Greibach Normal Form(GNF)

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Formal Definition: of GNF

A CFG is in Greibach Normal Form (GNF) if all production rules satisfy one of the following conditions:

1. A non-terminal generating a terminal (e.g., $X \rightarrow x$)
2. A non-terminal generates a terminal followed by any number of non-terminals (e.g., $X \rightarrow xX1X2 \ldots XN$)

Examples

G1 = {S->aA|bB, B->bB|b, A->aA|a}

G2 = {S->aA|bB, B->bB|ε, A->aA|ε}

How to Convert CFG to GNF ?

Step 1. If the given grammar is not in CNF, convert it to CNF.

Step 2. Change the names of non terminal symbols to X1…Xn in same sequence.

Step 3. Check for every production rule if RHS has first symbol as non terminal say Aj for the production of Ai, it is mandatory that i should be less than j. Not great and not even equal.

If i> j then replace the production rule of Aj at its place in Ai.

If i=j, it is the left recursion. Create a new state Z and eliminate left recursion

Step 4. Replace very first non terminal symbol in any production rule with its production until production rule satisfies the above conditions.

Example-1

Suppose this the production and we need to convert it into GNF.

$$S \rightarrow ABb \mid a \mid b$$
$$A \rightarrow aaA \mid B$$
$$B \rightarrow bAb$$

Example-2

Suppose this the production and we need to convert it into GNF.

$$S \rightarrow XA|BB$$
$$B \rightarrow b|SB$$
$$X \rightarrow b$$
$$A \rightarrow a$$

Example-3

Convert the CFG

G=({A1, A2, A3},{a, b}, R, A1)

where

R={A1->A2A3,A2->A3A1|b, A3->A1A2|a}

into Greibach Normal Form (GNF)