

# Homework Syntax Analysis1

Exercises for Compiler Principles by Li Jiang, 2015 Autumn Semester

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1. Consider the context-free grammar:  $S \rightarrow SS + | SS * | a$   
and the string  $aa + a^*$ .
  - a) Give a leftmost derivation for the string.
  - b) Give a rightmost derivation for the string.
  - c) Give a parse tree for the string.

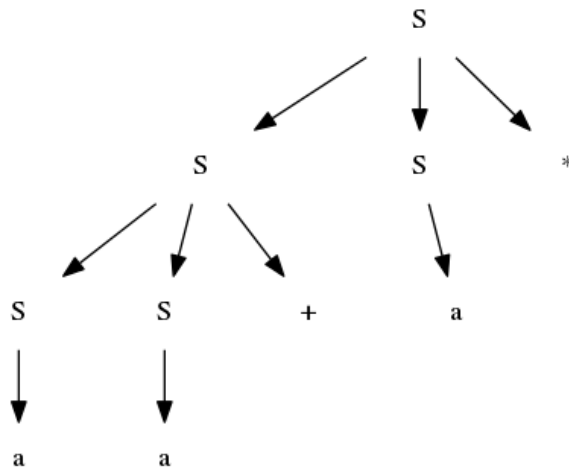
**Solution.**

(a)

$$S \xRightarrow{lm} SS* \xRightarrow{lm} SS + S* \xRightarrow{lm} aS + S* \xRightarrow{lm} aa + S* \xRightarrow{lm} aa + a*$$

(b)

$$S \xRightarrow{rm} SS* \xRightarrow{rm} Sa* \xRightarrow{rm} SS + a* \xRightarrow{rm} Sa + a* \xRightarrow{rm} aa + a*$$



(c)

□

2. The following is a grammar for regular expressions over symbols  $a$  and  $b$  only, using  $+$  in place of  $\cup$  for union, to avoid conflict with the use of vertical bar as a metasymbol in grammars:

$$r_{expr} \rightarrow r_{expr} + r_{term} | r_{term}$$

$$r_{term} \rightarrow r_{term} r_{factor} | r_{factor}$$

$$r_{factor} \rightarrow r_{factor} * | r_{primary}$$

$$r_{primary} \rightarrow a | b$$

- a) Left factor this grammar.
- b) Does left factoring make the grammar suitable for top-down parsing?
- c) In addition to left factoring, eliminate left recursion from the original grammar.
- d) Is the resulting grammar suitable for top-down parsing?

**Solution.**

(a) This grammar is already left factored.

(b) No.

(c)

$$\begin{aligned}rexpr &\rightarrow rterm\ rexpr' \\rexpr' &\rightarrow +rterm\ rexpr'|\epsilon \\rterm &\rightarrow rfactor\ rterm' \\rterm' &\rightarrow rfactor\ rterm'|\epsilon \\rfactor &\rightarrow rprimary\ rfactor' \\rfactor' &\rightarrow *rfactor'|\epsilon \\rprimary &\rightarrow a|b\end{aligned}$$

(d) Yes.

□

3. Compute FIRST and FOLLOW for the grammar:

a)  $S \rightarrow 0S1|01withstring000111$ .

b)  $S \rightarrow +SS|*SS|awithstring+*aaa$ .

**Solution.**

(a)  $\text{FIRST}(S) = \{0\}$   
 $\text{FOLLOW}(S) = \{1, \$\}$

(b)  $\text{FIRST}(S) = \{+, *, a\}$   
 $\text{FOLLOW}(S) = \{+, *, a, \$\}$

□