BU CS320 Assignment 5: Context Free Grammars

October 30, 2023

1. Given the following grammar where $\langle expr \rangle$ is the starting symbol

$\langle digit \rangle ::= 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9$

$\langle nat \rangle ::= \langle digit \rangle \mid \langle digit \rangle \langle nat \rangle$

$\langle int \rangle ::= \langle nat \rangle \mid -\langle nat \rangle$

$\langle expr \rangle ::= \langle int \rangle$
$\quad\quad\quad \mid \; (\; \langle expr \rangle \;)$
$\quad\quad\quad \mid \; \langle expr \rangle + \langle expr \rangle$
$\quad\quad\quad \mid \; \langle expr \rangle \; * \; \langle expr \rangle$

Derive the sentence using *rightmost derivation*.

12 + 2 * -07

<expr> = <expr> * <expr>
<expr> = <expr> * <int>
<expr> = <expr> * -<nat>
<expr> = <expr> * -<digit> <nat>
<expr> = <expr> * -<digit> <digit>
<expr> = <expr> * -<digit> 7
<expr> = <expr> * -07
<expr> = <expr> + <expr> * -07
<expr> = <expr> + <int> * -07
<expr> = <expr> + <nat> * -07
<expr> = <expr> + <digit> * -07
<expr> = <expr> + 2 * -07
<expr> = <int> + 2 * -07
<expr> = <digit> <nat> + 2 * -07
<expr> = <digit> <digit> + 2 * -07
<expr> = <digit> 2 + 2 * -07
<expr> = 12 + 2 * -07

2. Given the following grammar where $\langle stmt \rangle$ is the starting symbol.

$\langle digit \rangle ::= 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9$

$\langle letter \rangle ::= a \mid b \mid c \mid \ldots \mid z$

$\langle nat \rangle ::= \langle digit \rangle \mid \langle digit \rangle \langle nat \rangle$

$\langle int \rangle ::= \langle nat \rangle \mid -\langle nat \rangle$

$\langle expr \rangle ::= \langle int \rangle$
$\qquad \mid \; (\; \langle expr \rangle \;)$
$\qquad \mid \; \langle expr \rangle + \langle expr \rangle$
$\qquad \mid \; \langle expr \rangle * \langle expr \rangle$

$\langle id \rangle ::= \langle letter \rangle \mid \langle letter \rangle \langle id \rangle$

$\langle stmt \rangle ::= \langle id \rangle = \langle expr \rangle$
$\qquad \mid \; \text{for } \langle id \rangle = \langle expr \rangle \text{ to } \langle expr \rangle \text{ do } \langle stmt \rangle$
$\qquad \mid \; \{ \; \langle stmts \rangle \; \}$
$\qquad \mid \; \text{pass}$

$\langle stmts \rangle ::= \langle stmt \rangle \mid \langle stmt \rangle ; \langle stmts \rangle$

Derive the sentence using *leftmost derivation*.

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for x = -12 to 10 do { y = 0; pass }
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<stmt> = for <id> = <expr> to <expr> do <stmt>
<stmt> = for <letter> = <expr> to <expr> do <stmt>
<stmt> = for x = <expr> to <expr> do <stmt>
<stmt> = for x = <int> to <expr> do <stmt>
<stmt> = for x = -<nat> to <expr> do <stmt>
<stmt> = for x = -<digit> <nat> to <expr> do <stmt>
<stmt> = for x = -<digit> 2 to <expr> do <stmt>
<stmt> = for x = -12 to <expr> do <stmt>
<stmt> = for x = -12 to <int> do <stmt>
<stmt> = for x = -12 to <nat> do <stmt>
<stmt> = for x = -12 to <digit> <nat> do <stmt>
<stmt> = for x = -12 to <digit> <digit> do <stmt>
<stmt> = for x = -12 to <digit> 0 do <stmt>
<stmt> = for x = -12 to 10 do <stmt>
<stmt> = for x = -12 to 10 do { <stmts> }
<stmt> = for x = -12 to 10 do { <stmt> ; <stmts> }
<stmt> = for x = -12 to 10 do { <id> = <expr> ; <stmts> }
<stmt> = for x = -12 to 10 do { <letter> = <expr> ; <stmts> }
<stmt> = for x = -12 to 10 do { y = <expr> ; <stmts> }
<stmt> = for x = -12 to 10 do { y = <int> ; <stmts> }
<stmt> = for x = -12 to 10 do { y = <nat> ; <stmts> }
<stmt> = for x = -12 to 10 do { y = <digit> ; <stmts> }
<stmt> = for x = -12 to 10 do { y = 0 ; <stmts> }
<stmt> = for x = -12 to 10 do { y = 0 ; <stmt> }
<stmt> = for x = -12 to 10 do { y = 0 ; pass }