

```
#Manhattan approach
```

```
import heapq
```

```
from termcolor import colored
```

```
class PuzzleState:
```

```
    def __init__(self, board, parent, move, depth):
```

```
        self.board = board
```

```
        self.parent = parent
```

```
        self.move = move
```

```
        self.depth = depth
```

```
        self.heuristic = heuristic(board)
```

```
        self.cost = self.depth + self.heuristic
```

```
    def __lt__(self, other):
```

```
        return self.cost < other.cost
```

```
def print_board(board):
```

```
    print("+---+---+---+")
```

```
    for row in range(0, 9, 3):
```

```
        row_visual = ""
```

```
        for tile in board[row:row + 3]:
```

```
            if tile == 0:
```

```
                row_visual += f" {colored(' ', 'cyan')}} |"
```

```
            else:
```

```
                row_visual += f" {colored(str(tile), 'yellow')}} |"
```

```
        print(row_visual)
```

```
    print("+---+---+---+")
```

```
goal_state = [1,2,3,8,0,4,7,6,5]
```

```
moves = {
```

```
    'U': -3,
```

```
    'D': 3,
```

```
    'L': -1,
```

```
    'R': 1
```

```
}
```

```
def heuristic(board):
```

```
    distance = 0
```

```
    for i in range(9):
```

```
        if board[i] != 0:
```

```
            x1, y1 = divmod(i, 3)
```

```
            x2, y2 = divmod(board[i] - 1, 3)
```

```
            distance += abs(x1 - x2) + abs(y1 - y2)
```

```
    return distance
```

```

def move_tile(board, move, blank_pos):
    new_board = board[:]
    new_blank_pos = blank_pos + moves[move]
    new_board[blank_pos], new_board[new_blank_pos] = new_board[new_blank_pos], new_board[blank_pos]
    return new_board

def a_star(start_state):
    open_list = []
    closed_list = set()
    heapq.heappush(open_list, PuzzleState(start_state, None, None, 0))

    while open_list:
        current_state = heapq.heappop(open_list)

        if current_state.board == goal_state:
            return current_state

        closed_list.add(tuple(current_state.board))

        blank_pos = current_state.board.index(0)

        for move in moves:
            if move == 'U' and blank_pos < 3:
                continue
            if move == 'D' and blank_pos > 5:
                continue
            if move == 'L' and blank_pos % 3 == 0:
                continue
            if move == 'R' and blank_pos % 3 == 2:
                continue

            new_board = move_tile(current_state.board, move, blank_pos)

            if tuple(new_board) in closed_list:
                continue

            new_state = PuzzleState(new_board, current_state, move, current_state.depth + 1)
            heapq.heappush(open_list, new_state)

    return None

```

```
def print_solution(solution):
    path = []
    current = solution
    while current:
        path.append(current)
        current = current.parent
    path.reverse()

    for step in path:
        print(f"Move: {step.move}")
        print_board(step.board)

    total_cost = solution.depth
    print(colored(f"Total cost to reach the goal node (g(n)): {total_cost}", "green"))

initial_state = [2,8,3,1,6,4,7,0,5]

solution = a_star(initial_state)

if solution:
    print(colored("Solution found:", "green"))
    print_solution(solution)
else:
    print(colored("No solution exists.", "red"))
print("Goal reached")
```

Solution found:

Move: None

2	8	3	
1	6	4	
7		5	

Move: U

2	8	3	
1		4	
7	6	5	

Move: U

2		3	
1	8	4	
7	6	5	

Move: L

	2	3	
1	8	4	
7	6	5	

Move: D

1	2	3	
	8	4	
7	6	5	

Move: R

1	2	3	
8		4	
7	6	5	

Total cost to reach the goal node ($g(n)$): 5

Goal reached