National University of Singapore
School of Computing

Semester 2, AY2023-24

CS4246/CS5446 AI Planning and Decision Making

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# Tutorial Week 4: Hierarchical Planning

**Guidelines**

- You can discuss the content of the questions with your classmates.
- However, everyone should work on and be ready to present ALL the solutions.
- Your attendance is marked in the tutorial and participation noted to award class participation marks.

## Package delivery

You have a number of trucks with which to deliver a set of packages. Each package starts at some location on a grid map, and has a destination somewhere else. Each truck is directly controlled by moving forward and turning. The package can be loaded to the truck and unloaded from the truck.

1) *Forward* action:
   If you model the *Forward* action as a primitive action, what would be the precondition and effect? Assume that addition is defined and available as an operator. State any assumptions you make in the modeling.

2) What other primitive actions are needed define the planning problem? (no need to write the PDDL definition)

3) Construct a hierarchy of high-level actions for this problem.

4) What knowledge about the solution does your hierarchy encode?

5) What are some shortcomings (in terms of real-life implementation) of the hierarchy defined above?

## Air cargo problem

Consider the air-cargo problem that we have seen in the lecture.

$Init(At(C_1,\ SFO)\ \wedge\ At(C_2,\ JFK)\ \wedge\ At(P_1,\ SFO)\ \wedge\ At(P_2,\ JFK)$
$\quad \wedge\ Cargo(C_1)\ \wedge\ Cargo(C_2)\ \wedge\ Plane(P_1)\ \wedge\ Plane(P_2)$
$\quad \wedge\ Airport(JFK)\ \wedge\ Airport(SFO))$
$Goal(At(C_1,\ JFK)\ \wedge\ At(C_2,\ SFO))$
$Action(Load(c,\ p,\ a),$
$\quad$ PRECOND: $At(c,\ a)\ \wedge\ At(p,\ a)\ \wedge\ Cargo(c)\ \wedge\ Plane(p)\ \wedge\ Airport(a)$
$\quad$ EFFECT: $\neg\ At(c,\ a)\ \wedge\ In(c,\ p))$
$Action(Unload(c,\ p,\ a),$
$\quad$ PRECOND: $In(c,\ p)\ \wedge\ At(p,\ a)\ \wedge\ Cargo(c)\ \wedge\ Plane(p)\ \wedge\ Airport(a)$
$\quad$ EFFECT: $At(c,\ a)\ \wedge\ \neg\ In(c,\ p))$
$Action(Fly(p,\ from,\ to),$
$\quad$ PRECOND: $At(p,\ from)\ \wedge\ Plane(p)\ \wedge\ Airport(from)\ \wedge\ Airport(to)$
$\quad$ EFFECT: $\neg\ At(p,\ from)\ \wedge\ At(p,\ to))$

1) Write the successor state axiom for the fluent $At(P_1, SFO)$.

2) Desribe how you will modify the problem so that each plane can carry only one cargo.