Homework 1
Programming Languages
CS 320
Stephen Giang RedID: 823184070

Section A. Regular Expressions

Write "regex" statements for the following patterns:

(a) A string that has either "comp" or "imp"
Expression: ".*(co|i)mp.*"

(b) A string that starts and ends with "virus"
Expression: "^virus.*virus$"

(c) A string that has a "z" followed by at least one "o"
Expression: "zo+"

Section B. Sebesta Review Questions

(a) Define syntax and semantics.

Syntax - the form or structure of the expressions, statements, and program units
Semantics - the meaning of the expressions, statements, and program units

(b) Define a left-recursive grammar rule.

Left-Recursive Grammar Rule - a rule in which the leftmost variable on the right hand side is the same as the variable on the right hand side.

Section C. From Sebesta Problem Set Questions

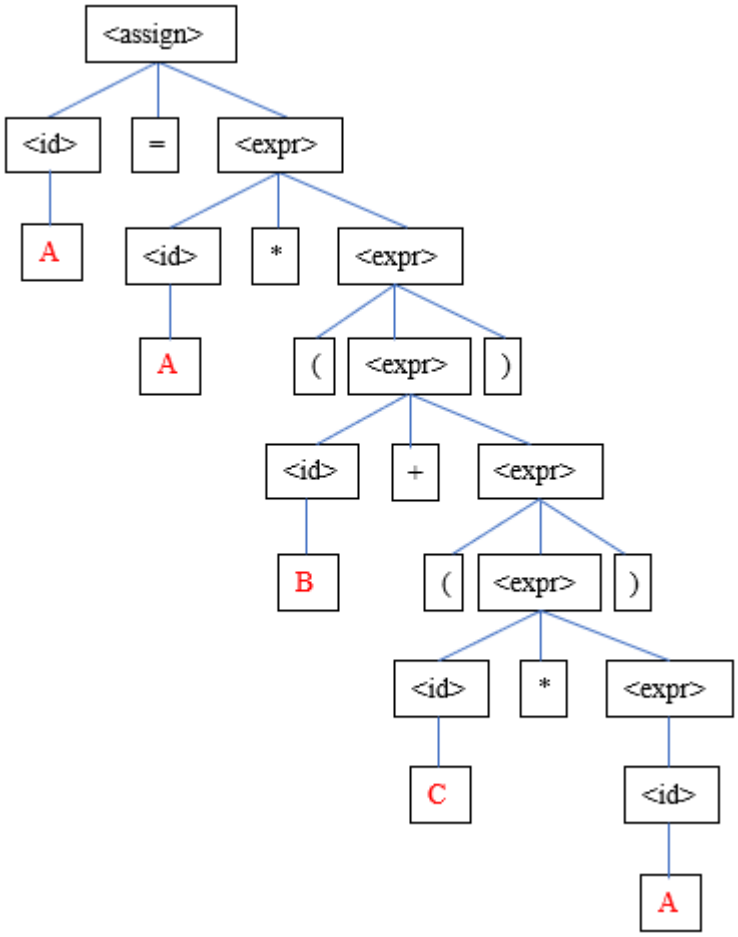
1. Write an EBNF description for a Java class definition header statement.

$$
\begin{aligned}
&< \text{header} > \rightarrow \quad < \text{modifier} > \textbf{class} < \text{class\_name} > \\
&\qquad\qquad [\textbf{extends} < \text{extend\_class\_name} >] \\
&\qquad\qquad [\textbf{implements} < \text{interface\_name} > \{, < \text{interface\_name} >\}] \\
&< \text{modifier} > \rightarrow \text{public} \mid \text{abstract} \mid \text{final}
\end{aligned}
$$

2. Using the grammar in Example 3.2, show a parse tree and a leftmost derivation for the following statement:

$$A = A * (B + (C * A))$$

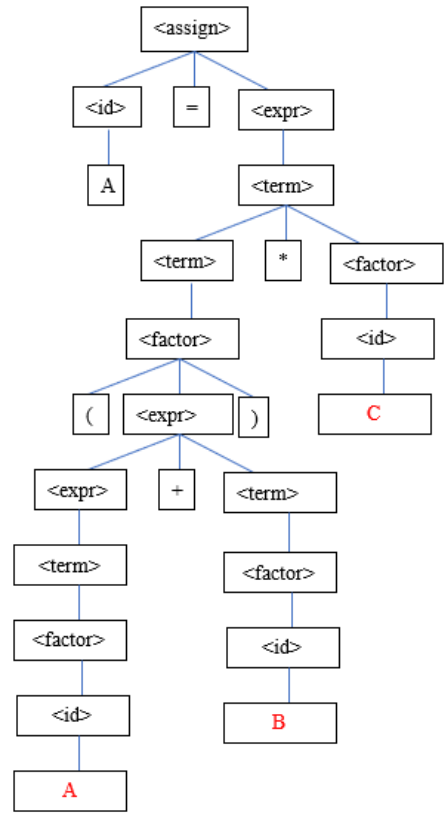
$$\begin{aligned}
< \text{assign} > &\rightarrow \ < \text{id} > \ = \ < \text{expr} > \\
&\rightarrow \ \text{A} \ = \ < \text{expr} > \\
&\rightarrow \ \text{A} \ = \ < \text{id} > \ * \ < \text{expr} > \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ < \text{expr} > \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (< \text{expr} >) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (< \text{id} > \ + \ < \text{expr} >) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (B \ + \ < \text{expr} >) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (B \ + \ (< \text{expr} >)) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (B \ + \ (< \text{id} > \ * \ < \text{expr} >)) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (B \ + \ (\ \text{C} \ * \ < \text{expr} >)) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (B \ + \ (\ \text{C} \ * \ < \text{id} >)) \\
&\rightarrow \ \text{A} \ = \ \text{A} \ * \ (B \ + \ (\ \text{C} \ * \ A))
\end{aligned}$$



3. Using the grammar in Example 3.2, show a parse tree and a leftmost derivation for the following statement:

$$A = (A + B) * C$$

$$\begin{aligned}
< \text{assign} > &\rightarrow \ < \text{id} > \ = \ < \text{expr} > \\
&\rightarrow A = \ < \text{expr} > \\
&\rightarrow A = \ < \text{term} > \\
&\rightarrow A = \ < \text{term} > \ * \ < \text{factor} > \\
&\rightarrow A = \ < \text{factor} > \ * \ < \text{factor} > \\
&\rightarrow A = \ (< \text{expr} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (< \text{expr} > + \ < \text{term} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (< \text{term} > + \ < \text{term} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (< \text{factor} > + \ < \text{term} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (< \text{id} > + \ < \text{term} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (\text{A} \ + \ < \text{term} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (\text{A} \ + \ < \text{factor} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (\text{A} \ + \ < \text{id} >) \ * \ < \text{factor} > \\
&\rightarrow A = \ (\text{A} \ + \ \text{B}) \ * \ < \text{factor} > \\
&\rightarrow A = \ (\text{A} \ + \ \text{B}) \ * \ < \text{id} > \\
&\rightarrow A = \ (\text{A} \ + \ \text{B}) \ * \ \text{C}
\end{aligned}$$



4. Consider the following grammar:

$$(S) \rightarrow (A)\ a\ (B)\ b$$
$$(A) \rightarrow (A)\ b \mid b$$
$$(B) \rightarrow a\ (B) \mid a$$

Which of the following sentences are in the language generated by this grammar?

(a) baab

$$\begin{aligned}(S) &\rightarrow (A)\ a\ (B)\ b\\ &\rightarrow b\ a\ (B)\ b\\ &\rightarrow b\ a\ a\ b\end{aligned}$$

(b) bbbab
Impossible because the conversion of (B) will always give us more than one "a".

(c) bbaaaaa
Impossible because the last letter will always be "b" in the given grammar

(d) bbaab

$$\begin{aligned}(S) &\rightarrow (A)\ a\ (B)\ b\\ &\rightarrow (A)\ b\ a\ (B)\ b\\ &\rightarrow b\ b\ a\ (B)\ b\\ &\rightarrow b\ b\ a\ a\ b\end{aligned}$$

5. Convert the BNF of Example 3.1 to EBNF.

$$\begin{aligned}< \text{program} > &\rightarrow \textbf{begin}\ < \text{stmt} >\ \{;\ < \text{stmt} >\ \}\ \textbf{end}\\ < \text{stmt} > &\rightarrow\ < \text{var} >\ =\ < \text{var} >\ \{[+|-]\ < \text{var} >\ \}\\ < \text{var} > &\rightarrow A \mid B \mid C\end{aligned}$$