Homework #5: Chapter 11-12

The following exercises are due at the beginning of class on Wednesday, April 7. Note, this homework is continued on the reverse side of the paper.

1. *[30 points]* Consider the STRIPS actions defined for the air cargo problem in Figure 11.2 on page 380 of the book, and the problem instance described below:

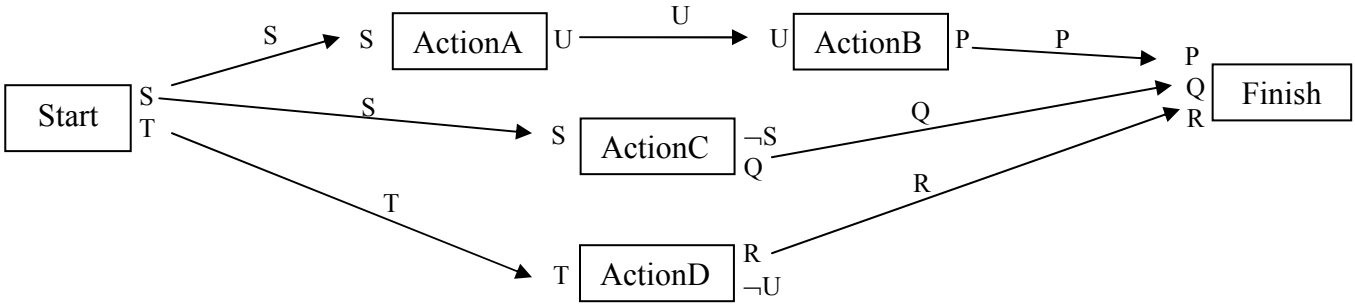
   Initial State: At(P1,LAX) ∧ At(P2,JFK) ∧ At(C1,ORD) ∧ In(C2,P1) ∧ Plane(P1) ∧ Plane(P2) ∧ Cargo(C1) ∧ Cargo(C2) ∧ Airport(JFK) ∧ Airport(LAX) ∧ Airport(ORD)
   Goal: At(P1,JFK) ∧ At(P2,LAX) ∧ At(C1,JFK) ∧ In(C2,P1)

   a) *[15 points]* Do the first level of a breadth-first forward state-space search on this problem. You should show all actions that are applicable in the initial state, as well as the successor states that result from these actions. For convenience, your state descriptions may omit literals that use the Plane, Airport, and Cargo predicates. Note, some of the applicable actions may be spurious, but you should show them anyway.
   b) *[15 points]* Do the first level of a breadth-first backward state-space search on this problem. You should show all actions that are relevant and consistent with the given goal, and show the predecessor states for these actions. In addition to omitting literals that use the Plane, Airport, and Cargo predicates as above, you may use variables as parameters for the actions.

2. *[40 points]* The monkey-and-bananas problem is faced by a monkey in a laboratory with some bananas hanging out of reach from the ceiling. A box is available that will enable the monkey to reach the bananas if he climbs on it. Assume that your domain predicates are:
   - *At*(*x*,*l*): *x* is at location *l*
   - *Height*(*x*,*h*): *x* has height *h*
   - *Holding*(*x*,*o*): *x* is holding object *o*
   - *On*(*x*,*o*): *x* is on object *o*
   - *Climbable*(*o*): object *o* can be climbed on (such as a box)
   - *Pushable*(*o*): object *o* can be pushed across the floor (such as a box)
   - *Small*(*x*): *x* is small enough to hold in a monkey's hand

   Initially, the *Monkey* is at location *A*, the *Bananas* at *B*, and the *Box* at *C*. The monkey and box have height *Low*, but if the monkey climbs onto the box, he will have height *High*, the same as the bananas. The actions available to the monkey include *Go* from one place to another, *Push* a pushable object from one place to another, *ClimbUp* onto or *ClimbDown* from a box, and *Grasp* or *Ungrasp* a small object. The monkey may only push or climb on a climbable object if it is at the same location as the box. Grasping results in holding the object if the monkey and object are in the same place at the same height.
   a) *[5 points]* Write down the initial state description.
   b) *[15 points]* Write down STRIPS-style definitions of the six actions. Be sure your actions schemas have correct parameter lists and that the preconditions and effects capture the semantics of the action as closely as STRIPS allows.
   c) *[5 points]* Give a total-order plan that is a solution to the goal *Holding*(*Monkey*,*Bananas*). You do not have to use an algorithm to find this plan, nor do you need to show your work.

3. *[20 points]* Consider the inconsistent partially ordered plan below. Identify the conflicts in this plan and show all ways of resolving them that follow the principle of least commitment. For each conflict-free solution, draw the new partially ordered plan, and list all of its linearizations.



4. *[10 points]* Give a real-world example of bounded indeterminacy. Give one of unbounded indeterminacy. Do not repeat the examples from the book or class. Explain your answers.