Homework 5

CS 540
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Craig A. Rich

1 Consider the following fragment of a Pascal program:

```
i := 1;
repeat
   x := a[i];
   y := a[i + 1];
   i := i + 1
until x < y or i > 100
```

a) Translate the fragment into a three-address program and construct the flow graph which corresponds to it. Assume the array a contains 4-byte elements starting at offset 0, i does not occur elsewhere, and short-circuit boolean evaluation is not used. Every statement except the first should contain one arithmetic, boolean, relational, or indexing operation; therefore, 5 temporary variables should be introduced.

b) Apply strength reduction to the flow graph loop in a). Show all induction variables and the resulting flow graph.

c) Apply induction variable elimination to the flow graph loop in b). Show the resulting flow graph.

d) Apply the DAG basic block optimization to each block of the flow graph in c). You need not show the DAG's constructed, but show the resulting flow graph.

2 Consider the flow graph constructed in Homework 1, problem 2a).

a) Apply algorithmic reaching definition analysis to the flow graph, showing the values of IN[B] and OUT[B] after each while-loop iteration. Process blocks in their physical order (which is a depth-first order).

b) Apply algorithmic live variable analysis to the flow graph, showing the values of OUT[B] and IN[B] after each while-loop iteration. Process blocks in reverse physical order.

3 Let $(D, \leq)$ be a lattice, $x, y, z \in D$. Prove the following lemmas:

a) **Lemma**. $x \wedge y \leq x$ and $x \wedge y \leq y$.

b) **Lemma**. $x \leq y$ and $x \leq z \iff x \leq y \wedge z$.

c) **Lemma**. $x \leq y \iff x = x \wedge y$.

d) **Lemma**. $x \leq y \wedge z \implies x \leq z$.

e) **Lemma**. $x \leq y \implies x \wedge z \leq y \wedge z$.