

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

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

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

$$\begin{aligned} S & ::= N \cdot P \\ P & ::= V \cdot N \\ N & ::= N \cdot N \\ N & ::= A \cdot N \\ N & ::= \text{student} \mid \text{trainer} \mid \text{team} \mid \text{trains} \\ V & ::= \text{trains} \mid \text{team} \\ A & ::= \text{The} \mid \text{the} \end{aligned}$$

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

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

into Chomsky normal form.

4. Consider the following grammar G

$$\begin{aligned}
 S &::= \text{if } 0 \cdot E \cdot \text{then } \cdot S \\
 S &::= \text{print } \cdot S \\
 S &::= \text{begin } \cdot B \cdot \text{end} \\
 B &::= S \cdot ; \\
 B &::= S \cdot ; \cdot B \\
 S &::= \text{num} \\
 E &::= \text{num} \\
 B &::= \text{num}
 \end{aligned}$$

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) $S ::= \text{if } 0 \cdot E \cdot \text{then } \cdot S \cdot \text{else } \cdot S$
- (ii) $B ::= B \cdot B$
- (iii) $E ::= (\cdot E \cdot)$
- (iv) $E ::= E \cdot + \cdot E$

5. Suppose the string “ $9 - 5 + 2$ ”. Give all ASTs that the following two grammars generate for this string.

Grammar 1, where $List$ is the starting symbol:

$$\begin{aligned}
 List &::= List + Digit \mid List - Digit \mid Digit \\
 Digit &::= 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9
 \end{aligned}$$

Grammar 2, where $String$ is the starting symbol:

$$\begin{aligned}
 String &::= String + String \mid String - String \mid \\
 &0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9
 \end{aligned}$$