Discrete Mathematics

Homework I One More Puzzle with SMT Solver

but not with your team members this time

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Assignment Overview

- Write a C program that finds a solution of a given game of the Number Cross puzzle using the Z3 SMT solver
- Submission
 - deadline: 9 Oct (Wed), 11:59 PM
 - deliverables
 - program (C source code files, build script, README)
 - write up (I page)
- You are not allowed to collaborate with any one in or out of the class in doing this homework
 - it is allowed to reuse the PA I results of your team

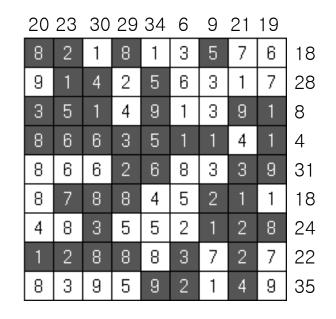
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Number Cross

- Number Cross consists of a $M \times N$ grid where every square, every row, and every column and is labeled with a positive integer
- The goal of the game is to determine the color of each square as either Black or White, such that
 - the label (number) of each column is the same as the sum of the numbers in the Black squares of the column
 - the label of each row is the same as the sum of the numbers in the White squares of the column
 - the number of a square label is greater than or equal to 1, and not greater than 9
 - initially, no information on the coloring is given

20	23	30	29	34	6	9	21	19	
8	2	1	8	1	က	5	7	6	18
9	1	4	2	5	6	3	1	7	28
3	5	1	4	9	1	3	9	1	8
8	6	6	3	5	1	1	4	1	4
8	6	6	2	6	8	3	3	9	31
8	7	8	8	4	5	2	1	1	18
4	8	3	5	5	2	1	2	8	24
1	2	8	8	8	3	7	2	7	22
8	3	9	5	9	2	1	4	9	35



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Requirements

- Your program must use the Quantifier-free LIA logic to model this game (not propositional logic)
- Input
 - input is given via the standard input
 - the first line consists of N tokens which are a sequence of the column labels
 - each of the following M lines has N+1 tokens; first N tokens are a sequence of the square labels in the row, and the last label for the row label
 - M is not greater than 50, and so is N.
- Output
 - print the coloring of the grid to the standard output
 - I : Black
 - 0 : White
 - print "No solution" if there's no solution

```
20
23
30
29
34
6
9
21
19

8
2
1
8
1
3
5
7
6
18

9
1
4
2
5
6
3
1
7
28

3
5
1
4
9
1
3
9
1
8

8
6
6
3
5
1
1
4
1
4

8
6
6
2
6
8
3
3
9
31

8
7
8
8
4
5
2
1
1
18

4
8
3
5
5
2
1
2
8
24

1
2
8
8
8
3
7
2
7
22

8
3
9
5
9
2
1
4
9
35
```

<Input example>

<Output example>

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Program Structure

- Write a C program running on UNIX/LINUX
 - Each program receives input from the standard input and produces the ouput to the standard output
 - Tests will be conducted on Peace
- The program must be built as a single executable
 - Programs can execute Z3 in a middle of execution through popen (see an example of nqueen-LIA.c)
- You must submit a build script and README together with source code files
 - buid script: Bash script, Makefile, Ant, Maven, etc.
 - REAME: instruction/manual on how to build and run your program

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Submission

- Deadline: 9 Oct (Wed), I 1:59 PM
 - no late submission will be accepted

- Submit the program and one write-up (report)
 - Program: source code files, build script and README
 - Write up: must not exceed I page (in A4; either in single or double column)
- Submit all deliverables via Hisnet homework submission repository

• Your submissions may be open to the class and public

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Evalution Criteria

- Write up (60 points)
 - Description (50 points)
 - check whether you found all constraints of a solution
 - check whether each constraint is correctly represented as a logic formula
 - check whether you demonstrate the correctness of your programs in a convincing way (e.g., by tests)
 - check whether all descriptions are clear and consistent
 - Discussion (10 points)
 - detailed analysis of results, interesting observations, lessons learned, suggestions, new ideas, etc.
- Tests (40 points)
 - Run each program with several inputs to see whether the results are correct
 - Note that tests will be conducted on the Peace server

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