AI theory homework week 4

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1 Logistic Problem I

a

- $PackageIn(x)$: Package is in location x, $x \in \{a, b, c, Truck\}$
- $TruckIn(y)$ Truck is in location y, $y \in \{a, b, c\}$
- $TruckFree$ Truck is load free

b. move(x,y)

1. pre-conditions: $TruckIn(x)$
2. post-conditions:
   add: $TruckIn(y)$
   delete: $TruckIn(x)$

load(x)

1. pre-conditions: $TruckIn(x), PackageIn(x), TruckFree$
2. post-conditions:
   add: $PackageIn(Truck)$
   delete: $TruckFree, PackageIn(x)$

unload(x)

1. pre-conditions: $TruckIn(x), PackageIn(Truck)$
2. post-conditions:
   add: $TruckFree, PackageIn(x)$
   delete: $PackageIn(Truck)$

Initial State. $\{TruckIn(a) \hat{} PackageIn(c) \hat{} TruckFree\}$

Goal state. $\{PackageIn(b) \hat{} TruckFree\}$

2 Logistic Problem II

a. Optimal solution contains 5 steps: $\{move(a, b), move(b, c), load(c), move(c, b), unload(b)$

b. Changes are made to all the actions by remove the delete in their post effects. **move(x,y)**

1. pre-conditions: $TruckIn(x)$
2. post-conditions:
   add: $TruckIn(y)$
   delete: nil

load(x)

1. pre-conditions: $TruckIn(x), PackageIn(x), TruckFree$
2. post-conditions:
   add: $PackageIn(Truck)$
   delete: nil

unload(x)

1. pre-conditions: $TruckIn(x), PackageIn(Truck)$
2. post-conditions:
   add: $TruckFree, PackageIn(x)$
   delete: nil

c. level 0
$F_x = TruckIn(a), PackageIn(c), TruckFree$
$A_x = move(a, b)$

level1
$F_x = TruckIn(a), TruckIn(b), PackageIn(c), TruckFree$
$A_x = move(a, b), move(b, a), move(b, c)$

level2
$F_x = TruckIn(a), TruckIn(b), TruckIn(c), TruckFree, PackageIn(c)$
$A_x = move(a, b), move(b, a), move(b, c), move(c, b), load(x)$

level3
$F_x = TruckIn(a), TruckIn(b), TruckIn(c), TruckFree, PackageIn(c), PackageIn(Truck)$
$A_x = move(a, b), move(b, a), move(b, c), move(c, b), load(c), unload(a), unload(b), unload(c)$

level4
$F_x = TruckIn(a), TruckIn(b), TruckIn(c), TruckFree, PackageIn(a), PackageIn(b), PackageIn(c), PackageIn(Tr$
$A_x = move(a, b), move(b, a), move(b, c), move(c, b), load(a), load(b), load(c), unload(a), unload(b), unload(c)$

3 Logistic Problem III

a. solution: $\{move(a, b), move(b, c), load(c), unload(b)$ The heuristic is call h_+ heuristic

b. 4, since the desired goal state $PackageIn(c)$ first appears on the 4th level and $TruckFree$ appears on the 0th level, so $h_{add} = 4 + 0 = 4$

c. 4, since the desired goal state $PackageIn(c)$ appears on the 4th level and $TruckFree$ appears on the 0th level, so $h_{max} = max(4, 0) = 4$

4 Generic Planning I

the relaxed problem is to remove the delete in post-condition **level0** $F_x = m$
$A_x = A$

level1 $F_x = m, n, o$
$A_x = B, D$

level2 $F_x = m, n, o, p$
$A_x = A, B, C, D$

Goal state m appears at level 0, n, o appears at the level 1, p appears at level 2

a. value of h_+ is 2, as we can see apply action A, B or A, D is the optimal solution for this delete-relaxed problem and it only requires 2 step.

b. value of h_{add} is 4, the value is adding the first layer each state appears. $0 + 1 + 1 + 2 = 4$

c. value of h_{max} is 2, the value is taking the max of the first layer each state appears. $max(0, 1, 1, 2) = 2$

5 Generic Planning II

the relaxed problem is to remove the delete in post-condition
level0
$F_x = p$
$A_x = C$

level1
$F_x = p, m$
$A_x = A, C$

level2
$F_x = m, n, o, p$
$A_x = A, B, C, D$

Goal state m appears at level 1, n, o appears at the level 2, p appears at level 0

a. value of h_+ is the optimal plan for delete-relax problem, as we can see apply action $\{C, A\}$ is the optimal solution for this delete-relaxed problem so $h_+ = 2$

b. value of h_{add} is 5, h_{add} is the summed cost of all goal facts. The value is adding the first layer each state appears, $0 + 1 + 2 + 2 = 5$

c. value of h_{max} is 2, h_{max} is the cost of the single most costly goal fact. The value is taking the max of the first layer each state appears. $max(0, 1, 2, 2) = 2$