This handout includes space for every question that requires a written response. Please feel free to use it to handwrite your solutions (legibly, please). If you choose to typeset your solutions, the `README.md` for this assignment includes instructions to regenerate this handout with your typeset LaTeX solutions.

0.a

1. Variables:

Button Variables: 'B1, B2, ..., Bm', each representing a button. The domain of each button variable is '0, 1', where '0' represents not pressing the button and '1' represents pressing the button. Light Bulb Variables: 'L1, L2, ..., Ln', each representing a light bulb. The domain of each light bulb variable is '0, 1', where '0' means off and '1' means on. Initially, all light bulb variables are set to '0' (off).

2. Constraints:

Each light bulb 'Li' has a constraint that depends on its initial state (which is '0' for all bulbs) and the states of the buttons that control it. If 'Ti' is the subset of buttons controlling light bulb 'i', then the constraint for light bulb 'i' is a function such that 'Li' equals the XOR of its initial state with the states of the buttons in 'Ti'. This can be expressed as $Li = \text{initial\_state\_i} \oplus (\text{Bj1} \oplus \text{Bj2} \oplus \ldots \text{Bjx})$ for all $j1, j2, \ldots, jx$ in Ti.

3. Goal:

The goal of the CSP is to find values for the variables 'B1' to 'Bm' and 'L1' to 'Ln' such that all the constraints are satisfied, which in this case means all 'Ln' variables are set to '1' (all light bulbs are on).

0.b

1 i

To determine the number of consistent assignments for the CSP with three variables X_1, X_2, X_3 and two XOR constraints $t_1(X) = X_1 \oplus X_2$ and $t_2(X) = X_2 \oplus X_3$, we need to check each possible combination of values for X_1, X_2, and X_3 and count those that satisfy both t_1 and t_2.

The XOR operation yields true (or 1) if and only if the inputs are different. So, for each constraint to be satisfied: - $t_1(X) = X_1 \oplus X_2$ should be 1, meaning X_1 and X_2 must be different. - $t_2(X) = X_2 \oplus X_3$ should be 1, meaning X_2 and X_3 must be different.

Now, let's enumerate the possibilities: 1. $X_1 = 0, X_2 = 0, X_3 = 0 \Rightarrow t_1 = 0 \oplus 0 = 0$, $t_2 = 0 \oplus 0 = 0$ (Inconsistent) 2. $X_1 = 0, X_2 = 0, X_3 = 1 \Rightarrow t_1 = 0 \oplus 0 = 0$, $t_2 = 0 \oplus 1 = 1$ (Inconsistent) 3. $X_1 = 0, X_2 = 1, X_3 = 0 \Rightarrow t_1 = 0 \oplus 1 = 1$, $t_2 = 1 \oplus 0 = 1$ (Consistent) 4. $X_1 = 0, X_2 = 1, X_3 = 1 \Rightarrow t_1 = 0 \oplus 1 = 1$, $t_2 = 1 \oplus 1 = 0$ (Inconsistent) 5. $X_1 = 1, X_2 = 0, X_3 = 0 \Rightarrow t_1 = 1 \oplus 0 = 1$, $t_2 = 0 \oplus 0 = 0$ (Inconsistent) 6. $X_1 = 1, X_2 = 0, X_3 = 1 \Rightarrow t_1 = 1 \oplus 0 = 1$, $t_2 = 0 \oplus 1 = 1$ (Consistent) 7. $X_1 = 1, X_2 = 1, X_3 = 0 \Rightarrow t_1 = 1 \oplus 1 = 0$, $t_2 = 1 \oplus 0 = 1$ (Inconsistent) 8. $X_1 = 1, X_2 = 1, X_3 = 1 \Rightarrow t_1 = 1 \oplus 1 = 0$, $t_2 = 1 \oplus 1 = 0$ (Inconsistent)

Among these 8 possible assignments, only 2 are consistent (satisfying both constraints). Therefore, there are 2 consistent assignments for this CSP.

2 ii

1 initial call

2 calls to assign X_1

4 calls to assign X_3 (2 for each value of X_1)

8 calls to assign X_2 (2 for each combination of X_1 and X_3)

This totals to 15 calls to 'backtrack'.

3 iii

1 initial call

2 calls to assign X_1

2 calls to assign X_3 (1 for each value of X_1)

2 calls to assign X_2 (1 for each combination of X_1 and X_3)

This totals to 7 calls to 'backtrack'.

2.d

```
# Unit limit per quarter.
minUnits 4
maxUnits 6
# These are the quarters that I need to fill. It is assumed that
# the quarters are sorted in chronological order.
register Win2017
register Spr2018
# Courses I've already taken
taken CS103
taken CS106B
taken CS107
taken CS109
taken CS140
taken CS161
taken CS221
taken MATH51
taken CS145
taken CS124
# Courses that I'm requesting
request CS224M
request CS224S
request CS227B
request CS229A
request CS232
request CS244E
Best schedule
Here's the best schedule:
Quarter Units Course
Win2017 4 CS229A
Spr2018 3 CS227B
Spr2018 3 CS232
```

3.a

In addressing the unsatisfiable constraints in the hospital's residency scheduling, I would advocate for changing factor B, the work to be performed by residents as opposed to other staff. By redistributing some responsibilities to other staff members, the hospital can alleviate the workload on residents, making it more feasible to meet the constraints for rest and working hours. This approach prioritizes the well-being of residents, which is crucial for both their health and the quality of care they provide to patients. It also addresses the root cause of the problem - an excessive workload - rather than merely adjusting the constraints around an unsustainable work schedule.