The Monkey-and-Bananas Problem

In the first and the fourth exercise we will consider (variants of) the monkey-and-bananas problem, in which there is a monkey in a room with some bananas hanging out of reach from the ceiling, but a box is available that will enable the monkey to reach the bananas if he climbs on it. Initially, the monkey is at $A$, the bananas at $B$, and the box at $D$. The monkey and the 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, $Climb$ onto an object, $Push$ and object from one place, to another, and $Grasp$ an object.

Exercise 8.1

When we want to represent actions and reason about them we have to somehow deal with the frame problem (which we have mentioned in the lecture), but also the qualification problem and the ramification problem. Find out what these problems are and describe them (including the frame problem) in your own words.

Now, think of a STRIPS-style definition of the $Push$ operator within the monkey-and-bananas problem. Probably, the definition you think of is incorrect, because if the object is to heavy, its position will remain the same when the $Push$ operator is applied. Is this an example of the frame problem, the ramification problem or of the qualification problem?
Exercise 8.2
There are many ways to characterize planners. For each of the following dichotomies, explain what they mean, and how the choice between them affects the efficiency and completeness of a planner.

1. *Situation/state space vs. plan space.*
2. *Progressive vs. regressive.*
3. *Bound variables vs. unbound variables.*
4. *Total order vs. partial order.*
5. *optimal vs. non-optimal*

Exercise 8.3
In Figure 1, you see a typical problem in the *Manhattan or Grid World.*

![Figure 1: A typical problem in the Manhattan World.](image)

The shapes are keys. The squares with holes in them represent locks. Initially, all intersections with locks are locked. The robot can only move along the grid. Furthermore, it can open a locked intersection \((i, j)\) by standing next to it with a key of the same shape as the lock, and executing the action `open(i, j)`. The robot can pick up a key when standing at the key’s position, but it can carry only one key at a time.

In this problem, the robot is initially standing at the center of the grid, at position \(\langle 0, 0 \rangle\). The goal is to get the box-shaped key \(\text{bk}\) (at position \(\langle 2, 1 \rangle\)) to location \(3, 0\).

(A solution would be to unlock intersection \(\langle 3, 1 \rangle\), which is locked with a circular key. It does no good to try to use a triangular key, because the only one is trapped inside a ring of
triangular-looking intersections. Hence the robot must use bk to open \((-4, 0), (-3, 1),\) or 
\((-3, -1),\) carry the circular key ck to where the intersection \((3, 1)\) can be unlocked, then

go back and retrieve bk.)

Encode the operators, problem facts, and goals within the STRIPS language.

**Exercise 8.4**

In the lecture, we were talking about GRAPHPLAN. In this exercise, you can gain practical experience using it. The program as well as interesting background material can be found at

http://www.cs.cmu.edu/~avrim/plan.html

Acquaint yourself with the program. Some of the example files you find in the Graphplan home directory (monkey_ops, monkey_facts1, monkey_facts2, monkey_facts3) encode a variant of the monkey-and-bananas problem.

1. Modify the set monkey_ops of operators to monkey1_ops such that the problem monkey_facts3 is solvable.

2. Recall the situation of Exercise 8.1. Modify the set monkey1_ops of operators to monkey2_ops such that a box could only be pushed if it is pushable. Encode a variant monkey2_facts3 of monkey_facts3 where the box is pushable. Use monkey2_ops to solve monkey2_facts3.

E-mail the files monkey1_ops, monkey2_ops and monkey2_facts3 to your tutor no later than Wednesday, July 2, 11am. Please, indicate clearly the names of the group members in your e-mail.