Software-Modellierung und Verifikation
Informatik 2
Prof. J.-P. Katoen
RWTH Aachen

Priv.-Doz. T. Noll noll@cs.rwth-aachen.de
D. Klink klink@cs.rwth-aachen.de

3. Exercise sheet *Compiler Construction 2008*

Due to Wed., 21 May 2008, *before* the exercise course begins.
Hand in your solutions in groups of three!

Exercise 3.1:

In the lecture two characterizations of $LL(1)$ have been given:

- $G \in LL(1)$ iff for all leftmost derivations of the form

$$S \Rightarrow_l^* wA\alpha \begin{cases} \Rightarrow_l w\beta\alpha \\ \Rightarrow_l w\gamma\alpha \end{cases}$$

  such that $\beta \neq \gamma$, it follows that $\text{fi}(\beta\alpha) \cap \text{fi}(\gamma\alpha) = \emptyset$.

- $G \in LL(1)$ iff for all pairs of rules $A \to \beta \mid \gamma \in P$ (where $\beta \neq \gamma$):

$$\text{la}(A \to \beta) \cap \text{la}(A \to \gamma) = \emptyset$$

a) Lift the second definition to $LL(k)$ for $k \in \mathbb{N}^+$. (The first definition was given for $k \in \mathbb{N}^+$ in the lecture.)

b) Show that the definitions are not equivalent by showing that the following grammar is in $LL(2)$ according to the first definition but not according to the second definition (also refered to as *strong* $LL(2)$ property).

$$\begin{array}{lcl} S & \to & aAab \mid bAbb \\ A & \to & a \mid \varepsilon \end{array}$$

c) Explain (in a few words) why the definitions are not equivalent.

Exercise 3.2:

Consider the following *parameterized* grammar $G_n = \langle N, \Sigma, P_n, S \rangle$ with $\Sigma = \{0, 1, \ldots, n, \hookleftarrow\}$. The symbol $\hookleftarrow$ may be represented by a linebreak.

$$\begin{array}{llcll} P_n: & S & \to & 1 \hookleftarrow S_1 \mid \ldots \mid n \hookleftarrow S_n & \\ & S_i & \to & R_i \overset{i\times}{\ldots} R_i & \text{for all } i \in \{1, \ldots, n\} \\ & R_i & \to & N \overset{i\times}{\ldots} N \hookleftarrow & \text{for all } i \in \{1, \ldots, n\} \\ & N & \to & 0 \mid 1 & \end{array}$$

a) Construct the NTA for grammar $G_n \in LL(1)$.

b) Construct the DTA for grammar G_n.

c) Compute the run of $DTA(G_1)$ and $DTA(G_2)$ for input:

```
2
0 1
1 0
```

Exercise 3.3:

a) Show that the following grammar is ambiguous:

$$S \quad \rightarrow \quad (S) \mid S \vee S \mid S \wedge S \mid \neg S \mid \text{true}$$

b) Devise a method that chooses a reasonable derivation out of the set of all leftmost derivations for a given word $w \in \Sigma^*$ by investigating the leftmost analysis information. Reasonable in this context means that

$\neg$ binds stronger than $\vee$ and $\wedge$,

$\wedge$ binds stronger than $\vee$.

Exercise 3.4:

Prove the correctness of the top down analysis automaton $NTA(G)$ for a grammar $G = \langle N, \Sigma, P, S \rangle$, i.e. show that for all $w \in \Sigma^*$ and all $z \in \{1, \ldots, |P|\}^*$:

$$(w, S, \varepsilon) \vdash^* (\varepsilon, \varepsilon, z) \quad \text{implies} \quad S \overset{z}{\underset{l}{\Rightarrow}} w$$