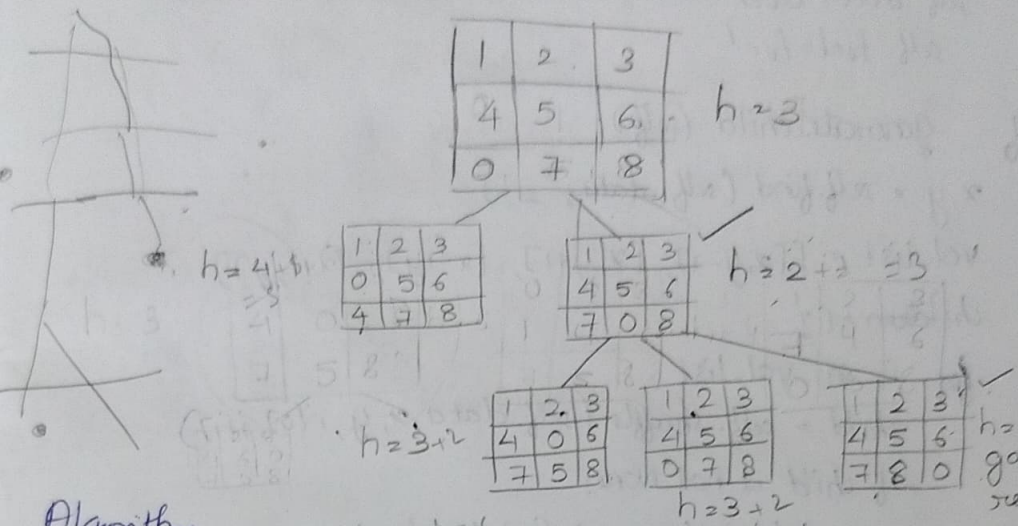
8/12/2023

Solving 8-puzzle using A* algorithm

goal

1	2	3
4	5	6
7	8	0

h=0 (heuristics, number of misplaced tiles)



Algorithm

1) Create the initial state and goal state for the problem
In A* the heuristics is considered, lower heuristic node is considered in each step.
fvalue = hvalue + pathcost

2) Initially expand the node, find the location of empty tile and generate the nodes.
Calculate the heuristic function value
$f(x) = h(x) + g(x)$
↙ misplaced tiles. ↘ depth from starting node (path cost)

3) Maintain two list namely 'open' and 'close' the explored path, with lowest heuristics value are stored in 'open'
The nodes (states) generated are stored in the open list, sort using the f(x) values
The explored nodes are stored in close list, and removed from open.

4) The goal is reached when $h(x) = 0$, implies that all the tiles are in the correct position

Code:

```
def process

class Node:
    def __init__(self, data, level, fval):
        self.data = data
        self.level = level
        self.fval = fval

    def generate_child(self):
        x, y = self.find(self.data, '_')
        val_list = [[x, y-1], [x, y+1], [x-1, y], [x+1, y]]
        children = []
        for i in val_list:
            child = self.shuffle(self.data, x, y, i[0], i[1])
            if child is not None:
                child_node = Node(child, self.level+1, 0)
                children.append(child_node)
        return children

    def shuffle(self, puz, x1, y1, x2, y2):
        if x2 >= 0 and x2 < len(self.data) and y2 >= 0 and
                y2 < len(self.data):
            temp_puz = []
            temp_puz = self.copy(puz)
            temp = temp_puz[x2][y2]
            temp_puz[x2][y2] = temp_puz[x1][y1]
            temp_puz[x1][y1] = temp
            return temp_puz
        else:
            return None

    def copy(self, root):
        temp = []
        for i in root:
            t = []
            for j in i:
                t.append(j)
```

```
        temp.append(i)
    return temp

def find(self, puz, x):
    for i in range(0, len(self.data)):
        for j in range(0, len(self.data)):
            if puz[i][j] == x:
                return i,j

class Puzzle:
    def __init__(self, size):
        self.n = size
        self.open = []
        self.closed = []

    def accept(self):
        puz = []
        for i in range(0, self.n):
            temp = input().split(" ")
            puz.append(temp)
        return puz

    def f(self, start, goal):
        return self.h(start.data, goal) + start.level

    def h(self, start, goal):
        temp = 0
        for i in range(0, self.n):
            for j in range(0, self.n):
                if start[i][j] != goal[i][j] and start[i][j] != '_':
                    temp += 1
        return temp

    def process(self):
        print("Enter the start state matrix \n")
        start = self.accept()
        print("Enter the goal state matrix \n")
        goal = self.accept()
```

```
start = Node(start, 0, 0)
start.fval = self.f(start, goal)
self.open.append(start)
print("\n\n")
while True:
    cur = self.open[0]
    print("")
    print(" |")
    print(" | ")
    print(" \\\'/\n")
    for i in cur.data:
        for j in i:
            print(j, end=" ")
        print("")
    if(self.h(cur.data, goal) == 0):
        break
    for i in cur.generate_child():
        i.fval = self.f(i, goal)
        self.open.append(i)
    self.closed.append(cur)
    del self.open[0]
    self.open.sort(key = lambda x: x.fval, reverse=False)

puz = Puzzle(3)
puz.process()
```

Output:

Enter the start matrix

1 2 3
4 5 6
_ 7 8

↓

1 2 3
4 5 6
7 _ 8

↓

1 2 3
4 5 6
7 8 _

Enter the goal matrix

1 2 3
4 5 6
7 8 _

```
Enter the start state matrix

1 2 3
4 5 6
_ 7 8
Enter the goal state matrix

1 2 3
4 5 6
7 8 _
```

```
1 2 3
4 5 6
_ 7 8
```

```
1 2 3
4 5 6
7 _ 8
```

```
1 2 3
4 5 6
7 8 _
```