

Quiz II (CS6013)

20-Mar-2017

Read all the instructions and questions carefully. You can make any reasonable assumptions that you think are necessary; but state them clearly. There are total three questions. Answer any two (15 marks questions), the third one will be treated as a bonus question (for 5 marks, interpolated from 15). You will need approximately 20-25 minutes for answering a 15 marks question (plan your time accordingly). If you are done with two of the three questions, you are encouraged to try the third one as a bonus. For questions with sub-parts, the division for the sub-parts are given in square brackets.

Start each question on a new page. Think about the question before you start writing and write briefly. Each question also specifies the maximum number of allowed pages for the question. If the answer for any question is spanning more than specified number of pages, we will strictly ignore the spill-over text. If you scratch/cross some part of the answer, you can use space from the next page.

1. [15 marks, 2 pages] **Structural Analysis:**

Write the transfer functions for the following general constructs [3×1.5]: (i) Seq-stmts, (ii) if-statement, and (iii) while-loop. For each construct, assume that In is the input flow-value. Write the formulas for (i) the input flow-value at each basic-block [3×1], (ii) overall output flow-values [3×1]. For a basic-block B , assumed F_B be the flow-function.

For the example code shown below, (i) do structural analysis to build the control tree in a step-by-step manner [2], (ii) write the flow function of each basic-block to perform constant-propagation [2.5] – do not have to actual perform the constant-propagation.

```
void foo(int x){
    int y, z, l;
    y = 99;
    z = x;
    l = 2;
    while (z > 0){
        y = y - 1;
        z = z - 2;
        y = y + 1;
    };
    if (z < 0) z = 0;
}
```

2. [15 marks, 2 pages] **Loop Optimization and Dependence Analysis:**

State the GCD test for dependence analysis [3] and use it to show dependence and independence of the iterations of two example loops [$1.5 + 1.5$].

For the following loop optimizations show the sample transformation, correctness condition, and conditions under which it is profitable: (a) Loop distribution, (b) Loop inversion, (c) Loop unrolling [$3 \times (1 + 1 + 1)$].

3. [15 marks, 2 pages] **Interprocedural Analysis:**

Consider a new variation of C language where each parameter is only passed by reference and only integer parameters can be passed. Assume, (i) variables can be of integer type only, (ii) only four types of statements are admitted: declaration (e.g., `int x`), copy I (e.g., `x=y`), copy II (e.g., `x=const`), calls to functions that do not return any value (e.g., `foo(x)`). Write an inter-procedural flow-sensitive context-sensitive analysis to identify accesses to uninitialized variables in copy statements (in the RHS) [9]. Make sure you clearly show how you will handle call statements and assignment statements. What scheme will you use to handle recursion? [2]. The following example, illustrates the problem.

```
void main(){
    int x;
    int y;
    int z;
    int l;
    x = 2;
    foo(x,y,z);
    l = x; // initialized
    l = y; // initialized
    l = z; // un-initialized
    foo(x, z, y);
    l = z; // initialized
}
void foo(int x, int y, int z){
    int p;
    p = x; // initialized
    fubar(y);
}
void fubar(int s){
    int r;
    r = 2;
    s = r; // initialized
}
```

Give an argument why context sensitive analysis can be quite expensive and may not even terminate in general [2+2].