Solve Puzzle with SMT Solver

Discrete Mathematics | Shin Hong | 21800412 Shin heeju

Puzzle. Numbrix

**1. Constraints of a solution**

(1) the label of each column is the same as the sum of the Black squares of the column.

(2) the label of each row is the same as the sum of numbers in White squares of the row.

(3) 1<= the number in a square<=9

(4) Initially, no information on color is given.

**2. Represent constraints as Logic formula**

* To distinguish between black and white squares, I multiplied the number of black squares by 100. Because third condition says the number in label doesn’t not exceed 9, multiplying by 100 does not cause problems.

The numbers in squares are either black or white, so if the number of input is n, it would be n or 100\*n. Apply condition1 to all numbers in the squares.

[condition 1] (assert (or (= py\_x n) (= py\_x 100\*n)

* The sum of each column can be expressed as (SOB in each column) \* 100 + (SOW in each column)

[condition 2] (assert (= (+ p1\_1 p2\_1 …. PM\_1 ) (SOB in each column) \*100 + (SOW in each column)))

* The sum of each row can be expressed as (SOB in each row) \* 100 + (SOW in each row)

[condition3] (assert (= (+ p1\_1 p1\_2 …. P1\_N ) (SOB in each row)\*100 + (SOB in each row))).

\*SOB (sum of numbers in black squares), SOW(sum of numbers in white squares)

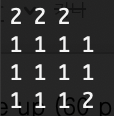
1. How to get the sum of black and white numbers?

* Reading input, obtain the sum of numbers in each row and each column, regardless of color -> define as ‘sum’
* sum of numbers of white squares in each column = sum – sum of black squares in each column
* sum of numbers of black squares in each row = sum – sum of white squares in each row

**3. Demonstrate the correctness of program**

전자기기, 키보드이(가) 표시된 사진

자동 생성된 설명 전자기기, 키보드이(가) 표시된 사진

자동 생성된 설명  표지판이(가) 표시된 사진

자동 생성된 설명 (input – output)

**4. Discussion**

1) At first, I thought that single P should have both Int-type and Bool type, because the specified number should be represented by zero or 1. However, with the 3rd contidion, I noticed that I can solve the problem by giving different weighting to numbers in black and white squares.

2) In the process of checking that logic works well in large scale of inputs, I found that multiple solutions could occur in NumberCross too. It usually occurs when the same numbers is used a lot.

3) What other logic can use to solve this puzzle? I’ll discuss it with my friends after HW submission date.