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Task 2:

Initial state:

(On_left a_1)
(On_left a_2)
(On_left c_1)
(On_left c_2)
(On_left b)
(isAdult a_1)
(isAdult a_2)
(isChild c_1)
(isChild c_2)
(isboat b)

Goal state:

(On_right a_1)
(On_right a_2)
(On_right c_1)
(On_right c_2)

Semantics:

(On_left x): x is on the left
(On_right x): x is on the right
(isAdult x): x is adult
(isChild x): x is a child
(isboat x): x is a boat.

Action: OneGoRight(X, Y)
Precond: (On_left x), (On_left Y), (isboat J)
Effect: ¬(On_left x), ¬(On_left Y), (On_right x), (On_right Y)

Action: OneGoLeft(X, Y)
Precond: (On_right x), (On_right Y), (isboat Y)
Effect: ¬(On_right x), ¬(On_right Y), (On_left x), (On_left Y)

Action: TwoGoRight(X, Y, Z)
Precond: (On_left x), (On_left Y), (On_left Z), (isChild x), (isChild Y), (isboat Z)
Effect: ¬(On_left x), ¬(On_left Y), ¬(On_left Z), (On_right x), (On_right Y), (On_right Z)

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Action : TwoChoLeft(X,Y,Z)

Precond: (On_right X), (On_right Y), (On_right Z),
(isChild X), (isChild Y), (isboat Z)

Effects: ¬(On_right X), ¬(On_right Y), ¬(On_right Z)
(On_left X), (On_left Y), (On_left Z)

Task 3:-

aaa(B, C)

Preconditions:

(PPP1 B C), (PPP2 B), (PPP3 C)

Action can be applied.

New State after application:

(A ttt 1)
(B ttt 1)
(C ttt 1)
(PPP1 B C)
(PPP2 A)
(PPP2 B)
(PPP3 C)
(eee 1 A C)
(eee 1 B C)
(eee 2 B)
(eee3 A)

(eee2 C) (eee3 C) will be removed as an effect.

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Task 4:

We have

4 predicates

3 Argument for each predicate

And 5 constants.

Total combinations for 3 arguments

$5^3 = 125$

For 4 predicates we have 500 values [$\because 4 \times 125$]

$\therefore 2^{500}$ [$\because$ each argument can be either be True / false.]

PDDL is used to define properties of domain, the predicates which are used and action definition.

A predicate defines the property of the object which can be either true or false.

Therefore the unique states bound for the jungle world is 2^{500}.