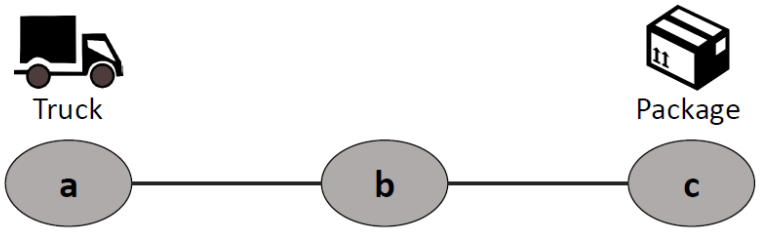
Logistic Problem 1

1 Logistic Problem I

Consider the following logistic problem. There are three lcoations a, b and c, with a truck at a and package at c. The truck is able perform the following actions: (i) move(x,y): move from location x to y; (ii) load(x): load a package at location x; and (iii) unload(x): unload the package at location x.



Given the start state in the above diagram, your goal is to get the package to lcoation b. Formulate this logistic problem using the STRIPS representation and answer the following:
a.) List down the propositional variables (facts).
b.) Specify the operators (actions), including the pre-conditions and post-conditions.
c.) Specify the initial state.
d.) List down the goal state/specification.

a) STRIPS Predicate

- truckAt(location)
- at(location, package)
- free(truck)
- carry(package, truck)
- canMove(locX, locY)

b) STRIPS Operators

- move(locX, locY)
  - pre: truckAt(locX), canMove(locX, locY)
  - add: truckAt(locY)
  - del: truckAt(locX)
- load(locX)
  - pre: at(locX, package), truckAt(locX), free(truck)
  - add: carry(package, truck)
  - del: free(truck), at(locX, package)
- unload(locY)
  - pre: truckAt(locY), carry(package, truck)
  - add: at(locY, package), free(truck)
  - del: carry(package, truck)

c) STRIPS Initial State

{ truckAt(a), free(truck), at(c, package),
canMove(a, b), canMove(b, a), canMove(b, c), canMove(c, b) }

d) STRIPS Goal State

{ at(b, package) }

Logistic Problem 2

2 Logistic Problem II

Based on your STRIPS formulation from Q1 (Logistic Problem I), answer the following:
a.) What is the optimal solution to this problem?
b.) Make this a delete-relaxed problem. What are the changes to the original STRIPS formulation you made?
c.) Based on this delete-related problem, list down all the facts F_x and actions A_x at levels $x = \{0, 1, ..., M\}$.

a) Optimal Solution

[move(a, b), move(b, c), load(c), move(c, b), unload(b)]

b) Delete Relaxed Problem

- move(locX, locY)
  - pre: truckAt(locX), canMove(locX, locY)
  - add: truckAt(locY)
  - ~~del: truckAt(locX)~~
- load(locX)
  - pre: at(locX, package), truckAt(locX), free(truck)
  - add: carry(package, truck)
  - ~~del: free(truck), at(locX, package)~~
- unload(locY)
  - pre: truckAt(locY), carry(package, truck)
  - add: at(locY, package), free(truck)
  - ~~del: carry(package, truck)~~

c) Delete Relaxed F & A

- F0 = truckAt(a), free(truck), at(c, package), canMove(a, b), canMove(b, a), canMove(b, c), canMove(c, b)
- A0 = move(a, b)
- F1 = truckAt(a), truckAt(b), free(truck), at(c, package), canMove(a, b), canMove(b, a), canMove(b, c), canMove(c, b)
- A1 = move(b, c)
- F2 = truckAt(a), truckAt(b), truckAt(c), free(truck), at(c, package), canMove(a, b), canMove(b, a), canMove(b, c), canMove(c, b)
- A2 = load(c)
- F3 = truckAt(a), truckAt(b), truckAt(c), carry(package, truck), free(truck), at(c, package), canMove(a, b), canMove(b, a), canMove(b, c), canMove(c, b)
- A3 = unload(b)
- F4 = truckAt(a), truckAt(b), truckAt(c), carry(package, truck), free(truck), at(c, package), at(b, package), canMove(a, b), canMove(b, a), canMove(b, c), canMove(c, b) #GOAL

Logistic Problem 3

3 Logistic Problem III

Based on your answer from Q2 (Logistic Problem II), answer the following:
a.) What is the optimal solution to this delete-relaxed problem? What is this heuristic called?
b.) What is the value of h_{add}? Explain why.
c.) What is the value of h_{max}? Explain why.

a) Delete Relaxed Optimal Solution

[move(a, b), move(b, c), load(c), unload(b)], h+ heuristic

b) Value of h-add

h-add = 4 (only 1 goal fact, which is at(b, package) which happens at F4)

c) Value of h-max

h-max = 4 (only 1 goal fact, which is at(b, package) which happens at F4)

Generic Planning 1

4 Generic Planning I

Consider a STRIPS problem with propoitional variables (facts) m, n, o, p, and the below STRIPS actions with their pre/post-conditions.

Action	Pre	Add	Del
A	m	n,o	$\emptyset$
B	m,o	p	m
C	p	m	p
D	n,o	p	o

Given an initial state $s = \{m\}$ and goal specification $g = \{m, n, o, p\}$, answer the following questions:
a.) What is the value of h_+? Explain why.
b.) What is the value of h_{add}? Explain why.
c.) What is the value of h_{max}? Explain why.

- F0 = m
- A0 = A
- F1 = m, n, o
- A1 = B, D
- F2 = m, n, o, p

a) Value of h+

h+ = 2 (min number of required to achieve all, which happens at F2)

b) Value of h-add

h-add = 4 (add cost of m, n, o, p = 0 + 1 + 1 + 2 = 4)

c) Value of h-max

h-max = 2 (max cost of m, n, o, p which is p at F2)

Generic Planning 2

5 Generic Planning II

Based on the same STRIPS formulation in Q4 (Generic Planning I). Now, based on initial state $s = \{p\}$ and goal specification $g = \{m, n, o, p\}$, answer the following questions:
a.) What is the value of h_+ (if any)? Explain why.
b.) What is the value of h_{add} (if any)? Explain why.
c.) What is the value of h_{max} (if any)? Explain why.

- F0 = p
- A0 = C
- F1 = p, m
- A1 = A
- F2 = m, n, o, p

d) Value of h+

h+ = 2 (min number of required to achieve all, which happens at F2)

e) Value of h-add

h-add = 5 (add cost of m, n, o, p = 1 + 2 + 2 + 0 = 5)

f) Value of h-max

h-max = 2 (max cost of m, n, o, p, which is n and o at F2)