Homework 7

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

Qn:	**…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

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

   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

$$\boldsymbol{S} ::= \boldsymbol{N} \cdot \boldsymbol{P}$$

$$\boldsymbol{P} ::= \boldsymbol{V} \cdot \boldsymbol{N}$$

$$\boldsymbol{N} ::= \boldsymbol{N} \cdot \boldsymbol{N}$$

$$\boldsymbol{N} ::= \boldsymbol{A} \cdot \boldsymbol{N}$$

$$\boldsymbol{N} ::= \texttt{student} \mid \texttt{trainer} \mid \texttt{team} \mid \texttt{trains}$$

$$\boldsymbol{V} ::= \texttt{trains} \mid \texttt{team}$$

$$\boldsymbol{A} ::= \texttt{The} \mid \texttt{the}$$

   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

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

into Chomsky normal form.

4. Consider the following grammar G

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

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.

$$
\begin{array}{rl}
\text{(i)} & S \rightarrow \texttt{if0} \cdot E \cdot \texttt{then} \cdot S \cdot \texttt{else} \cdot S \\
\text{(ii)} & B \rightarrow B \cdot B \\
\text{(iii)} & E \rightarrow (\cdot E \cdot) \\
\text{(iv)} & E \rightarrow E \cdot + \cdot E
\end{array}
$$