Discrete Mathematics
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HW 1 Number Cross

1. Description

a. All Constraints of Solution

i. The number of a square label is greater than or equal to 1, and not greater than 9
ii. The color of a square label is black or white
iii. The label (number) of each column is the same as the sum of the numbers in the Black squares of the column.
iv. The label (number) of each row is the same as the sum of the numbers in the White squares of the column

b. Logical Formulas

There are formulas in order to create the constraints of the Number Cross.
The variable number(i,j) = n and color(i,j) = n was selected for this purpose.

number(i,j) → $0 \le i \le M$, $0 \le j \le N$, number(0,N) doesn't exist.
number value of label in i-th row, j-th column

color(i,j) → $1 \le i \le M$, $0 \le j \le N-1$,
color value of label in i th row, j th column
(Black : 1
white : 0

The constraints that were required to be created by the formulae were identified as the range constraint, black constraint, white constraint.

$$Q_{Range} = \left(\bigwedge_{i=1}^{M} \bigwedge_{j=0}^{N-1} 1 <= number(i,j) <= 9 \right) \wedge \left(\bigwedge_{i=1}^{M} \bigwedge_{j=0}^{N-1} (color(i,j) = 0) \vee (color(i,j) = 1) \right)$$

$$Q_{Black} = \bigwedge_{j=0}^{N-1} \left(\left(\sum_{i=1}^{M} (number(i,j) \times color(i,j)) \right) = number(0,j) \right)$$

$$Q_{White} = \bigwedge_{i=1}^{M} \left(\left(\sum_{j=0}^{N-1} (number(i,j) \times (1 - color(i,j))) \right) = number(i,N) \right)$$

c. Correctness

To check the correctness of our program, we ran some input file that has M x N grid and result was glittering. Besides, when I change the number in the grid cells and the size of the grid (M x N), the output resulted without errors. After modifying one of the given values as previous value + 1, the output resulted in no solution.

2. Discussion

After I thought all the logic and implemented the puzzle, I felt that logic was a useful tool to think about computing thinking and to verify. I thought that the reason for learning logic in discrete mathematics was to abstract the complex problems, to judge them logically and to model them in accurate way.

And when I think about connecting logic to computer science, I think it's easy to model it through logic when we're developing artificial intelligence. And I thought I could communicate with artificial intelligence using logic. I felt that logic has its own terms and notations for effective communication in many fields of mathematics, puzzle and real life.