

Theory of Computer Science

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Exercise Sheet 6

Due: Wednesday, April 10, 2019

Exercise 6.1 (Chomsky Normal Form; 2 Points)

Specify a grammar in Chomsky normal form that generates the same language as grammar $G = \langle \Sigma, V, P, S \rangle$ with $\Sigma = \{a, b, c\}$, $V = \{S, X, Y\}$ and the following rules P :

$$S \rightarrow XY$$

$$X \rightarrow c$$

$$X \rightarrow cS$$

$$Y \rightarrow abb$$

$$Y \rightarrow aYb$$

$$Y \rightarrow \epsilon$$

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 ($w \neq \epsilon$), 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 (PDAs, 2 Points)

Specify a PDA that accepts that language

$$L = \{w_1\$w_2 \mid w_1, w_2 \in \{a, b\}^* \text{ and } w_1 \text{ and } w_2 \text{ contain the same number of } a\}$$

over $\Sigma = \{a, b, \$\}$.

Exercise 6.4 (Nondeterministic Turing Machines; 4 Points)

Consider language $L = \{w\$w \mid w \in \{0, 1\}^*\}$ over $\{0, 1, \$\}$. Specify the state/transition diagram of an NTM M with $\mathcal{L}(M) = L$. Also explain the behaviour of your TM in words.