Lab 2

Working with solvers is like magic.

November 5, 2019

Deadline

Due: December 3, 2019, 23:59. Good luck!

Prerequisite

Pink words below are hyperlinks. You can click on them to open websites.

1. This lab should be implemented in Linux environment, such as debian and ubuntu. Virtual machine provided by ICS TA is OK.
2. Read 1.2 of notes on z3 c++ bindings to install Z3. Z3 is a powerful SMT solver developed by Microsoft.
3. After installing Z3, you can read notes on z3 c++ bindings to learn how to invoke Z3 API in C++. To implement the lab, you just need to understand 2.1, 2.2, 2.10.
4. Source codes are under code directory. You can only write codes in lab2.cpp. After writing the codes, you can open a terminal in the directory and input "make run", then the files will be compiled and executed.

1 Problem

This lab composed of three small parts is intended to help you learn how to use Z3 to solve actual problems.

1.1 Func1

The func1 in lab2.cpp is to solve a linear system of equation. There are four variables. For example,

$$\begin{cases} a & = 3 \\ b & = -1 \\ c+d & = 2 \\ c+3d & = 4 \end{cases}$$

It's a linear system of equation. The answer is a=3, b=-1, c=1, d=1. In lab2.cpp, the argument "data" of func1 stores the linear system of equation. It has 4 rows and 5 columns. In this case, data =
1 0 0 0 3
0 1 0 0 -1
0 0 1 1 2
0 0 1 3 4. Because the linear system of equation has answer, func1 will return true and store the answers in the buffer "answer". The contents of "answer" are { 3, -1, 1, 1 }. Otherwise, func1 will return false.

We only consider integers.

1.2 Func2

The func2 in lab2.cpp is to find a positive integer which is not 1 under some constraints. For example, the test case in test.txt is
2
3 1
5 1. The first line means there are 2 constraints. The argument "n" of func2 is set to 2. The argument "data" is
3 1
5 1. Then func2 will find the minimum positive integer i such that i%3=1, i%5=1. And the integer must not be 1 and must be less than 1000000. If there exists such an integer, func2 will return it. Otherwise, func2 should return -1. Here, func2 will return 16.

You need to give the minimum positive integer.

1.3 Func3

Given an undirected complete graph（无向的完全图）, we want to color every edge of the graph with some different kinds of colors. And there should not be a triangle whose

three edges have the same color. The argument "node_num" of func3 is the number of nodes in the complete graph. The argument "color" of func3 is the number of different kinds of colors. If we can use these colors to color edges in the graph such that there isn't a triangle whose three edges have the same color, func3 will store the color of every edge in the argument "graph" and return true. Otherwise, func3 will return false. For example, in test.txt, the input data is 3 2. It means func3 should judge if we can use 2 kinds of colors to color an undirected complete graph with 3 nodes and there isn't a triangle whose three edges have the same color. In this case, it;s feasible to color the graph with 2 colors. So func3 will return true and store colors of edges in the argument "graph". A feasible answer is
0 1 1
0 0 2
0 0 0. Because it's an undirected graph, we just need to use half of the space of "graph". The colors are denoted by positive integers 1, 2, 3, ... If you can use m colors, the colors should be encoded into 1,2, ..., m.

The number of nodes and colors are all positive integers. Number of nodes is not 1.

2 Input

Test cases are in test.txt.

3 Output

Answers will be written into answer.txt.

4 Framework

The main function is in main.cpp. You can only change lab2.cpp. You need to implement func1, func2 and func3. Makefile is used to compile and run the program.