CmpE 260 - Principles of Programming Languages
Spring 2019
Assignment 1

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Solution 1

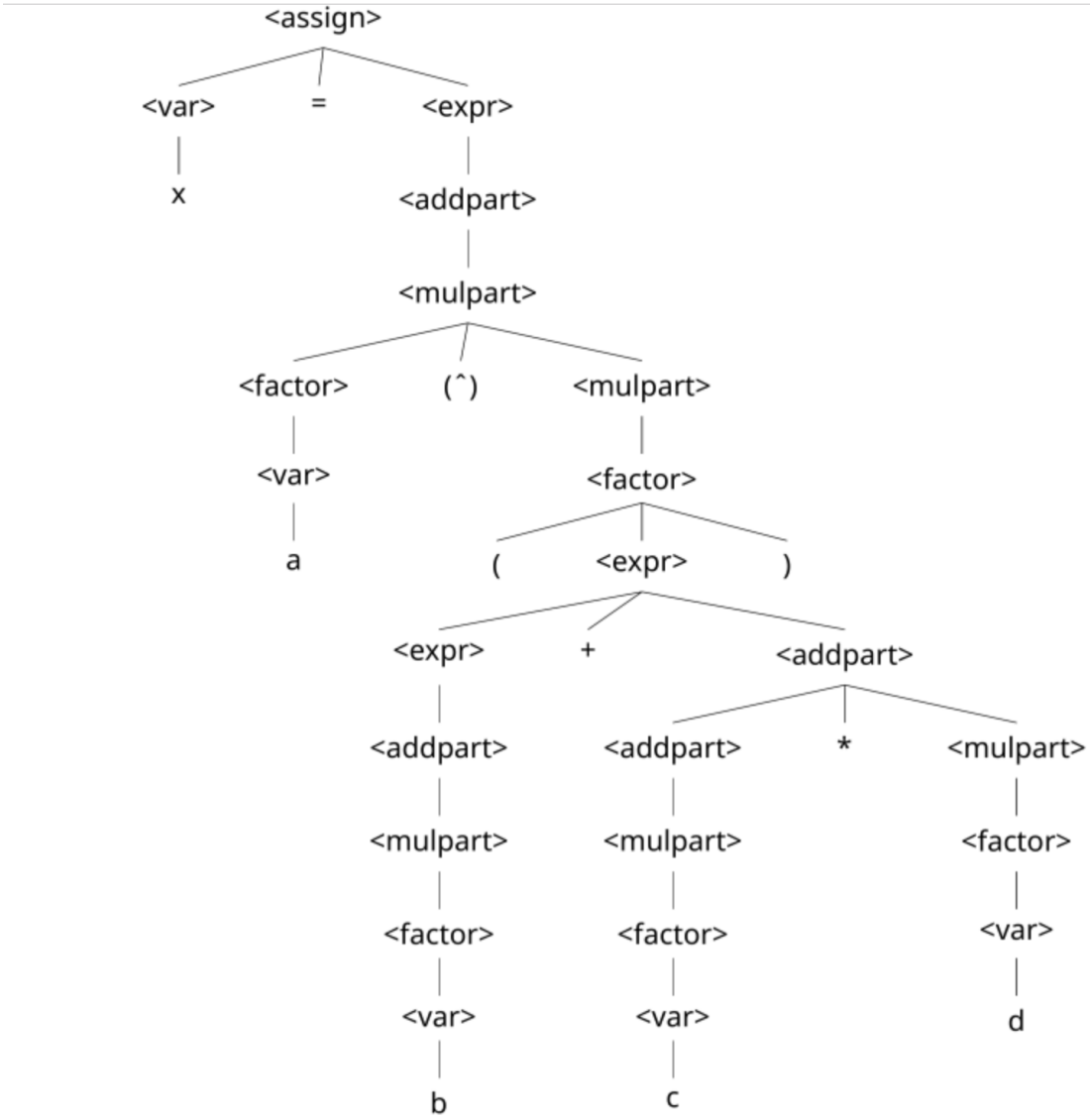
a)

$$
\begin{aligned}
< assign > &\rightarrow < var > = < expr > \\
< expr > &\rightarrow < expr > + < addpart > \mid < expr > - < addpart > \mid < addpart > \\
< addpart > &\rightarrow < addpart > * < mulpart > \mid < addpart > / < mulpart > \mid < mulpart > \\
< mulpart > &\rightarrow (< expr >) \mid < var > \\
< var > &\rightarrow a \mid b \mid ... \mid x \mid y \mid z
\end{aligned}
$$

b)

$$
\begin{aligned}
< assign > &\rightarrow < var > = < expr > \\
< expr > &\rightarrow < expr > + < addpart > \mid < expr > - < addpart > \mid < addpart > \\
< addpart > &\rightarrow < addpart > * < mulpart > \mid < addpart > / < mulpart > \mid < mulpart > \\
< mulpart > &\rightarrow < factor > \hat{} < mulpart > \mid < factor > \\
< factor > &\rightarrow (< expr >) \mid < var > \\
< var > &\rightarrow a \mid b \mid ... \mid x \mid y \mid z
\end{aligned}
$$

c)


<assign>
<var>
=
<expr>
x
<addpart>
<mulpart>
<factor>
(^)
<mulpart>
<var>
<factor>
a
(
<expr>
)
<expr>
+
<addpart>
<addpart>
<mulpart>
<addpart>
*
<mulpart>
<mulpart>
<factor>
<factor>
<factor>
<var>
<var>
<var>
d
b
c

Solution 2

$\mathrm{M}_{rpt}(repeat{<}st-list{>}until{<}bool{>},\ s) \equiv$
$if\ M_{stlist}({<}st-list{>},\ s) = error$
$then\ error$
$else\ if\ M_{bool}({<}bool{>},\ M_{stlist}({<}st-list{>}, s)) = error$
$then\ error$
$else\ if\ M_{bool}({<}bool{>},\ M_{stlist}({<}st-list{>},\ s)) = true$
$then\ M_{stlist}({<}st-list{>},\ s)$
$else\ M_{rpt}(repeat{<}st-list{>}until{<}bool{>},\ M_{stlist}({<}st-list{>},\ s))$

$M_{bool}({<}var{>}_1 == {<}var{>}_2,\ s) \equiv$
$if\ VarMap({<}var{>}_1,\ s) = undef$
$then\ error$
$else\ if\ VarMap({<}var{>}_2,\ s) = undef$
$then\ error$
$else\ if\ VarMap({<}var{>}_1,\ s) = VarMap({<}var{>}_2,\ s)$
$then\ true$
$else\ false$

$M_{stlist}({<}assign-st{><}st-list{>},\ s) \equiv$
$if\ M_{ass}({<}assign-st{>},\ s) = error$
$then\ error$
$else\ M_{stlist}({<}st-list{>},\ M_{ass}({<}assign-st{>},\ s))$

$M_{stlist}({<}assign-st{>},\ s) \equiv\ M_{ass}({<}assign-st{>},\ s)$

$M_{ass}({<}var{>}_1 = {<}var{>}_2,\ s) \equiv$
$if\ VarMap({<}var{>}_2,\ s) = undef$
$then\ error$
$else\ {<}i_1, v_1{>}, ..., {<}i_n, v_n{>}\ where$
$v_j =\ VarMap\ (i_j,\ s)\ ,\ if\ i_j \neq {<}var{>}_1$
$v_j = VarMap({<}var{>}2, s)\ , if\ ij = {<}var{>}_1$

Solution 3

$$< declaration > \ \rightarrow\ < person_1 >< person_2 >< person_3 >< person_4 >$$
$$< person_1 > .count \ =\ < person_2 > .count \qquad =$$

$$
\begin{aligned}
< person_3 > .count & \\
& = < person_4 > .count \\
< person_1 > & \rightarrow katara < list_1 > \\
< person_1 > .count & \leftarrow < list_1 > .countW \\
< person_2 > & \rightarrow toph < list_2 > \\
< person_2 > .count & \leftarrow < list_2 > .countE \\
< person_3 > & \rightarrow zuko < list_3 > \\
< person_3 > .count & \leftarrow < list_3 > .countF \\
< person_4 > & \rightarrow aang < list_4 > \\
< person_4 > .count & \leftarrow < list_4 > .countAll \\
< list_1 > & \rightarrow < elements > \\
< list_1 > .countW & \leftarrow < elements > .countW \\
< list_2 > & \rightarrow < elements > \\
< list_2 > .countE & \leftarrow < elements > .countE \\
< list_3 > & \rightarrow < elements > \\
< list_3 > .countF & \leftarrow < elements > .countF \\
< list_4 > & \rightarrow < elements > \\
< list_4 > .countAll & \leftarrow < elements > .countW + < element > .countE + < elements > .countF \\
+ < elements > .countA & \\
< elements >_1 & \rightarrow < element >< elements >_2 \\
< elements >_1 .countW & \leftarrow < element > .countW + < elements >_2 .countW \\
< elements >_1 .countE & \leftarrow < element > .countE + < elements >_2 .countE \\
< elements >_1 .countF & \leftarrow < element > .countF + < elements >_2 .countF \\
< elements >_1 .countA & \leftarrow < element > .countA + < elements >_2 .countA \\
< elements > & \rightarrow < element > \\
< elements > .countW & \leftarrow < element > .countW \\
< elements > .countE & \leftarrow < element > .countE \\
< elements > .countF & \leftarrow < element > .countF \\
< elements > .countA & \leftarrow < element > .countA \\
< element > & \rightarrow W \\
< element > .countW & \leftarrow 1 \\
< element > .countE & \leftarrow 0 \\
< element > .countF & \leftarrow 0 \\
< element > .countA & \leftarrow 0 \\
< element > & \rightarrow E \\
< element > .countW & \leftarrow 0 \\
< element > .countE & \leftarrow 1 \\
< element > .countF & \leftarrow 0 \\
< element > .countA & \leftarrow 0 \\
< element > & \rightarrow F \\
< element > .countW & \leftarrow 0 \\
< element > .countE & \leftarrow 0 \\
< element > .countF & \leftarrow 1 \\
< element > .countA & \leftarrow 0
\end{aligned}
$$

$$
\begin{aligned}
< element > &\rightarrow A \\
< element > .countW &\leftarrow 0 \\
< element > .countE &\leftarrow 0 \\
< element > .countF &\leftarrow 0 \\
< element > .countA &\leftarrow 1
\end{aligned}
$$