

## Context-Free Grammar Practice Problems\*

For each grammar and the given string, draw the parse tree showing how the string may be derived. Whitespace is used for clarity but is not meaningful in these exercises. Non-terminals are written with an initial capital letter.

1.  $S \rightarrow 0 S 1 \mid 0 1$   
Generate the string 000111
2.  $S \rightarrow + S S \mid * S S \mid a$   
Generate the string  $+*aaa$
3.  $S \rightarrow (S)S \mid \epsilon$   
Generate the string  $(( ))( )$
4.  $S \rightarrow S + S \mid S S \mid (S) \mid S * \mid a$   
Generate  $(a + a) * a$
5.  $S \rightarrow a S b S \mid b S a S \mid \epsilon$   
Generate aabbab
6.  $Id \rightarrow Char Rest$   
 $Rest \rightarrow Symbol Rest \mid \epsilon$   
 $Symbol \rightarrow Char \mid Digit \mid Underscore$   
 $Char \rightarrow a \mid b \mid c \mid \dots \mid z$   
 $Digit \rightarrow 0 \mid 1 \mid \dots \mid 9$   
 $Underscore \rightarrow \_$

Generate:

- a. a
  - b. a1
  - c. a\_1
  - d. ax\_1
7. Assume Id is defined as in #6, then add:  
 $Call \rightarrow Id ( Optparams )$   
 $Optparams \rightarrow Params \mid \epsilon$   
 $Params \rightarrow Params, Param \mid Param$   
 $Param \rightarrow Id$

Generate:

- a. f()
  - b. f(x)
  - c. f(x, y)
8.  $S \rightarrow S S \mid (S) \mid \epsilon$   
Generate the string  $(( ))( )$   
Compare your parse tree with other people/groups. Do they have the same answer as you?

\*Most of these are based on examples in Compilers: Principles, Techniques, and Tools by Aho, Lam, Sethi, and Ullman.