Advanced Compiler Techniques

Homework #2 Solutions

9.2.4 Meet operators

a) & b) : NO
c) & d) : YES

S1. DFA on Value Range

In many cases knowing the range of variables is beneficial. For instance, knowing that variables *a* and *b* are between 0 and 127 may allow us to represent both variables within one byte instead of two words, thereby providing a more compact representation for certain data structures.

Suppose you are analyzing a program consisting of the following types of statements:

- `a = <const>`
- `a = b`
- `a = b + <const>`
- `a = b + c`

where all variables and constants are integers.

Your task is to formulate a dataflow problem called **VarRange** that would allow one to approximate the range of any given variable at any point in the program.

The range is to be represented by an interval **[*x*, *y*]** where both *x* and *y* are constants. Assume that **MAX** is the biggest representable integer and we are dealing with **positive** numbers (including zero) only.

a) (4 pt) What are the top and bottom elements of the lattice for the dataflow framework formulation of VarRange?

TOP: [0, MAX]
BOT: UNDEF

b) (3 pt) What is the JOIN ($\vee$) operator for VarRange?

[low1, high1] $\vee$ [low2, high2] = [Min(low1,low2), Max(high1, high2)]

c) (3 pt) What is the partial order (≤) □relation induced by the ∨ □operator?

[low1, high1] ≤ [low2, high2] if and only if low2≤low1 and high1≤high2.

d) (8 pt) Assume for simplicity that each basic block consists of at most one statement. Define the transfer function for VarRange.

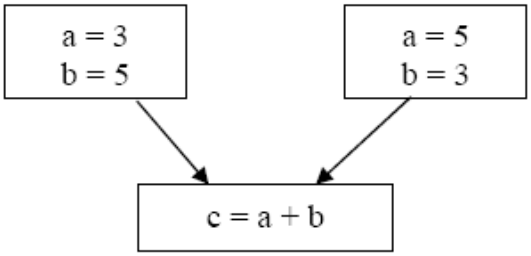
- a = <const> $tf(B)_a$ = [const, const]
- a = b $tf(B)_a = [low_b, high_b]$
- a = b + <const> $tf(B)_a = [low_b+<const>, high_b+<const>]$
- a = b + c $tf(B)_a = [low_b+low_c, high_b+high_c]$

e) (3 pt) Is the transfer function you defined above monotonic?

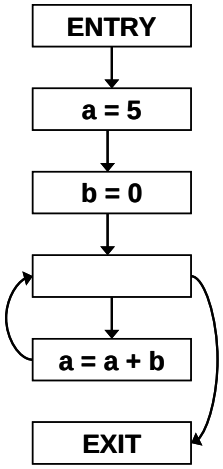
Yes.

f) (3 pt) Is the transfer function you defined above distributive?

No.



g) (6 pt) What is the range for variable a [on EXIT] as computed by your algorithm for the CFG below?



Variable a belongs to range **[5,5]**