* Lab - 04:

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* Iterative developing search algorithm
A* Algorithm for 8 puzzle.

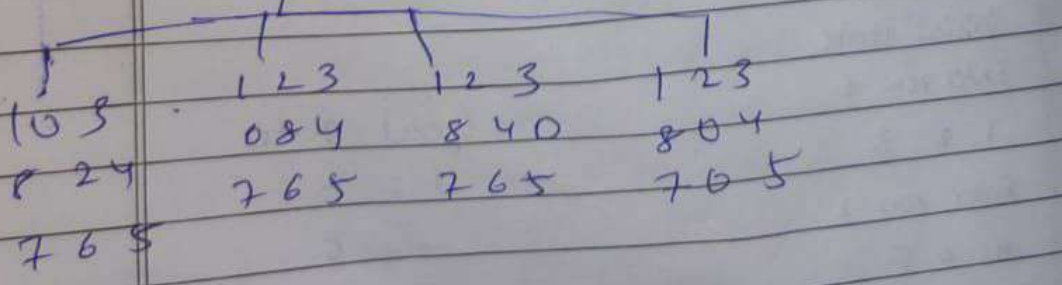
1. Initalize
   * start with the initial state of puzzle
   * set the goal state
2. Queue :-
   To store the state of puzzle
   $f(n) = g(n) + h(n)$.
   g(n) :- is the no. of moves taken from start
   h(n) - misplaced title which count how many titles are not in their goal positions
3. States :
   - If the goal state is achieved then return goal state achieved
   - If the goal state not achieved then given all the possible move
4. continue / Repeat until the goal state is reached

Initial state

1	2	3
8		4
7	6	5

goal state

2	8	1
	4	3
7	6	5



pseudo code :- A* 8puzzle

1. Initialize priority queue with initial start
   set g(n) = 0
   sets f(n) = no of misplaced tits
   set f(n) = g(n) + h(n)
2. while ques ! = 0:
   * Remove state with smaller f(n)
   * If cur - state = goal - state
     - Rets sol
   * Generate all the new states
     - calculate g(n), h(n), f(n)
3. If goal reached then return the soln

Pseudocode :- A* IDFS

1. function IDFS (root, goal)
   for d = 0 to ∞ :
   res = DLS (root, goal, d)
   if res ≠ NULL :
   return res
   return NULL
   function DLS (node, goal, d)
   if d == 0 and node == goal
   return node
   if dept > 0
   for child in node.children
   res = DLS (child, goal)
   if res ≠ NULL
   return result
   return NULL

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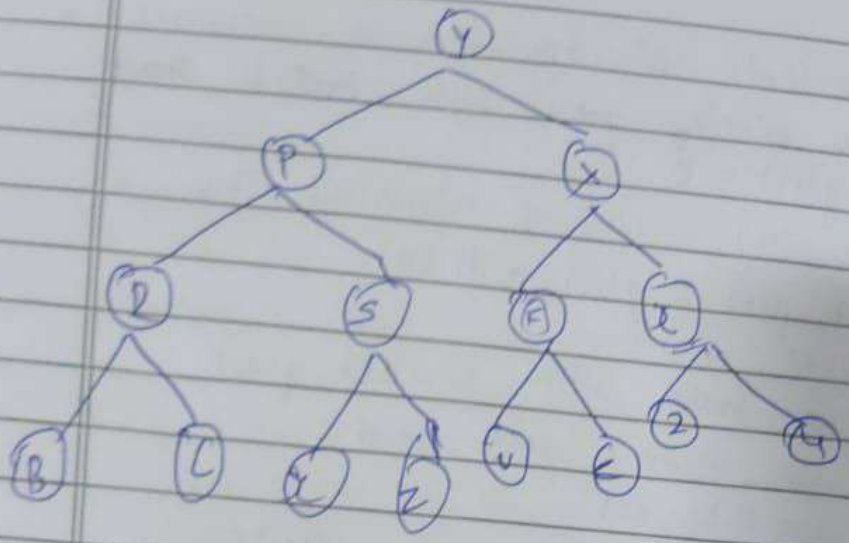
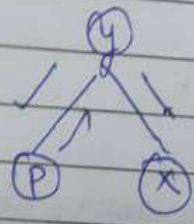


d = 0

q

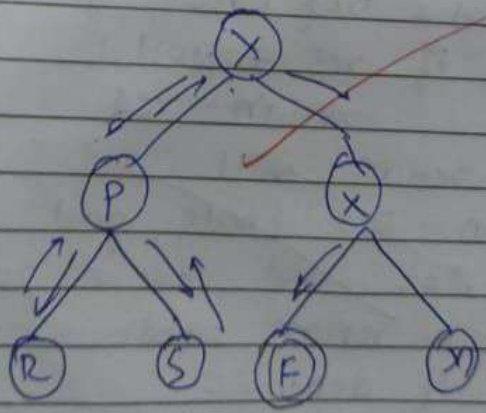
return NULL

d = 1



return NULL

d = 2



return 5

LAB-04 - 8 Puzzle with A* and IDDFS on a Graph

Code: (8 Puzzle with A*)

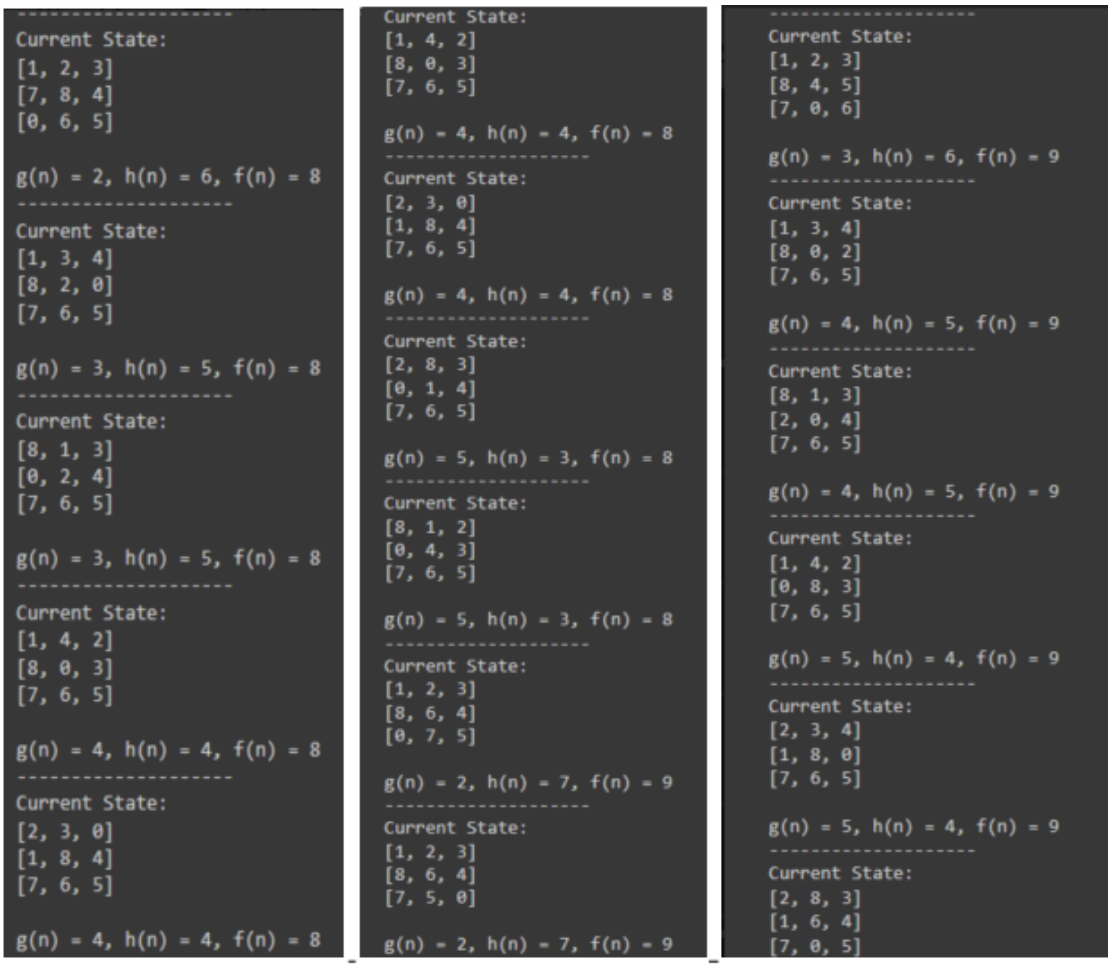
```
import heapq

# Goal state where blank (0) is the first tile

goal_state = [

[0, 1, 2],

[3, 4, 5],

[6, 7, 8]

]

# Helper functions

def flatten(puzzle):

return [item for row in puzzle for item in row]

def find_blank(puzzle):

for i in range(3):

for j in range(3):

if puzzle[i][j] == 0:

return i, j

def misplaced_tiles(puzzle):

flat_puzzle = flatten(puzzle)

flat_goal = flatten(goal_state)

return sum([1 for i in range(9) if flat_puzzle[i] != flat_goal[i] and flat_puzzle[i] != 0])

def generate_neighbors(puzzle):

x, y = find_blank(puzzle)

neighbors = []

moves = [(-1, 0), (1, 0), (0, -1), (0, 1)]
```

```
for dx, dy in moves:
nx, ny = x + dx, y + dy
if 0 <= nx < 3 and 0 <= ny < 3:
new_puzzle = [row[:] for row in puzzle]
new_puzzle[x][y], new_puzzle[nx][ny] = new_puzzle[nx][ny], new_puzzle[x][y]
neighbors.append(new_puzzle)
return neighbors
def is_goal(puzzle):
return puzzle == goal_state
def print_puzzle(puzzle):
for row in puzzle:
print(row)
print()
def a_star_misplaced_tiles(initial_state):
# Priority queue (min-heap) and visited states
frontier = []
heapq.heappush(frontier, (misplaced_tiles(initial_state), 0, initial_state, []))
visited = set()
while frontier:
f, g, current_state, path = heapq.heappop(frontier)
# Print the current state
print("Current State:")
print_puzzle(current_state)
h = misplaced_tiles(current_state)
print(f"g(n) = {g}, h(n) = {h}, f(n) = {g + h}")
```

```
print("-" * 20)

if is_goal(current_state):

print("Goal reached!")

return path

visited.add(tuple(flatten(current_state)))

for neighbor in generate_neighbors(current_state):

if tuple(flatten(neighbor)) not in visited:

h = misplaced_tiles(neighbor)

heapq.heappush(frontier, (g + 1 + h, g + 1, neighbor, path + [neighbor]))

return None # No solution found

# Initial puzzle state

initial_state = [

[1, 2, 0],

[3, 4, 5],

[6, 7, 8]

]

solution = a_star_misplaced_tiles(initial_state)

if solution:

print("Solution found!")

else:

print("No solution found.")
```

Ouput:-

```
Current State:
[1, 2, 3]
[8, 0, 4]
[7, 6, 5]

g(n) = 0, h(n) = 5, f(n) = 5
--------------------
Current State:
[1, 2, 3]
[8, 4, 0]
[7, 6, 5]

g(n) = 1, h(n) = 4, f(n) = 5
--------------------
Current State:
[1, 2, 0]
[8, 4, 3]
[7, 6, 5]

g(n) = 2, h(n) = 3, f(n) = 5
--------------------
Current State:
[1, 0, 3]
[8, 2, 4]
[7, 6, 5]

g(n) = 1, h(n) = 5, f(n) = 6
--------------------
Current State:
[1, 2, 3]
[0, 8, 4]
[7, 6, 5]

g(n) = 1, h(n) = 5, f(n) = 6
--------------------
Current State:
[1, 0, 2]
[8, 4, 3]
[7, 6, 5]

g(n) = 3, h(n) = 3, f(n) = 6
--------------------
Current State:
[1, 2, 3]
[8, 6, 4]
[7, 0, 5]

g(n) = 1, h(n) = 6, f(n) = 7
--------------------
Current State:
[0, 1, 3]
[8, 2, 4]
[7, 6, 5]

g(n) = 2, h(n) = 5, f(n) = 7
--------------------
Current State:
[0, 2, 3]
[1, 8, 4]
[7, 6, 5]

g(n) = 2, h(n) = 5, f(n) = 7
--------------------
Current State:
[1, 2, 3]
[8, 4, 5]
[7, 6, 0]

g(n) = 2, h(n) = 5, f(n) = 7
--------------------
Current State:
[1, 3, 0]
[8, 2, 4]
[7, 6, 5]

g(n) = 2, h(n) = 5, f(n) = 7
--------------------
Current State:
[2, 0, 3]
[1, 8, 4]
[7, 6, 5]

g(n) = 3, h(n) = 4, f(n) = 7
--------------------
Current State:
[0, 1, 2]
[8, 4, 3]
[7, 6, 5]

g(n) = 4, h(n) = 3, f(n) = 7
--------------------
Current State:
[2, 8, 3]
[1, 0, 4]
[7, 6, 5]

g(n) = 4, h(n) = 3, f(n) = 7
--------------------
Current State:
[2, 8, 3]
[1, 4, 0]
[7, 6, 5]

g(n) = 5, h(n) = 2, f(n) = 7
--------------------
Current State:
[2, 8, 0]
[1, 4, 3]
[7, 6, 5]

g(n) = 6, h(n) = 1, f(n) = 7
```



Code: (IDDFS on a Graph)

class Graph:

def __init__(self):

```
self.adjacency_list = {}
def add_edge(self, u, v):
if u not in self.adjacency_list:
self.adjacency_list[u] = []
self.adjacency_list[u].append(v)
def depth_limited_dfs(self, node, goal, limit, visited):
if limit < 0:
return False
if node == goal:
return True
visited.add(node)
for neighbor in self.adjacency_list.get(node, []):
if neighbor not in visited:
if self.depth_limited_dfs(neighbor, goal, limit - 1, visited):
return True
visited.remove(node) # Allow revisiting for the next iteration
return False
def iddfs(self, start, goal, max_depth):
for depth in range(max_depth + 1):
visited = set()
if self.depth_limited_dfs(start, goal, depth, visited):
return True
return False
def main():
graph = Graph()
# Input number of edges
num_edges = int(input("Enter the number of edges: "))
# Input edges
```

```
for _ in range(num_edges):
edge = input("Enter an edge (format: A B): ").split()
graph.add_edge(edge[0], edge[1])
start_node = input("Enter the start node: ")
goal_node = input("Enter the goal node: ")
max_depth = int(input("Enter the maximum depth for IDDFS: "))
if graph.iddfs(start_node, goal_node, max_depth):
print(f"Goal node {goal_node} found!")
else:
print(f"Goal node {goal_node} not found within depth {max_depth}.")
if __name__ == "__main__":
main()
```

Output: