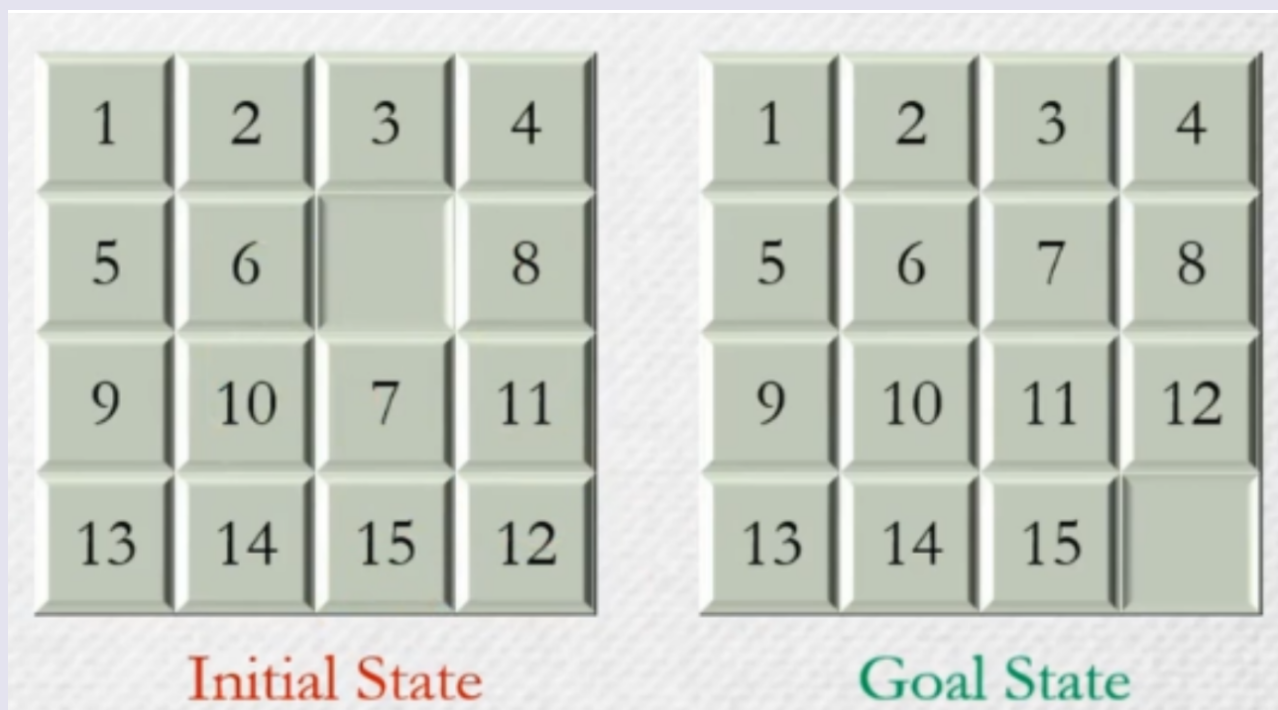Name - Yash Lakhtariya
Enrollment number - 21162101012
Branch - CBA   Batch - 51
AAD Practical 15

Institute of Computer Technology
B. Tech Computer Science and Engineering

Sub: Algorithm Analysis and Design

Practical 15

Problem : 15 Puzzle Problem - Given an initial State, reach to the GOAL state using branch and bound algorithm.

Initial State   Goal State

Code :

```
import YSL_io

GOAL = [[1, 2, 3, 4], [5, 6, 7, 8], [9, 10, 11, 12], [13, 14, 15, ' ']]
MOVES = [(0, -1), (0, 1), (-1, 0), (1, 0)]
```

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```python
def is_valid(x, y):
    return 0 <= x < 4 and 0 <= y < 4


def find_empty(state):
    for i in range(4):
        for j in range(4):
            if state[i][j] == ' ':
                return i, j


def apply_move(state, move):
    x, y = find_empty(state)
    new_x, new_y = x + move[0], y + move[1]
    if is_valid(new_x, new_y):
        state[x][y], state[new_x][new_y] = state[new_x][new_y], state[x][y]
        return True


def is_solved(state):
    return state == GOAL
```

```python
def misplaced_tiles(state):

count = 0

for i in range(4):

for j in range(4):

if state[i][j] ≠ ' ' and state[i][j] ≠ GOAL[i][j]:

count += 1

return count




def branch_and_bound(initial_state):

queue = [(initial_state, [initial_state])]


while queue:

current_state, path = queue.pop(0)


if is_solved(current_state):

return path


for move in MOVES:

new_state = [row[:] for row in current_state]

if apply_move(new_state, move):

new_path = path + [new_state]

queue.append((new_state, new_path))
```

```python
    queue.sort(key=lambda x: misplaced_tiles(x[0]))


    return None



def print_puzzle(puzzle):
    for row in puzzle:
        YSL_io.printCYN(" ".join(f"{cell:2}" for cell in row))



initial_state = [[1, 2, 3, 4], [5, 6, ' ', 8], [9, 10, 7, 11], [13, 14,
15, 12]]


steps = branch_and_bound(initial_state)

if steps:
    YSL_io.printORNG("\nSolution steps : \n")
    for step in steps:
        print_puzzle(step)
        print()
else:
    YSL_io.printRED("\n\tNo solution found!")
```
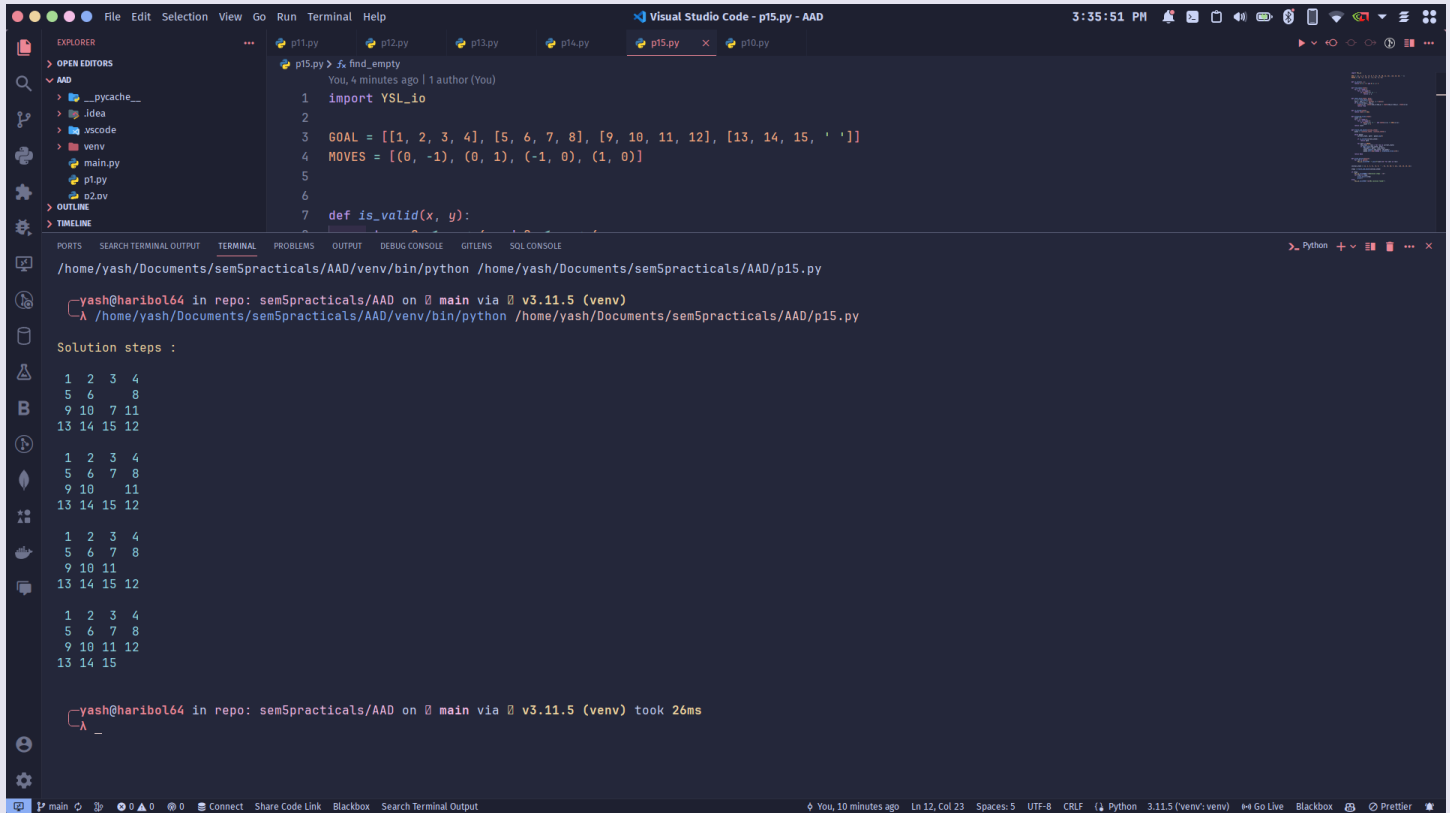
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Screenshot :