

# Homework 5

CS 4313 – Spring 2003  
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assigned February 12, 2003  
due date February 19, 2003

1. Provide regular expressions for the following languages on  $\Sigma = \{a, b\}$ 
  - (a) Each run of  $a$ 's contains exactly 2  $a$ 's.
  - (b) Each run of  $a$ 's contains either exactly 1  $a$  or at least 3  $a$ 's.
2. Do Exercise 4.3.4f.
3. Do Exercise 4.3.5c. Use the pumping lemma to prove that it is not regular. Hint: How many  $a$ 's are needed to go from  $a^{m^2}$  to  $a^{(m+1)^2}$ ?
4. Do Exercise 5.1.8c. Show a derivation tree for  $aaabccccc$ .
5. Find a context-free grammar for the following language:

$$L = \{w \in \{a, b\}^* : n_a(w) = n_b(w)\}$$

Hint: Add one more production to the grammar for Example 5.4. Show a derivation tree for  $bbaaaababb$ .

6. (Extra Credit) Let  $L$  be the following language:

$$L = \{ww : w \in \{a, b\}^*\}$$

Find a context-free grammar for  $\bar{L}$ .