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**Department of Computer Engineering**
**Academic Term II : 23-24**

**Class: B.E (Computer), Sem – VI Subject Name: Artificial Intelligence Student**

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| **Practical No:** | 4 |
| **Title:** | Solve by implementing BFS method in Python :- a) Missionaíies & cannibals<br>b) Wateí Jug Píoblem |
| **Date of Performance:** | **26/02/2024** |
| **Date of Submission:** | **04/03/2024** |

## Rubrics for Evaluation:

| **Sr. No** | **Performance Indicator** | **Excellent** | **Good** | **Below Average** | **Marks** |
|---|---|---|---|---|---|
| 1 | On time Completion & Submission (01) | 01 (On Time ) | NA | 00 (Not on Time) | |
| 2 | Logic/Algorithm Complexity analysis(03) | 03(Correct) | 02(Partial) | 01 (Tried) | |
| 3 | Coding Standards (03): Comments/indention/Naming conventions<br>Test Cases /Output | 03(All used) | 02 (Partial) | 01 (rarely followed) | |
| 4 | Post Lab Assignment (03) | 03(done well) | 2 (Partially Correct) | 1(submitted) | |

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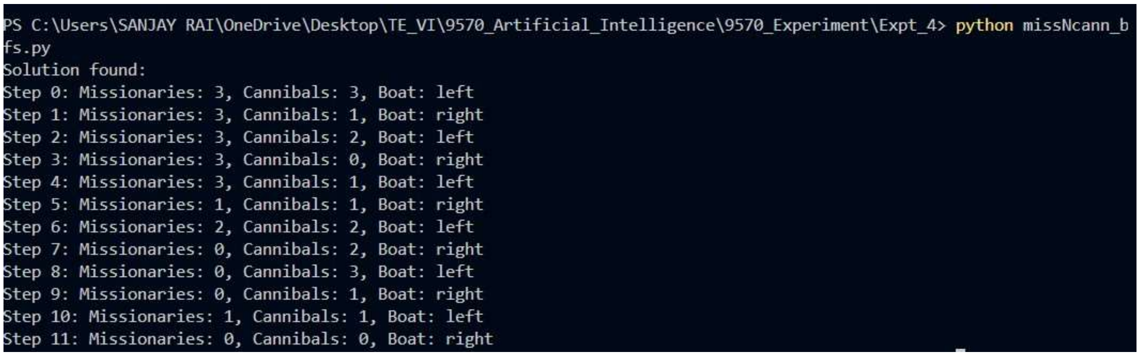
|---|---|
| **Total** |  |

**Signature of the Teacher:**

### a) Missionaries & cannibals:

Source code:

```
from collections import deque

class State:
   def __init__(self, missionaries, cannibals, boat):
       self.missionaries = missionaries
       self.cannibals = cannibals
       self.boat = boat

   def is_valid(self):
       if self.missionaries < 0 or self.cannibals < 0 or self.missionaries > 3 or self.cannibals >
3:
          return False
       if self.missionaries < self.cannibals and self.missionaries > 0:
          return False
       if (3 - self.missionaries) < (3 - self.cannibals) and (3 - self.missionaries) > 0:
          return False
       return True

   def is_goal(self): return self.missionaries == 0 and self.cannibals == 0
      and self.boat == 0

   def __eq__(self, other):
       return self.missionaries == other.missionaries and self.cannibals == other.cannibals
       and
self.boat == other.boat

   def __hash__(self): return hash((self.missionaries,
      self.cannibals, self.boat))

   def __repr__(self):
       return f"Missionaries: {self.missionaries}, Cannibals: {self.cannibals}, Boat: {'left' if
self.boat == 1 else 'right'}"

# Actions represented using vector subtraction/addition
ACTIONS = [(1, 0, 1), (2, 0, 1), (0, 1, 1), (0, 2, 1), (1, 1, 1)]

def successors(state):
   moves = [] for action in
   ACTIONS:
        if state.boat == 1:
            new_state = State(state.missionaries - action[0], state.cannibals - action[1], 0)
        else:
            new_state = State(state.missionaries + action[0], state.cannibals + action[1], 1)
        if new_state.is_valid():
            moves.append(new_state)
    return moves
def bfs(start_state): queue =
    deque([(start_state, [start_state])]) visited
    = set()

    while queue: state, path =
        queue.popleft() if
        state.is_goal():
            return path
        if state not in visited:
            visited.add(state) for successor in
            successors(state):
                if successor not in visited:
                    queue.append((successor, path + [successor]))
    return None

def print_solution(solution):
    for i, state in enumerate(solution):
        print(f"Step {i}: {state}")

def main():
    initial_state = State(3, 3, 1)
    solution = bfs(initial_state)
    if solution:
        print("Solution found:")
        print_solution(solution)
    else: print("No solution
        found.")

if __name__ ==

"__main__": main() Output:
```



```
PS C:\Users\SANJAY RAI\OneDrive\Desktop\TE_VI\9570_Artificial_Intelligence\9570_Experiment\Expt_4> python missNcann_b
fs.py
Solution found:
Step 0: Missionaries: 3, Cannibals: 3, Boat: left
Step 1: Missionaries: 3, Cannibals: 1, Boat: right
Step 2: Missionaries: 3, Cannibals: 2, Boat: left
Step 3: Missionaries: 3, Cannibals: 0, Boat: right
Step 4: Missionaries: 3, Cannibals: 1, Boat: left
Step 5: Missionaries: 1, Cannibals: 1, Boat: right
Step 6: Missionaries: 2, Cannibals: 2, Boat: left
Step 7: Missionaries: 0, Cannibals: 2, Boat: right
Step 8: Missionaries: 0, Cannibals: 3, Boat: left
Step 9: Missionaries: 0, Cannibals: 1, Boat: right
Step 10: Missionaries: 1, Cannibals: 1, Boat: left
Step 11: Missionaries: 0, Cannibals: 0, Boat: right
```

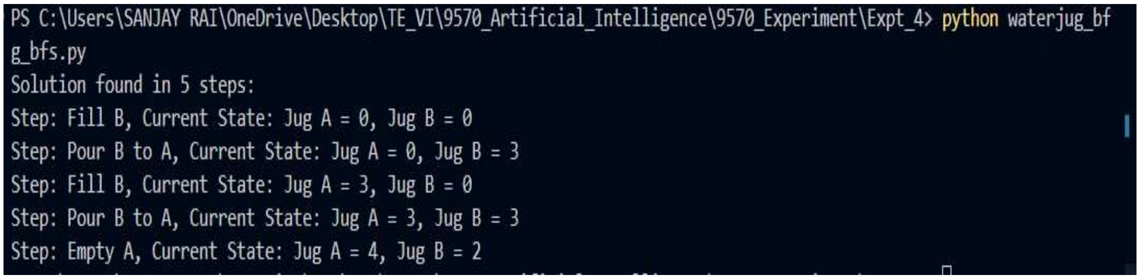
**b) Water Jug Problem:**

Source code: from collections

```
import deque

def bfs_water_jug(capacity_a, capacity_b, target): queue =
  deque([(0, 0, [])]) # (current state A, current state B, path) visited =
  set()

  while queue: current_state_a, current_state_b, path =
    queue.popleft()

    if (current_state_a, current_state_b) == target:
      return path

    if (current_state_a, current_state_b) in visited:

    continue visited.add((current_state_a,

    current_state_b))

    # Fill jug A
    queue.append((capacity_a, current_state_b, path + [(current_state_a, current_state_b,
'Fill A')]))

    # Fill jug B
    queue.append((current_state_a, capacity_b, path + [(current_state_a, current_state_b,
'Fill B')]))

    # Empty jug A
    queue.append((0, current_state_b, path + [(current_state_a, current_state_b, 'Empty
A')]))

    # Empty jug B
    queue.append((current_state_a, 0, path + [(current_state_a, current_state_b, 'Empty
B')]))
```

```
        # Pour water from jug A to jug B
        pour_amount = min(current_state_a, capacity_b - current_state_b)
        queue.append((current_state_a - pour_amount, current_state_b + pour_amount,
        path + [(current_state_a, current_state_b, 'Pour A to B')]))

        # Pour water from jug B to jug A
        pour_amount = min(current_state_b, capacity_a - current_state_a)
    queue.append((current_state_a + pour_amount, current_state_b - pour_amount,
    path + [(current_state_a, current_state_b, 'Pour B to A')])) return None # No
    solution found
# Example usage: capacity_a = 4 capacity_b = 3
target_amount = (0, 2) result = bfs_water_jug(capacity_a,
capacity_b, target_amount)

if result:
    print(f"Solution found in {len(result)} steps:") for step in result:
    print(f"Step: {step[-1]}, Current State: Jug A = {step[0]}, Jug B = {step[1]}")
else: print("No solution
    found.")
```

<u>Output:</u>



```
PS C:\Users\SANJAY RAI\OneDrive\Desktop\TE_VI\9570_Artificial_Intelligence\9570_Experiment\Expt_4> python waterjug_bf
g_bfs.py
Solution found in 5 steps:
Step: Fill B, Current State: Jug A = 0, Jug B = 0
Step: Pour B to A, Current State: Jug A = 0, Jug B = 3
Step: Fill B, Current State: Jug A = 3, Jug B = 0
Step: Pour B to A, Current State: Jug A = 3, Jug B = 3
Step: Empty A, Current State: Jug A = 4, Jug B = 2
```