0.a

Variables:

Define X_i to be one of m switches.

X_j $(j = 1, \ldots, m)$ are a tuple of size n where each column is a 1 if the switches toggles the bulb and 0 otherwise.

$X_j = (x_1, x_2, \ldots, x_n)$ where $x_i = \begin{cases} 1 & \text{if } x_i \subseteq T_j \\ 0 & \text{otherwise} \end{cases}$

Constraints:

The sum of column i for all X_j should be odd.

So there will be n constraints in total.

0.b

i There are 2 consistent assignments for the CSP.

ii backtrack() will be called 9 times.

Backtrack($\{\phi\}$, 1, $\{0,1\}$)

$X_1 = 0$, $\delta = 1$

Backtrack($\{X_1=0\}$, 1, $\{0,1\}$)

$X_3 = 0$, $\delta = 1$

Backtrack($\{X_1=0, X_3=0\}$, 1, $\{0,1\}$)

$X_2 = 0$, $\delta = 0$

continue

$X_2 = 1$, $\delta = 1$

Backtrack($\{X_1=0, X_3=0, X_2=1\}$, 1, $\{0,1\}$)

complete assignment. update best and return

$X_3 = 1$, $\delta = 1$

Backtrack($\{X_1=0, X_3=1\}$, 1, $\{0,1\}$)

$X_2 = 0$, $\delta = 0$

continue.

$X_2 = 1$, $\delta = 0$

continue

$X_1 = 1$, $\delta = 1$

Backtrack($\{X_1=1\}$, 1, $\{0,1\}$)

$X_3 = 0$, $\delta = 1$

Backtrack($\{X_1=1, X_3=0\}$, 1, $\{0,1\}$)

$X_2 = 0$, $\delta = 0$

continue

$X_2 = 1$, $\delta = 1$

continue

$X_3 = 1$, $\delta = 1$

Backtrack($\{X_1=1, X_3=1\}$, 1, $\{0,1\}$)

$X_2 = 0$, $\delta = 0$

~~Backtrack($\{X_1=1, X_3=1\}$, 1, $\{0,1\}$)~~

~~$X_2 = 0$, $\delta = 0$~~

Backtrack($\{X_1=1, X_3=1, X_2=0\}$, 1, $\{0,1\}$)

complete assignment. update best and return

$X_2 = 1$, $\delta = 0$

continue

0.b

iii) backtrack() will be called 7 times.

Backtrack ({ϕ}, 1, {0,1})

$X_1 = 0$, $\delta = 1$

Backtrack ({$X_1 = 0$}, 1, {0,1})

Enforce arc consistency on neighbors

Add $X_1 = 0$ to set

while set is nonempty

Remove $X_1 = 0$ from set

Enforce arc consistency on X_2. Domain of $X_2 = \{1\}$

Add $X_2 = 1$ to set

Remove $X_2 = 1$ from set

Enforce arc consistency on X_3. Domain of $X_3 = \{0\}$

Add $X_3 = 0$ to set

Remove $X_3 = 0$ from set

set is empty so return

$X_3 = 0$, $\delta = 1$

Backtrack ({$X_1 = 0$, $X_3 = 0$}, 1, {0,1})

$X_2 = 1$, $\delta = 1$

Backtrack ({$X_1 = 0$, $X_3 = 0$, $X_2 = 1$}, 1, {0,1})

complete assignment. update best and return.

$X_1 = 1$, $\delta = 1$

Backtrack ({$X_1 = 1$}, 1, {0,1})

Enforce arc consistency on neighbors

Add $X_1 = 1$ to set

while Set is nonempty

Remove $X_1 = 1$, Domain of $X_2 = \{0\}$, add $X_2 = 0$ to set

remove $X_2 = 0$, Domain of $X_3 = \{1\}$, add $X_3 = 1$ to set

Remove $X_3 = 1$, set is empty

$X_3 = 1$, $\delta = 1$

Backtrack ({$X_1 = 1$, $X_3 = 1$}, 1, {0,1})

$X_2 = 0$, $\delta = 0$

Backtrack ({$X_1 = 1$, $X_3 = 1$, $X_2 = 0$}, 1, {0,1})

complete assignment. update best and return.

2.a

Since X_i has domain $\{0, 1, 2\}$, let's define A_i as follows

Factors

Initialization : $A_0 = 0$

Processing : $A_i = A_{i-1} + X_i$

Final output : $A_4 \leq K$

we now need to pack A_{i-1} and A_i into one variable B_i where B_i is (A_{i-1}, A_i)

Factors

Initialization : $B_i[1] = 0$

Processing : $B_i[2] = B_i[1] + X_i$

Final output : $B_4[2] \leq K$

Consistency : $B_{i-1}[2] = B_i[1]$

3.c

Units: 0-3

Quarter: ['spring 2021', 'Aut 2021', 'Spr 2022']

Taken: {'CS103'}

Requests: request {['CS229', 'CS221']

Here's the best schedule:

Aut 2021 3 units CS 221