Task 2

Given	Preconditions	Effects
(A1 Adult) (A2 Adult) (A3 Adult) (C1 Child) (C2 Child) (C3 Child) (Boat Object) (LeftBank Bank) (RightBank Bank)	(on A1 LeftBank) (on A2 LeftBank) (on A3 LeftBank) (on C1 LeftBank) (on C2 LeftBank) (on C3 LeftBank) (Boat LeftBank) (Boat Clear)	(on A1 RightBank) (on A2 RightBank) (on A3 RightBank) (on C1 RightBank) (on C2 RightBank) (on C3 RightBank) (Boat RightBank) (Boat Clear)

Actions:

addOneAdult
(params
(<a> Adult) (<b> Object) (<bank> Bank))
(preconds
(clear <b>) (on <b> <bank>) (on <a> <bank>))
(effects
(del clear <b>) (del on <a> <bank>) (on <a> <b>))

addOneChild
(params
(<c> Child) (<b> Object) (<bank> Bank))
(preconds
(clear <b>) (on <b> <bank>) (on <c> <bank>))
(effects
(del clear <b>) (del on <c> <bank>) (on <c> <b>))

addTwoChild
(params
(<c1> Child) (<c2> Child) (<b> Object) (<bank> Bank))
(preconds
(on <c1> <bank>) (on <c2> <bank>) (clear <b>) (on <b> <bank>))
(effects
(del clear <b>) (del on <c1> <bank>) (on <c1> <b>) (del on <c2> <bank>) (on <c2> <b>))

moveOneAdult
(params
(<from> Bank) (<to> Bank) (<b> Object) (<a> Adult))
(preconds
(on <a> <b>) (on <b> <from>))
(effects
(on <b> <to>) (del on <b> <from>) (del on <a> <b>) (on <a> <to>) (clear <b>)))

moveOneChild
(params
(<from> Bank) (<to> Bank) (<b> Object) (<c> Child))
(preconds
(on <c> <b>) (on <b> <from>))
(effects
(on <b> <to>) (del on <b> <from>) (del on <c> <b>) (on <c> <to>) (clear <b>)))

moveTwoChild
(params
(<from> Bank) (<to> Bank) (<b> Object) (<c1> Child) (<c2> Child))
(preconds
(on <c1> <b>) (on <c2> <b>) (on <b> <from>))
(effects
(on <b> <to>) (del on <b> <from>) (del on <c1> <b>) (on <c1> <to>)
(del on <c2> <b>) (on <c2> <to>) (clear <b>)))

Complete plan:

addTwoChild (C1 C2 Boat leftBank)
moveTwoChild (leftBank rightBank Boat C1 C2)
addOneChild (C1 Boat rightBank)
moveOneChild (rightBank leftBank Boat C1)
addOneAdult (A1 Boat leftBank)
moveOneAdult (leftBank rightBank Boat A1)
addOneChild (C2 Boat rightBank)
moveOneChild (rightBank leftBank Boat C2)
addTwoChild (C1 C2 Boat leftBank)
moveTwoChild (leftBank rightBank Boat C1 C2)
addOneChild (C1 Boat rightBank)
moveOneChild (rightBank leftBank Boat C1)
addOneAdult (A2 Boat leftBank)
moveOneAdult (leftBank rightBank Boat A2)
addOneChild (C2 Boat rightBank)
moveOneChild (rightBank leftBank Boat C2)
addTwoChild (C1 C2 Boat leftBank)
moveTwoChild (leftBank rightBank Boat C1 C2)
addOneChild (C1 Boat rightBank)
moveOneChild (rightBank leftBank Boat C1)
addOneAdult (A3 Boat leftBank)
moveOneAdult (leftBank rightBank Boat A3)
addOneChild (C2 Boat rightBank)
moveOneChild (rightBank leftBank Boat C2)
addTwoChild (C1 C2 Boat leftBank)
moveTwoChild (leftBank rightBank Boat C1 C2)
addOneChild (C2 Boat rightBank)

moveOneChild (rightBank leftBank Boat C2)
addTwoChild (C2 C3 Boat leftBank)

Task 3

Number of arguments = 3

Number of constants = 4

Number of predicated = 5

Taking 3 arguments and 5 predicates => $4^3 * 5 = 320$

Number of possible states = 2^{320}

Task 5

Execution monitoring / online planning:

We plan till the boat reaches other side even if the boat blows off course. The preconditions and effects remain the same till they reach the other end.

Conditional planning:

moveOneChild:
(params
(<from> Bank) (<to> Bank) (<b> Object) (<c> Child))
(preconds
(on <c> <b>) (on <b> <from>))
(effects: If the boat doesn't blow off course then Plan A:
(on <b> <to>) (del on <b> <from>) (del on <c> <b>) (on <c> <to>)
(clear <b>)))
Else:
(on <b> from) (on <c> from) (clear <b>)

moveOneAdult:
(params
(<from> Bank) (<to> Bank) (<b> Object) (<a> Adult))
(preconds
(on <a> <b>) (on <b> <from>))
(effects: If the boat doesn't blow off course then Plan C:
(on <b> <to>) (del on <b> <from>) (del on <a> <b>) (on <a> <to>)
(clear <b>)))
Else:
(on <b> from) (on <a> from) (clear <b>)

moveTwoChild is unchanged because there is more than one person on the boat. moveOneChild and moveOneAdult should be modified as shown above as they contain only one person on the boat.

Task 4

State	Given
(A ttt1) (B ttt1) (C ttt1) (ppp1 B C) (ppp2 A) (ppp2 B) (ppp3 C) (eee1 A C) (eee2 C) (eee3 C) (eee3 A)	(operator aaa (params (<b> ttt1) (<c> ttt1)) (preconds (ppp1 <b> <c>) (ppp2 <b>) (ppp3 <c>)) (effects (eee1 <b> <c>) (eee2 <b>) (del eee2 <c>) (del eee3 <c>)))

Applying action aaa(B, C):
(operator aaa (params (B ttt1) (C ttt1)) (preconds (ppp1 B C) (ppp2 B) (ppp3 C)) (effects (eee1 B C) (eee2 B) (del eee2 C) (del eee3 C)))

Result state:
(A ttt1)
(B ttt1)
(C ttt1)
(ppp1 B C)
(ppp2 A)
(ppp2 B)
(ppp3 C)
(eee1 A C)
(eee1 BC)
(eee2 B)
(eee3 A)