |
   |
   V
-------
 1 2 3
 4 5 6
 7 0 8
```

```
-------
   |
   |
   V
-------
 1 2 3
 4 5 6
 7 8 0
-------
A* Search found Path to goal state
Nos of moves from source to goal: 10
Nos of states explored: 33
```

Discussion:

1. We see that number of states explored depends upon the heuristic strategy considered, though the number of moves to goal state remains same for both. This is because the final goal state always lies at the same rank of the state-space tree, but the states to be explored depends on their respective heuristic values, which obviously differ for various heuristic functions.

2. In the aforementioned outputs, we see that Manhattan distance-based heuristic explores lesser number of states as compared to the latter. Thus, we note the importance of formulating an improved heuristic function for more efficient search.
