

BU CS320 Assignment 5: Context Free Grammars

October 30, 2023

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

$$\begin{aligned}\langle digit \rangle &::= 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9 \\ \langle nat \rangle &::= \langle digit \rangle \mid \langle digit \rangle \langle nat \rangle \\ \langle int \rangle &::= \langle nat \rangle \mid -\langle nat \rangle \\ \langle expr \rangle &::= \langle int \rangle \\ &\quad \mid (\langle expr \rangle) \\ &\quad \mid \langle expr \rangle + \langle expr \rangle \\ &\quad \mid \langle expr \rangle * \langle expr \rangle\end{aligned}$$

Derive the sentence using *rightmost derivation*.

12 + 2 * -07

$\langle expr \rangle ::= \langle expr \rangle * \langle expr \rangle$
 $\langle expr \rangle * \langle int \rangle$
 $\langle expr \rangle * -\langle nat \rangle$
 $\langle expr \rangle * -\langle digit \rangle \langle nat \rangle$
 $\langle expr \rangle * -\langle digit \rangle \langle nat \rangle$
 $\langle expr \rangle * -\langle digit \rangle \langle digit \rangle$
 $\langle expr \rangle * -07$
 $\langle expr \rangle + \langle expr \rangle * -07$
 $\langle int \rangle + \langle int \rangle * -07$
 $\langle nat \rangle + \langle nat \rangle * -07$
 $\langle nat \rangle + \langle digit \rangle * -07$
 $\langle nat \rangle + 2 * -07$
 $\langle digit \rangle \langle nat \rangle + 2 * -07$
 $\langle digit \rangle \langle digit \rangle + 2 * -07$
12 + 2 * -07

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

$$\begin{aligned} \langle digit \rangle &::= 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9 \\ \langle letter \rangle &::= a \mid b \mid c \mid \dots \mid z \\ \langle nat \rangle &::= \langle digit \rangle \mid \langle digit \rangle \langle nat \rangle \\ \langle int \rangle &::= \langle nat \rangle \mid - \langle nat \rangle \\ \langle expr \rangle &::= \langle int \rangle \\ &\quad \mid (\langle expr \rangle) \\ &\quad \mid \langle expr \rangle + \langle expr \rangle \\ &\quad \mid \langle expr \rangle * \langle expr \rangle \\ \langle id \rangle &::= \langle letter \rangle \mid \langle letter \rangle \langle id \rangle \\ \langle stmt \rangle &::= \langle id \rangle = \langle expr \rangle \\ &\quad \mid \text{for } \langle id \rangle = \langle expr \rangle \text{ to } \langle expr \rangle \text{ do } \langle stmt \rangle \\ &\quad \mid \{ \langle stmts \rangle \} \\ &\quad \mid \text{pass} \\ \langle stmts \rangle &::= \langle stmt \rangle \mid \langle stmt \rangle \langle stmts \rangle \end{aligned}$$

Derive the sentence using *leftmost derivation*.

for x = -12 to 10 do { y = 0; pass }

$\langle stmts \rangle$
 $\langle stmt \rangle$
 for $\langle id \rangle = \langle expr \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $\langle letter \rangle = \langle expr \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = \langle expr \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = \langle int \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = - \langle nat \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = - \langle digit \rangle \langle nat \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = - \langle digit \rangle \langle digit \rangle$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = - 12$ to $\langle expr \rangle$ do $\langle stmt \rangle$
 for $x = - 12$ to $\langle int \rangle$ do $\langle stmt \rangle$
 for $x = - 12$ to $\langle nat \rangle$ do $\langle stmt \rangle$
 for $x = - 12$ to $\langle digit \rangle \langle nat \rangle$ do $\langle stmt \rangle$
 for $x = - 12$ to $\langle digit \rangle \langle digit \rangle$ do $\langle stmt \rangle$
 for $x = - 12$ to 10 do $\langle stmt \rangle$

for $x = -12$ to 10 do { <stmts> }

for $x = -12$ to 10 do { <stmt> ; <stmts> }

for $x = -12$ to 10 do { <id> = <expr> ; <stmts> }

for $x = -12$ to 10 do { <letter> = <expr> ; <stmts> }

for $x = -12$ to 10 do { $y = \text{<expr>}$; <stmts> }

for $x = -12$ to 10 do { $y = \text{<int>}$; <stmts> }

for $x = -12$ to 10 do { $y = \text{<nat>}$; <stmts> }

for $x = -12$ to 10 do { $y = \text{<digit>}$; <stmts> }

for $x = -12$ to 10 do { $y = 0$; <stmts> }

for $x = -12$ to 10 do { $y = 0$; <stmt> }

for $x = -12$ to 10 do { $y = 0$; pass }