Homework 7

Please submit your solutions via email. Please submit only PDFs! Every solution should be preceded by the corresponding question text, like:

> **Q**n**:** ...a difficult question from me...
> **A:** ...an answer from you ...
> **Q**$n+1$ ...another difficult question...
> **A:** ...another brilliant answer from you...

Solutions will only be accepted until 20th December! Please send only one homework per email.

1. Suppose the context-sensitive grammar

$$
\begin{aligned}
S &\rightarrow bSAA \mid \epsilon \\
A &\rightarrow a \\
bA &\rightarrow Ab
\end{aligned}
$$

   where S is the starting symbol of the grammar. Give a derivation of the string *"aaabaaabb"*. What can you say about the number of as and bs in the strings recognised by this grammar.

2. Consider the following grammar

   $S ::= N \cdot P$

   $P ::= V \cdot N$

   $N ::= N \cdot N$

   $N ::= A \cdot N$

   $N ::=$ `student` $\mid$ `trainer` $\mid$ `team` $\mid$ `trains`

   $V ::=$ `trains` $\mid$ `team`

   $A ::=$ `The` $\mid$ `the`

   where S is the start symbol and S, P, N, V and A are non-terminals. Using the CYK-algorithm, check whether or not the following string can be parsed by the grammar:

   `The trainer trains the student team`

3. Transform the grammar

$$\begin{aligned} A &\rightarrow 0A1 \mid BB \\ B &\rightarrow \epsilon \mid 2B \end{aligned}$$

into Chomsky normal form.

4. Consider the following grammar G

$$\begin{aligned} S &\rightarrow \texttt{if0} \cdot E \cdot \texttt{then} \cdot S \\ S &\rightarrow \texttt{print} \cdot S \\ S &\rightarrow \texttt{begin} \cdot B \cdot \texttt{end} \\ B &\rightarrow S \cdot \texttt{;} \\ B &\rightarrow S \cdot \texttt{;} \cdot B \\ S &\rightarrow num \\ E &\rightarrow num \\ B &\rightarrow num \end{aligned}$$

where S is the start symbol and S, E and B are non-terminals.

Check each rule below and decide whether, when added to G, the combined grammar is ambiguous. If yes, give a string that has more than one parse tree.

   (i) $S \rightarrow \texttt{if0} \cdot E \cdot \texttt{then} \cdot S \cdot \texttt{else} \cdot S$
  (ii) $B \rightarrow B \cdot B$
 (iii) $E \rightarrow (\cdot E \cdot)$
 (iv) $E \rightarrow E \cdot + \cdot E$