Linguistics 106
Homework Six
Context Free Grammars (1)

Due: 2 August 2002

1  Defining a CFG for a language
   1. Let $L_1$ be the following set:

      \[ L_1 = \{ \omega \in \{a, b\}^* | \omega \text{ is the same forwards as backwards} \} \]

      Give a Context Free Grammar that generates $L_1$.

   2. Let $L_2$ be the following set of 24 strings:

      \[ L_2 = \{ \text{the boy sing s, the boy s sing, every boy sing s, both boy s sing,} \]

      \[ \text{the boy laugh s, the boy s laugh, every boy laugh s, both boy s laugh,} \]

      \[ \text{the girl sing s, the girl s sing, every girl sing s, both girl s sing,} \]

      \[ \text{the girl laugh s, the girl s laugh, every girl laugh s, both girl s laugh,} \]

      \[ \text{the man sing s, the men sing, every man sing s, both men sing,} \]

      \[ \text{the man laugh s, the men laugh, every man laugh s, both men laugh,} \]

      \[ \text{the woman sing s, the women sing, every woman sing s, both women sing} \]

      \[ \text{the woman laugh s, the women laugh, every woman laugh s, both women laugh} \}

   Assume that the alphabet of $L_2$, $\Sigma_2$, is the following set of 12 symbols:

      \[ \Sigma_2 = \{ \text{boy, girl, man, men, woman, women, the, every, both, s, sing, laugh} \} \]

   Give a Context Free Grammar that generates $L_2$.

   Do not give a CFG that also counts as a Regular Grammar!

   Try to have the CFG match your intuitions about the structure of these
   sentences in English. Specifically, try to have the non-terminals you use
   correspond to grammatical categories of English.

   For example, suppose you have a rule: $S \rightarrow AB$. Then $A$ and $B$ should
   correspond to the major parts of $S$, according to your intuitions about
   English.
2 Describing the language of a CFG

1. Let $G_3$ be the following Context Free Grammar:

   \[ S \rightarrow SaSbS \quad S \rightarrow ShSaS \quad S \rightarrow \epsilon \]

   Describe $L(G_3)$, the Context Free Language generated by $G_3$.

2. Let $G_4$ be the following Context Free Grammar:

   \[
   \begin{align*}
   S & \rightarrow aBbC \quad S \rightarrow AbWc \\
   B & \rightarrow aBb \quad W \rightarrow bWc \\
   B & \rightarrow \epsilon \quad W \rightarrow \epsilon \\
   C & \rightarrow cC \quad A \rightarrow aA \\
   C & \rightarrow \epsilon \quad A \rightarrow \epsilon
   \end{align*}
   \]

   Describe $L(G_4)$, the Context Free Language generated by $G_4$. 