CS 580 Homework 5

September 27 4:10 PM, 2023

1. What language does the following CFG generate?

$$S \to aSaSb \mid aSbSa \mid bSaSa \mid SS \mid \lambda$$

2. Give a CFG generating each language.

   a. $\{a^i b^j | i < j \leq 2i\}$

   b. $\{a^i b^{i+j} c^j | i + j \geq 1\}$

   c. $\{s | s \in (a+b)^*,\ s \text{ contains equal numbers of } a\text{'}s \text{ and } b\text{'}s\}$

3. Prove that the following CFG is ambiguous.

$$S \to aS \mid aSbS \mid \lambda$$

4. Simplify the following grammar by applying, in the correct order, the four lemmas we have learned. Show the result after applying each lemma.

$$S \to BD \mid A$$

$$A \to FG$$

$$B \to aBb \mid C \mid \lambda$$

$$C \to B \mid \lambda$$

$$D \to Dc \mid \lambda$$

$$E \to bBa \mid cD \mid \lambda$$

$$F \to AG$$

$$G \to FA$$

5. For the CFG below, produce an equivalent CFG in

   a. Chomsky normal form (CNF).

   b. Greibach normal form (GNF).

$$S \to AB \mid A$$

$$A \to Aa \mid \lambda$$

$$B \to bBb \mid A$$