Exam in Optimizing Compilers EDA230

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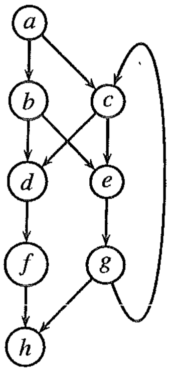

Figure 1: Control flow graph.

1. (10p) Explain how the Lengauer-Tarjan algorithm (the $O(N^2)$-version) finds the dominator tree in the control flow graph in Figure 1. For each vertex, your solution should explain:
    - when is the vertex put in a bucket?
    - in which bucket?
    - when is it deleted from the bucket?
    - when does the algorithm find the immediate dominator for the vertex?

2. (10p) Consider again the control flow graph in Figure 1. Suppose there is a use of variable x in each vertex and an assignment to x in vertices a and c. When there is both a definition and a use in a vertex, the definition is before the use.

    Translate the program to SSA form. Show the contents of the rename stack and when the stack is pushed and popped. *You do not have to show how you compute the dominance frontiers.*

3. (5p) Show an algorithm in pseudo code for detecting which vertices can not be reached from the start vertex.

4. (5p) Give the definition of dominance frontiers of a control flow graph.

```
void f(int a)
{
        int     b, c;

        c = 9;

        if (a != 3) {
                if (c > 2)
                        a = 4;
                else
                        a = 5;
                b = a * 2;
                put(b);
        } else {
                b = a * 3 * c;  // not improved by the standard algorithm.
                put(b);
        }
}
```

Figure 2: C function for question on constant propagation.

5. (10p) How does constant propagation with conditional branches on SSA form optimize the program in Figure 2? Explain how the algorithm proceeds. You will notice that the code in the second else-clause (see comment) will not be improved.

   How can you improve the algorititthm so that the else-clause also can be optimized?

6. (10p) What is partial redundancy elimination (PRE)? Explain briefly an algorithm for doing PRE. Show an example code which PRE can optimise which partion-based value numbering cannot.

7. (10p) Chaitin-style graph coloring consists of the steps *Build, Coalesce, Simplify, Spill,* and *Select.* Describe each and explain its purpose.

   What does optimistic colouring mean?