Theory of Computer Science

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Exercise Sheet 5

Due: Wednesday, April 6, 2016

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).

Exercise 5.1 (Formal grammars; 0.5 + 2 + 0.5 Points)
Consider the following formal language over $\{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$:

$$L = \{\mathtt{a}^n \mathtt{b}^m \mathtt{c}^n \mid n \geq 0, m \geq 0\}$$

(a) Is ε an element of L? Justify your answer.

(b) Specify a *complete description* of a formal grammar G that generates L (i.e., $\mathcal{L}(G) = L$). A formal grammar is a four tuple $G = \langle \Sigma, V, P, S \rangle$, remember to define all components of this tuple.

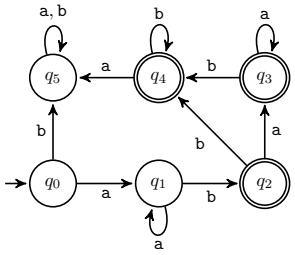
(c) Which types (in the Chomsky-Hierarchy) is your formal grammar part of? You don't have to prove your answers.

Exercise 5.2 (Derivation of words; 1 Points)
Consider the following formal grammar $G = \langle \Sigma, V, P, \mathrm{E} \rangle$ with $\Sigma = \{\mathtt{0}, \mathtt{1}, \oplus, \otimes, [\![,]\!]\}$, $V = \{\mathrm{E}, \mathrm{A}, \mathrm{M}, \mathrm{Z}\}$ and the following rules in the set P:

$\mathrm{E} \to \mathrm{A}$	$\mathrm{E} \to \mathrm{M}$	$\mathrm{E} \to \mathtt{0}$	$\mathrm{E} \to \mathtt{1Z}$	
$\mathrm{A} \to [\![\mathrm{E} \oplus \mathrm{E}]\!]$	$\mathrm{M} \to [\![\mathrm{E} \otimes \mathrm{E}]\!]$	$\mathrm{Z} \to \mathtt{0Z}$	$\mathrm{Z} \to \mathtt{1Z}$	$\mathrm{Z} \to \varepsilon$

Specify a derivation of the word $[\![[\![\mathtt{1} \oplus \mathtt{0}]\!] \oplus [\![\mathtt{10} \otimes \mathtt{110}]\!]]\!]$.

Exercise 5.3 (DFAs and regular grammars; 1.5 + 1.5 Points)
Consider the following DFA M:



(a) Which language does the DFA accept?

(b) Specify a *regular* grammar, which generates the same language.

Exercise 5.4 (DFAs; 2 Points)
Specify a deterministic finite automaton that accepts the language of all words over $\Sigma = \{\mathtt{a}, \mathtt{b}\}$ that do *not* contain `abb`.

Exercise 5.5 (NFAs; 1 Point)
Specify a non-deterministic finite automaton that accepts the language of those words over $\Sigma = \{\mathtt{a}, \mathtt{b}\}$ that start with `ab` or contain `bab`.