CS 430 Grammar Lab

Part 1: Grammars and Ambiguity

Consider the following context-free grammar, written using the variant of BNF we've used in class.

A → V = E
E → E ^ E
  | E ~ E
  | V
V → a | b | c ... y | z

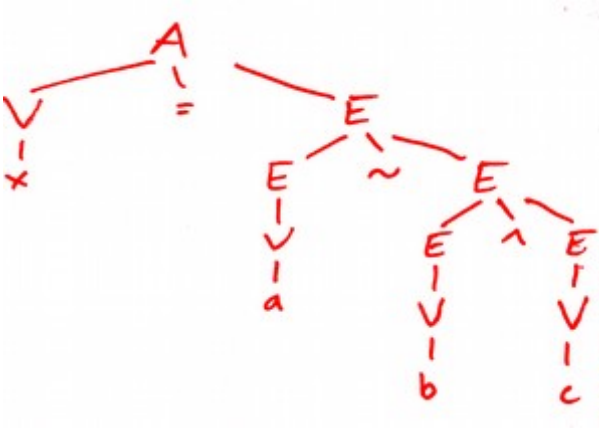
1. List all non-terminals.
   A, E, V

2. How many productions are there total?
   1 (A) + 3 (E) + 26 (V) = 30

3. List all terminals.
   =, ^, ~, a, b, c, ... y, z

4. Write a leftmost derivation and draw the corresponding parse tree for the statement "x = a ~ b ^ c"

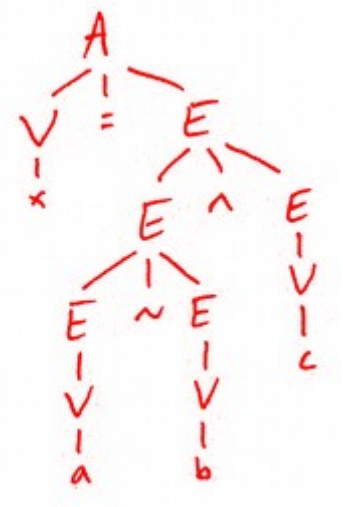
A
V = E
x = E
x = E ~ E
x = V ~ E
x = a ~ E
x = a ~ E ^ E
x = a ~ V ^ E
x = a ~ b ^ E
x = a ~ b ^ V
x = a ~ b ^ c



5. Is the grammar ambiguous? If it is, prove it by providing an example.

yes, here is an alternative leftmost derivation and parse tree of the same sentence:

A
V = E
x = E
x = E ^ E
x = E ~ E ^ E
x = V ~ E ^ E
x = a ~ E ^ E
x = a ~ V ^ E
x = a ~ b ^ E
x = a ~ b ^ V
x = a ~ b ^ c



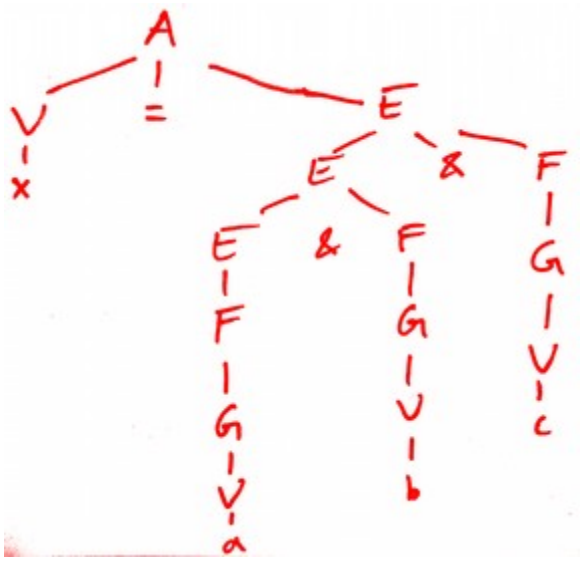
Part 2: Associativity and Precedence

Consider the following grammar, written using the variant of BNF we've used in class.

```
A → V = E
E → E ^ F
E → E & F
  | F
F → F ~ G
  | G
G → ! G
  | V
V → a | b | c ... y | z
```

6. Is the & operator left or right associative? Give an example sentence and parse tree.

left associative
one possible example sentence:
x = a & b & c



7. List all operators in order of precedence from higher to lower. If two operators have the same precedence, list them on the same line.

!
~
^, &
=

8. Modify the grammar to allow chained assignments (e.g., "x = y = a ~ b ^ c"). List only the productions for any non-terminals that you add or modify. Is the = operator left or right associative?

one possible solution:

```
A →  V = A
   |  V = E      (right associative)
```