

Programming Languages - HW #2

1. $\langle S \rangle \rightarrow \langle A \rangle a \langle B \rangle b$

$\langle A \rangle \rightarrow \langle A \rangle b \mid b$

$\langle B \rangle \rightarrow a \langle B \rangle \mid a$

a. $\langle A \rangle a \langle B \rangle b$

b a $\langle B \rangle b$

b a a b

Yes, baab can be generated
by this grammar

b. $\langle A \rangle a \langle B \rangle b$

$\langle A \rangle b a \langle B \rangle b$

$\langle A \rangle b b a \langle B \rangle b$

b b b a $\langle B \rangle b$

b b b a a b

No, bbbab cannot be

generated by this grammar,
the closest sentence is

bbbbaab

c. bbaadaa cannot be generated by this grammar
because it must end with a b.

d. $\langle A \rangle a \langle B \rangle b$

Yes, bbaab can be generated

$\langle A \rangle b a \langle B \rangle b$

by this grammar

b b a $\langle B \rangle b$

b b a a b

2. $\langle S \rangle \rightarrow a \langle S \rangle c \langle B \rangle \mid \langle A \rangle \mid b$
 $\langle A \rangle \rightarrow c \langle A \rangle \mid c$
 $\langle B \rangle \rightarrow d \mid \langle A \rangle$

a. $a \langle S \rangle c \langle B \rangle$ Yes, abcd can be
a b c d generated by this grammar

b. $a \langle S \rangle c \langle B \rangle$ No, acccbcd cannot be generated by this
a $\langle A \rangle \mid c \langle A \rangle \mid \langle B \rangle$ grammar
a c c c $\langle B \rangle$
a c c c d

c. No, acccbcc cannot be generated by this grammar

d. No, acd is not part of the language generated by this grammar

e. $a \langle S \rangle c \langle B \rangle$ Yes, accc can be
a $\langle A \rangle \mid c \mid \langle B \rangle$ generated by this grammar
a c c $\langle B \rangle$
a c c c

3. $\langle \text{exp} \rangle ::= \langle \text{exp} \rangle + \langle \text{add part} \rangle \mid \langle \text{exp} \rangle - \langle \text{add part} \rangle \mid \langle \text{add part} \rangle$
 $\langle \text{add part} \rangle ::= \langle \text{add part} \rangle * \langle \text{mul part} \rangle \mid \langle \text{mul part} \rangle$
 $\langle \text{mul part} \rangle ::= \langle \text{var} \rangle \mid (\langle \text{exp} \rangle)$
 $\langle \text{var} \rangle ::= x \mid y \mid z$

$z - (x + y) * x$

$\langle \text{exp} \rangle$

$\langle \text{exp} \rangle - \langle \text{add part} \rangle$

$\langle \text{add part} \rangle - \langle \text{add part} \rangle$

$\langle \text{mul part} \rangle - \langle \text{add part} \rangle$

$\langle \text{var} \rangle - \langle \text{add part} \rangle$

$z - \langle \text{add part} \rangle$

$z - \langle \text{add part} \rangle * \langle \text{mul part} \rangle$

$z - \langle \text{mul part} \rangle * \langle \text{mul part} \rangle$

$z - (\langle \text{exp} \rangle * \langle \text{mul part} \rangle)$

$z - (\langle \text{exp} \rangle + \langle \text{add part} \rangle) * \langle \text{mul part} \rangle$

$z - (\langle \text{add part} \rangle + \langle \text{add part} \rangle) * \langle \text{mul part} \rangle$

$z - (\langle \text{mul part} \rangle + \langle \text{add part} \rangle) * \langle \text{mul part} \rangle$

$z - (\langle \text{var} \rangle + \langle \text{add part} \rangle) * \langle \text{mul part} \rangle$

$z - (x + \langle \text{add part} \rangle) * \langle \text{mul part} \rangle$

$z - (x + \langle \text{mul part} \rangle) * \langle \text{mul part} \rangle$

$z - (x + \langle \text{var} \rangle) * \langle \text{mul part} \rangle$

$z - (x + y) * \langle \text{mul part} \rangle$

$z - (x + y) * \langle \text{var} \rangle$

$z - (x + y) * x$

Yes, $z - (x + y) * x$ can be generated from this grammar

4. $\langle \text{assign} \rangle \rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$

$\langle \text{id} \rangle \rightarrow A \mid B \mid C$

$\langle \text{expr} \rangle \rightarrow \langle \text{id} \rangle + \langle \text{expr} \rangle \mid \langle \text{id} \rangle * \langle \text{expr} \rangle \mid (\langle \text{expr} \rangle) \mid \langle \text{id} \rangle$

a. $\langle \text{id} \rangle = \langle \text{expr} \rangle$

$A = \langle \text{expr} \rangle$

$A = \langle \text{id} \rangle * \langle \text{expr} \rangle$

$A = A * \langle \text{expr} \rangle$

$A = A * (\langle \text{expr} \rangle)$

$A = A * (\langle \text{id} \rangle + \langle \text{expr} \rangle)$

$A = A * (B + \langle \text{expr} \rangle)$

$A = A * (B + (\langle \text{expr} \rangle))$

$A = A * (B + (\langle \text{id} \rangle * \langle \text{expr} \rangle))$

$A = A * (B + (C * \langle \text{expr} \rangle))$

$A = A * (B + (C * \langle \text{id} \rangle))$

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

b. $\langle \text{id} \rangle = \langle \text{expr} \rangle$

$B = \langle \text{expr} \rangle$

$B = \langle \text{id} \rangle * \langle \text{expr} \rangle$

$B = C * \langle \text{expr} \rangle$

$B = C * (\langle \text{expr} \rangle)$

$B = C * (\langle \text{id} \rangle * \langle \text{expr} \rangle)$

$B = C * (A * \langle \text{expr} \rangle)$

$B = C * (A * (\langle \text{id} \rangle + \langle \text{expr} \rangle))$

$B = C * (A * (B + \langle \text{expr} \rangle))$

$B = C * (A * (B + (C * \langle \text{expr} \rangle)))$

$B = C * (A * (B + (C * \langle \text{id} \rangle)))$

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

C. $\langle \text{id} \rangle = \langle \text{expr} \rangle$

$A = \langle \text{expr} \rangle$

$A = \langle \text{id} \rangle * \langle \text{expr} \rangle$

$A = A * \langle \text{expr} \rangle$

$A = A * (\langle \text{expr} \rangle)$

$A = A * (\langle \text{id} \rangle + \langle \text{expr} \rangle)$

$A = A * (B + \langle \text{expr} \rangle)$

$A = A * (B + (\langle \text{expr} \rangle))$

$A = A * (B + (\langle \text{id} \rangle))$

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

5. $\langle \text{assign} \rangle \rightarrow \langle \text{id} \rangle = \langle \text{expr} \rangle$

$\langle \text{id} \rangle \rightarrow A \mid B \mid C$

$\langle \text{expr} \rangle \rightarrow \langle \text{expr} \rangle + \langle \text{term} \rangle \mid \langle \text{term} \rangle$

$\langle \text{term} \rangle \rightarrow \langle \text{term} \rangle * \langle \text{factor} \rangle \mid \langle \text{factor} \rangle$

$\langle \text{factor} \rangle \rightarrow (\langle \text{expr} \rangle) \mid \langle \text{id} \rangle$

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

(cont) $A = B + \langle \text{term} \rangle + \langle \text{term} \rangle$

$\langle \text{id} \rangle = \langle \text{expr} \rangle$

$A = B + \langle \text{factor} \rangle + \langle \text{term} \rangle$

$A = \langle \text{expr} \rangle$

$A = B + \langle \text{id} \rangle + \langle \text{term} \rangle$

$A = \langle \text{term} \rangle$

$A = B + C + \langle \text{term} \rangle$

$A = \langle \text{term} \rangle * \langle \text{factor} \rangle$

$A = B + C + \langle \text{id} \rangle$

$A = \langle \text{factor} \rangle * \langle \text{factor} \rangle$

$A = B + C + \langle \text{id} \rangle$

$A = (\langle \text{expr} \rangle * \langle \text{factor} \rangle)$

$A = B + C + A$

$A = (\langle \text{expr} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle$

$A = B + C + A$

$A = (\langle \text{term} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle \quad c. \quad A = A * (B + C)$

$A = (\langle \text{factor} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle \quad \langle \text{id} \rangle = \langle \text{expr} \rangle$

$A = (\langle \text{id} \rangle + \langle \text{term} \rangle) * \langle \text{factor} \rangle \quad A = \langle \text{expr} \rangle$

$A = (A + \langle \text{term} \rangle) * \langle \text{factor} \rangle \quad A = \langle \text{term} \rangle$

$A = (A + \langle \text{factor} \rangle) * \langle \text{factor} \rangle \quad A = \langle \text{term} \rangle * \langle \text{factor} \rangle$

$A = (A + \langle \text{id} \rangle) * \langle \text{factor} \rangle \quad A = \langle \text{factor} \rangle * \langle \text{factor} \rangle$

$A = (A + B) * \langle \text{factor} \rangle \quad A = \langle \text{id} \rangle * \langle \text{factor} \rangle$

$A = (A + B) * \langle \text{id} \rangle \quad A = A * \langle \text{factor} \rangle$

$A = (A + B) * C \quad A = A * (\langle \text{expr} \rangle)$

$A = A * (\langle \text{expr} \rangle + \langle \text{term} \rangle)$

b) $A = B + C + A$

$A = A * (\langle \text{term} \rangle + \langle \text{term} \rangle)$

$\langle \text{id} \rangle = \langle \text{expr} \rangle$

$A = A * (\langle \text{factor} \rangle + \langle \text{term} \rangle)$

$A = \langle \text{expr} \rangle$

$A = A * (\langle \text{id} \rangle + \langle \text{term} \rangle)$

$A = \langle \text{expr} \rangle + \langle \text{term} \rangle$

$A = A * (B + \langle \text{term} \rangle)$

$A = \langle \text{expr} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$

$A = A * (B + \langle \text{factor} \rangle)$

$A = \langle \text{term} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$

$A = A * (B + \langle \text{id} \rangle)$

$A = \langle \text{factor} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$

$A = A * (B + C)$

$A = \langle \text{id} \rangle + \langle \text{term} \rangle + \langle \text{term} \rangle$

$$d \quad A = B * (C * (A + B))$$

$\langle id \rangle = \langle expr \rangle$

$A = \langle expr \rangle$

$A = \langle term \rangle$

$A = \langle term \rangle * \langle factor \rangle$

$A = \langle factor \rangle + \langle factor \rangle$

$A = \langle id \rangle + \langle factor \rangle$

$A = \langle B \rangle + \langle factor \rangle$

$A = B * (\langle expr \rangle)$

$A = B * (\langle term \rangle)$

$A = B * (\langle term \rangle * \langle factor \rangle)$

$A = B * (\langle factor \rangle * \langle factor \rangle)$

$A = B * (\langle id \rangle * \langle factor \rangle)$

$A = B * (C * \langle factor \rangle)$

$A = B * (C * (\langle expr \rangle))$

$A = B * (C * (\langle term \rangle + \langle term \rangle))$

$A = B * (C * (\langle factor \rangle + \langle term \rangle))$

$A = B * (C * (\langle id \rangle + \langle term \rangle))$

$A = B * (C * (A + \langle term \rangle))$

$A = B * (C * (A + \langle factor \rangle))$

$A = B * (C * (A + \langle id \rangle))$

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