CS411 Homework 4
Program Analysis *Due: 9 March 2007*

Hand in your assignment next Friday in class and turn in the programming part using CMS Friday evening. Write your solution clearly.

1. Write an analysis for do-while loops.

2. This problem asks you to design an analysis that computes relations of the form $x = y$, $x < y$ and $x \leq y$, where x and y are program variables.

   (a) Define an appropriate abstract domain for this analysis.

   (b) Define the analysis for assignments of the form $x := y$, $x := y + n$, $x := x + n$, where x and y are two variables and n is an integer.

   (c) Define the analysis for assignments of the form $x := y + z$, $x := y * n$ and $x := y * z$.

   (d) Test conditions that appear in if and while commands can provide useful information to the analysis. If the analysis encounters a test $x < y$, it can learn this relation on the true branch, and can learn the opposite relation $x \geq y$ on the false branch. Redefine the analysis of `if` and `while` statements to take advantage of this information.

3. Implement the above analysis for IMP, using the IMP parser provided in the first assignment. You must implement a function `analyze : com -> unit` that analyzes a command and prints out the computed sets of equalities and inequalities before and after each assignment in that command. Each assignment must show up exactly once. For assignments inside loops, only the final result must be printed.

   For instance, a possible output for the program `x := y + 1; z := y;` would be:

   ```
   {}
   x := y + 1
   {y < x}

   {y < x}
   z := y
   {y < x, z < x, z = y}
   ```

   Submit your code in CMS in a file `analysis.ml`.