CS 374 Spring 2015
Homework 3 Problem 3

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Give CFGs for the following languages, and clearly explain how they work and the role of each nonterminal. Grammars can be very difficult to understand, and if the grader does not understand how your construction is intended to generate the language, then you will receive 0 points.

1. $\{w \mid w \in \{0,1\}^*$ and w is *not* a palindrome$\}$
2. $\{a^i b^j c^k \mid j = i + k\}$
3. $\{a^i b^j c^k d^l \mid i + l = j + k\}$

Solution:

(a) $\{w|w \in \{0,1\}$ and w is not a palindrome $\}$

$$< S > \rightarrow < F >< S >< F > \mid < Q >$$
$$< Q > \rightarrow 0 < T > 1 \mid 1 < T > 0$$
$$\text{<T>} \rightarrow < F >< T >< F > \mid \epsilon$$
$$\text{<F>} \rightarrow 1|0$$

<S> is a start state. <F> is for base state. <Q> is for making non-palindrome. <T> is for expansion.

(b) $\{a^i b^j c^k \mid j = i + k\}$

$$< S > \rightarrow < A > \mid < C > \mid < A >< C > \mid \epsilon$$
$$< A > \rightarrow a < A > b \mid ab$$
$$< C > \rightarrow b < C > c \mid bc$$

<S> is a start state. <A> is for k = 0 and j = i. <C> is for i = 0 and j = l. <A><C> is for j = i+k.

(c) $\{a^i b^j c^k d^l \mid i + l = j + k\}$

$$< S > \rightarrow < AB > \mid < AC > \mid < BD > \mid < CD > \mid < AB >< CD > \mid \epsilon$$
$$< AB > \rightarrow a < AB > b \mid ab$$
$$< AC > \rightarrow a < AC > c \mid ac$$
$$< BD > \rightarrow b < BD > d \mid bd$$
$$< CD > \rightarrow c < CD > d \mid cd$$

<S> is a start state. <AB> is for l=0,k=0, and i=j. <AC> is for l=0, j=0, and i=k. <BD> is for i=0, k=0, and j = l. <CD> is for i=0, j=0, and k = l. <AB><CD> is for i+l = j+k.

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