

# CSC388 Programming Languages

## Homework 1

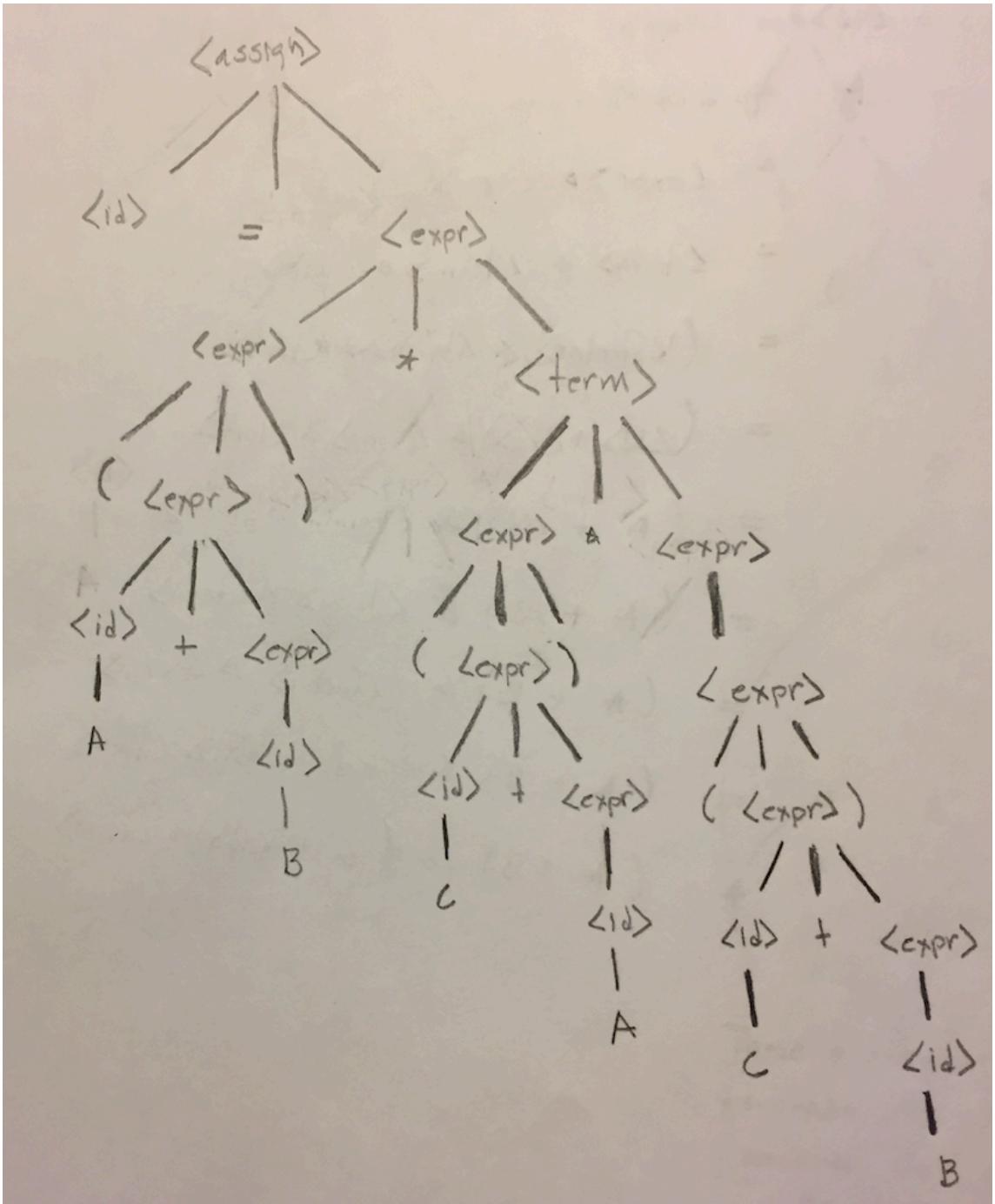
---

Hannah Roach  
388 Programming Languages  
9-30-2018

1. (25 points) Using the grammar in Example 3.4 (page 125) show a parse tree and a leftmost derivation for the following statement (make sure you do not omit parentheses in your derivation):

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

```
<assign> = <id> =<expr>
C = <expr>
C = <expr>*<term>
C = <expr>*<expr>*<expr>
C = (<expr>)*<expr>*<expr>
C = (<id>+<expr>)*<expr>*<expr>
C = (A+<expr>)*<expr>*<expr>
C = (A+<id>)*<expr>*<expr>
C = (A+B)*<expr>*<expr>
C = (A+B)* (<id>+<expr>)*<expr>
C = (A+B)* (C+<expr>)*<expr>
C = (A+B)* (C+<id>)*<expr>
C = (A+B)* (C+A)*<expr>
C = (A+B)* (C+A)*(<id>+<expr>)
C = (A+B)* (C+A)*(C+<expr>)
C = (A+B)* (C+A)*(C+<id>)
C = (A+B)* (C+A)*(C+D)
```



2. (25 points) Consider the following grammar (S is the start symbol; 0 and 1 are terminal symbols; A and B are nonterminals)

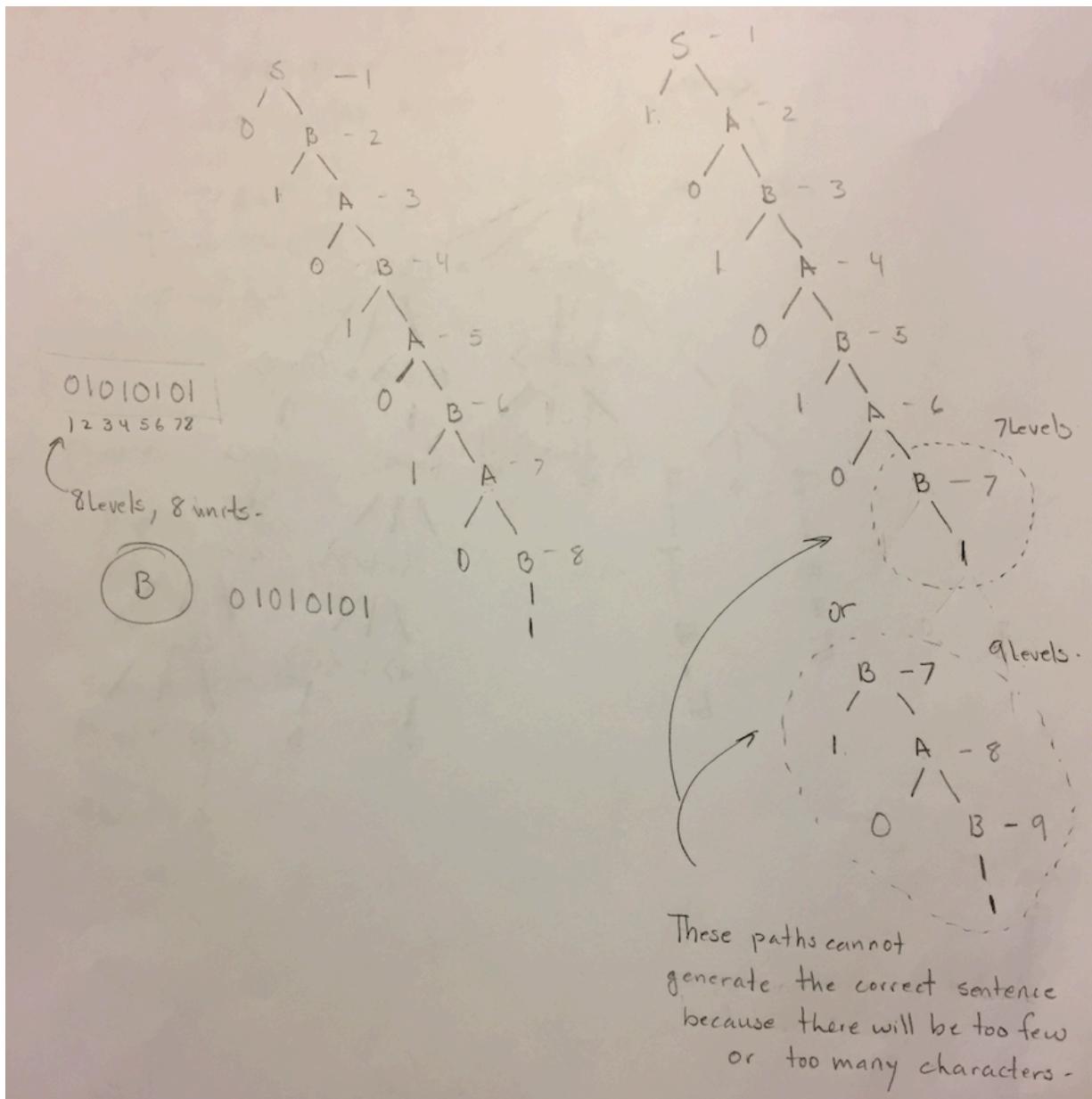
$$S \rightarrow 0B \mid 1A$$

$$A \rightarrow 0B$$

$$B \rightarrow 1A \mid 1$$

Which of the following sentences are in the language generated by the grammar? Show derivations. If a sentence cannot be generated by the grammar, explain why.

- a) 01010100
- b) 01010101
- c) 10101010
- d) 10010011



3. (25 Points) For the following grammar and the right sentential form  $F^*$  ( $\text{id} + \text{id}$ ) draw a parse tree and show all phrases, simple phrases, and the handle ( $E$ ,  $T$ , and  $F$  are nonterminal symbols;  $\text{id}$  is a terminal symbol). Explain.

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T * F \mid F$$

$$F \rightarrow (E) \mid \text{id}$$

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T * F \mid F$$

$$F \rightarrow (E) \mid \text{id}$$

Phrases:

$F^* (E + T)$

$(E + T)$

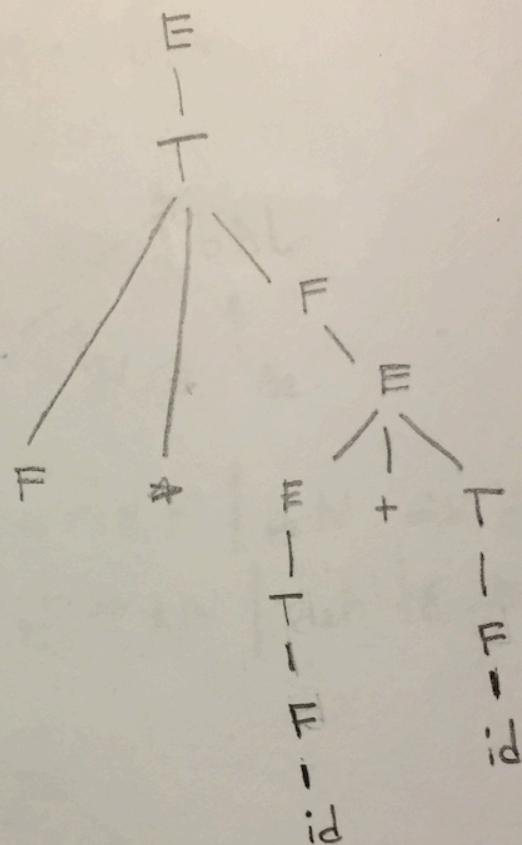
$\text{id}$

Simple phrases:

$\text{id}$

Handle:

$\text{id}$



4. (25 Points) Transform the following left recursive EBNF grammar into an equivalent non-left recursive grammar (S and A are nonterminal symbols; S is the start symbol; a and b are terminal symbols):

$$S \rightarrow aSb \mid bAS$$

$$A \rightarrow AaA \mid bAA \mid AAa \mid bAb$$

$$A \rightarrow AaA \mid AaA \mid bAA \mid bAb.$$

$\uparrow \alpha_1$        $\uparrow \alpha_2$        $\uparrow \beta_1$        $\uparrow \beta_2$

$$\alpha_1 = aA$$

$$\alpha_2 = a$$

$$\beta_1 = bAA$$

$$\beta_2 = bAb.$$

$$A \rightarrow \beta_1 A' \mid \beta_2 A' \Rightarrow bAAA' \mid bAbA'$$

$$A' \rightarrow \alpha_1 A' \mid \alpha_2 A' \mid \epsilon \Rightarrow aAA' \mid aA' \mid \epsilon.$$

$$S \rightarrow aSb \mid bAs$$

$$A \rightarrow bAAA' \mid bAbA'$$

$$A' \rightarrow aAA' \mid aA' \mid \epsilon$$