6.825 Recitation Problems: Lec. 11

Solutions

December 13, 2001

1 Book Problem 11.2

a. Buy(x, store)
-Pre: At(store), Sells(store, x), Have(CC)
-Eff: Have(x)

b. PickUp(x)
-Pre: At(y), At(x, y), Portable(x)
-Eff: Have(x)
Note: We have implicitly added another version of At that takes 2 arguments. $At(x, y)$ means object x is at location y. In the original 1-argument version, $At(y)$ means the agent is at location y.

c. For this, I won't draw the plan but explain how you would change the original plan (lecture slide 11-8) to incorporate the changes.

First, we've changed the Buy action to include the precondition of Have(CC). So we need to **add the action PickUp(CC)** to the plan. The preconditions for PickUp(CC) are At(CC, y), At(y), and Portable(CC). They are all effects of the Start action if we instantiate y = Home. So then the **Go actions threaten PickUp(CC) action**, so we put in the ordering constraint that the **PickUp(CC) action come before the Go actions**.

So the modified plan is

(1) Start

(2) PickUp(CC)

(3) Go(SM)

(4) Buy(Banana), Buy(Milk)

(5) Go(HDW)

(6) Buy(Drill)

(7) Finish

d. In a plan in which the agent leaves home without the card, the agent cannot do the Buy action because a precondion of Buy is Have(CC), and the only way to achieve Have(CC) is to do the action PickUp(CC). But the preconditions of PickUp, At(CC, y) and At(y), cannot be satisfied at the same time because CC is at Home, and after the Go action, the agent is not at Home anymore. So the agent must go back home to be able to do the PickUp(CC) action.

2 Book Problem 11.7

a. 1. $\forall x, y, r, s. At(Shakey, x, s) \wedge In(x, r) \wedge In(y, r) \wedge On(Shakey, Floor, s) \Rightarrow At(Shakey, y, Result(Go(y)))$

2. $\forall b, x, y, r, s. At(Shakey, x, s) \wedge In(x, r) \wedge In(y, r) \wedge Pushable(b)$
$wedgeOn(Shakey, Floor, s) Rightarrow At(Shakey, y, Result(Go(y))) \wedge At(b, y, Result(Go(y)))$

3. $\forall b, x, s. At(Shakey, x, s) \wedge At(b, x, s) \wedge Climbable(x) \Rightarrow On(Shakey, b, Result(Climb(b)))$

4. $\forall b, x.On(Shakey, b, s) \wedge Climbable(b) \Rightarrow On(Shakey, b, Result(Down(b)))$
5. $\forall ls, b, x, s.On(Shakey, b, s) \wedge At(b, x, s) \wedge At(ls, x) \wedge TurnedOff(ls) \Rightarrow TurnedOn(ls, Result(TurnOn(ls)))$
6. $\forall ls, b, x, s.On(Shakey, b, s) \wedge At(b, x, s) \wedge At(ls, x) \wedge TurnedOff(ls) \Rightarrow TurnedOff(ls, Result(TurnOff(ls)))$

b. 1. Go(y)
   -Pre: At(Shakey, x), In(y, r), In(x, r), On(Shakey, Floor)
   -Eff: At(Shakey, y), ¬At(Shakey, x), On(Shakey, Floor)
2. Push(b, x, y)
   -Pre: At(Shakey, x), At(b, x), In(y, r), In(x, r), Pushable(b), On(Shakey, Floor)
   -Eff: At(Shakey, y), ¬At(Shakey, x), At(b, y), ¬At(b, x), On(Shakey, Floor)
3. Climb(b)
   -Pre: At(Shakey, x), At(b, x), Climbable(b)
   -Eff: On(Shakey, b), ¬On(Shakey, Floor)
4. Down(b)
   -Pre: On(Shakey, b)
   -Eff: On(Shakey, Floor), ¬On(Shakey, b)
5. TurnOn(ls)
   -Pre: On(Shakey, b), TurnedOff(ls), At(b, x), At(ls, x)
   -Eff: TurnedOn(ls)
6. TurnOff(ls)
   -Pre: On(Shakey, b), TurnedOff(ls), At(b, x), At(ls, x)
   -Eff: TurnedOff(ls)

c. Assume Box2 is at Loc1, and we're pushing it to the location Loc2 in Room2.

1. Go(Door3)
2. Go(Corridor)
3. Go(Door1)
4. Go(Loc2)
5. Push(Box2, Loc1, Door1)
6. Push(Box2, Door1, Corridor)
7. Push(Box2, Corridor, Door2)
8. Push(Box2, Door2, Loc2)

3 Book Problem 11.9

a. $At(Monkey, A) \wedge At(Banana, B) \wedge At(Box, C) \wedge Height(Monkey, Low) \wedge Height(Box, Low) \wedge Height(Banana, High)$

b. 1. Go(x, y)
   -Pre: At(Monkey, x)
   -Eff: At(Monkey, y), ¬At(Monkey, x)
2. Push(a, x, y)
   -Pre: At(Monkey, x), At(a, x)
   -Eff: At(Monkey, y), ¬At(Money, x), At(a, y), ¬At(a, x)
3. Climb(a)
   -Pre: At(Monkey, x), At(a, x), Height(Monkey, Low), Height(a, Low)
   -Eff: Height(Monkey, High)
4. Grasp(a)
   -Pre: At(Monkey, x), At(Monkey, a), Height(Monkey, y), Height(a, y)
   -Eff: Holding(a)

c. $At(Monkey, x, S_0) \wedge At(Box, y, S_0) \wedge At(Banana, z, S_0) \wedge At(Box, y, S_1) \wedge Holding(Banana, S_1)$

d. qualification problem