

Theoretical Computer Science II

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Exercise Sheet 10

Due: January 16, 2012

Exercise 10.1 (Chomsky Normal Form, 2 marks)

Show that for every context-free grammar in Chomsky Normal Form any derivation of a string $w \neq \epsilon$ has $2n - 1$ derivation steps, where n is the length of w ($n = |w|$).

Exercise 10.2 (Context-free grammars, 1.5 + 1.5 marks)

Give context-free grammars generating the following languages (if you prefer, you can also hand in PDAs recognizing these languages):

(a) $L_1 = \{a^n b^m b^n a^m \mid n, m \in \mathbb{N}\}$

(b) $L_2 = \{a^n b^m c^{n+m} \mid n, m \in \mathbb{N}\}$

Exercise 10.3 (Context-free Languages: Pumping Lemma, 3 + 2 marks)

Are the following languages context-free? If so, give a context-free grammar describing it, if not use the pumping lemma to prove it:

(a) $A = \{a^n b^m c^{n \cdot m} \mid n, m \in \mathbb{N}\}$

(b) $B = \{0^n 1^{n^2} \mid n \in \mathbb{N}\}$