Gianna Julio

CMPT440 - Formal Languages and Computability
Assignment 7 - Context Free Grammars

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1. **Webber Chap. 12 Exercise 1**
   Give CFGs for the following languages:

   (a) S → aS | B
   B → bB | ϵ

   (b) S → S0S0S0S | X | ϵ
   X → 1 | ϵ

   (c) S → XXXS | ϵ
   X → 0 | 1

   (d) S → 0A0 | 1A1 | ϵ
   A → 0A | 1A | 0B | 1B | ϵ
   B → 0B0 | 1B1 | S

   (e) S → A | B | ϵ
   A → aAb | aBb
   B → aB | bB | ϵ

   (f) S → aSbb | B
   B → bB | ϵ

   (g) S → aaSbb | ϵ

   (h) S → abSde | c

   (i) S → ab | aaSbb

   (j) S → XSY | ϵ
   X → aXb | ϵ
   Y → Yz | ϵ

2. **Webber Chap. 12 Exercise 2**
   Give a BNF grammar for each of the languages below:

   (a) <exp> ::= a <exp> | ϵ

   (b) <exp> ::= <upper> <char>
   <upper> ::= any uppercase letter
   <char> ::= any uppercase letter — any digit (0-9)

   (c) <exp> ::= a <exp> | a

   (d) <digit> ::= <digit> <digit> | any digit (0-9)

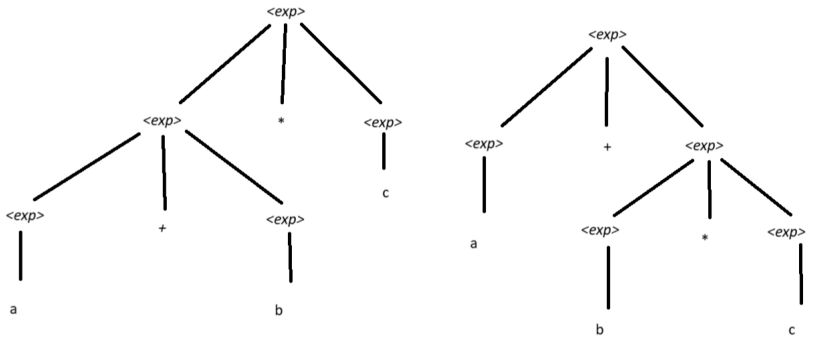
   (e) <exp> ::= a; <exp> | ϵ

   (f) <exp> ::= begin <stmt>; end
   <stmt> ::= <stmt>; <stmt>; | <statement> | ϵ

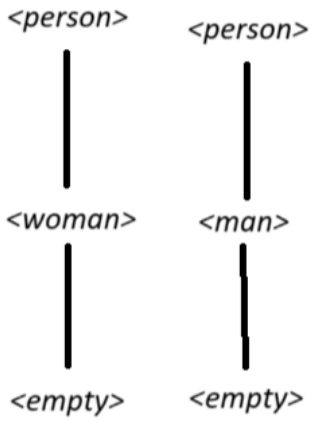
   (g) <exp> ::= a; <exp>| a;

3. **Webber Chap. 12 Exercise 4**
   Show that each of the following BNF grammars is ambiguous. (To show that a grammar is ambiguous, you must demonstrate that it can generate two parse trees for the same string.)

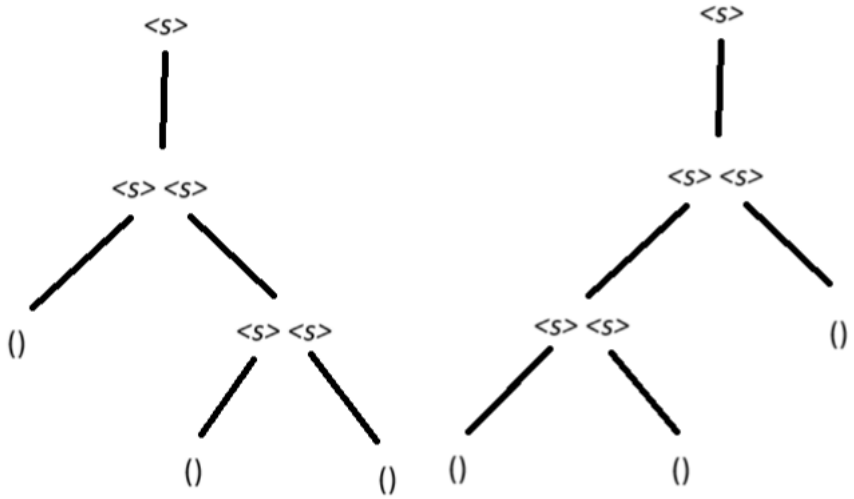
(a) a+b*c



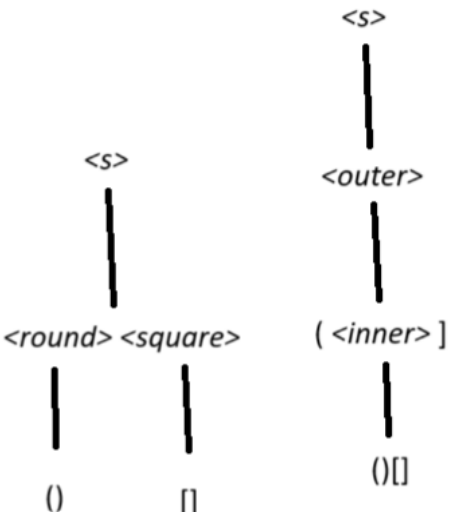
(b) <empty>



(c) ()()()



(d) ()[]



4. **Webber Chap. 13 Exercise 1**

	read	pop	push
1.	*a*	*S*	*S*1
2.	ε	*S*	ε
3.	*b*	1	ε

How would you change the stack machine of section 13.2 so that the language it accepts is $\{a^n b^n \mid n > 0\}$?

	read	pop	push
1.	a	S	S1
2.	E	S1	1
3.	b	1	E

5. **Webber Chap. 13 Exercise 2**

Show the table of moves for a stack machine for the language $\{a^n c b^n\}$

	read	pop	push
1.	a	S	S1
2.	c	S	E
3.	b	1	E