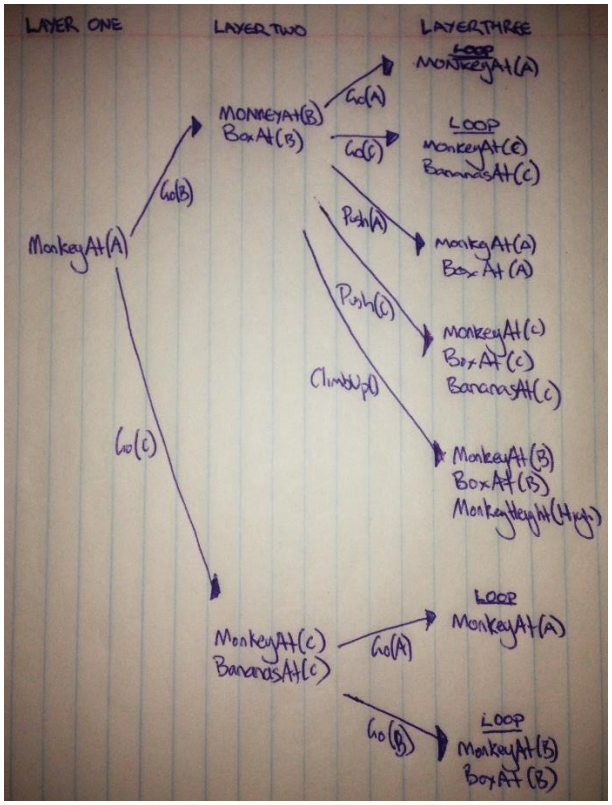
Burrell, David COMP307
300209541 Assignment Four

Part One: Classical Planning – Monkey and Bananas

1. INIT (MonkeyAt(A) ^ MonkeyHeight(Low) ^ MonkeyHold(¬Bananas) ^ BoxAt(B) ^ BoxHeight(Low) ^ BananasAt(C) ^ BananasHeight(High))
   GOAL (MonkeyHold(Banana)

2. ACTION(Go(x),
   PRECOND: MonkeyAt(¬x)
   EFFECT: MonkeyAt(x))
   ACTION(Push(x),
   PRECOND: MonkeyAt(y) ^ BoxAt(y)
   EFFECT: MonkeyAt(x) ^ BoxAt(x))
   ACTION(ClimbUp(),
   PRECOND: MonkeyAt(x) ^ BoxAt(x) ^ MonkeyHeight(Low)
   EFFECT: MonkeyAt(x) ^ BoxAt(x) ^ MonkeyHeight(High))
   ACTION(ClimbDown(),
   PRECOND: MonkeyAt(x) ^ BoxAt(x) ^ MonkeyHeight(High)
   EFFECT: MonkeyAt(x) ^ BoxAt(x) ^ MonkeyHeight(Low))
   ACTION(Grasp(),
   PRECOND: MonkeyAt(x) ^ BoxAt(x) ^ BananasAt(x) ^ MonkeyHeight(High) ^
   BananasHeight(High) ^ MonkeyHold(¬Bananas)
   EFFECT: MonkeyHold(Bananas))
   ACTION(Ungrasp(),
   PRECOND: MonkeyHold(Bananas)
   EFFECT: MonkeyHold(¬Bananas))

3. 

4. Initial State: MonkeyAt(A)
   Action 1: Go(B)
   State 1: MonkeyAt(B) ^ BoxAt(B)
   Action 2: Push(C)
   State 2: MonkeyAt(C) ^ BoxAt(C) ^ BananasAt(C)
   Action 3: ClimbUp()
   State 3: MonkeyAt(C) ^ BoxAt(C) ^ BananasAt(C) ^ MonkeyHeight(High)
   Action 4: Grasp()
   State 4 (Goal): MonkeyAt(C) ^ BoxAt(C) ^ BananasAt(C) ^ MonkeyHeight(High) ^ MonkeyHold(Bananas)

Part Two: Job Shop Scheduling

1. $t_1 = 0$
   $t_2 = 10$
   $t_3 = 50$
   $t_4 = 50$
   $t_5 = 90$
   $t_6 = 90$

2. $J_1 = 65$
   $J_2 = 125$
   $J_3 = 110$
   Makespan = 125

3. Step 0:
   Partial solution: (empty, no action is scheduled)
   earliestIdleTime(M_1) = 0, earliestIdleTime(M_2) = 0
   earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = ∞
   earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = ∞
   earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = ∞

   Step 1:
   Partial solution: 0_{11} at t = 0
   earliestIdleTime(M_1) = 50, earliestIdleTime(M_2) = 0
   earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = 50
   earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = ∞
   earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = ∞

   Step 2:
   Partial solution: O_{11} O_{21} at t = 10
   earliestIdleTime(M_1) = 50, earliestIdleTime(M_2) = 40
   earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = 50
   earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = 40
   earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = ∞

Step 3:
Partial solution: O_{11} O_{21} O_{22} O_{12} at t = 50
earliestIdleTime(M_1) = 85, earliestIdleTime(M_2) = 75
earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = 50
earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = 40
earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = ∞

Step 4:
Partial solution: O_{11} O_{21} O_{22} O_{12} O_{31} at t = 85
earliestIdleTime(M_1) = 125, earliestIdleTime(M_2) = idle
earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = 50
earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = 40
earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = 125

Step 5:
Partial solution: O_{11} O_{21} O_{22} O_{12} O_{31} O_{32} at t = 125
earliestIdleTime(M_1) = idle, earliestIdleTime(M_2) = 145
earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = 50
earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = 40
earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = 125

Step 6:
Final solution: O_{11} O_{21} O_{22} O_{12} O_{31} O_{32} at t = 145
earliestIdleTime(M_1) = idle, earliestIdleTime(M_2) = idle
earliestReadyTime(O_{11}) = 0, earliestReadyTime(O_{12}) = 50
earliestReadyTime(O_{21}) = 10, earliestReadyTime(O_{22}) = 40
earliestReadyTime(O_{31}) = 20, earliestReadyTime(O_{32}) = 125

4. J_1 = 75
   J_2 = 85
   J_3 = 145
   Makespan = 145
   FCFS is better in makespan

5. If one solution is better in one way i.e. makespan, that does not mean the solution rule is better than the rule, as the job completion times on average could be lower in using the other rule.

Part Three: Vehicle Routing

1. R_1 = (1,2,3,5,1)
   R_2 = (1,6,8,4,1)
   R_3 = (1,7,9,10,1)

2. R_1 = (1,2,3,5,1) = 1+1+1+2.24 = 5.24
   R_2 = (1,6,8,4,1) = 1.41 + 1.41 + 1.41 + 3.16 = 7.39
   R_3 = (1,7,9,10,1) = 2.23 + 3.16 + 2 + 5.39 = 12.78
   5.24 + 7.39 + 12.78 = 25.41