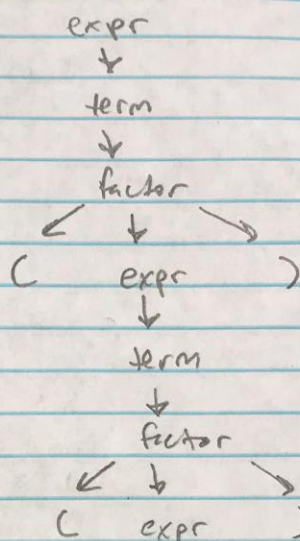


Eduardo Abreu
 Syntax & Semantics #1

1. Textbook page 247, Problem 6.14 (a), (c), (d).
 Give a leftmost derivation & draw a parse tree.

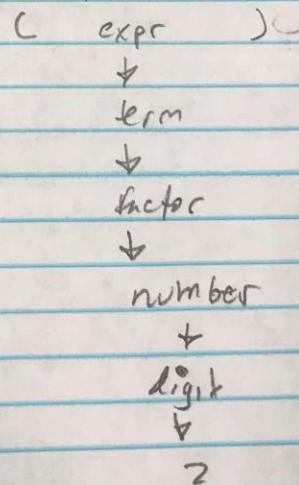
(a) $((2))$

$\text{expr} \Rightarrow \text{term}$
 $\Rightarrow \text{factor}$
 $\Rightarrow (\text{expr})$
 $\Rightarrow (\text{term})$
 $\Rightarrow (\text{factor})$
 $\Rightarrow ((\text{expr}))$
 $\Rightarrow ((\text{term}))$
 $\Rightarrow ((\text{factor}))$
 $\Rightarrow ((\text{number}))$
 $\Rightarrow ((\text{digit}))$
 $\Rightarrow ((2))$

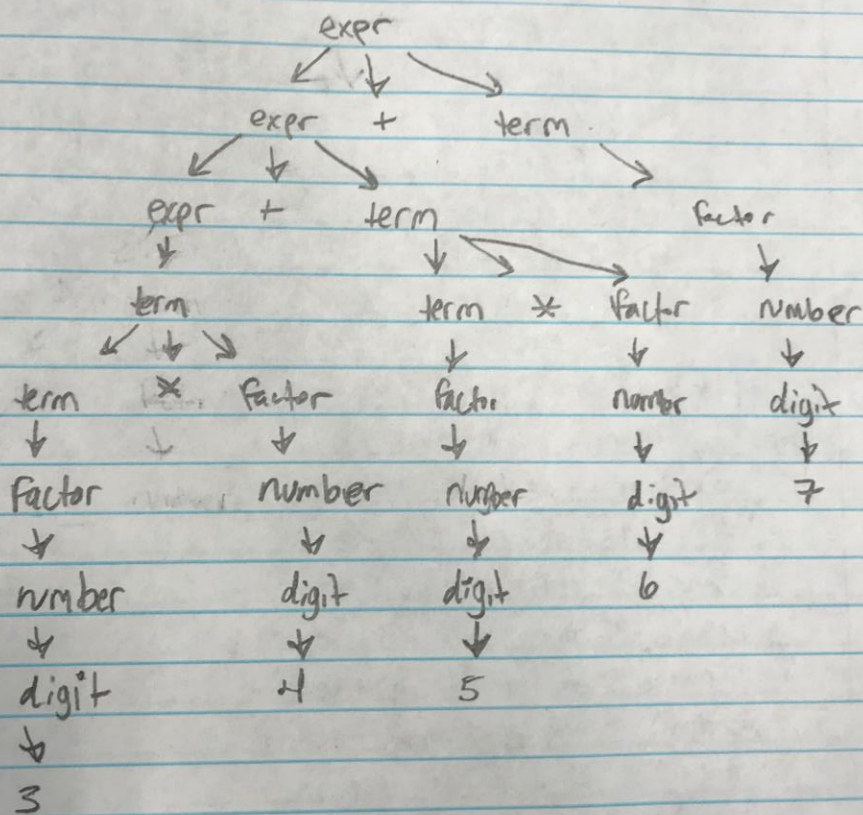


(c) $3 * 4 + 5 * 6 + 7$

$\text{expr} \Rightarrow \text{expr} + \text{term}$
 $\Rightarrow \text{expr} + \text{term} + \text{term}$
 $\Rightarrow \text{term} + \text{term} + \text{term}$
 $\Rightarrow \text{term} * \text{factor} + \text{term} + \text{term}$
 $\Rightarrow \text{factor} * \text{factor} + \text{term} + \text{term}$
 $\Rightarrow \text{number} * \text{factor} + \text{term} + \text{term}$
 $\Rightarrow \text{digit} * \text{factor} + \text{term} + \text{term}$
 $\Rightarrow 3 * \text{factor} + \text{term} + \text{term}$
 $\Rightarrow 3 * \text{number} + \text{term} + \text{term}$
 $\Rightarrow 3 * \text{digit} + \text{term} + \text{term}$
 $\Rightarrow 3 * 4 + \text{term} + \text{term}$
 $\Rightarrow 3 * 4 + \text{term} * \text{factor} + \text{term}$
 $\Rightarrow 3 * 4 + \text{factor} * \text{factor} + \text{term}$
 $\Rightarrow 3 * 4 + \text{number} * \text{factor} + \text{term}$
 $\Rightarrow 3 * 4 + \text{digit} * \text{factor} + \text{term}$
 $\Rightarrow 3 * 4 + 5 * \text{factor} + \text{term}$
 $\Rightarrow 3 * 4 + 5 * \text{number} + \text{term} \rightarrow$



$\Rightarrow 3 \times 4 + 5 \times \text{digit} + \text{term}$
 $\Rightarrow 3 \times 4 + 5 \times 6 + \text{term}$
 $\Rightarrow 3 \times 4 + 5 \times 6 + \text{factor}$
 $\Rightarrow 3 \times 4 + 5 \times 6 + \text{number}$
 $\Rightarrow 3 \times 4 + 5 \times 6 + \text{digit}$
 $\Rightarrow 3 \times 4 + 5 \times 6 + 7$



$$(d) \ 3 * (4 + 5) * (6 + 7)$$

expr \Rightarrow term

\Rightarrow term * factor

\Rightarrow term * factor * factor

\Rightarrow factor * factor * factor

\Rightarrow number * factor * factor

\Rightarrow digit * factor * factor

$\Rightarrow 3 * \text{factor} * \text{factor}$

$\Rightarrow 3 * (\text{expr}) * \text{factor}$

$\Rightarrow 3 * (\text{expr} + \text{term}) * \text{factor}$

$\Rightarrow 3 * (\text{term} + \text{term}) * \text{factor}$

$\Rightarrow 3 * (\text{factor} + \text{term}) * \text{factor}$

$\Rightarrow 3 * (\text{number} + \text{term}) * \text{factor}$

$\Rightarrow 3 * (\text{digit} + \text{term}) * \text{factor}$

$\Rightarrow 3 * (4 + \text{term}) * \text{factor}$

$\Rightarrow 3 * (4 + \text{factor}) * \text{factor}$

$\Rightarrow 3 * (4 + \text{number}) * \text{factor}$

$\Rightarrow 3 * (4 + \text{digit}) * \text{factor}$

$\Rightarrow 3 * (4 + 5) * \text{factor}$

$\Rightarrow 3 * (4 + 5) * (\text{expr})$

$\Rightarrow 3 * (4 + 5) * (\text{expr} + \text{term})$

$\Rightarrow 3 * (4 + 5) * (\text{term} + \text{term})$

$\Rightarrow 3 * (4 + 5) * (\text{factor} + \text{term})$

$\Rightarrow 3 * (4 + 5) * (\text{number} + \text{term})$

$\Rightarrow 3 * (4 + 5) * (\text{digit} + \text{term})$

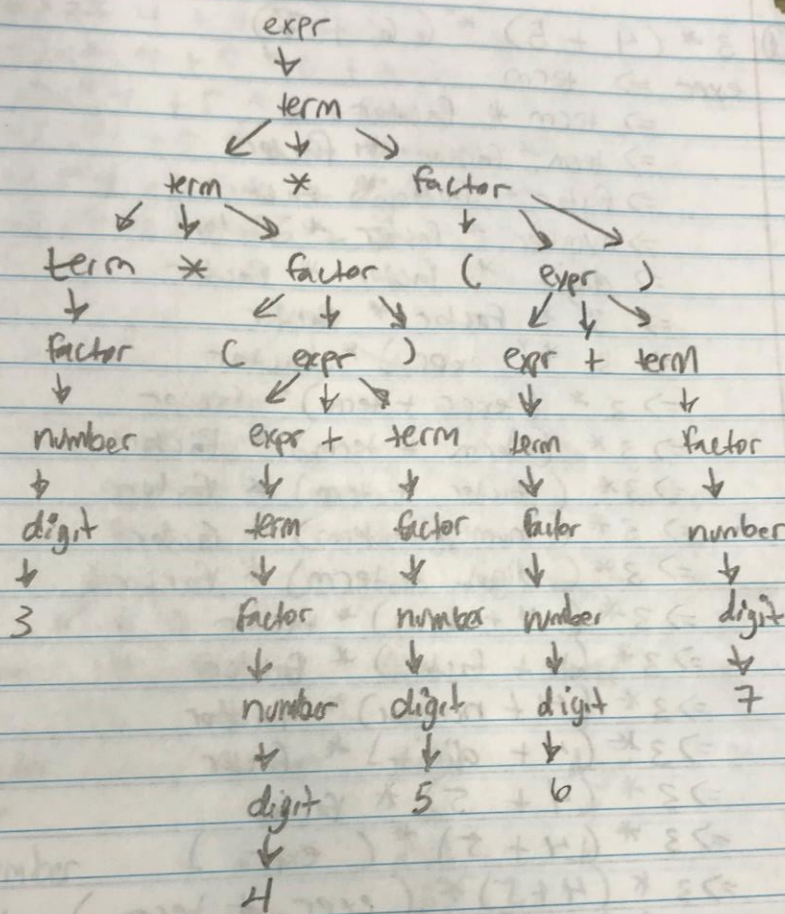
$\Rightarrow 3 * (4 + 5) * (6 + \text{term})$

$\Rightarrow 3 * (4 + 5) * (6 + \text{factor})$

$\Rightarrow 3 * (4 + 5) * (6 + \text{number})$

$\Rightarrow 3 * (4 + 5) * (6 + \text{digit})$

$\Rightarrow 3 * (4 + 5) * (6 + 7)$



2. Textbook Page 246, Problem 6.5 (a).

(a) Describe the strings that are represented by the regular expression:

$[0-9]^+((E|e)(\backslash+|\backslash-)?[0-9]^+)?$

- "[0-9]" are numbers.
- "+" means it can be repeated 1 or more times.
- "()?" means that anything inside is optional.
- "(E|e)" option of "E" or "e".
- "(\+|\-)" option of "+" or "-".

3. Consider the following BNF grammar rules:

$\langle \text{pop} \rangle \rightarrow [\langle \text{bop} \rangle, \langle \text{pop} \rangle] | \langle \text{bop} \rangle$

$\langle \text{bop} \rangle \rightarrow \langle \text{boop} \rangle | (\langle \text{bop} \rangle)$

$\langle \text{boop} \rangle \rightarrow x | y | z$

For each of the following strings give a leftmost derivation; draw a parse tree. If no such derivation is possible, indicate this:

(a) (Y)

$\langle \text{pop} \rangle \Rightarrow \langle \text{bop} \rangle$
 $\Rightarrow (\langle \text{bop} \rangle)$
 $\Rightarrow (\langle \text{boop} \rangle)$
 $\Rightarrow (Y)$

$\langle \text{pop} \rangle$

↓

$\langle \text{bop} \rangle$

↙ ↓ ↘
 $(\langle \text{boop} \rangle)$

↓

$\langle \text{boop} \rangle$

↓

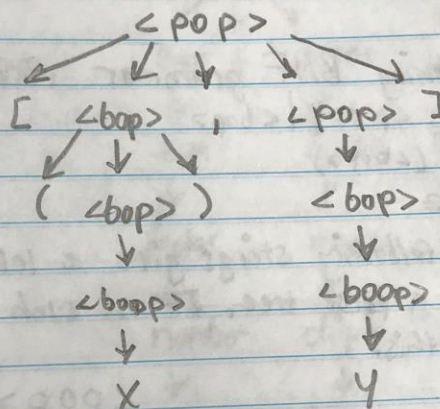
Y

(b) [Y]

• No such derivation is possible

© $[(x), y]$

$\langle \text{pop} \rangle \Rightarrow [\langle \text{bop} \rangle, \langle \text{pop} \rangle]$
 $\Rightarrow [(\langle \text{bop} \rangle), \langle \text{pop} \rangle]$
 $\Rightarrow [(\langle \text{bop} \rangle), \langle \text{pop} \rangle]$
 $\Rightarrow [(x), \langle \text{pop} \rangle]$
 $\Rightarrow [(x), \langle \text{bop} \rangle]$
 $\Rightarrow [(x), \langle \text{bop} \rangle]$
 $\Rightarrow [(x), y]$



④ $[(x), [z, x], ([z])]$

$\langle \text{pop} \rangle \Rightarrow [\langle \text{bop} \rangle, \langle \text{pop} \rangle]$
 $\Rightarrow [(\langle \text{bop} \rangle), \langle \text{pop} \rangle]$
 $\Rightarrow [(\langle \text{bop} \rangle), \langle \text{pop} \rangle]$
 $\Rightarrow [(x), \langle \text{pop} \rangle]$

• Derivation not possible.

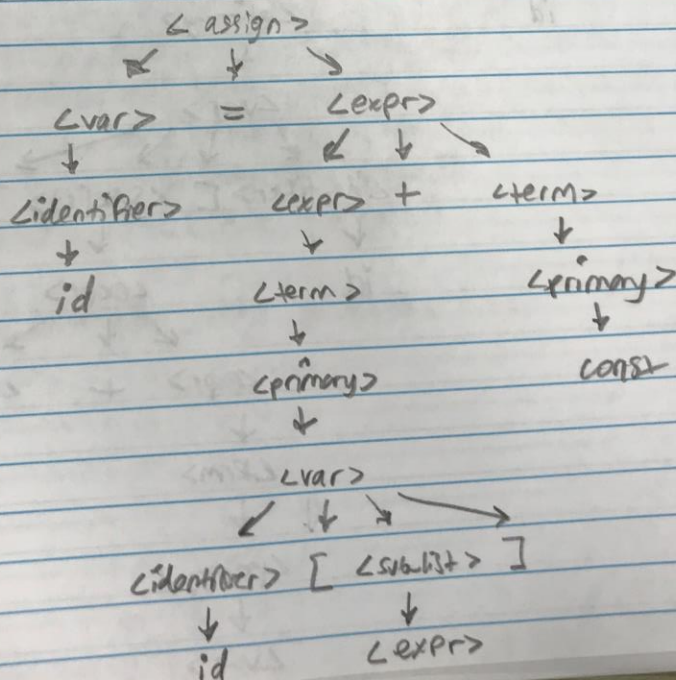
4. Consider the following grammar:

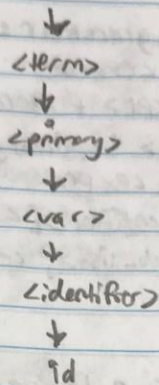
$\langle \text{assign} \rangle \rightarrow \langle \text{var} \rangle = \langle \text{expr} \rangle$
 $\langle \text{expr} \rangle \rightarrow \langle \text{term} \rangle \mid \langle \text{expr} \rangle + \langle \text{term} \rangle \mid \langle \text{expr} \rangle - \langle \text{term} \rangle$
 $\langle \text{term} \rangle \rightarrow \langle \text{primary} \rangle \mid \langle \text{term} \rangle * \langle \text{primary} \rangle \mid \langle \text{term} \rangle / \langle \text{primary} \rangle$
 $\langle \text{primary} \rangle \rightarrow \langle \text{var} \rangle \mid \text{const} \mid \langle \text{expr} \rangle$
 $\langle \text{var} \rangle \rightarrow \langle \text{identifier} \rangle \mid \langle \text{identifier} \rangle [\langle \text{sublist} \rangle]$
 $\langle \text{sublist} \rangle \rightarrow \langle \text{expr} \rangle \mid \langle \text{sublist} \rangle, \langle \text{expr} \rangle$
 $\langle \text{identifier} \rangle \rightarrow \text{id}$

- Assume here that "id" is a lexical analyzer's classification of a non-reserved name (such as might be used for a variable or function), and that "const" represents a lexical analyzer's classification of a number.

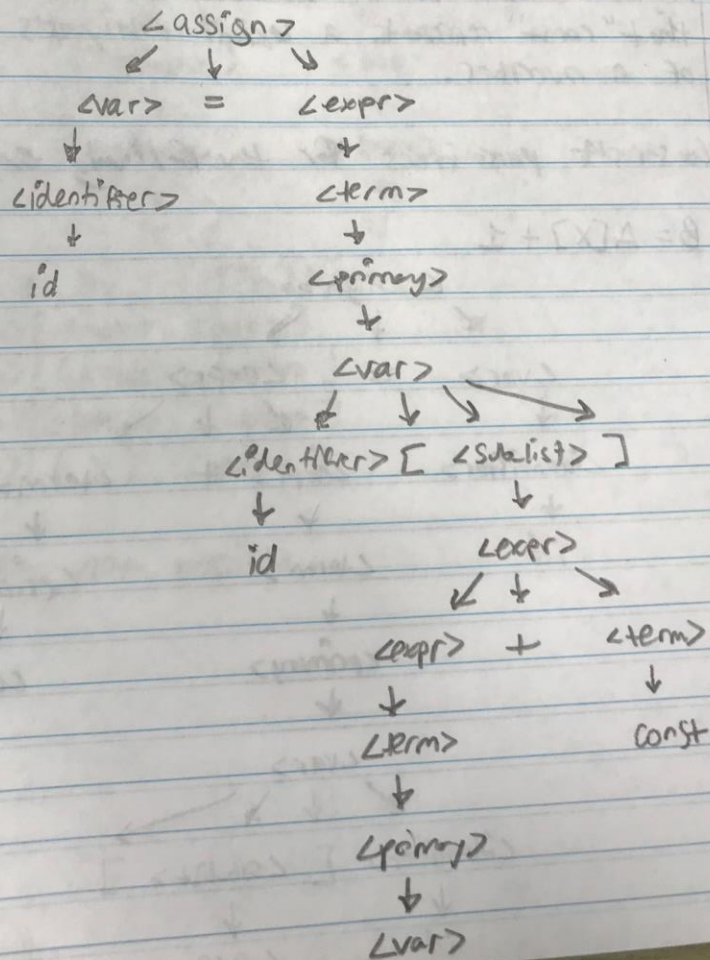
Construct parse trees for the following expressions.

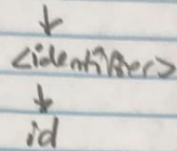
(a) $B = A[X] + 1$





⑥ $B = A[x+1]$





© $X = U - V * W + X / Y$

