Juan Pablo García Malta A01639025

Practicando los lenguajes libres de contexto

Equipo con Leonardo Luna

4.1 Give context-free grammars generating the following sets.

a) The set of palindromes (strings that read the same forward as backward) over alphabet {a,b}.

$$S \to \varepsilon \mid a \mid b \mid aSa \mid bSb$$

c) The set of all strings over alphabet {a,b} with exactly twice as many a's as b's.

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

d) The set of all strings over alphabet {a, b, ·. +, *, (,), ε, ∅} that are well-formed regular expressions over alphabet {a,b}. Note that we must distinguish between ε as the empty string and as a symbol in a regular expression. We use ε in the latter case.

$$S \to \emptyset \mid A$$

$$A \to \varepsilon \mid a \mid b \mid A + A \mid A \cdot A \mid (A) \mid A*$$

4.10 Find a CFG with no useless symbols equivalent to

$S \to AB \mid CA \quad B \to BC \mid AB$

$A \to a \qquad S \to aB \mid b$

We remove B since it does not generate terminals.

$S \to CA \qquad A \to a \qquad C \to b$

4.14 Find a Greibach normal-form grammar equivalent to the following CFG:

$S \rightarrow AA|0 \quad A \rightarrow SS|1$

The CFG is already in ChNF as there are no more than 2 terminal symbols and only generators without them being mixed.

$$S \rightarrow AA \mid 0$$

$$A \rightarrow SS \mid 1$$

$$Z_1 = S$$

$$Z_2 = A$$

$Z_1 = Z_2 Z_2 \mid 0$ This is in order

$Z_2 = Z_1 Z_1 \mid 1$ This is not in order as $Z_2 > Z_1$ So, we substitute

$Z_2 = Z_2 Z_2 Z_1 \mid 0Z_1 \mid 1$ Now it's in order,

$Z_1 = Z_2 Z_2 \mid 0$ However, there is now recursivity from the left.

So, we create a new generator.

$$Y_1 = Z_2 Z_1 \mid Z_2 Z_1 Y_1$$

$$Z_1 = Z_2 Z_2 \mid 0$$

$$Z_2 = 0Z_1 Y_1 \mid 0Y_1 \mid 1Y_1 \mid 1$$

We now have these 3 expressions.

$$Z_1 = 0Z_1 Y_2 Z_2 \mid 0Z_1 Z_2 \mid 1Y_1 Z_2 \mid 1Z_2 \mid 0$$

$$Z_2 = 0Z_1 Y_1 \mid 0Y_1 \mid 1Y_1 \mid 1$$

$$Y_1 = 0Z_1 Z_1 \mid 0Z_1 Y_1 Z_1 \mid 0Z_1 Z_1 Y_1 \mid 0Z_1 Y_1 Z_1 Y_1 \mid 1Z_1 \mid 1Y_1 Z_1 \mid 1Z_1 Y_1 \mid 1Y_1 Z_1 Y_1$$