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Code

JupyterLab Python (Pyodide)

[8]:

```
def is_goal(state, goal):
    return state == goal

def get_neighbors(state):
    neighbors = []
    zero_pos = state.index(0)
    row, col = divmod(zero_pos, 3)

    moves = {
        'up': (row - 1, col),
        'down': (row + 1, col),
        'left': (row, col - 1),
        'right': (row, col + 1)
    }

    for move, (r, c) in moves.items():
        if 0 <= r < 3 and 0 <= c < 3:
            new_pos = r * 3 + c
            new_state = list(state)
            # Swap zero with the adjacent tile
            new_state[zero_pos], new_state[new_pos] = new_state[new_pos], new_state[zero_pos]
            neighbors.append((tuple(new_state), move))
    return neighbors

def dfs(start_state, goal_state):
    stack = [(start_state, [], [start_state])]  # (state, moves_path, states_path)
    visited = set()

    while stack:
        current_state, moves_path, states_path = stack.pop()

        if is_goal(current_state, goal_state):
            return moves_path, states_path  # Return moves and states

        if current_state in visited:
            continue
        visited.add(current_state)

        for neighbor, move in get_neighbors(current_state):
            if neighbor not in visited:
                stack.append((neighbor, moves_path + [move], states_path + [neighbor]))

    return None, None  # No solution found
```

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Code

JupyterLab Python (Pyodide)

```
        visited.add(current_state)

        for neighbor, move in get_neighbors(current_state):
            if neighbor not in visited:
                stack.append((neighbor, moves_path + [move], states_path + [neighbor]))

    return None, None  # No solution found

# Example usage

start_state = (1, 2, 3,
               4, 0, 6,
               7, 5, 8)

goal_state = (1, 2, 3,
              4, 5, 6,
              7, 8, 0)

moves, solution = dfs(start_state, goal_state)

if solution:
    print(f"Solution found in {len(moves)} moves:")
    for i, state in enumerate(solution):
        print(state[0:3])
        print(state[3:6])
        print(state[6:9])
        if i < len(moves):
            print(f"Move: {moves[i]}")
        print()
else:
    print("No solution found.")
```

```
(0, 7, 5)
Move: up
```

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Code

JupyterLab Python (Pyodide)

```
            7, 8, 0)

moves, solution = dfs(start_state, goal_state)

if solution:
    print(f"Solution found in {len(moves)} moves:")
    for i, state in enumerate(solution):
        print(state[0:3])
        print(state[3:6])
        print(state[6:9])
        if i < len(moves):
            print(f"Move: {moves[i]}")
        print()
else:
    print("No solution found.")
```

```
Solution found in 434 moves:
(1, 2, 3)
(4, 0, 6)
(7, 5, 8)
Move: right

(1, 2, 3)
(4, 6, 0)
(7, 5, 8)
Move: down

(1, 2, 3)
(4, 6, 8)
(7, 5, 0)
Move: left

(1, 2, 3)
(4, 6, 8)
```

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Code

JupyterLab Python (Pyodide)

```
            7, 8, 0)

moves, solution = dfs(start_state, goal_state)

if solution:
    print(f"Solution found in {len(moves)} moves:")
    for i, state in enumerate(solution):
        print(state[0:3])
        print(state[3:6])
        print(state[6:9])
        if i < len(moves):
            print(f"Move: {moves[i]}")
        print()
else:
    print("No solution found.")
```

```
(6, 3, 1)
(7, 0, 2)
Move: up

(8, 5, 4)
(6, 0, 1)
(7, 3, 2)
Move: right

(8, 5, 4)
(6, 1, 0)
(7, 3, 2)
Move: down

(8, 5, 4)
(6, 1, 2)
(7, 3, 0)
Move: left
```

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Code

JupyterLab Python (Pyodide)

```
            7, 8, 0)

moves, solution = dfs(start_state, goal_state)

if solution:
    print(f"Solution found in {len(moves)} moves:")
    for i, state in enumerate(solution):
        print(state[0:3])
        print(state[3:6])
        print(state[6:9])
        if i < len(moves):
            print(f"Move: {moves[i]}")
        print()
else:
    print("No solution found.")
```

```
(0, 5, 6)
(4, 7, 8)
Move: down

(1, 2, 3)
(4, 5, 6)
(0, 7, 8)
Move: right

(1, 2, 3)
(4, 5, 6)
(7, 0, 8)
Move: right

(1, 2, 3)
(4, 5, 6)
(7, 8, 0)
```

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Code

JupyterLab | Python (Pyodide)

[9]:

```
GOAL = (1, 2, 3, 4, 5, 6, 7, 8, 0)
MOVES = {'UP': -3, 'DOWN': 3, 'LEFT': -1, 'RIGHT': 1}

def valid(idx, move):
    if move == 'LEFT' and idx % 3 == 0: return False
    if move == 'RIGHT' and idx % 3 == 2: return False
    if move == 'UP' and idx < 3: return False
    if move == 'DOWN' and idx > 5: return False
    return True

def move(state, direction):
    i = state.index(0)
    if not valid(i, direction): return None
    j = i + MOVES[direction]
    lst = list(state)
    lst[i], lst[j] = lst[j], lst[i]
    return tuple(lst)

def dls(state, depth, path, visited):
    if state == GOAL: return path
    if depth == 0: return None
    visited.add(state)
    for dir in MOVES:
        new = move(state, dir)
        if new and new not in visited:
            res = dls(new, depth - 1, path + [new], visited)
            if res: return res
    visited.remove(state)
    return None

def ids(start, max_depth=50):
    for d in range(max_depth):
        res = dls(start, d, [start], set())
        if res: return res
    return None

def print_state(s):
    for i in range(0, 9, 3): print(s[i:i+3])
    print()

# Example usage
start = (1, 2, 3, 4, 5, 6, 0, 7, 8)
path = ids(start)
if path:
    print(f"Solved in {len(path)-1} moves:")
    for p in path: print_state(p)
```

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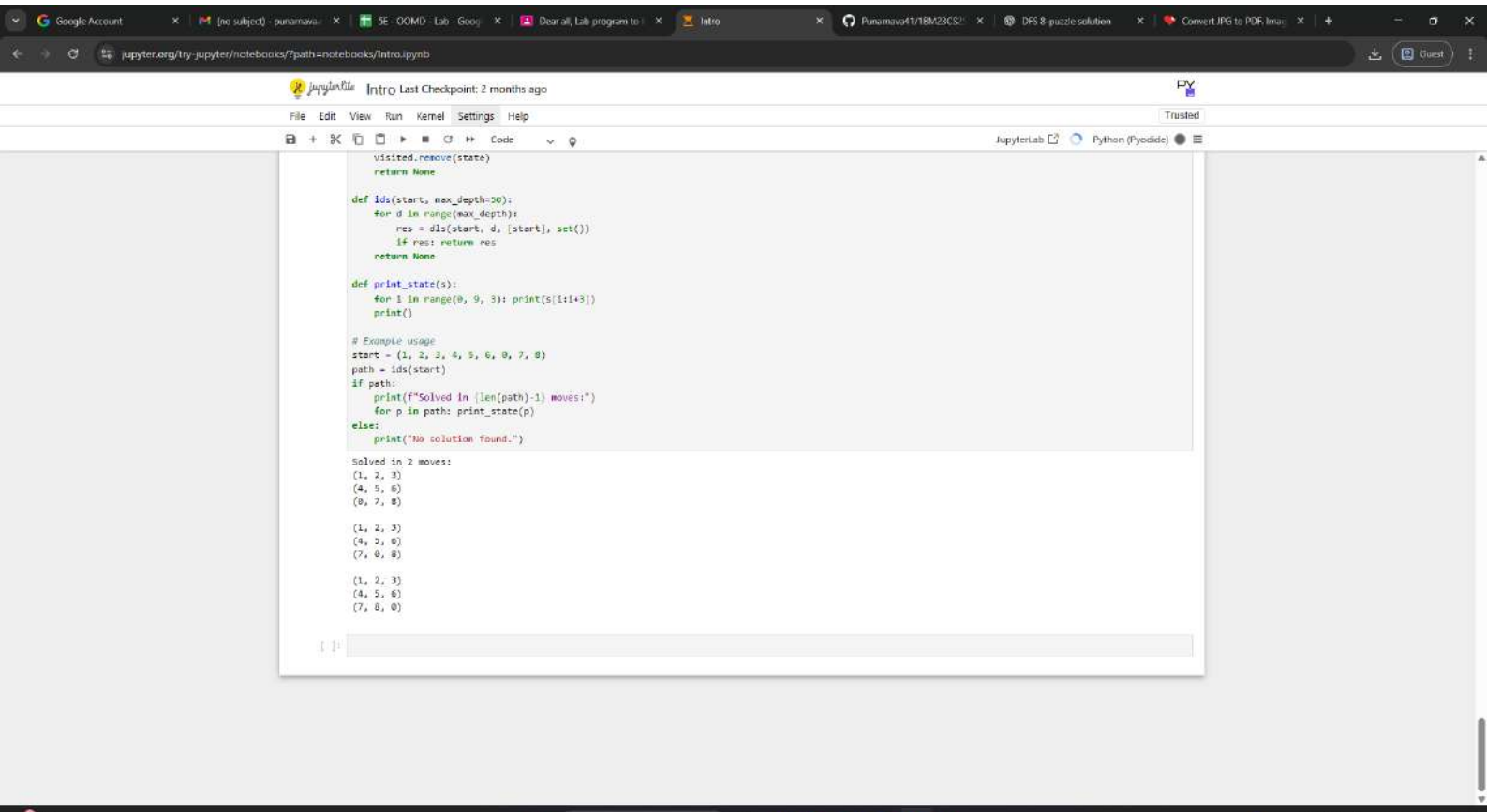
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Code
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Python (Pyodide)
visited.remove(state)
return None
def ids(start, max_depth=50):
for d in range(max_depth):
res = dls(start, d, [start], set())
if res: return res
return None
def print_state(s):
for i in range(0, 9, 3): print(s[i:i+3])
print()
# Example usage
start = (1, 2, 3, 4, 5, 6, 0, 7, 8)
path = ids(start)
if path:
print(f"Solved in {len(path)-1} moves:")
for p in path: print_state(p)
else:
print("No solution found.")
Solved in 2 moves:
(1, 2, 3)
(4, 5, 6)
(0, 7, 8)
(1, 2, 3)
(4, 5, 6)
(7, 0, 8)
(1, 2, 3)
(4, 5, 6)
(7, 8, 0)
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