

2005 Paper 8 Question 7

Optimising Compilers

- (a) A dataflow analyser is required which can report on local variables having *write-write dataflow anomalies*. A write-write anomaly is present in a program if there is a path in the flowgraph containing two writes to a given variable and with no intervening read to that variable. For example

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y=a; if (p) x=1; if (q) x=2; if (y==b) y=1; else y=2;
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has an anomaly for x but not for y .

Given node n in the flowgraph, let $R(n)$ be the set of variables v for which a node n' exists with n' writing to v and having a path from n' to n which does not contain a read from v .

- (i) Give dataflow equations for $R(n)$ and thence construct an algorithm which reports variables having such anomalies. Pay attention to the initialisation of any iteration which you employ. [8 marks]
- (ii) Discuss briefly to what extent your algorithm could be extended to deal with global variables or with address-taken local variables. [4 marks]
- (b) Let us say that an undirected graph (N, E) is k -cyclic if $N = \{n_1, \dots, n_k\}$ and $E = \{(n_1, n_2), (n_2, n_3), \dots, (n_{k-1}, n_k), (n_k, n_1)\}$.
- (i) Give a function body, or flowgraph, for which the register inference graph for its local variables forms a 4-cyclic graph. [4 marks]
- (ii) Give a formula $c(k)$ which gives the number of colours (or registers) needed for a minimal colouring of a k -cyclic graph. [4 marks]