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CS 482

Problem Set [2]

1. **Initial State:**

   In(Shakey_start_pos, Room 3) ∧ At(Shakey, Shakey_start_pos) ∧ In(Baby_start_pos, Room 1) ∧ At(Baby, Baby_ start_pos)

   In(Switch 1_pos, Room 1) ∧ At(Switch 1, Switch 1_pos) ∧ In(Switch 2_pos, Room 2) ∧ At(Switch 2, Switch 2_pos) ∧ In(Switch 3_pos, Room 3) ∧ At(Switch 3, Switch 3_pos) ∧ In(Switch 4_pos, Room 4) ∧ At(Switch 4, Switch 4_pos)

   In(Door 1, Room 1) ∧ In(Door 1, Corridor) ∧ In(Door 2, Room 2) ∧ In(Door 2, Corridor) ∧ In(Door 3, Room 3) ∧ In(Door 3, Corridor) ∧ In(Door 4, Room 4) ∧ In(Door 4, Corridor)

   TurnedOn(Switch 1) ∧ TurnedOff(Switch 2) ∧ TurnedOff(Switch 3) ∧ TurnedOn(Switch 4) ∧ TurnedOff(Luring Music) – I assume music is off at the beginning

   a. Action(Go(x, y, r))
      i. Precondition: At(Shakey, x) ∧ In(x, r) ∧ In(y, r)
      ii. Effect: At(Shakey, y)
   b. Action(Lure(b, x, y, r))
      i. Precondition: At(Baby, x) ∧ In(x, b) ∧ At(Shakey, y) ∧ In(y, r) ∧ ¬In(y, corridor)
      ii. Effect: In(Baby, r) ∧ At(Baby, y)
   c. Action(TurnOn(s, b)) – I assume b is the room the switch is in??
      i. Precondition: In(Shakey, b) ∧ ¬In(Baby, b) ∧ At(Shakey, s)
      ii. Effect: turnedOn(s)
   d. Disclaimer: if the baby is in b then the switch will already be off and the directions say the baby can't be in the same room as shakey for the light to be toggled by shakey.
      Action(TurnOff(s, b))
      i. Precondition: In(Shakey, b) ∧ ¬In(Baby, b) ∧ At(Shakey, s)
      ii. Effect: turnedOff(s)

   Plan: Assume we can treat corridor and adjacent room as one room
   Lure(Room 1, Baby_start_pos, Shakey_start_pos, Room 3)
   Go(Shakey_start_pos, Door 3, Corridor)
   Go(Door 3, Door 4, Room 4)
   Go(Door 4, Switch 4, Room 4)
   TurnOff(Switch 4, Room 4)
   Go(Switch 4, Door 4, Corridor)
   Go(Door 4, Door 2, Room 2)
   Go(Door 2, Switch 2, Room 2)
   TurnOn(Switch 2, Room 2)
   Go(Switch 2, Door 2, Corridor)

Go(Door 2, Door 1, Room 1)
Go(Door 1, Switch 1, Room 1)
TurnOff(Switch 1, Room 1)

2. Assumptions: We use STRIPS form.
   a. Definition and solution
      I assume we can use the predicates and actions that are defined in Figure 10.3
      On(x, y): x is on y
      Clear(x): the top of x is clear for stacking
      Move(x, y, z): Move x from on top of y to on top of z
      MoveToTable(x, y): Move x from on top of y to on top of table

      i. Start State according to Figure 10.4
         On(b, Table) ∧ On(a, Table) ∧ On(c, a) ∧ Clear(b) ∧ Clear(c)
      ii. Goal State according to Figure 10.4
         On(c, Table) ∧ On(b, c) ∧ On(a, b) ∧ Clear(a)
      iii. Solution
         MoveToTable(c, a)
         Move(b, Table, c)
         Move(a, Table, b)

   b. A non-interleaved planner cannot solve this problem since subgoals are simply concatenated which means we cannot perform an action that can satisfy subgoal, G_2 on the way to satisfying subgoal, G_1. This can lead to complications as to satisfy subgoal, G_2 we now have to undo the work we did in achieving subgoal, G_1. Consider the following two subgoals of our problem as determined by the goal state: On(a, b) and On(b, c). Given the initial state, if we first follow the second subgoal then we must undo our work to achieve the first subgoal since we can only move a block at a time. The same is true if we were to do the first subgoal first. Since we have to stack the blocks one on another in a specified order we must use interleaving.

3. We will need to make lists to hold the preconditions and effects we discover. We will also need a stack or vector to hold the refinement hierarchy. While the refinement hierarchy stack is not empty we will pop the action from that stack. If the action is primitive then we just add any preconditions not in effect to the preconditions list. Remove any complements from effects and add these to the effects list. If the action is not a primitive then it is a refinement, add preconditions to list and prepend the remaining actions to the hierarchy stack. When the stack is empty we are done.

4.
   a. We can use the combinations formula to arrive at this answer as there are 52 choose 5 ways of being dealt 5 cards:
      $C(52,5) = \frac{52!}{5!(52-5)!} = \frac{52!}{5!47!}$
      Canceling 47! We are left with $\frac{48*49*50*51*52}{5!} = \frac{311875200}{120} = 2598960$

   b. Probably is just 1 over the number we just got so:
      $P(each\ 5\ card\ hand) = \frac{1}{2598960} = 3.85 \times 10^{-7}$ or 0.000000385

c.

i. Royal Flush

There are only 4 possible ways to get a royal flush. The probability of getting a royal flush is the 4 possible ways over all the ways to be dealt 5 cards:

$P(\,royal\ flush\,) = \frac{4}{C(52,5)} = \frac{4}{2598960} = 1.54 \times 10^{-6}$ or 0.00000154

ii. Four of a kind

There are 13 types of cards in a standard deck. If we are dealt four of a kind, that leaves 52 – 4 = 48 possibilities for the fifth card.

$possibilities = 13 * 48 = 624$

To get the probability of this occurring we take the number of possible ways to obtain four of a kind over the total number of ways to be dealt 5 cards:

$P(\,four\ of\ a\ kind\,) = \frac{624}{C(52,5)} = \frac{624}{2598960} = 2.4 \times 10^{-4}$ or 0.00024

5.

a. $P(\,Toothache\,) = 0.108 + 0.012 + 0.016 + 0.064 = 0.2$

b. $P(\,Cavity\,) = 0.108 + 0.012 + 0.072 + 0.008 = 0.2$

c. $P(\,Toothache \mid cavity\,) = \frac{P(\,Toothache\ \wedge cavity\,)}{P(\,cavity\,)} = \frac{0.108+0.012}{0.108+0.012+0.072+0.008} = \frac{0.12}{0.2}$

$= 0.6$

d. $P(\,Cavity \mid toothache\ \vee catch) = \frac{P(\,cavity \wedge(\,toothache \vee catch\,))}{P(\,toothache \vee catch\,)}$

$= \frac{0.108+0.012+0.072}{0.108+0.012+0.072+0.016+0.064+0.144} = \frac{0.192}{0.416} = 0.46$

6.

a. For each wheel there are 4 possibilities so for all wheels there are $4 * 4 * 4 = 64$ possibilities. The probability of each permutation will be $\frac{1}{64}$. Assuming by payback you mean the full winnings and not subtracting the coin played we simply have to multiply this probability by each payout for the first four instances:

$\frac{1}{64} * 20 = 0.3125$

$\frac{1}{64} * 15 = 0.2344$

$\frac{1}{64} * 5 = 0.0781$

$\frac{1}{64} * 3 = 0.0469$

We have to think a little harder about the final two cherry permutations. For “cherry/cherry/?” our probability is $\frac{1}{4} * \frac{1}{4} = \frac{1}{16}$ we have to subtract out the case where ‘?’ is cherry so: $\frac{1}{16} - \frac{1}{64} = \frac{4}{64} - \frac{1}{64} = \frac{3}{64}$

$\frac{3}{64} * 2 = 0.0937$

For “cherry/?/?” we have a base probability of $\frac{1}{4}$ but we need to subtract out the other two cases where cherry is the first symbol which we have accounted for already:

$\frac{1}{4} - \frac{1}{64} - \frac{3}{64} = \frac{16}{64} - \frac{1}{64} - \frac{3}{64} = \frac{12}{64}$

$\frac{12}{64} * 1 = 0.1875$

Now we just add these all up to get the expected payback per coin played:

$0.3125 + 0.2344 + 0.0781 + 0.0469 + 0.0937 + 0.1875 = 0.9531$

b. For the probability that playing the slot machine once will result in a win we just add all the probabilities we just computed:
$\frac{1}{64} + \frac{1}{64} + \frac{1}{64} + \frac{1}{64} + \frac{3}{64} + \frac{12}{64} = \frac{19}{64} = 0.2969$

7. Note: network b can mimic network a
   a. Network c claims this as there is a connection diverging between each pair in G_{father}, G_{mother}, and G_{child}
   b. Networks a and b
   c. Network a best describes the hypothesis, although b can mimic a it allows for handedness to tie directly to those of the parents and not to genes which is a violation of the hypothesis
   d.

G_{father}	G_{mother}	l	r
l	l	1-m	m
l	r	1/2	1/2
r	l	1/2	1/2
r	r	m	1-m

   e. $P(G_{child} = l) = \sum_{G_f, G_m} P(G_c = l \mid G_f, G_m) P(G_f, G_m)$
   = $P(G_{child} = l) = \sum_{G_f, G_m} P(G_c = l \mid G_f, G_m) P(G_f) P(G_m)$
   $= (1-m)q^2 + \frac{1}{2}q(1-q) + \frac{1}{2}(1-q)q + m(1-q)^2$
   $= q^2 - mq^2 + q - q^2 + m - 2mq + mq^2$
   $= q + m - 2mq$

   f. Equilibrium: $P(G_{child} = l) = P(G_{father} = l), P(G_{mother} = l)$
   So: $q + m - 2mq = q \rightarrow m - 2mq = 0 \rightarrow m = 2mq \rightarrow \frac{1}{2} = q$
   It is pretty well known that left-handedness is far less common than right-handedness. According to Wikipedia(not a reliable source but good enough for this) about 10% of the world population is left-handed. The hypothesis stated must be wrong as real world representation for this trait is nowhere near what is represented here. Reasons for this may be that left-handedness may have an element of being a learned trait as well as the gene that may be responsible for the trait being recessive.