Grammars

1)

T = {$, #, *, @, X}

N = {<expr>, <term>, <factor>}

S = <expr>

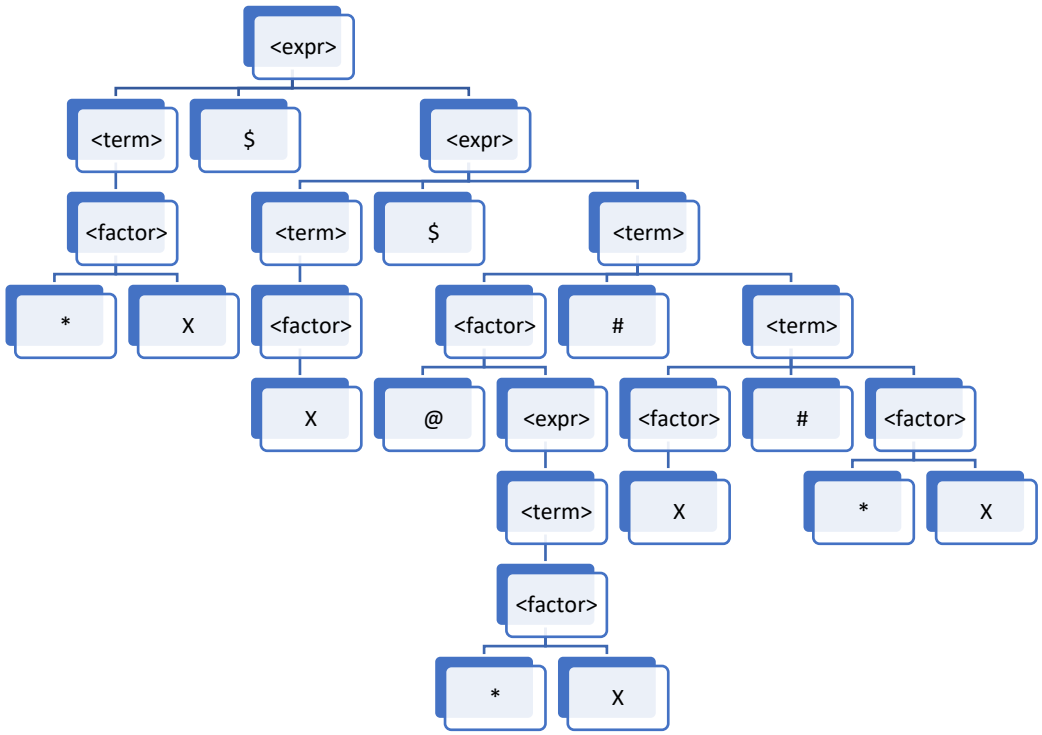
P = {<expr> ::= <term>
| <term> $ <term>
| <term> $ <expr>
<term> ::= <factor>
| <factor> # <factor>
| <factor> # <term>
<factor> ::= X
*X
@X
<expr>
*<expr>
@<expr>}

<expr> ::= <term> {$ <term>}
<term> ::= <factor> {# <factor>}
<factor> ::= [@|*] (X | <expr>)

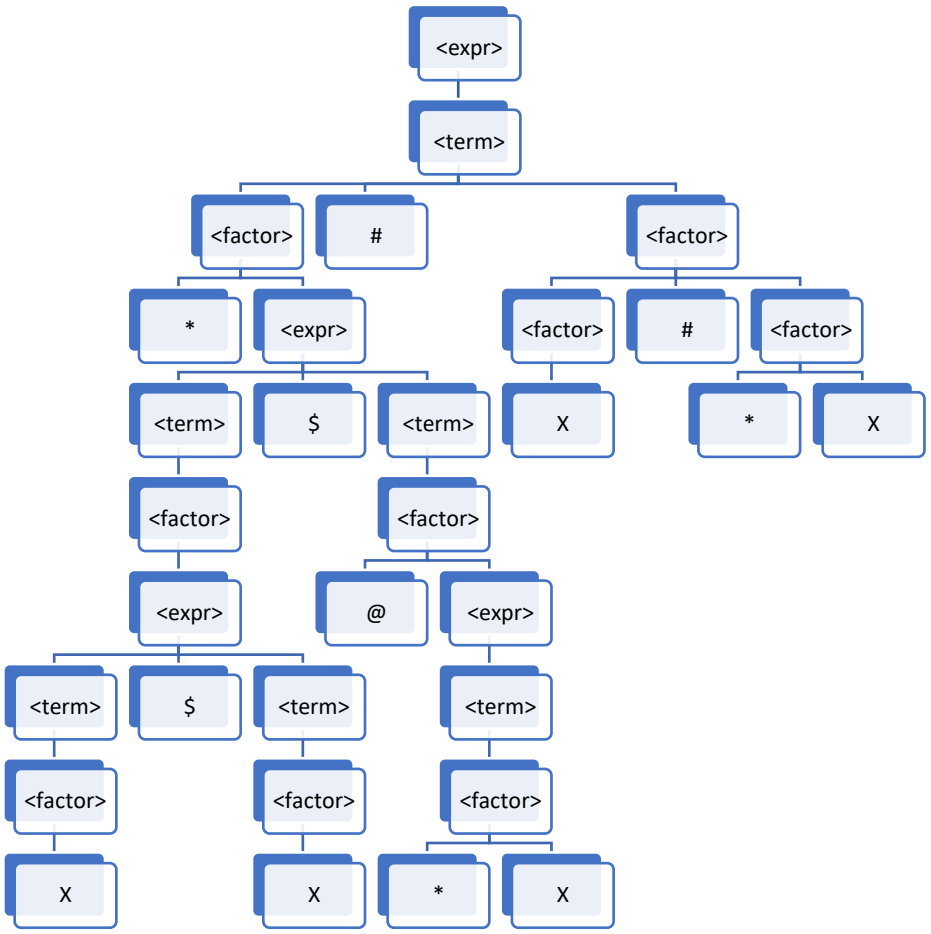
2) $ and # are both right associative.

@ *
#
$

4) Parse tree for *XX@*X#X#*X



5) This language is ambiguous. I will prove this by finding 2 different parse trees for `*X$X$@*X#X#*X`. I already found one parse tree for it in #4 so here I will find a different one.



Syntax Charts

Chart A EBNF

T = {0, 1}

N = {<A>}

S = <A>

P = {<A> ::= 0 { 0 0 } 1 { 0 { 0 0 } 1 }}

Justification: An <A> is a least 0 followed by a 1. There can be any even number of zeros between the 0 and 1. This can be followed by any number of repetitions of a 0 followed by a 1 with any even number of zeros between the zero and one

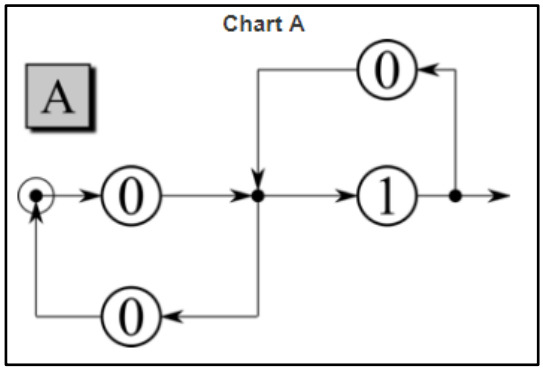


Chart B EBNF

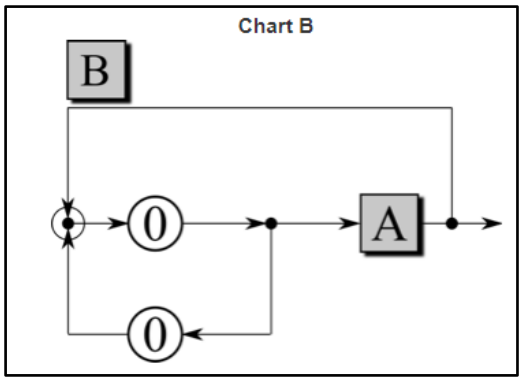
T = {0, 1}

N = {<A>, <B>}

S = <B>

P ={<A> ::= 0 { 0 0 } 1 { 0 { 0 0 } 1 }
<B> ::= 0 { 0 0 } { <A> 0 { 0 0 } } <A>}

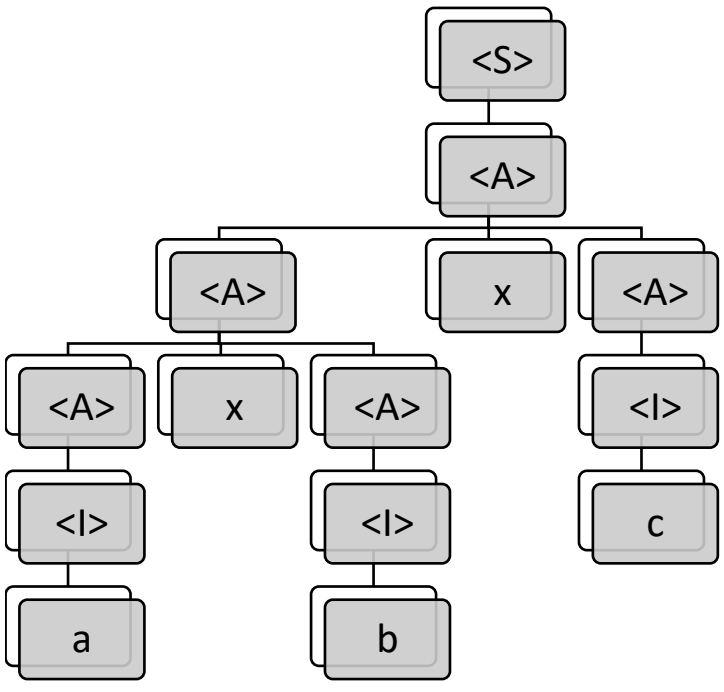
Justification: I justified <A> in the previous chart. <B> is at least a 0 followed by an <A>. Between them can be any even number of zeros followed by any number of repetitions of <A> followed by 0 with any even number of zeros after it.



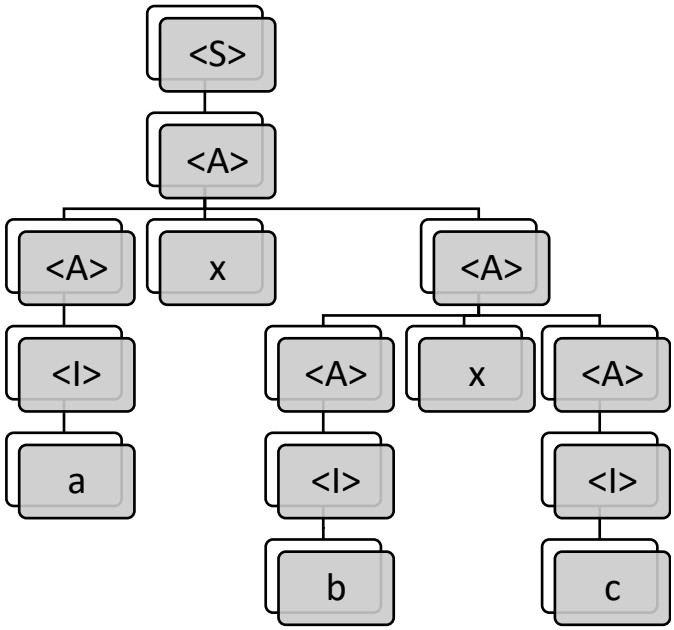
Syntactic Ambiguity

```
N = {<S>, <A>, <I>}
T = {a, b, c, x}
P = {<S> ::= <A>
     <A> ::= <A>x<A>
     <A> ::= <I>
     <I> ::= a
     <I> ::= b
     <I> ::= c}
S = <S>
```

Syntax Tree 1 for “a x b x c”



Syntax Tree 2 for “a x b x c”



There are 2 different syntax trees for the same expression “a x b x c” in this BNF grammar. This proves that this BNF grammar is ambiguous.