

## Modelling Challenge: Missionaries and Cannibals State Space Problem Solver

**Problem Statement:** Three missionaries and three cannibals, along with one boat that fits at most two people (and requires at least one person for operation), are on the left bank of a river. If ever the number of cannibals in any one spot (left bank, right bank, or on the boat) outnumber the missionaries, the outnumbered missionaries will be consumed – eaten! The goal is to get all six individuals safely across the river from the left bank to the right bank.

### **The Objects of the State Space World:**

C C C M M M B

Where C represents a cannibal, M represents a missionary, and B represents the boat.

### **Representation of a State of the World:**

The state of the world is represented by two lists:

$L < M \ C \ B > \ R < M \ C \ B >$

L is the left bank, and R is the right bank.

M and C represent the number of missionaries and cannibals on each of their respective banks such that  $M = \{0,1,2,3\}$  and  $C = \{0,1,2,3\}$

B represents the boat such that  $B = \{0,1\}$ . When  $B=1$  it is on that bank, when  $B=0$  it is on the other.

### **The State Space Description:**

*Initial state:*  $L < 3 \ 3 \ 1 > \ R < 0 \ 0 \ 0 >$

*Goal state:*  $L < 0 \ 0 \ 0 > \ R < 3 \ 3 \ 1 >$

*State space operators:*

CL = take one cannibal to the left

ML = take one missionary to the left bank

CML = take one cannibal and one missionary to the left bank

CCL = take two cannibals to the left bank

MML = take two missionaries and two cannibals to the left bank

CR = take one cannibal to the right

MR = take one missionary to the right

CMR = take one missionary and one cannibal to the right

CCR = take two cannibals to the right

MMR = take two missionaries to the right

### State Space Graph

L<3 3 1> R<0 0 0>



CCR

L<3 1 0> R<0 2 1>



CL

L<3 2 1> R<0 1 0>



CCR

L<3 0 0> R<0 3 1>



CL

L<3 1 1> R<0 2 0>



MMR

L<1 1 0> R<2 2 1>



MCL

L<2 2 1> R<1 1 0>



MMR

L<0 2 0> R<3 1 0>



CL

L<0 3 1> R<3 0 0>



CCR

L<0 1 0> R<3 2 1>



CL

L<0 2 1> R<3 1 0>



CCR

L<0 0 0> R<3 3 1>

### State Space Solution

< CCR, CL, CCR, CL, MMR, MCL, MMR, CL, CCR, CL, CCR >