

Derivation

Derivation is a sequence of production rules. It is used to get the input string through these production rules. During parsing, we have to take two decisions. These are as follows:

- We have to decide the non-terminal which is to be replaced.
- We have to decide the production rule by which the non-terminal will be replaced.

We have two options to decide which non-terminal to be placed with production rule.

1. Leftmost Derivation:

In the leftmost derivation, the input is scanned and replaced with the production rule from left to right. So in leftmost derivation, we read the input string from left to right.

Example:

Production rules:

$E = E + E$

$E = E - E$

$E = a \mid b$

Input

$a - b + a$

The leftmost derivation is:

$E = E + E$

$E = E - E + E$

$E = a - E + E$

$E = a - b + E$

$E = a - b + a$

2. Rightmost Derivation:

In rightmost derivation, the input is scanned and replaced with the production rule from right to left. So in rightmost derivation, we read the input string from right to left.

Example

Production rules:

$$E = E + E$$

$$E = E - E$$

$$E = a \mid b$$

Input

$$a - b + a$$

The rightmost derivation is:

$$E = E - E$$

$$E = E - E + E$$

$$E = E - E + a$$

$$E = E - b + a$$

$$E = a - b + a$$

When we use the leftmost derivation or rightmost derivation, we may get the same string. This type of derivation does not affect on getting of a string.

Examples of Derivation:

Example 1:

Derive the string "abb" for leftmost derivation and rightmost derivation using a CFG given by,

$$S \rightarrow AB \mid \epsilon$$

$$A \rightarrow aB$$

$$B \rightarrow Sb$$

Solution:

Leftmost derivation:

S

AB

aB B

a Sb B

A ϵ bB

ab Sb

ab ϵ b

abb

Rightmost derivation:

S

AB

A Sb

A ϵ b

aB b

a Sb b

a ϵ bb

abb

Example 2:

Derive the string "aabbabba" for leftmost derivation and rightmost derivation using a CFG given by,

$S \rightarrow aB \mid bA$

$S \rightarrow a \mid aS \mid bAA$

$S \rightarrow b \mid aS \mid aBB$

Solution:

Leftmost derivation:

S
 aB $S \rightarrow aB$
 aaBB $B \rightarrow aBB$
 aabB $B \rightarrow b$
 aabbS $B \rightarrow bS$
 aabbaB $S \rightarrow aB$
 aabbabS $B \rightarrow bS$
 aabbabbA $S \rightarrow bA$
 aabbabba $A \rightarrow a$

Rightmost derivation:

S
 aB $S \rightarrow aB$
 aaBB $B \rightarrow aBB$
 aaBbS $B \rightarrow bS$
 aaBbbA $S \rightarrow bA$
 aaBbba $A \rightarrow a$
 aabSbba $B \rightarrow bS$
 aabbAbba $S \rightarrow bA$
 aabbabba $A \rightarrow a$

Example 3:

Derive the string "00101" for leftmost derivation and rightmost derivation using a CFG given by,

$S \rightarrow A1B$
 $A \rightarrow 0A \mid \epsilon$
 $B \rightarrow 0B \mid 1B \mid \epsilon$

Solution:**Leftmost derivation:**

S
 A1B
 0A1B
 00A1B
 001B

0010B
00101B
00101

Rightmost derivation:

S
A1B
A10B
A101B
A101
0A101
00A101
00101

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