Let $G = (V, \Sigma, R, \langle \text{STMT} \rangle)$ be the following grammar.

$$\begin{aligned} \langle \text{STMT} \rangle &\to \langle \text{ASSIGN} \rangle \mid \langle \text{IF-THEN} \rangle \mid \langle \text{IF-THEN-ELSE} \rangle \\ \langle \text{IF-THEN} \rangle &\to \texttt{if condition then } \langle \text{STMT} \rangle \\ \langle \text{IF-THEN-ELSE} \rangle &\to \texttt{if condition then } \langle \text{STMT} \rangle \texttt{ else } \langle \text{STMT} \rangle \\ \langle \text{ASSIGN} \rangle &\to \texttt{a:=1} \end{aligned}$$

$$\Sigma = \{\texttt{if}, \texttt{condition}, \texttt{then}, \texttt{else}, \texttt{a:=1}\}$$

$$V = \{\langle \text{STMT} \rangle, \langle \text{IF-THEN} \rangle, \langle \text{IF-THEN-ELSE} \rangle, \langle \text{ASSIGN} \rangle\}$$

G is a natural-looking grammar for a fragment of a programming language, but G is ambiguous.

a. Show that G is ambiguous.

b. Give a new unambiguous grammar for the same language.

Step-by-step solution

Step 1 of 3

Ambiguous and unambiguous grammar

a.

Consider $G = (V, \Sigma, R, \langle \text{STMT} \rangle)$

To show that G is ambiguous

It is required to find out two leftmost derivations:

$\langle \text{Stmt} \rangle$
$\Rightarrow \langle \text{if-then} \rangle$
$\Rightarrow$ if condition then $\langle \text{Stmt} \rangle$

$\Rightarrow$ if condition then $\langle \text{if-then-else} \rangle$
$\Rightarrow$ if condition then if condition then $\langle \text{Stmt} \rangle$ else $\langle \text{Stmt} \rangle$
$\Rightarrow$ if condition then if condition then $\langle \text{Assign} \rangle$ else $\langle \text{Stmt} \rangle$

$\Rightarrow$ if condition then if condition then a:=1 else $\langle \text{Stmt} \rangle$
$\Rightarrow$ if condition then if condition then a:=1 else $\langle \text{Assign} \rangle$
$\Rightarrow$ if condition then if condition then a:=1 else a:=1

Now the second derivation will be:

$\langle \text{Stmt} \rangle$
$\Rightarrow \langle \text{if-then-else} \rangle$
$\Rightarrow$ if condition then $\langle \text{Stmt} \rangle$ else $\langle \text{Stmt} \rangle$

$\Rightarrow$ if condition then $\langle \text{if-then} \rangle$ else $\langle \text{Stmt} \rangle$
$\Rightarrow$ if condition then if condition then $\langle \text{Stmt} \rangle$ else $\langle \text{Stmt} \rangle$
$\Rightarrow$ if condition then if condition then $\langle \text{Assign} \rangle$ else $\langle \text{Stmt} \rangle$

$\Rightarrow$ if condition then if condition then a:=1 else $\langle \text{Stmt} \rangle$
$\Rightarrow$ if condition then if condition then a:=1 else $\langle \text{Assign} \rangle$
$\Rightarrow$ if condition then if condition then a:=1 else a:=1

Comment

Step 2 of 3

In both cases when it takes “if-then” or “if-then else” result is same. Hence both have same left derivation and it is ambiguous.

Comment

Step 3 of 3

For making unambiguous grammar, it is required to make correct interpretation of the above two. For that when "if-then-else" is derived, it should not allow then part for deriving "if-then”. So introduce a new variable $\langle \text{Stmt} \rangle$ the new grammar is:

$$\langle \text{Stmt} \rangle \Rightarrow \langle \text{if-then} \rangle \mid \langle \text{Assign} \rangle \mid \langle \text{if-then-else} \rangle$$

$$\langle \text{if-then-else} \rangle \Rightarrow \text{ if condition then } \langle \text{Stmt1} \rangle \text{ else } \langle \text{Stmt} \rangle$$

$$\langle \text{Stmt1} \rangle \Rightarrow \langle \text{if-then-else} \rangle \mid \langle \text{Assign} \rangle$$

$$\langle \text{if-then} \rangle \Rightarrow \text{if condition then } \langle \text{Stmt} \rangle$$

$$\langle \text{Assign} \rangle \Rightarrow \text{a:=1}$$

Comments (2)