Assignment 7

Task 2:

Constants:

ADULT_1, ADULT_2, ADULT_3, CHILDREN_1, CHILDREN_2, CHILDREN_3, BOAT_B

Predicates:

CHILDREN(X): It is TRUE if X is a child.
ADULT(X): It is TRUE if X is a adult.
BOAT(X): It is TRUE if X is a boat.
LEFT(X): It is TRUE if X is on left side of river.
RIGHT(X): It is TRUE if X is on right side of river.

Initial State:
ADULT(ADULT_1) AND ADULT(ADULT_2)
AND ADULT(ADULT_3) AND CHILDREN(CHILDREN_1) AND CHILDREN(CHILDREN_2) AND CHILDREN(CHILDREN_3) AND BOAT(BOAT_B) AND LEFT(ADULT_1) AND LEFT(ADULT_2)
AND LEFT(ADULT_3) AND LEFT(CHILDREN_1) AND LEFT(CHILDREN_2) AND LEFT(CHILDREN_3) AND LEFT(BOAT_B)

Goal State:
RIGHT(ADULT_1) AND RIGHT(ADULT_2)
AND RIGHT(ADULT_3) AND RIGHT(CHILDREN_1) AND RIGHT(CHILDREN_2) AND RIGHT(CHILDREN_3) AND RIGHT(BOAT_B)

Operations:

1. ACTION(MOVERIGHT_ONE(x, y))

PRECOND: (LEFT x) AND (LEFT y) AND (BOAT y)
EFFECT: (RIGHT x) AND (RIGHT y) AND NOT(LEFT x) AND NOT(LEFT y)

2. ACTION(MOVERIGHT_TWO(x, y, z))

PRECOND: (LEFT x) AND (LEFT y) AND (LEFT z) AND (CHILDREN x) AND (CHILDREN y) AND (BOAT z)
EFFECT: (RIGHT x) AND (RIGHT y) AND (RIGHT z) AND NOT(LEFT x) AND NOT(LEFT y) AND NOT(LEFT z)

3. ACTION(MOVELEFT_ONE(x, y))

PRECOND: (RIGHT x) AND (RIGHT y) AND (BOAT y)
EFFECT: (LEFT x) AND (LEFT y) AND NOT(RIGHT x) AND NOT(RIGHT y)

4. ACTION(MOVELEFT_TWO(x, y, z))

PRECOND: (RIGHT x) AND (RIGHT y) AND (RIGHT z) AND (CHILDREN x) AND (CHILDREN y) AND (BOAT z)
EFFECT: (LEFT x) AND (LEFT y) AND (LEFT z) AND NOT(RIGHT x) AND NOT(RIGHT y) AND NOT(RIGHT z)

Plan Actions:

1. ACTION(MOVERIGHT_CHILDREN(CHILDREN_1, CHILDREN_2, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND CHILDREN(CHILDREN_2) AND BOAT(BOAT_B) AND LEFT(CHILDREN_1) AND LEFT(CHILDREN_2) AND LEFT(BOAT_B)

EFFECT: RIGHT(CHILDREN_1) AND RIGHT(CHILDREN_2) AND RIGHT(BOAT_B) AND NOT(LEFT(CHILDREN_1)) AND NOT(LEFT(CHILDREN_2)) AND NOT(LEFT(BOAT_B))

2. ACTION(MOVELEFT_CHILDREN(CHILDREN_1, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND BOAT(BOAT_B) AND RIGHT(CHILDREN_1) AND RIGHT(BOAT_B)

EFFECT: LEFT(CHILDREN_1) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_1)) AND NOT(RIGHT(BOAT_B))

3. ACTION(MOVERIGHT_CHILDREN(CHILDREN_1, CHILDREN_3, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND CHILDREN(CHILDREN_3) AND BOAT(BOAT_B) AND LEFT(CHILDREN_1) AND LEFT(CHILDREN_3) AND LEFT(BOAT_B)

EFFECT: RIGHT(CHILDREN_1) AND RIGHT(CHILDREN_3) AND RIGHT(BOAT_B) AND NOT(LEFT(CHILDREN_1)) AND NOT(LEFT(CHILDREN_3)) AND NOT(LEFT(BOAT_B))

4. ACTION(MOVELEFT_CHILDREN(CHILDREN_1, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND BOAT(BOAT_B) AND RIGHT(CHILDREN_1) AND RIGHT(BOAT_B)

EFFECT: LEFT(CHILDREN_1) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_1)) AND NOT(RIGHT(BOAT_B))

5. ACTION(MOVERIGHT_ADULT(ADULT_1, CHILDREN_2, BOAT_B))

PRECOND: ADULT(ADULT_1) AND CHILDREN(CHILDREN_2) AND BOAT(BOAT_B) AND LEFT(ADULT_1) AND RIGHT(CHILDREN_2) AND LEFT(BOAT_B)

EFFECT: RIGHT(ADULT_1) AND RIGHT(BOAT_B) AND NOT(LEFT(ADULT_1)) AND NOT(LEFT(BOAT_B))

6. ACTION(MOVELEFT_CHILDREN(CHILDREN_2, BOAT_B))

PRECOND: CHILDREN(CHILDREN_2) AND BOAT(BOAT) AND RIGHT(CHILDREN_2) AND RIGHT(BOAT_B)

EFFECT: LEFT(CHILDREN_2) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_2)) AND NOT(RIGHT(BOAT_B))

7. ACTION(MOVERIGHT_ADULT(ADULT_2, CHILDREN_3, BOAT_B))

PRECOND: ADULT(ADULT_2) AND CHILDREN(CHILDREN_3) AND BOAT(BOAT_B) AND LEFT(ADULT_2) AND RIGHT(CHILDREN_3) AND LEFT(BOAT_B)

EFFECT: RIGHT(ADULT_2) AND RIGHT(BOAT_B) AND NOT(LEFT(ADULT_2)) AND NOT(LEFT(BOAT_B))

8. ACTION(MOVELEFT_CHILDREN(CHILDREN_3, BOAT_B))

PRECOND: CHILDREN(CHILDREN_3) AND BOAT(BOAT) AND RIGHT(CHILDREN_3) AND RIGHT(BOAT_B)

EFFECT: LEFT(CHILDREN_3) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_3)) AND NOT(RIGHT(BOAT_B))

9. ACTION(MOVERIGHT_CHILDREN(CHILDREN_1, CHILDREN_3, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND CHILDREN(CHILDREN_3) AND BOAT(BOAT_B) AND LEFT(CHILDREN_1) AND LEFT(CHILDREN_3) AND LEFT(BOAT_B)

EFFECT: RIGHT(CHILDREN_1) AND RIGHT(CHILDREN_3) AND RIGHT(BOAT_B) AND NOT(LEFT(CHILDREN_1)) AND NOT(LEFT(CHILDREN_3)) AND NOT(LEFT(BOAT_B))

10. ACTION(MOVELEFT_CHILDREN(CHILDREN_3, BOAT_B))

PRECOND: CHILDREN(CHILDREN_3) AND BOAT(BOAT_B) AND RIGHT(CHILDREN_3) AND RIGHT(BOAT)

EFFECT: LEFT(CHILDREN_3) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_3)) AND NOT(RIGHT(BOAT_B))

11. ACTION(MOVERIGHT_ADULT(ADULT_3, CHILDREN_1, BOAT_B))

PRECOND: ADULT(ADULT_3) AND CHILDREN(CHILDREN_1) AND BOAT(BOAT_B) AND LEFT(ADULT_3) AND RIGHT(CHILDREN_1) AND LEFT(BOAT_B)

EFFECT: RIGHT(ADULT_3) AND RIGHT(BOAT_B) AND NOT(LEFT(ADULT_3)) AND NOT(LEFT(BOAT_B))

12. ACTION(MOVELEFT_CHILDREN(CHILDREN_1, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND BOAT(BOAT_B) AND RIGHT(CHILDREN_1) AND RIGHT(BOAT_B)

EFFECT: LEFT(CHILDREN_1) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_1)) AND NOT(RIGHT(BOAT_B))

13. ACTION(MOVERIGHT_CHILDREN(CHILDREN_1, CHILDREN_2, BOAT_B))

PRECOND: CHILDREN(CHILDREN_1) AND CHILDREN(CHILDREN_2) AND BOAT(BOAT_B) AND LEFT(CHILDREN_1) AND LEFT(CHILDREN_2) AND LEFT(BOAT_B)

EFFECT: RIGHT(CHILDREN_1) AND RIGHT(CHILDREN_2) AND RIGHT(BOAT_B) AND NOT(LEFT(CHILDREN_1)) AND NOT(LEFT(CHILDREN_2)) AND NOT(LEFT(BOAT_B))

14. ACTION(MOVELEFT_CHILDREN(CHILDREN_2, BOAT_B))

PRECOND: CHILDREN(CHILDREN_2) AND BOAT(BOAT_B) AND RIGHT(CHILDREN_2) AND RIGHT(BOAT_B)

EFFECT: LEFT(CHILDREN_2) AND LEFT(BOAT_B) AND NOT(RIGHT(CHILDREN_2)) AND NOT(RIGHT(BOAT_B))

15. ACTION(MOVERIGHT_CHILDREN(CHILDREN_2, CHILDREN_3, BOAT_B))

PRECOND: CHILDREN(CHILDREN_2) AND CHILDREN(CHILDREN_3) AND BOAT(BOAT_B) AND LEFT(CHILDREN_2) AND LEFT(CHILDREN_3) AND LEFT(BOAT_B)

EFFECT: RIGHT(CHILDREN_2) AND RIGHT(CHILDREN_3) AND RIGHT(BOAT_B) AND NOT(LEFT(CHILDREN_2)) AND NOT(LEFT(CHILDREN_3)) AND NOT(LEFT(BOAT_B))

Task 3:

There are 5 predicates, each predicate takes at most 3 arguments and there are 4 constants.

Total number of combinations for 1 arguments = 4^1 = 4

Therefore, there can be 4 combinations for each predicate.

For 5 predicates, 5*4 = 20 values.

Each predicate can return TRUE or FALSE; therefore, total number of unique states = 2^20 states.

Total number of combinations for 3 arguments = 4^3 = 64

Therefore, there can be 64 combinations for each predicate.

For 5 predicates, 5*64 = 320 values.

Each predicate can return TRUE or FALSE; therefore, total number of unique states = 2^320 states.

Therefore, tight bound on the number of unique states in the JUNGLE world is in between 2^20 and 2^320.

Task 4:

ACTION(aaa(B ttt1, C ttt1))

PRECOND: (ppp1 B C) AND (ppp2 B) AND (ppp3 C)

EFFECT: (eee1 B C) AND (eee2 B) AND NOT(eee2 C) AND NOT(eee3 C)

Resulting State:

(A ttt1)

(B ttt1)

(C ttt1)

(ppp1 B C)

(ppp2 A)

(ppp2 B)

(ppp3 C)

(eee1 A C)

(eee1 B C)

(eee2 B)

(eee3 A)

Task 5:

Execution Monitoring/Online Replanning:

When online replanning is used, action definitions remains same. Before executing any action we check if the world is in expected state; if yes, then we execute the action as defined.

Conditional Planning:

ACTION: MOVERIGHT_ONE(x, y)

PRECOND: (LEFT x) AND (LEFT y) AND (BOAT y)

EFFECT: ((RIGHT x) AND (RIGHT y) AND NOT(LEFT x) AND NOT(LEFT y)) OR ((LEFT x) AND (LEFT y))

ACTION: MOVELEFT_ONE(x, y)

PRECOND: (RIGHT x) AND (RIGHT y) AND (BOAT y)

EFFECT: ((LEFT x) AND (LEFT y) AND NOT(RIGHT x) AND NOT(RIGHT y)) OR ((RIGHT x) AND (RIGHT y))