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Compiler Construction 2018/19

— Exercise Sheet 4 —

Hand in until November 12th before the exercise class.

General Remarks

- There is *no* practical exercise this week.

Exercise 1 (7 Points)

Consider the following grammar G:

$$\begin{aligned} S &\to Scc \mid Ac \\ A &\to Aab \mid a \mid aBb \\ B &\to dA \end{aligned}$$

(a) Show that $G \notin LL(1)$.

(b) Transform G into an equivalent grammar in $LL(1)$, i.e. provide a grammar $G' \in LL(1)$ such that $L(G') = L(G)$.

(c) Prove that G' has the $LL(1)$ property.

Consider the following grammar H:

$$\begin{aligned} S &\to Ab \\ A &\to Sc \mid Aa \mid d \mid a \end{aligned}$$

(d) Eliminate all left recursion in H to obtain grammar H'.

(e) Is $H' \in LL(1)$? Justify your answer.

Exercise 2 (4 Points)

Show that every regular language can be generated by an $LL(1)$-grammar.

Exercise 3 (9 Points)

Consider the grammar $G = (N, \Sigma, P, S)$ covering regular expressions:

- $N := \{S, R, T\}$
- $\Sigma := \{\texttt{+}, \texttt{.}, \texttt{*}, \texttt{(}, \texttt{)}, \texttt{a}, \texttt{b}\}$
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$$\begin{aligned} S &\to R \\ R &\to R\texttt{+}R \mid R\texttt{.}R \mid R\texttt{*} \mid T \\ T &\to \texttt{(}R\texttt{)} \mid \texttt{a} \mid \texttt{b} \end{aligned}$$

(a) Give the complete nondeterministic top-down parsing automaton $NTA(G)$.
(Either give a transition table as in the lecture or depict the automaton and specify what the edge labelling means. Do not forget to give a numbering to the grammar rules.)

(b) Provide a run of $NTA(G)$ on the input `a+(b*)`

(c) Consider the transformed grammar G':

$$\begin{aligned} S &\to R \\ R &\to TR' \\ R' &\to \texttt{+}R \mid \texttt{.}R \mid \texttt{*}R' \mid \varepsilon \\ T &\to \texttt{(}R\texttt{)} \mid \texttt{a} \mid \texttt{b} \end{aligned}$$

Prove that $G' \in LL(1)$.

(d) Specify the deterministic top-down parsing automaton $DTA(G')$.
(Again, either give a transition table as in the lecture or depict the automaton and specify what the edge labelling means. As before, do not forget to give a numbering to the grammar rules of G'.)

(e) Provide a run of $DTA(G')$ on the input `a+(b*)`