**Lecture: Program analysis**
**Exercise 4**
http://proglang.informatik.uni-freiburg.de/teaching/programanalysis/2010ss/

## Exercise 1

Consider the following program:

Input: $z, n$. Output: $(z+1) * n$.

$[result := 0]^1$;
`while` $[n > 0]^2$ `do`
    `if` $[n > 1]^3$ `then`
        $[x := z + 1]^4$;
        $[result := result + x]^5$;
        $[n := n - 1]$;
    `else`
        $[x := z + 1]^6$;
        $[result := result + (x \ll 1)]^7$;
        $[n := n - 2]^8$;
    `fi`;
`od`;

1. Perform an *Available Expressions* analysis for this program (cf. Nielson&Nielson, chap. 2.1.1.), i.e. define the *gen* and *kill* sets and the data flow equations, and find a least solution.
2. In a similar way, perform a *Very Busy Expression* analysis (cf. Nielson&Nielson, chap. 2.1.3.).
3. Transform the program such that it avoids unnecessary re-calculations of expressions.

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**Submission**

- Deadline: 01.06.2010, 11:00, per mail to `bieniusa@informatik.uni-freiburg.de`, or on paper to Annette Bieniusa, Geb. 079, Room 000-14.
- Late submissions will not be marked.
- Do not forget to put your name on the exercise sheet.
- You might want to read up in Chapter 2.1 of *Principles of Program Analysis*.