29-11-23 Program-2 8-Puzzle problem using breadth first search

8 puzzle problem (N puzzle problem / sliding puzzle problem) - Uninformed approach

~~N puzzle~~

In the problem, the square will have N+1 tiles where N = 8, 15, 24 and so on.

N = 8 means the square will have 9 tiles (3 rows & 3 columns)

In this problem, ~~will have~~ initial state / initial configuration (start state) will be given and we have to reach the goal state / goal configuration.

Suppose:

Initial state:

1	2	3
	4	6
7	5	8

Goal state:

1	2	3
4	5	6
7	8	

The puzzle can be solved by moving the tiles one by one in the single empty space & thus achieve the goal state.

Rules

- The empty can only move in 4 directions:
  1) up 2) down 3) right 4) left
- It cannot move diagonally
- Can take only one step at a time.

0	x	0
x	#	x
0	x	0

Tiles at 0 — no. of possible moves = 2.
Tiles at x — no of possible moves = 3
Tiles at # — no of possible moves = 4.

This problem can be solved using breadth first search approach:

↳ Uninformed / non-heuristic search

- This approach explores all nodes (does not use intelligence).

Complexity: $O(b^d)$ where
b - branching factor
d - depth factor

Worst case — 3^{20}.

For 8 puzzle problem.

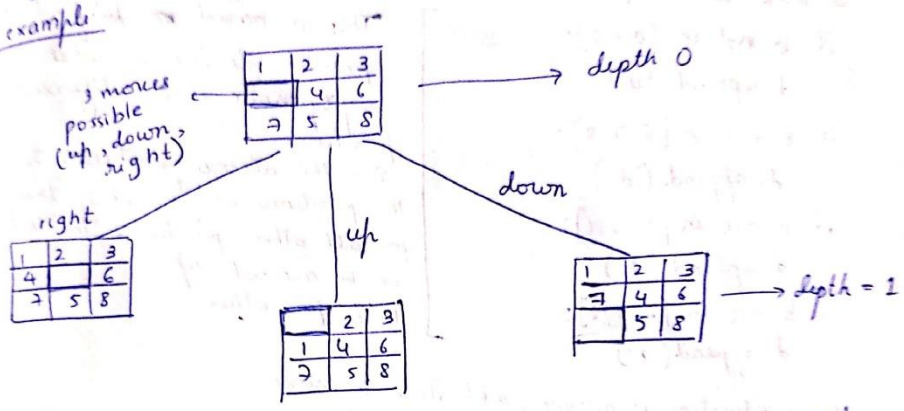
Branching factor b = $\frac{\text{all possible moves of empty tile at each position}}{\text{no of tiles.}}$

$= \frac{24}{9} = 2.67 \sim 3$

depth factor - initially will be 0
* as we explore the nodes, the depth factor increases.

Every time, we check the possible moves of the empty tile, branch it, consider all possible cases and finally to the goal state.

For example



We continue branching these nodes.
Since this is breadth first search, branch for possibilities of 'right' node, then 'up' node, then 'down' node and then only move to branch in the next level.

Code

```
import numpy as np
import pandas as pd
import os

def bfs(src, target):
    queue = []
    queue.append(src)
    exp = []
    while len(queue) > 0:
        source = queue.pop(0)
        exp.append(source)
        print(source)
        if source == target:
            print("success")
            return
    poss_moves_to_do = []
    poss_moves_to_do = possible_moves(source, exp)
    for move in poss_moves_to_do:
        if move not in exp and move not in queue:
            queue.append(move)
```

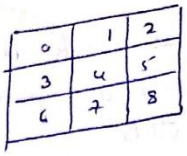
Same BFS code

```
def possible_moves(state, visited_states):
    # index of empty spot
    b = state.index(0)

    # directions array
    d = []
    # add all the possible directions
    if b not in [0,1,2]:
        d.append('u')
    if b not in [6,7,8]:
        d.append('d')
    if b not in [0,3,6]:
        d.append('l')
    if b not in [2,5,8]:
        d.append('r')
    # if direction is possible, add state to move
    pos_moves_it_can = []
    # for all possible directions, find the state if that move is played
    # by calling 'gen' function
    # Now for each direction, I want to generate different states of the matrix
    for i in d:
        pos_moves_it_can.append(gen(state, i, b))
    # which I append in pos_moves_it_can
    return [move_it_can for move_it_can in pos_moves_it_can if
            move_it_can not in visited_states]
    # — here, once I get a state which is not in visited_states, I return it.

def gen(state, m, b):
    temp = state.copy()
    if m=='d':
        temp[b+3], temp[b] = temp[b], temp[b+3]
    elif m=='u':
        temp[b-3], temp[b] = temp[b], temp[b-3]
    elif m=='l':
        temp[b-1], temp[b] = temp[b], temp[b-1]
    elif m=='r':
        temp[b+1], temp[b] = temp[b], temp[b+1]
    return temp

src = [1,2,3,4,5,6,0,7,8]
target = [1,2,3,4,5,6,7,8,0]
bfs(src, target).
```



This is to find the possible directions when the empty node is at different positions.
See the above matrix. If the positions are not 0, 1, 2, then for all other positions, the tile can be moved up.
Similarly for others.

To move down, I shift 3 indices front.
If I am at position 5, and I want to move down, I do 5+3 = 8.

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Output

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

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

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

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

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

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

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

success