

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)**

$G = (N, T, S, P)$

$N = \{S\}$

$T = \{a, b\}$

$S = S$ (Simbolo inicial)

$P = \{S \rightarrow aSa, bSb, \\ S \rightarrow a \\ S \rightarrow b \\ S \rightarrow \Sigma \}$

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

$G = (N, T, S, P)$

$N = \{S\}$

$T = \{a, b\}$

$P = \{S \rightarrow SaSbSaS, \\ S \rightarrow SaSaSbS \\ S \rightarrow SbSaSaS \\ S \rightarrow \Sigma \}$

4.8 Let G be the grammar

$S \rightarrow aB|bA$

$A \rightarrow a|aS|bAA$

$B \rightarrow b|bS|aBB$

For the string aaabbabbba find a:

a) leftmost derivation.

$S \rightarrow a\underline{B} \rightarrow aa\underline{BB} \rightarrow aaa\underline{BBB} \rightarrow aaab\underline{SBB} \rightarrow aaabb\underline{ABB} \rightarrow aaabba\underline{BB} \rightarrow aaabbab\underline{B}$
 $\rightarrow aaabbabb\underline{S} \rightarrow aaabbabbb\underline{A} \rightarrow aaabbabbba$

b) rightmost derivation.

$S \rightarrow a\underline{B} \rightarrow aa\underline{BB} \rightarrow aaBb\underline{S} \rightarrow aaBbb\underline{A} \rightarrow aa\underline{B}bba \rightarrow aaaB\underline{B}bba \rightarrow aaaBb\underline{S}bba$
 $\rightarrow aaaBba\underline{B}bba \rightarrow aaa\underline{B}babbbba \rightarrow aaabbabbba$

c) Parse tree.



