Assignment No 01: 8-Puzzle Problem

CSE-0408 Summer 2021

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***Abstract*—The puzzle can be solved by moving the tiles one by one in the single empty space and thus achieving the Goal state. Instead of moving the tiles in the empty space we can visualize moving the empty space in place of the tile. The empty space cannot move diagonally and can take only one step at a time.**

***Index Terms*—Python**

I. Introduction

The 8 puzzle consists of eight numbered, movable tiles set in a 3x3 frame. One cell of the frame is always empty thus making it possible to move an adjacent numbered tile into the empty cell.
The puzzle can be solved by moving the tiles one by one in the single empty space and thus achieving the Goal state.

II. Literature Review

Sadikov and Bratko (2006) studied the suitability of pessimistic and optimistic heuristic functions for a real-time search in the 8-puzzle. They discovered that pessimistic functions are more suitable. They also observed the pathology, which was stronger with the pessimistic heuristic function. However, they did not study the influence of other factors on the pathology or provide any analysis of the gain of a deeper search. In our paper, the basic pathology observed in (Sadikov and Bratko 2006) was confirmed.

III. Proposed Methodology

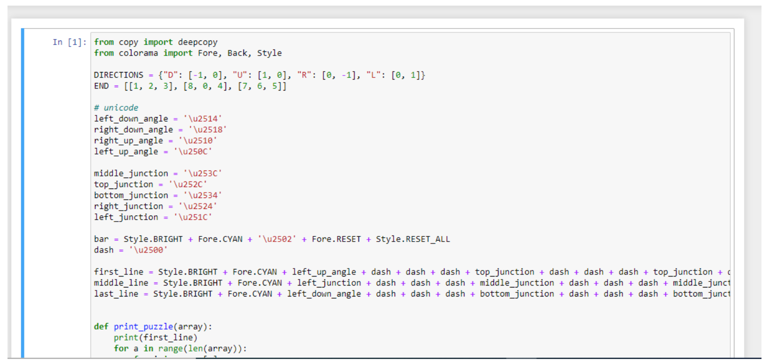
The 8-puzzle problem is a puzzle invented and popularized by Noyes Palmer Chapman in the 1870s. It is played on a 3-by-3 grid with 8 square blocks labeled 1 through 8 and a blank square. Your goal is to rearrange the blocks so that they are in order. The puzzle can be solved by moving the tiles one by one in the single empty space and thus achieving the Goal state.

IV. Rules for solving the puzzle

Instead of moving the tiles in the empty space, we can visualize moving the empty space in place of the tile, basically swapping the tile with the empty space. The empty space can only move in four directions.

1.Up
2.Down
3. Right or
4. Left

V. Code



```
In [1]: from copy import deepcopy
from colorama import Fore, Back, Style

DIRECTIONS = {"D": [-1, 0], "U": [1, 0], "R": [0, -1], "L": [0, 1]}
END = [[1, 2, 3], [8, 0, 4], [7, 6, 5]]

# unicode
left_down_angle = '\u2514'
right_down_angle = '\u2518'
right_up_angle = '\u2510'
left_up_angle = '\u250C'

middle_junction = '\u253C'
top_junction = '\u252C'
bottom_junction = '\u2534'
right_junction = '\u2524'
left_junction = '\u251C'

bar = Style.BRIGHT + Fore.CYAN + '\u2502' + Fore.RESET + Style.RESET_ALL
dash = '\u2500'

first_line = Style.BRIGHT + Fore.CYAN + left_up_angle + dash + dash + dash + top_junction + dash + dash + dash + top_junction + 
middle_line = Style.BRIGHT + Fore.CYAN + left_junction + dash + dash + dash + middle_junction + dash + dash + dash + middle_junct
last_line = Style.BRIGHT + Fore.CYAN + left_down_angle + dash + dash + dash + bottom_junction + dash + dash + dash + bottom_junct


def print_puzzle(array):
    print(first_line)
    for a in range(len(array)):
```

Fig. 1.

```
def print_puzzle(array):
    print(first_line)
    for a in range(len(array)):
        for i in array[a]:
            if i == 0:
                print(bar, Back.RED + ' ' + Back.RESET, end=' ')
            else:
                print(bar, i, end=' ')
        print(bar)
        if a == 2:
            print(last_line)
        else:
            print(middle_line)

class Node:
    def __init__(self, current_node, previous_node, g, h, dir):
        self.current_node = current_node
        self.previous_node = previous_node
        self.g = g
        self.h = h
        self.dir = dir

    def f(self):
        return self.g + self.h


def get_pos(current_state, element):
    for row in range(len(current_state)):
        if element in current_state[row]:
            return (row, current_state[row].index(element))
```

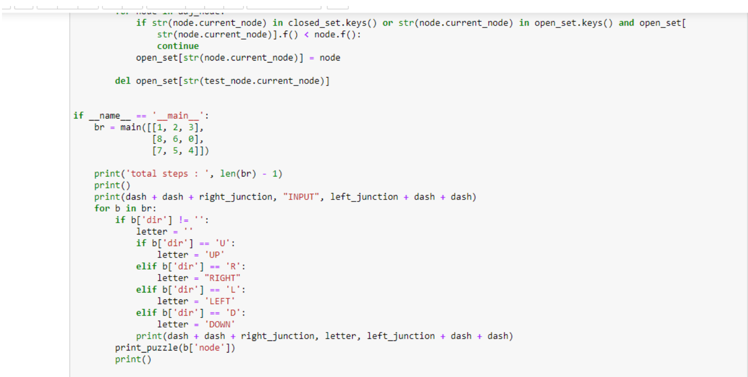
Fig. 2.

```
def euclidianCost(current_state):
    cost = 0
    for row in range(len(current_state)):
        for col in range(len(current_state[0])):
            pos = get_pos(END, current_state[row][col])
            cost += abs(row - pos[0]) + abs(col - pos[1])
    return cost

def getAdjNode(node):
    listNode = []
    emptyPos = get_pos(node.current_node, 0)

    for dir in DIRECTIONS.keys():
        newPos = (emptyPos[0] + DIRECTIONS[dir][0], emptyPos[1] + DIRECTIONS[dir][1])
        if 0 <= newPos[0] < len(node.current_node) and 0 <= newPos[1] < len(node.current_node[0]):
            newState = deepcopy(node.current_node)
            newState[emptyPos[0]][emptyPos[1]] = node.current_node[newPos[0]][newPos[1]]
            newState[newPos[0]][newPos[1]] = 0
            # listNode += [Node(newState, node.current_node, node.g + 1, euclidianCost(newState), dir)]
            listNode.append(Node(newState, node.current_node, node.g + 1, euclidianCost(newState), dir))

    return listNode

def getBestNode(openSet):
    firstIter = True

    for node in openSet.values():
        if firstIter or node.f() < bestF:
            firstIter = False
            bestNode = node
            bestF = bestNode.f()
    return bestNode
```

Fig. 3.

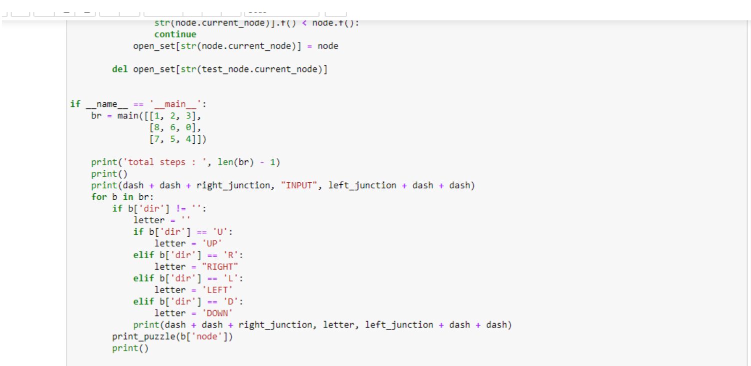
```python
def buildPath(closedSet):
    node = closedSet[str(END)]
    branch = list()

    while node.dir:
        branch.append({
            'dir': node.dir,
            'node': node.current_node
        })
        node = closedSet[str(node.previous_node)]
    branch.append({
        'dir': '',
        'node': node.current_node
    })
    branch.reverse()

    return branch

def main(puzzle):
    open_set = {str(puzzle): Node(puzzle, puzzle, 0, euclidianCost(puzzle), "")}
    closed_set = {}

    while True:
        test_node = getBestNode(open_set)
        closed_set[str(test_node.current_node)] = test_node

        if test_node.current_node == END:
            return buildPath(closed_set)

        adj_node = getAdjNode(test_node)
        for node in adj_node:
```

Fig. 4.



```python
            if str(node.current_node) in closed_set.keys() or str(node.current_node) in open_set.keys() and open_set[
                str(node.current_node)].f() < node.f():
                continue
            open_set[str(node.current_node)] = node

        del open_set[str(test_node.current_node)]


if __name__ == '__main__':
    br = main([[1, 2, 3],
               [8, 6, 0],
               [7, 5, 4]])

    print('total steps : ', len(br) - 1)
    print()
    print(dash + dash + right_junction, "INPUT", left_junction + dash + dash)
    for b in br:
        if b['dir'] != '':
            letter = ''
            if b['dir'] == 'U':
                letter = 'UP'
            elif b['dir'] == 'R':
                letter = "RIGHT"
            elif b['dir'] == 'L':
                letter = 'LEFT'
            elif b['dir'] == 'D':
                letter = 'DOWN'
            print(dash + dash + right_junction, letter, left_junction + dash + dash)
        print_puzzle(b['node'])
        print()

    print(dash + dash + right_junction, 'ABOVE IS THE OUTPUT', left_junction + dash + dash)
```

Fig. 5.



```python
                str(node.current_node)].f() < node.f():
                continue
            open_set[str(node.current_node)] = node

        del open_set[str(test_node.current_node)]


if __name__ == '__main__':
    br = main([[1, 2, 3],
               [8, 6, 0],
               [7, 5, 4]])

    print('total steps : ', len(br) - 1)
    print()
    print(dash + dash + right_junction, "INPUT", left_junction + dash + dash)
    for b in br:
        if b['dir'] != '':
            letter = ''
            if b['dir'] == 'U':
                letter = 'UP'
            elif b['dir'] == 'R':
                letter = "RIGHT"
            elif b['dir'] == 'L':
                letter = 'LEFT'
            elif b['dir'] == 'D':
                letter = 'DOWN'
            print(dash + dash + right_junction, letter, left_junction + dash + dash)
        print_puzzle(b['node'])
        print()

    print(dash + dash + right_junction, 'ABOVE IS THE OUTPUT', left_junction + dash + dash)
```

Fig. 6.

VI. Conclusion

I tested the code to see that how many state it would take to get from the current state to the goal state,I try many moves and it worked.

Acknowledgment

I would like to thank my honourable **Khan Md. Hasib Sir** for his time, generosity and critical insights into this project.

References

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Assignment No 02: Best-First search in Graph representation Of Problems

CSE-0408 Summer 2021

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***Abstract*—Breadth-first search (BFS) is an algorithm for searching a tree data structure for a node that satisfies a given property. It starts at the tree root and explores all nodes at the present depth prior to moving on to the nodes at the next depth level. Extra memory, usually a queue, is needed to keep track of the child nodes that were encountered but not yet explored.**

***Index Terms*—C++,Python**

I. INTRODUCTION

Breadth First Search (BFS) is an algorithm for traversing or searching layerwise in tree or graph data structures.If we consider searching as a form of traversal in a graph, an uninformed search algorithm would blindly traverse to the next node in a given manner without considering the cost associated with that step. An informed search, like Best first search, on the other hand would use an evaluation function to decide which among the various available nodes is the most promising (or 'BEST') before traversing to that node. The Best first search uses the concept of a Priority queue and heuristic search. To search the graph space, the BFS method uses two lists for tracking the traversal.

II. LITERATURE REVIEW

Best First Search is a merger of Breadth First Search . Best First Search is implemented using the priority queue. while Breadth First Search arrives at a solution without search guaranteed that the procedure does not get caught. Best First Search, being a mixer of these two, licenses exchanging between paths. At each stage the nodes among the created ones, the best appropriate node is chosen for facilitating expansion, might be this node have a place to a similar level or different, hence can flip between Depth First and Breadth First Search [3]. It is also known as greedy search. Time complexity is O(bd) and space complexity is O(bd), where b is branching factor and d is solution depth [2].

III. PROPOSED METHODOLOGY

1.Begin the search algorithm, by knowing the key which is to be searched. Once the key/element to be searched is decided the searching begins with the root (source) first.

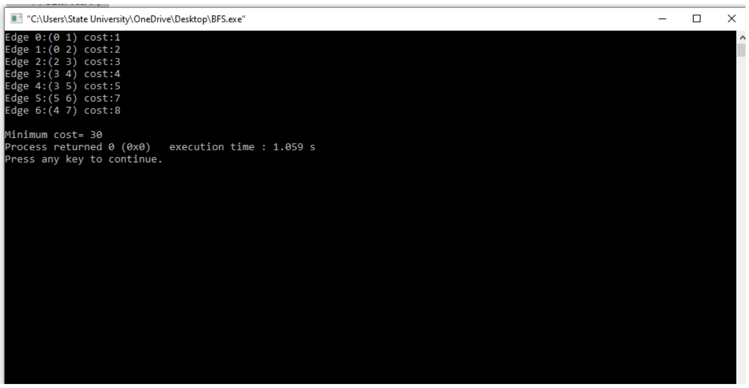
IV. CODE

```cpp
#include <bits/stdc++.h>
using namespace std;
int P,Q;
int parent[100];
int cost [1000][10000];
int find(int i)
{

    while (parent[i] != i)
        i = parent[i];
    return i;
}

void union1(int i, int j)
{
    int s = find(i);
    int r = find(j);
    parent[s] = r;
}

void BFsMST()
{
    int mincost = 0;
    int edge_count = 0;
    while (edge_count < P - 1)
    {
        int min = INT_MAX, s = -1, r = -1;
        for (int i = 0; i < P; i++) {
            for (int j = 0; j < P; j++)
            {
                if (find(i) != find(j) && cost[i][j] < min)
                {
                    min = cost[i][j];
                    s = i;
                    r = j;
                }
```

```cpp
                    min = cost[i][j];
                    s = i;
                    r = j;
                }
            }
        }

        union1(s, r);
        cout<<"Edge "<<edge_count++<<":("<<s<<" "<<r<<") cost:"<<min<<endl;
        mincost += min;
    }
    cout<<endl<<"Minimum cost= "<<mincost;
}

int main()
{

    //freopen("input.txt","h",stdin);

    //cin>>M>>;

    P=8;
    Q=9;
    for(int i=0;i<P;i++)
    {
        for(int j=0; j<P; j++)
        {
            cost[i][j]= INT_MAX;
        }
    }

    /*for(int j = 0;j<N;j++)
    {
        int p,q;
        cin>>p>>q;
        cin>>cost[p][q];
```

```cpp
    //cin>>M>>;

    P=8;
    Q=9;
    for(int i=0;i<P;i++)
    {
        for(int j=0; j<P; j++)
        {
            cost[i][j]= INT_MAX;
        }
    }

    /*for(int j = 0;j<N;j++)
    {
        int p,q;
        cin>>p>>q;
        cin>>cost[p][q];
        //cost[q][p];
    }*/
cost[0][1]=1;
cost[0][2]=2;
cost[2][3]=3;
cost[3][4]=4;
cost[3][5]=5;
cost[5][4]=100;
cost[5][6]=7;
cost[6][7]=101;
cost[4][7]=8;
    for (int i = 0; i < P; i++)
        parent[i] = i;
    /// Print the solution
    BFsMST();
    return 0;
}
```

V. OUTPUT



2.Visit the contiguous unvisited vertex. Mark it as visited. Display it (if needed). If this is the required key, stop. Else, add it in a queue.

3.On the off chance that no neighboring vertex is discovered, expel the first vertex from the Queue.

4.Repeat step 2 and 3 until the queue is empty.

VI. CONCLUSION

The BFS algorithm is useful for analyzing the nodes in a graph and constructing the shortest path of traversing through these.

ACKNOWLEDGMENT

I would like to thank my honourable **Khan Md. Hasib Sir** for his time, generosity and critical insights into this project.

REFERENCES

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[3] Korf, R. E., & Chickering, D. M. (1996). Best-first minimax search. Artificial intelligence, 84(1-2), 299-337.