

5. Exercises Formal Grammars, Languages and Machines, Week 5, May 31, 2012

- 5.1. (i) Show and explain that the language $\{w \in \{a, b\}^* \mid abba \text{ is a subword of } w\}$ satisfies the pumping lemma for regular languages.
(ii) Show and explain that the language $\{w \in \{a, b\}^* \mid abba \text{ is a not subword of } w\}$ satisfies the pumping lemma for regular languages.
- 5.2. Show that the language $\{w \in \{a, b\}^* \mid W \text{ is a palindrome of even length}\}$ does not satisfy the pumping lemma for regular languages.
- 5.3. Show that the language $\{a^n b^{2m} c^{2n+1} \mid n \geq 0\}$ is context-free.
- 5.4. Given is the following grammar G . The alphabet consists of finitely many words over the latin alphabet with upper-case and lower-case letters, occurring below in red. The auxiliary symbols consist of linguistic names in cornered brackets!

$S = \langle \text{sentence} \rangle \rightarrow \langle \text{noun} - \text{phrase} \rangle \langle \text{verb} - \text{phrase} \rangle.$
$\langle \text{sentence} \rangle \rightarrow \langle \text{noun} - \text{phrase} \rangle \langle \text{verb} - \text{phrase} \rangle \langle \text{object} - \text{phrase} \rangle.$
$\langle \text{noun} - \text{phrase} \rangle \rightarrow \langle \text{name} \rangle \mid \langle \text{article} \rangle \langle \text{noun} \rangle$
$\langle \text{name} \rangle \rightarrow \text{John} \mid \text{Jill}$
$\langle \text{noun} \rangle \rightarrow \text{bicycle} \mid \text{mango}$
$\langle \text{article} \rangle \rightarrow \text{a} \mid \text{the}$
$\langle \text{verb} - \text{phrase} \rangle \rightarrow \langle \text{verb} \rangle \mid \langle \text{adverb} \rangle \langle \text{verb} \rangle$
$\langle \text{verb} \rangle \rightarrow \text{eats} \mid \text{rides}$
$\langle \text{adverb} \rangle \rightarrow \text{slowly} \mid \text{frequently}$
$\langle \text{adjective} - \text{list} \rangle \rightarrow \langle \text{adjective} \rangle \langle \text{adjective} - \text{list} \rangle \mid \lambda$
$\langle \text{adjective} \rangle \rightarrow \text{big} \mid \text{juicy} \mid \text{yellow}$
$\langle \text{object} - \text{phrase} \rangle \rightarrow \langle \text{adjective} - \text{list} \rangle \langle \text{name} \rangle$
$\langle \text{object} - \text{phrase} \rangle \rightarrow \langle \text{article} \rangle \langle \text{adjective} - \text{list} \rangle \langle \text{noun} \rangle$

- (i) Show that 'Jill frequently eats a juicy yellow mango' belongs to $L(G)$.
(ii) Show that other English sentences belong to $L(G)$.
(iii) Give an example of an English sentences made from the red words that does not belong to $L(G)$.
(iv) Give an example of an element of $L(G)$ that is not correct English.
- 5.5. Do the exercise on slide 7.
- 5.6. Do the blue exercise on slide 8.