Hierarchical analysis of loops with relaxed abstract transformers

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Circulation is an indispensable component of the program's completion of complex functions. Circulation analysis is a difficult problem in the field of program analysis. The main reason is that it is difficult to find a sufficiently accurate loop invariant to describe the behavior of the loop, especially when the loop exists. The situation becomes more complicated when linear invariants are used.

***Index Terms*—Loop analysis, Abstract Interpretation, Non-linear invariant, Hierarchical analysis, Relax transformer, Formal Method**

I. Introduction

THE static analysis technique based on Abstract Interpretation [1] does not run the program, but analyzes the source code of the program to automatically obtain the semantics of the program, thereby verifying the correctness of the program or detecting possible program errors. The abstract interpretation uses the abstract semantics to approximate the specific semantics of the program, so that within a limited time and space, an approximation of the set of program reachable states at any program point is obtained. This approximation contains behavior that does not exist in the program, so it may generate false positives. Improving the accuracy of analysis and reducing the false alarm rate is one of the major challenges faced by static analysis techniques based on abstract interpretation in practical applications. x=2n;y= [2n-1,3n-1]

$$lfp\ F \ = \ \tau^* \ (\mathrm{X}_0) = \bigcup_{n \geq 0} \tau^n \ (\mathrm{X}_0)$$

II. Overview

In the actual program, we can easily find that there is a hierarchical dependency between the variables in the loop. For example, loop control variables (such as loop counter) often do not depend on other variables in the loop, besides relying on themselves or some input; many variables depend on loop control variables in one direction. If you use the abstract domain to analyze all the variables in the loop at the same time, it is very likely that there are too many unstable factors in the two iterations (for example, many variable values are changing). After widening, the precision loss is very large. Especially for programs such as Motivating example with non-linear behavior, if the linear abstraction domain is used to analyze all the variables at the same time, it is easy to make the analysis inaccurate due to widening.

III. Variable Layering and Cyclic Slicing Based on Variable Dependent Layered Graphs

Hierarchal Variable Dependency GraphHVDG

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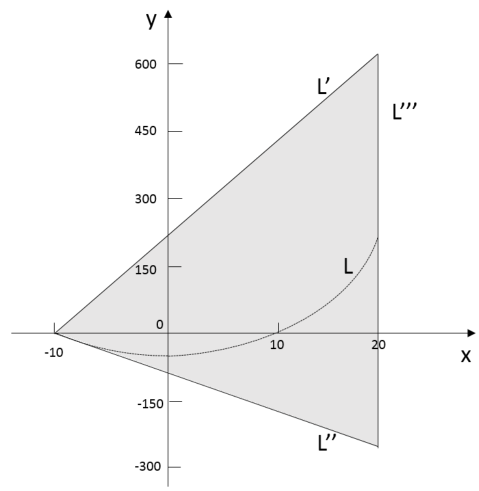

Fig. 1. Motivation Example

A. Variable Dependency

Definition of VD

B. Variable Dependency Graph

1) Some Definitions

Hasse Diagram

2) Construct VDG

We will introduce how to construct the VDG.

C. Variable layering

How to layer variables based on Hasse Diagram.

D. Slicing based on variable Hierarchy

How to slice the loop by vh.

IV. Relaxing transformers based on partial loop invariant

A. Definition of Relax and its soundness

Definition of Relax Soundness of Relax

B. Relaxing Strategy

1) All variables relaxing strategy

2) Templated relaxing strategy

(1)Linearization Relaxing of single assignments
(2)Relational Relaxing of multiple assignments
(3)Relaxing of single variable assignments

V. COMPUTING FIX-POINT BY FORMULA METHOD

A. Formula Method of single variable assignments

B. Loop counter calculation by Formula Method

C. Fix-point solver combining Kleene iteration and Formula Method

VI. DISCUSSION

Talk about the soundness and precision of our method.

VII. EXPERIMENT AND EVALUATION

VIII. CONCLUSION

The conclusion goes here.

APPENDIX A
PROOF OF THE FIRST ZONKLAR EQUATION

Appendix one text goes here.

APPENDIX B

Appendix two text goes here.

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The authors would like to thank...

REFERENCES

[1] H. Kopka and P. W. Daly, *A Guide to LATEX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.

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Michael Shell Biography text here.

John Doe Biography text here.

Jane Doe Biography text here.