Intelligent Systems

Exercise sheet 8
Planning

Exercise 1[1] (15 points)

Given the axioms from Figure 1.

$$
\begin{aligned}
&Init(At(C_1, SFO) \land At(C_2, JFK) \land At(P_1, SFO) \land At(P_2, JFK)\\
&\quad \land Cargo(C_1) \land Cargo(C_2) \land Plane(P_1) \land Plane(P_2)\\
&\quad \land Airport(JFK) \land Airport(SFO))\\
&Goal(At(C_1, JFK) \land At(C_2, SFO))\\
&Action(Load(c, p, a),\\
&\quad \text{PRECOND: } At(c, a) \land At(p, a) \land Cargo(c) \land Plane(p) \land Airport(a)\\
&\quad \text{EFFECT: } \neg At(c, a) \land In(c, p))\\
&Action(Unload(c, p, a),\\
&\quad \text{PRECOND: } In(c, p) \land At(p, a) \land Cargo(c) \land Plane(p) \land Airport(a)\\
&\quad \text{EFFECT: } At(c, a) \land \neg In(c, p))\\
&Action(Fly(p, from, to),\\
&\quad \text{PRECOND: } At(p, from) \land Plane(p) \land Airport(from) \land Airport(to)\\
&\quad \text{EFFECT: } \neg At(p, from) \land At(p, to))
\end{aligned}
$$

Figure 1: A STRIPS problem

What are all applicable concrete instances of *Fly(p,from,to)* in the state described by

$$At(P_1, JFK) \land At(P_2, SFO) \land Plane(P_1) \land Plane(P_2) \land Airport(JFK) \land Airport(SFO)\ ?$$

Exercise 2[1] (15 points)

The original STRIPS program was designed to control Shakey the robot. Figure 2 below shows a version of Shakey's world consisting of four rooms lined up along a corridor, where each room has a door and a light switch.

[1] Exercise from Russel/Norvig

The actions in Shakey's world include moving from place to place, pushing movable objects (such as boxes), climbing onto and down from rigid objects (such as boxes), and turning light switches on and off. The robot itself was never dexterous enough to climb on a box or toggle a switch, but the STRIPS planner was capable of finding and printing out plans that were beyond the robot's abilities. Shakey's six actions are the following:

- *Go(x,y)*, which requires that Shakey be at x and that x and y are locations in the same room. By convention a door between two rooms is in both of them.
- Push a box b from location x to location y within the same room: *Push(b,x,y)*. We will need the predicate *Box* and constants for the box.
- Climb onto a box: *ClimbUp(b)*; climb down from a box: *ClimbDown(b)*. We will need the predicate *On* and the constant *Floor*.
- Turn a light switch on: *TurnOn(s)*; turn it off: *TurnOff(s)*. To turn a light on or off, Shakey must be on top of a box at the light switch's location.

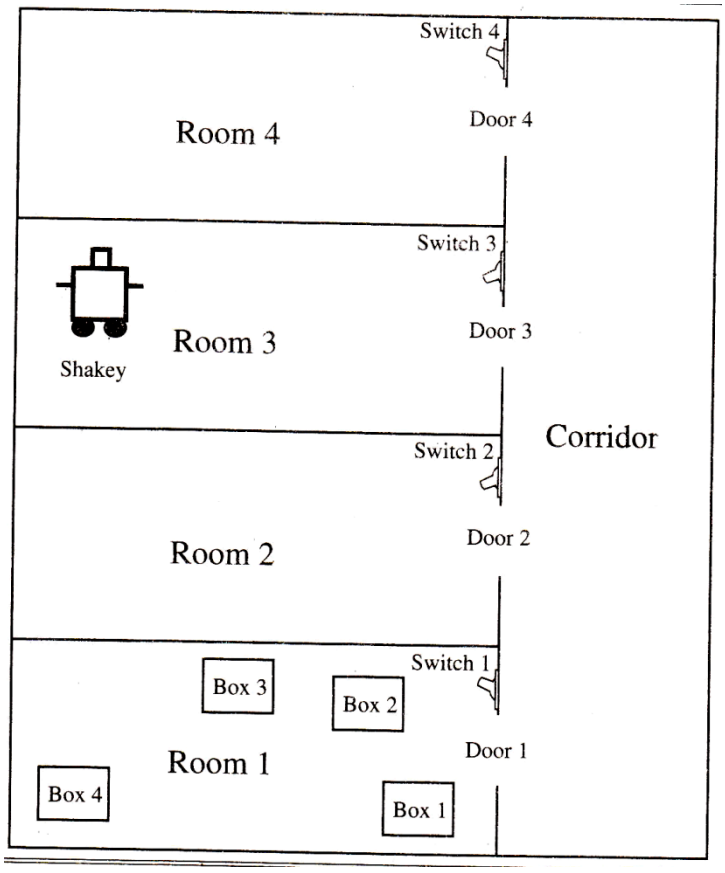

Figure 2: Shakey's world

Describe Shakey's six actions and the initial state from Figure 2 in STRIPS notation. Construct a plan for Shakey to get Box_2 into $Room_2$.