Assignment - 7

Task - 2 PDDL :

☆ Initial [Adult $(A_1) \wedge$ Adult $(A_2) \wedge$ Adult $(A_3) \wedge$
Child $(C_1) \wedge$ Child $(C_2) \wedge$ Child $(C_3) \wedge$
River $(R) \wedge$ Boat $(B) \wedge$
Left $(A_1, R) \wedge$ Left $(A_2, R) \wedge$ Left $(A_3, R) \wedge$
Left $(C_1, R) \wedge$ Left $(C_2, R) \wedge$ Left $(C_3, R) \wedge$
Left (B, R)]

☆ Goal [Right $(A_1, R) \wedge$ Right $(A_2, R) \wedge$ Right $(A_3, R) \wedge$
Right $(C_1, R) \wedge$ Right $(C_2, R) \wedge$ Right $(C_3, R) \wedge$
~~Right~~ (B, R)]

~~Action : Move Child Right (C, b, r)~~
~~Precond : Right $(C, r) \wedge$ Right~~
~~Left (C_1, r), Left~~

☆ ⇒ Action : Move Both Children Right (C_1, C_2, B, R)
Precond : Left $(C_1, R) \wedge$ Left $(C_2, R) \wedge$ Left $(B, R) \wedge$
Child $(C_1) \wedge$ Child $(C_2) \wedge$ Boat $(B) \wedge$ River (R)
Effect : $\neg$ Left $(C_1, R) \wedge \neg$ Left $(C_2, R) \wedge \neg$ Left (B, R)
$\wedge$ Right $(C_1, R) \wedge$ Right $(C_2, R) \wedge$ Right (B, R)

⇒ Action : Move Child Left (C, B, R)
Precond : Right $(C, R) \wedge$ Right $(B, R) \wedge$ Child (C)
$\wedge$ Boat $(B) \wedge$ River (R)
Effect : $\neg$ Right $(C, R) \wedge \neg$ Right $(B, R) \wedge$
Left $(C, R) \wedge$ Left (B, R)

⇒ Action : Move Adult Right (A, B, R)

Precond : Left (A, R) ∧ Left (B, R) ∧ Adult (A) ∧ Boat (B) ∧ River (R)

Effect : ¬ Left (A, R) ∧ ¬ Left (B, R) ∧ Right (A, R) ∧ Right (B, R)

★ Plan for Achieving Goal State :

Initial State : $A_1 A_2 A_3 C_1 C_2 C_3$ B ——— R

① Move Both Children Right

A_1, A_2, A_3, C_3 —— C_1, C_2, B ⟶ B C_1, C_2

A_1, A_2, A_3, C_3

② Move Child Left

A_1, A_2, A_3, C_3 ⟵ BC_2 —— C_1

$A_1, A_2, A_3, C_2, C_3, B$ C_1

③ Move Both Children Right

A_1, A_2, A_3 —— B, C_2, C_3 ⟶ C_1

A_1, A_2, A_3 B, C_1, C_2, C_3

④ Move Child Left

A_1, A_2, A_3 ⟵ B, C_3 —— C_1, C_2

A_1, A_2, A_3, C_3, B C_1, C_2

⑤ Move Adult Right

A_2, A_3, C_3 —— B, A_1 ⟶ C_1, C_2

A_2, A_3, C_3 B, A_1, C_1, C_2

⑥ Move Child Left

A_2, A_3, C_3 ⟵ B, C_2 —— A_1, C_1

A_2, A_3, C_2, C_3, B A_1, C_1

(7) Move Adult Right

$A_3, C_2, C_3,$ B $\xrightarrow{B, A_2}$ A_1, C_1

A_3, C_2, C_3, B B, A_3, A_2, C_1

(8) Move Child Left

A_3, C_2, C_3 $\xleftarrow{B, C_1}$ B, A_1, A_2

A_3, C_1, C_2, C_3, B A_1, A_2

(9) Move Both Child Right

$A_3, C_3,$ $\xrightarrow{B, C_1, C_2}$ A_1, A_2

A_3, C_3 B, C_1, C_2, A_1, A_2

(10) Move Child Left

A_3, C_3 $\xleftarrow{B, C_2}$ C_1, A_1, A_2

A_3, C_2, C_3, B C_1, A_1, A_2

(11) Move Adult Right

$C_2, C_3,$ $\xrightarrow{B, A_3}$ C_1, A_1, A_2

C_2, C_3 B, C_1, A_1, A_2, A_3

(12) Move Child Left

C_1, C_3 $\xleftarrow{B, C_1}$ A_1, A_2, A_3

C_1, C_2, C_3, B A_1, A_2, A_3

(13) Move Both Child Right

C_3 $\xrightarrow{B, C_1, C_2}$ A_1, A_2, A_3

C_3, B A_1, A_2, A_3, C_1, C_2

(14) Move Child Right

C_3 $\xleftarrow{B, C_3}$ A_1, A_2, A_3, C_1

C_2, C_3, B A_1, A_2, A_3, C_1

(15) Move Both Children Right

$\xrightarrow{B, C_2, C_3}$ A_1, A_2, A_3, C_1

$B, A_1, A_2, A_3, C_1, C_2, C_3$

Goal State Achieved

Task-3 Predicates : 5

Each predicates having 4 constants and 3 arguments.

Lower Bound Each ~~Constant~~ take atmost 1

$= 2^{4+4+4+4+4}$

$= 2^{20}$

Upper Bound : 4 Constants & 3 arguments

total : $4^3 = 64$

with 5 predicates $5 \times 64 = 320$

So, 2^{320}

Tight Bound : $[2^{20}\ 2^{320}]$

Task-4

Preconditions for aaa(B, C) are
(ppp1 B C), (ppp2 B), (ppp3 C) present.

By Applying Actions resulting states are

(A ttt1)
(B ttt1)
(C ttt1)
(ppp1 B C)
(ppp2 A)
(ppp2 B)
(ppp3 C)
(eee1 A C)
(eee1 B C)
(eee3 A)
(eee2 B)

This is the state resulting from applying action 'aaa(B, C)' to S1.

Task-5

① Online Replanning
Actions are performed on regular basis
i.e. repetition is present.
Thus, no modification needed.

② ~~Conditional Planning~~:
~~TakeTool(t1, B)~~] ~~No need to change as~~
~~TakeTool(t2, C)~~] ~~two persons are used.~~

(b) Conditional Planning :

In case of a single person in the boat, the boat can be flown back to the starting point. So, the boat will reach the opposite end or it might not. The following action will change.

Action : MoveChildLeft (C, B, R)
Precond : Right (C, R) ∧ Right (B, R) ∧ Child (C)
∧ Boat (B) ∧ River (R)
Effect : (→ Right (C, R) ∧ → Right (B, R) ∧
Left (C, R) ∧ Left (B, R))
∨
(Right (C, R) ∧ Right (B, R))

Action : MoveAdultRight (A, B, R)
Precond : Left (A, R) ∧ Left (B, R) ∧ Adult (A) ∧
Boat (B) ∧ River (R)
Effect : (→ Left (A, R) ∧ → Left (B, R) ∧ Right (A, R)
∧ Right (B, R))
∨
(Left (A, R) ∧ Left (A, R))

In this situation, we also need to allow plan with 'if' statements.