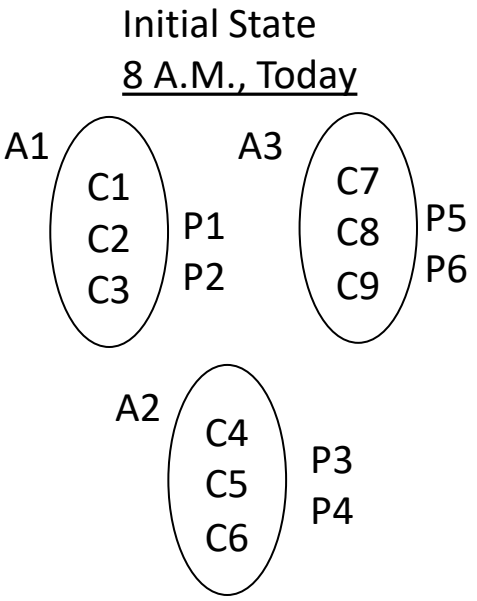
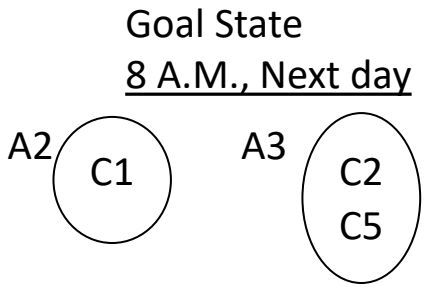
Chapter 4. Planning Problems

Topic 4.1. Air-Cargo Transportation Problem as a Planning Problem

A) Representation of the problem

a) Schematic representation

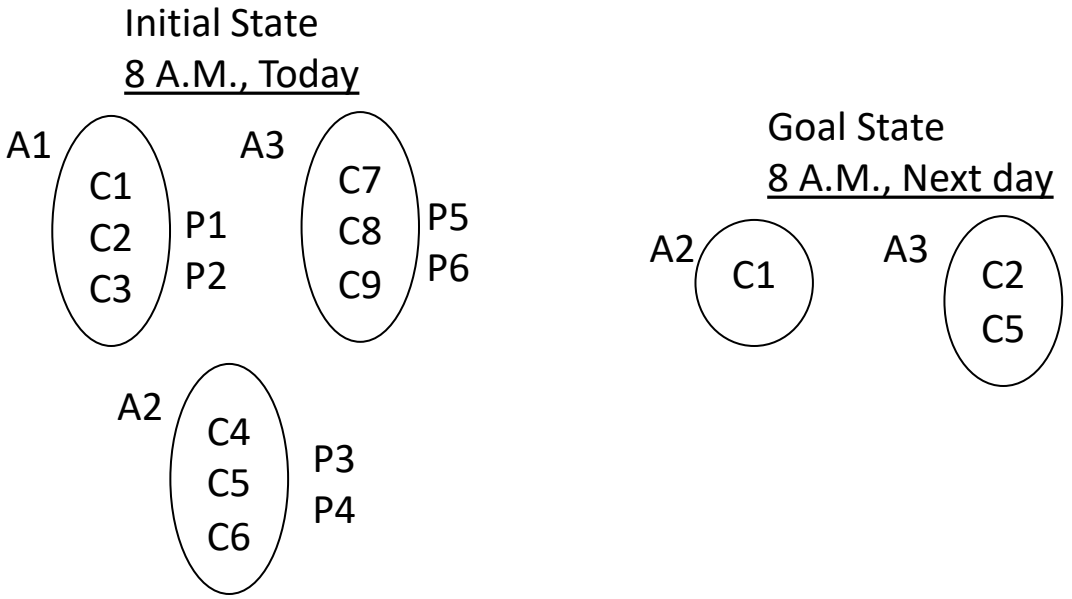




Assumptions:

- 3 busy airports
- No restriction on plane movement
- 'Fly' is the only 'costly action'
- Any plane can reach another port directly or via the 3rd by the given time

b) Representation in Planning Domain Definition Language (PDDL)



Initial State (IS):

Airport(A1) $\wedge$ Airport(A2) $\wedge$ Airport(A3) $\wedge$ Cargo(C1) $\wedge$ Cargo(C2) $\wedge$ …
$\wedge$ Cargo(C9) $\wedge$ Plane(P1) $\wedge$ Plane(P2) $\wedge$ … $\wedge$ Plane(P6) $\wedge$ At(A1,C1) $\wedge$
At(A1,C2) $\wedge$ ... $\wedge$ At(A3,C9) $\wedge$ At(A1,P1) $\wedge$ At(A1,P2) $\wedge$ … $\wedge$ At(A3,P6)

Goal State (GS):

At(A2,C1) $\wedge$ At(A3,C2) $\wedge$ At(A3,C5) $\wedge$ Airport(A2) $\wedge$ Airport(A3) $\wedge$
Cargo(C1) $\wedge$ Cargo(C2) $\wedge$ Cargo(C5)

c) Action Schemas:

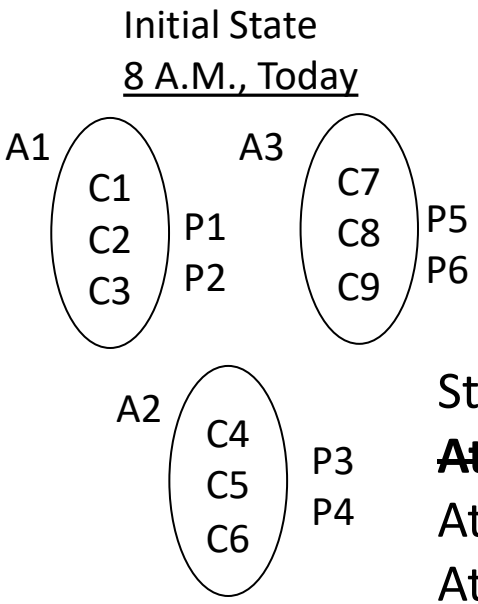
i) Action: Load(c, p, a)
Precondition: $Cargo(c) \wedge Plane(p) \wedge Airport(a) \wedge At(a, c) \wedge At(a, p)$
Effect: $\neg At(a, c) \wedge In(p, c)$

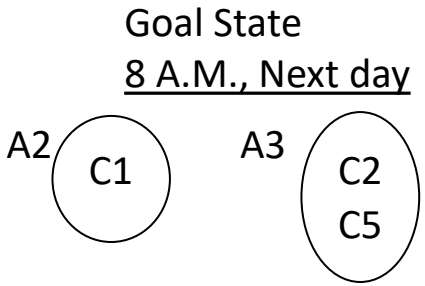
ii) Action: Unload(c, p, a)
Precondition: $Cargo(c) \wedge Plane(p) \wedge Airport(a) \wedge At(a, p) \wedge In(p, c)$
Effect: $At(a, c) \wedge \neg In(p, c)$

iii) Action: Fly(p, from, to)
Precondition: $Plane(p) \wedge Airport(from) \wedge Airport(to) \wedge At(from, p)$
Effect: $\neg At(from, p) \wedge At(to, p)$

B) Construction of a plan through Forward State Space Search

Initial State → Action Group 1 → State 1, Goal test = False → …… → State n, Goal test = True





Action Group 1:
Load(C1, P1, A1)
Load(C2, P1, A1)

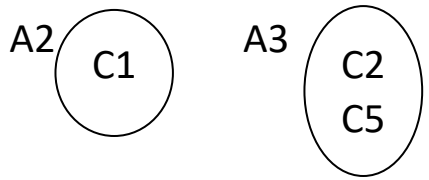
State 1:

~~**At(A1,C1) ∧ At(A1,C2)**~~ ∧ At(A1,C3) ∧ At(A2,C4) ∧ At(A2,C5) ∧ At(A2,C6) ∧ At(A3,C7) ∧ At(A3,C8) ∧ At(A3,C9) ∧ At(A1,P1) ∧ At(A1,P2) ∧ At(A2,P3) ∧ At(A2,P4) ∧ At(A3,P5) ∧ At(A3,P6) ∧ **In(P1, C1) ∧ In(P1, C2)**

[Predicates Airport, Cargo and Plane not shown]

Goal test = False;

Goal State
8 A.M., Next day



State ……. :

~~**At(A1,C1) ∧ At(A1,C2)**~~ ∧ At(A1,C3) ∧ At(A2,C4) ∧ At(A2,C5) ∧ At(A2,C6) ∧ At(A3,C7) ∧ At(A3,C8) ∧ At(A3,C9) ∧ At(A1,P1) ∧ At(A1,P2) ∧ At(A2,P3) ∧ At(A2,P4) ∧ At(A3,P5) ∧ At(A3,P6) ∧ **In(P1, C1) ∧ In(P1, C2)**

Goal Test = ……..

Action Group2:
Fly(P1, A1, A2)

Action Group 3:
Unload(C1, P1, A2)
Load(C5, P1, A2)

Action Group 4:
Fly(P1, A2, A3)

Action Group 5:
Unload(C2, P1, A3)
Unload(C5, P1, A3)

Plan: Action Group1, Action Group 2, … , Action Group 5; Optimal?