apl. Prof. Dr. Thomas Noll

Sebastian Junges, Christoph Matheja, Matthias Volk

Compiler Construction 2017
— Exercise Sheet 7 —

Hand in until July 18th before the exercise class.

Exercise 1 (2 Points)

Consider the context-free grammar G that is given by the rules

$$S \to a \mid b \mid S\,S.$$

Define an attribute *size* that assigns to every node v in a derivation tree t of G the number of nodes in the subtree of t with v as the root whenever the aforementioned subtree contains more a's than b's.

Exercise 2 (3 Points)

In this exercise we apply attribute grammars to evaluate simple arithmetic expressions.

a) Write an *unambiguous* context-free grammar for arithmetic expressions that contains arbitrary numerical values (which you may represent by a single terminal symbol *num*), addition, multiplication, and parenthesis.

b) Define an attribute *value* to compute the value of an expression. That is, the value of a given expression should correspond to the value of attribute *value* at the root of the corresponding derivation tree.

c) Evaluate $2 \cdot 5 + 3$. To this end, first construct the corresponding derivation tree, then set up the equation system, and solve it.

Exercise 3 (2 Points)

Give a context-free grammar for the language $\{a, b\}^*$. Extend this grammar to an attribute grammar G containing a Boolean attribute *val* whose language is

$$L(G, val) \;=\; \{ww \mid w \in \{a, b\}^*\}$$

Hint: The language of an attribute grammar G and a Boolean attribute *val* is the set of all words w such that there is a derivation tree of G corresponding to w and the attribute *val* is evaluated to `true` at the root of this tree.

Exercise 4 (3 Points)

Consider the following grammar $G = (N, \Sigma, P, S)$ with inherited attributes $i1, i2$ and synthesised attributes $s1, s2$.

$$
\begin{array}{llll}
S' & \rightarrow & S & i1.0 = 1 \\
 & & & i2.0 = 2 \\
 & & & i1.1 = s1.1 \\
 & & & i2.1 = i1.0 \\
 & & & s2.0 = s2.1 \\
S & \rightarrow & AA & i1.1 = s1.1 \\
 & & & i2.1 = i1.0 \\
 & & & i1.2 = 0 \\
 & & & i2.2 = i2.0 \\
 & & & s1.0 = s2.1 \\
 & & & s2.0 = s2.2 \\
S & \rightarrow & A & i1.1 = 0 \\
 & & & i2.1 = i2.0 \\
 & & & s2.0 = s2.1 \\
A & \rightarrow & a & s1.0 = 0 \\
 & & & s2.0 = i1.0 \\
A & \rightarrow & b & s2.0 = 0 \\
 & & & s1.0 = i2.0
\end{array}
$$

(a) Provide the dependency graph for each production in G.

(b) Apply the circularity test from the lecture to G.

1. Calculate the set $IS(A)$ for all $A \in N$.
2. Is G circular? Justify your answer.