CSCE-433 Formal Languages & Automata
CSCE-627 Theory of Computability

Spring 2022

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Assignment # 3
(Due February 28, 2022)

Instructions.

- Your assignment must be typed using your favorite word processor. You may draw diagrams by hand, but only if you are very neat and the diagram is legible.
- Turn in a PDF file of your homework on Canvas.
- Homework is always due at the **beginning** of the class on the due day.

Questions.

1. (32 points) Use the pumping lemma for regular languages to show that the following languages are not regular (you might find it useful to study the solutions in the textbook to Exercise 1.29, parts (a) and (c)):
   a) $\{www | w \in \{a, b\}^*\}$
   b) $\{a^i(ab)^j(ca)^{2i} | i > 0, j > 0\}$
   c) the set of properly nested parentheses (e.g., includes "()(())()" but not ")("
   d) (CSCE 433 students only) $\{a^n b^m | n < m\}$
   e) (CSCE 627 students only) $\{a^i b^j c^{2j} | i \geq 0, j \geq 0\}$

2. (20 points) Textbook, page 90, Exercise 1.46 (a) and (c).

3. (18 points) Write a context-free grammar for each of these languages; include a brief English intuition for how it works.
   (a) $\{a^m b^i a^n | i = m + n, m \geq 0, n \geq 0\}$
   (b) set of all strings over $\{a, b\}$ that have the same number of a's as b's; includes ϵ
   (c) the complement of $\{a^n b^n | n \geq 0\}$, where $\Sigma = \{a, b\}$

4. (15 points) Textbook, page 155, Exercise 2.9.

5. (15 points) Textbook, page 156, Exercise 2.14. Be sure to show all your steps.

Further suggested practice. Exercises 2.1, 2.3, 2.4 and 2.6. in the textbook.