UNIVERSITY OF HELSINKI
Department of Computer Science
P.O. Box 68 (Gustaf Hällströmin katu 2b)
00014 UNIVERSITY OF HELSINKI

581330-2 Models for Programming and Computing

Exercise 5 (21.-25.2.2005)

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1. Construct a right-linear grammars for the following languages
   (a) $\{x \in \{0,1\}^* \mid x$ contains substring $000\}$
   (b) $\{x \in \{0,1\}^* \mid$ the amount of zeros in x is dividable by three $\}$

2. Let G be the following grammar:

$$\begin{array}{lcl} S & \rightarrow & SS \mid A \mid \epsilon \\ A & \rightarrow & AAA \mid B \mid a \\ B & \rightarrow & b \end{array}$$

   (a) Show that G is ambiguous.
   (b) Is $L(G)$ inherently ambiguous? Why?

3. (a) Show that the following grammar is ambiguous.
   $S \rightarrow Aa \mid AB$
   $A \rightarrow Ab \mid b$
   $B \rightarrow Ba \mid a$
   (b) Transform the grammar into LL(1)-form using the method given in the lectures. Is it now unambiguous?

4. Consider the following (equivalent) grammars for list structures:

$$G: \quad \begin{array}{lcl} S & \rightarrow & (L) \mid a \\ L & \rightarrow & L, S \mid S \end{array} \qquad\qquad G': \quad \begin{array}{lcl} S & \rightarrow & (L) \mid a \\ L & \rightarrow & S, L \mid S \end{array}$$

   (a) Show that neither G nor G' is in LL(1)-form.
   (b) Transform G into LL(1)-form by eliminating the immediate left recursion.
   (c) Transform G' into LL(1)-form by using left factorization.

5. Consider the language L_{bal} from the exercise 5&6 in the first set of exercises.
   (a) Give a context-free grammar for L_{bal}.
   (b) Give an $LL(1)$-grammar for L_{bal}.
   (c) Write a recursive parser for the grammar in part (b) (in pseudo-code).

6. Transform the grammar

$$\begin{array}{lcl} S & \rightarrow & ABC \mid a \\ A & \rightarrow & aAaa \mid \epsilon \\ B & \rightarrow & bBbb \mid \epsilon \\ C & \rightarrow & cCa \mid c \end{array}$$

   into Chomsky normal form. Show also the intermediate stages.