

```
1 from collections import deque
2
3 def is_valid(state):
4     M_left, C_left, boat = state
5     M_right = 3 - M_left
6     C_right = 3 - C_left
7
8     if (M_left >= 0 and M_left >= C_left or M_left == 0) and \
9         (M_right >= 0 and M_right >= C_right or M_right == 0) and \
10         0 <= M_left <= 3 and 0 <= C_left <= 3:
11         return True
12     return False
13
14 def get_next_states(state):
15     M_left, C_left, boat = state
16     moves = []
17
18     for m in range(3):
19         for c in range(3):
20             if 1 <= m + c <= 2:
21                 if boat == 1:
22                     next_state = (M_left - m, C_left - c, 0)
23                 else:
24                     next_state = (M_left + m, C_left + c, 1)
25                 if is_valid(next_state):
26                     moves.append(next_state)
27     return moves
28
```

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29 def missionaries_cannibals_bfs():
30     start = (3, 3, 1)
31     goal = (0, 0, 0)
32     queue = deque()
33     queue.append((start, [start]))
34     visited = set()
35     visited.add(start)
36
37     while queue:
38         state, path = queue.popleft()
39         if state == goal:
40             return path
41
42         for next_state in get_next_states(state):
43             if next_state not in visited:
44                 visited.add(next_state)
45                 queue.append((next_state, path + [next_state]))
46
47     return None
48
49 def print_solution(path):
50     print("Steps to solve Missionaries and Cannibals problem:")
51     for step, state in enumerate(path):
52         M_left, C_left, boat = state
53         M_right = 3 - M_left
54         C_right = 3 - C_left
55         boat_pos = "Left" if boat == 1 else "Right"
56         print(f"Step {step}: Left Bank: M={M_left}, C={C_left} | Right Bank: M={M_right}, C={C_right} | Boat: {boat_pos}")

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56
57 solution = missionaries_cannibals_bfs()
58 if solution:
59     print_solution(solution)
60 else:
61     print("No solution found.")
62
```

>>> %Run -c \$EDITOR_CONTENT

Steps to solve Missionaries and Cannibals problem:

Step 0: Left Bank: M=3, C=3	Right Bank: M=0, C=0	Boat: Left
Step 1: Left Bank: M=3, C=1	Right Bank: M=0, C=2	Boat: Right
Step 2: Left Bank: M=3, C=2	Right Bank: M=0, C=1	Boat: Left
Step 3: Left Bank: M=3, C=0	Right Bank: M=0, C=3	Boat: Right
Step 4: Left Bank: M=3, C=1	Right Bank: M=0, C=2	Boat: Left
Step 5: Left Bank: M=1, C=1	Right Bank: M=2, C=2	Boat: Right
Step 6: Left Bank: M=2, C=2	Right Bank: M=1, C=1	Boat: Left
Step 7: Left Bank: M=0, C=2	Right Bank: M=3, C=1	Boat: Right
Step 8: Left Bank: M=0, C=3	Right Bank: M=3, C=0	Boat: Left
Step 9: Left Bank: M=0, C=1	Right Bank: M=3, C=2	Boat: Right
Step 10: Left Bank: M=0, C=2	Right Bank: M=3, C=1	Boat: Left
Step 11: Left Bank: M=0, C=0	Right Bank: M=3, C=3	Boat: Right

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