CSI 311 — Spring 2003: Sample Problems

1. Design an L-attributed grammar for nonnegative integers using the following context-free grammar as the underlying grammar:

\[
\begin{align*}
<\text{number}> & : = <\text{digit}> \mid <\text{digit}> <\text{number}> \\
<\text{digit}> & : = 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9
\end{align*}
\]

As done in class, the nonterminal \(<\text{number}>\) should have a synthesized attribute corresponding to the decimal value of the string of digits.

2. Design an L-attributed grammar for real numbers in decimal notation. You should not allow representations like 10. (10.0 is the correct form) and .52 (0.52 is the correct form). In other words, neither the integer part nor the fractional part should be empty strings.

The start symbol should have a synthesized attribute corresponding to the value of the input string.

3. Consider the following attribute grammar:

\[
\begin{align*}
<A> & : = a <A> \\
&A.val = 2 * (<A2>.val)
\end{align*}
\]

\[
\begin{align*}
<A> & : = \text{empty} \\
&A.val = 1
\end{align*}
\]

The terminal alphabet is \{a\}. Construct a decorated parse tree for the string \texttt{aaaa}.

4. In the attribute grammar given below, the nonterminal \(<B>\) has an inherited attribute, \(i\). All other attributes are synthesized. The terminal alphabet is \{a,b\}.

Construct a decorated parse tree for the string \texttt{aabb}.
\[
\begin{align*}
&S ::= \langle A \rangle \langle B \rangle \\
&S.val &= \langle B \rangle.s \\
&B.i &= \langle A \rangle.val \\
&A ::= a \langle A \rangle \\
&A.val &= \langle A2 \rangle.val + 1 \\
&A ::= a \\
&A.val &= 1 \\
&B ::= b \langle B \rangle \\
&B.s &= \langle B2 \rangle.s + \langle B \rangle.i \\
&B2.i &= \langle B \rangle.i \\
&B ::= b \\
&B.s &= \langle B \rangle.i \\
\end{align*}
\]

5. In the attribute grammar given below, the nonterminal \( \langle A \rangle \) has an inherited attribute, \( i \). All other attributes are synthesized. The terminal alphabet is \( \{a, b\} \). Construct a decorated parse tree for the string \( babb \).

\[
\begin{align*}
&S ::= \langle A \rangle \\
&S.val &= \langle A \rangle.val + 1 \\
&A.i &= 0 \\
&A ::= a \langle A \rangle \\
&A.val &= \langle A2 \rangle.val \\
&A2.i &= 2 \times \langle A \rangle.i \\
&A ::= b \langle A \rangle \\
&A.val &= \langle A2 \rangle.val \\
&A2.i &= 1 + (2 \times \langle A \rangle.i) \\
&A ::= a \\
&A.val &= 2 \times \langle A \rangle.i \\
&A ::= b \\
\end{align*}
\]
\( <A>.val = 1 + (2 \times <A>.i) \)

6. In the attribute grammar given below, the nonterminal \(<A>\) has an inherited attribute, \(i\). All other attributes are synthesized. The terminal alphabet is \( \{a, b\} \).

Construct a decorated parse tree for the string \(aaabbb\) (= \(a^3b^4\)).

\[
<\text{S}> ::= <\text{A}>
\]
\[
<\text{S}>.val = <\text{A}>.val
\]
\[
<\text{A}>.i = 0
\]

\[
<\text{A}> ::= a<A>b
\]
\[
<\text{A}>.val = <\text{A}2>.val + <\text{A}2>.c
\]
\[
<\text{A}>.c = <\text{A}2>.c
\]
\[
<\text{A}2>.i = <\text{A}>.i + 1
\]

\[
<\text{A}> ::= a
\]
\[
<\text{A}>.val = <\text{A}>.i
\]
\[
<\text{A}>.c = 1
\]

\[
<\text{A}> ::= b
\]
\[
<\text{A}>.val = <\text{A}>.i
\]
\[
<\text{A}>.c = 2
\]