Theory of Computer Science

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Exercise Sheet 6

Due: Wednesday, April 8, 2015

Note: Submissions that are exclusively created with LaTeX will receive a bonus mark. Please submit only the resulting PDF file (or a printout of this file).

Note: Because of the Easter break, 4 out of 10 points on this sheet are counted as bonus points.

Exercise 6.1 (Chomsky Normal Form; 2 Points)

Specify a grammar G' in Chomsky normal form that generates the same language as the context-free grammar $G = (\Sigma, V, P, S)$ with $\Sigma = \{a, b\}$, $V = \{S, X, Y, Z\}$ and the following rules in P:

$$S \to \varepsilon \qquad S \to XZ \qquad S \to Y \qquad X \to Z \qquad X \to aYa$$
$$Y \to bb \qquad Y \to bY \qquad Z \to X \qquad Z \to bZ$$

Exercise 6.2 (Length of Derivations in Chomsky Normal Form; 2 Points)

Let G be a grammar in Chomsky normal form and $w \in \mathcal{L}(G)$ a non-empty word ($w \neq \varepsilon$), which is generated by G. Show that every derivation of w from the start variable of G consists of exactly $2|w| - 1$ steps.

Exercise 6.3 (Pumping Lemma for Context-free Languages; 3 Points)

Use the pumping lemma to show that the language $L = \{tt \mid t \in \Sigma^*\}$ over $\Sigma = \{a, b\}$ is not context-free.

Exercise 6.4 (PDAs; 3 Points)

Specify a PDA that accepts the language $L = \{a^n c(ba)^n c \mid n \geq 0\}$ over $\Sigma = \{a, b, c\}$.