Exam: Compiler Construction

January 14 2005, 10.00 – 13.00h.

This exam consists of 4 exercises, by which 100 points in total can be obtained. Each exercise contains several parts. The maximum number of points to be achieved per part is given between [..].
It is not allowed to consult any other information except for your own knowledge and what during the exam the assistants will explain.
You may answer the questions either in Dutch or in English.
Finally: do not forget to write down your name, ARGUE ALL ANSWERS (only numbers, yes/no, etc will not be honored!!!), and write clearly. Success!

<u>Exercise 1</u> Lexical analysis

a. How can tokens be specified and how can they be recognized in the lexical analysis? **[5]**

b. Given the following C function

```
int max (i, j)  /* return maximum of integers i and j */
int i, j;
{
   return i>j?i:j;
}
```

Identify the lexemes that make up the tokens in this function. **[5]**

c. Give reasonable attribute values for the tokens found in **b**. **[5]**

d. Given the following Pascal function

```
function fac (n: integer): integer;
begin
   if n=1 then fac:=1 else
   fac:=n*fac(n-1)
end;
```

Identify the lexemes that make up the tokens in this function. **[5]**

e. Give reasonable attribute values for the tokens found in **d**. **[5]**

Exercise 2 Parsing

a. Explain why top-down parsing methods cannot handle left-recursive grammars. **[5]**

b. Given the grammar

$$A \rightarrow p\,B\,q\,A \mid p\,B\,q\,A\,r\,A \mid s$$

$$B \rightarrow t$$

Derive a equivalent left-factored grammar for this grammar. **[5]**

c. Show that the resulting left-factored grammar is LL(1). **[5]**

d. Is the given grammar in **b** SLR(1)? **[10]**

Exercise 3 Code optimization

Given the Pascal-like fragment

```
for i := 1 to N do
  begin
    term := 5;
    if ( i = 1 ) then x := 10 + term
    y := x + N;
    a[i] := y;
  end
```

a. What kind of code-optimization techniques can be applied by a compiler to obtain a more efficient version of this fragment? **[10]**

b. Give the resulting optimized version and quantify the improvement. **[10]**

c. Is this optimized version the most efficient code for this fragment or can it be further improved? Explain your answer. **[5]**

Exercise 4 Miscellanies

a. What are the different phases of a compiler? **[5]**

b. What is a 'type system'? **[5]**

c. What is the relation between a 'declaration of a name' and a 'binding of a name', and between a 'scope of a declaration' and a 'lifetime of a binding'? **[5]**

d. Describe three implementations of three-address code. **[5]**

e. What is the difference between 'register allocation' and 'register assignment'? **[5]**

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