

CMPT 477 Program Assignment 1 description

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This graph coloring program uses the Z3 solver to solve the graph coloring problem. Below is a brief explanation of the program's code.

1. Input reading
 - a) The program reads the number of vertices and colors from the input file (.txt format) and parses each edge. Then program create a array list to store each edge, where each edge is represented by two integers corresponding to the two connected vertices (indexing starting from 0).
2. Z3 Context and Boolean Variables:
 - a) Then program create a Z3 context (ctx) and a two-dimensional boolean array colorVars is defined to represent whether each vertex is colored. colorVars[v][c] indicates whether vertex v is assigned color c.
3. Adding Constraints:
 - a) **At Least One Color for Each Vertex:** For each vertex, a logical expression using mkOr ensures that at least one color is assigned to it.
 - b) **At Most One Color for Each Vertex:** For each pair of colors for a vertex, mkNot and mkAnd are used to ensure that the same vertex cannot be assigned two colors.
 - c) **Adjacent Vertices Cannot Have the Same Color:** For each edge, it ensures that the two connected vertices cannot be assigned the same color using mkNot and mkAnd.
4. Solving the Problem:
 - a) The program calls solver.check() to check if the constraints are

satisfiable. If satisfiable, it retrieves a model (assignment); otherwise, it outputs "No Solution."

5. Outputting Results:

- a) If a solution exists, it calls writeSolution to write the colors of each vertex to the output file. This method evaluates each vertex's color using the model.
- b) If there is no solution, it calls writeNoSolution to write "No Solution" in the output file.

Encoding description:

The program reads from an input file that specifies the number of vertices, the number of colors, and the edges connecting the vertices. The input format is as follows:

- The first line contains two integers: the number of vertices and the number of colors.
- Subsequent lines each contain a pair of integers representing an edge between two vertices there is a space between them.

Design choices:

Base on its ability to handle complex logical constraints, this program use Z3 to solve the coloring question. The problem is encoded using Boolean variables, where each variable $P_{V,c}$ indicates whether vertex V is assigned color C . The program implements the following constraints:

At least one color per vertex: Ensures each vertex is assigned at least one color.

At most one color per vertex: Prevents any vertex from being assigned multiple colors.

Adjacent vertices cannot share the same color: Ensures that connected vertices do not have the same color, which is the core requirement

of the graph coloring problem.