10.3

定义: At(x,y)   x在y处
     H(x,h)   x的高度为h

(CE(x) 表示 x 可被抓   On(x,y) x在y
ME位n(x)表示x可被某动 have(x,y)x有y.

a. 初始状态.

At(猴,A) ∧ At(香蕉,B) ∧ At(箱子,C) ∧ H(猴,LOW) ∧ H(香蕉,High)

∧ H(箱子,LOW) ∧ E美 ME(箱子) ∧ CE(箱子)

b. 动作模式
由于此处针对猴子的动作描述, 暂将猴子表示为M.

~~Action(x,y)~~

1. Action(Go(x,y),
        PRECOND: At(M,x)
        EFFECT: ¬At(M,x) ∧ At(M,y))

2. Action(Push(m,x,y),
        PRECOND: ~~At(M,m) ∧ At(m~~
                 At(M,x) ∧ At(m,x) ∧ ME(m)

        EFFECT: At(M,y) ∧ At(m,y) ∧ ¬At(M,x) ∧ ¬At(m,x))

3. Action(ClimbUp(S),
        PRECOND: At(S,x) ∧ At(M,x) ∧ CE(S) ∧ H(M,LOW)
        EFFECT: At(S,x) ∧ At(M,x) ∧ H(M,High) ∧ On(M,S))
                 ∧ ¬H(M,LOW)

4. Action(ClimbDown(S),
        PRECOND: At(S,x) ∧ At(M,x) ∧ H(M,High) ∧ On(M,S)
        EFFECT: At(S,x) ∧ At(M,x) ∧ H(M,LOW) ∧ ¬On(M,S)
                 ∧ ¬H(M,High))

5. Action(Grasp(S),
        PRECOND: At(S,x) ∧ At(S,M,x) ∧ H(M,y) ∧ H(AS,y)
        EFFECT: have(M,S)

5. Action(Ungrasp(S),
        PRECOND: have(M,S)
        EFFECT: ¬have(M,S)

C. S为目标状态，S₀为初始态）

由题：

have (M, 香蕉 | S) ∧ (∃x At(箱子, x | S₀) ∧ At(箱子, x | S))

d. 由实际上在问题定义中已有 ME (move enable) 来判断物体是否可移动. 无须修改.

作出如上定义为题干所得信息: 将对象推动, 就要考虑对象是否可移动

爬上对象, 就要考虑对象是否可爬 (如刀子山必然不可爬)

10.4   In(x, y) : x在y内部   At(x, y)   x在y处   On(x, y) : x在y上.
~~Open~~ O(S) : S开保持开状态, ~~C(S) : S保持关闭状态~~

PDDL :

1. Action (Go(x, y, r),
    PRECOND : In(x, r) ∧ In(y, r) ∧ At(Shaky, x̶/y̶) At
    EFFECT :   At(Shaky, y) ∧ ¬At(Shaky, x)

2. Action (Push(b, x, y, r),
    PRECOND : In(x, r) ∧ In(y, r) ∧ At(b, x) ∧ At(Shaky, x)
    EFFECT :   At(Shaky, y) ∧ At(b, y) ∧ ¬At(Shaky, x) ∧ ¬At(b, x)

3. Action (P̶u̶s̶h̶ ClimbUp(x, b),
    PRECOND : At(Shaky, x) ∧ At(b, x) ∧ ¬On(Shaky, b)
    EFFECT : On(Shaky, b) ∧ ¬On(shaky, floor)

4. Action (ClimbDown(x, b),
    PRECOND : At(Shaky, x) ∧ At(b, x) ∧ On(Shaky, b)
    EFFECT : ¬On(Shaky, b)

5. Action (TurnOn(s, b),
    PRECOND : At(Shaky, x) ∧ At(b, x) ∧ At(s, x) ∧ On(Shaky, b)
                                                    ∧ ¬O(S)
    EFFECT :   O(S)

6. Action (TurnOff(s, b),
    PRECOND : At(Shaky, x) ∧ At(b, x) ∧ At(s, x) ∧ O(S)
                                                    ∧ On(Shaky, b)
    EFFECT : ¬O(S)

假设 Shaky 能在黑暗情况下感知场景并帮助搬运东西.

初始状态 S_0:

$At(Box1, X1) \land At(Box2, X_2) \land At(Box3, X_3) \land At(Box4, X4) \land$

$In(Box1, Room1) \land In(Box2, Room1) \land In(Box3, Room1) \land In(Box4, Room1) \land$

$In(Door1, Room1) \land In(Door1, Corridor) \land In(Door2, Room2) \land In(Door2, Corridor)$

$\land In(Door3, Room3) \land In(Door3, Corridor) \land In(Door4, Room4) \land In(Door4, Corridor)$

$\land In(Shaky, Room3) \land At(Shaky, X_S)$

$\land Switch \ O(Switch4) \land O(Switch1) \land \neg O(Switch3) \land \neg O(Switch2)$

规划

$Go(X_S, Door3, Room3) \longrightarrow Go(Door3, Door1, Corridor)$

$\longrightarrow Go(Door1, X_2, Room1) \longrightarrow Push(Box2, X_2, Door1, Room1)$

$\longrightarrow Push(Box2, Door1, Door2, Ro\ Corridor)$

通过上述步骤, Box2 带到了 Door2, 由于 $In(Door2, Room2)$, 因此 Box2 被带到了 Room2.

11.10
定义 CleanH 表示当前方块干净
  Clean O 表示其他方块干净.
Suck 动作标述:
  Action (Suck, Precond: , Effect: CleanH).

Left:
  Action (Left, Precond: AtR, Effect:
      AtL $\land$ $\neg$AtR $\land$ when CleanH: CleanO $\land$ when CleanO: CleanH $\land$ when $\neg$CleanO:
  $\neg$CleanH $\land$ when $\neg$CleanH: $\neg$CleanO)

Right:
  Action (Right, Precond: AtL, Effect:
      AtR $\land$ $\neg$AtL $\land$ when CleanH: CleanO $\land$ when CleanO: when CleanH $\land$ when $\neg$CleanO
  $\neg$CleanH) $\land$ when $\neg$CleanH: $\neg$cleanO)