Final Exam Part 2

Compilers, Monsoon-2020, IIIT-H
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1. Is it safe to promote a variable which is an union member (in C)? Explain. [1 point]

2. **Anticipable Expressions Analysis** An expression e is anticipable at a program point p, if every path from p to the $EXIT$ node contains an evaluation of e which is not preceded by a definition of any operand of e. Let p and p' be the program points before and after a statement $*ptr = c$. If $ANTE(p)$ and $ANTE(p')$ denote the set of anticipable expressions at program points p and p', what is the relationship between them? Define the GEN[B] and KILL[B] sets. Write data flow equations for this analysis problem. [3.5 points]

3. Consider the following sequence of three address tuples. Convert the sequence into SSA form. Identify live ranges and allocate virtual registers suitably. Then construct an live range interference graph. What is the minimum number of registers required to do register allocation without spilling? If you have one less register available than that, which virtual register you would spill? Explain. [3 points]

```
x = x + z
t1 = 2 * x
y = t1 + 1
t2 = y + 4
t3 = x + 1
t4 = t2 + x
t3 = t3 + 1
```

4. Explain the register spilling strategy in a Bottom-up register allocation in only one sentence. [1 point]

5. Is the following grammar LALR(1) parsable? Argue. [1.5 points]

$$E \rightarrow E + E \mid a$$

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1. In LL(1) parsing, if a grammar is such that there exists no derivations $A \Rightarrow^* \epsilon$, then arrive at a simplified parse tree expansion strategy which doesn't require computation of FOLLOW sets. Specifically give the parsing strategy to expand a non-terminal symbol A in the parse tree with substitution rules $A \rightarrow \alpha_1 \mid \alpha_2$. [2 points]

2. If we use an iterative fixed-point algorithm to compute FIRST sets, what is the maximum number of iterations required to converge for a CFG $G = (S, N, T, P)$? Does the worst case depends on the number of productions in the grammar? [3 points]

3. If a grammar is not LR(1) parsable, then it is ambiguous. Prove or disprove [2 points]

4. For the following CFG, construct the initial state of LR(1) automaton and all outgoing transitions from it.

$$\begin{aligned} S &\rightarrow Aa \mid bAc \mid dc \mid bda \\ A &\rightarrow d \end{aligned}$$