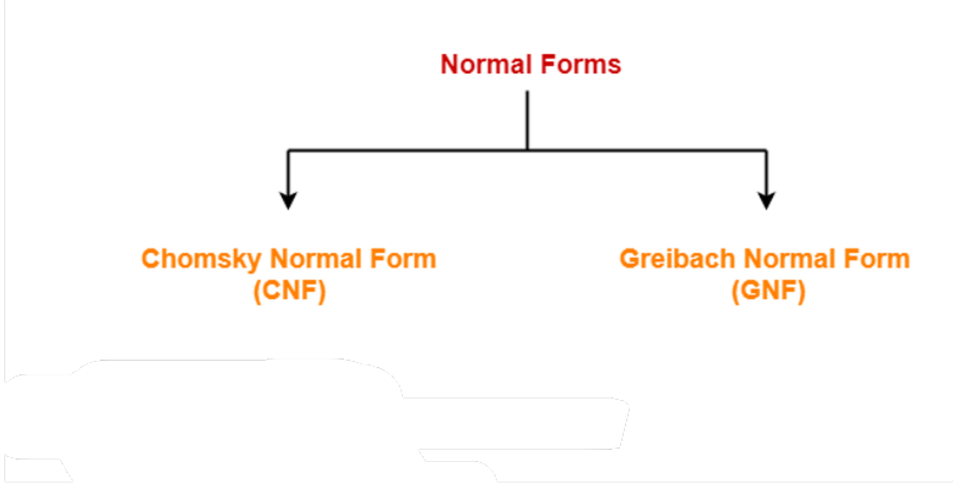


Chomsky Normal Form-

A context free grammar is said to be in chomsky normal form (CNF)

if all its productions are of the form-

$A \rightarrow BC$ or $A \rightarrow a$

where A, B, C are non-terminals and a is a terminal.

Steps for converting CFG into CNF

1.Eliminate Start symbol from RHS

eg:

If the start symbol T is at the RHS of any production, create a new production as: $S1 \rightarrow S$
Where S1 is the new start symbol.

2. Reduce the grammar completely by-

Eliminating □ productions
Eliminating unit productions
Eliminating useless productions

3. Eliminate terminals from the RHS of the production if they exist with other non-terminals or terminals.

production $S \rightarrow aA$ can be decomposed as:
$S \rightarrow RA \quad R \rightarrow a$

4.Eliminate RHS with more than two non-terminals.

For example, $S \rightarrow ASB$ can be decomposed as:
$S \rightarrow RS \quad R \rightarrow AS$

construct the follwing set of production and convert them to be in CNF

S--> ABC A--->aAb A---> ∈ B--->b C--->aC C--->a C---> ∈

rule 2: eliminate ∈

step 1:

removing ∈ from A,C

S--->ABC S--->BC S--->AB S--->B

A--->aAb A---->ab

C----> aC C----> a

B--->b

step 2 : Removing unit production

remove S---> B so

S--->ABC S--->BC S--->AB

A--->aAb A---->ab S--->b

C----> aC C----> a

B--->b

step 3:

to replace combined terminals new production X1--->a X2---->b

S---->ABC C--->a

S--->BC A--->X1AX2

S---> AB A--->X1X2

S--->b C---->X1C

STER 4: EITHER A SINGLE STRING OR 2 NON NON TERMINALS

REPLACE

AC--->X3

X1 A---->X4

S---->BX3 C--->a

S--->BC A--->X4X2

S---> AB A--->X1X2

S--->b C---->X1C

convert CFG to CNF. Consider the given grammar G1:

S → ASB
A → aAS|a|ε
B → SbS|A|bb

START SYMBOL APPEAR

ELIMINATE

S0 ---> S

S → ASB
A → aAS|a|ε
B → SbS|A|bb

eliminate A from ε

S--->ASB
S-->SB
A--->aAS
A--->aS
A--->a
B--->SbS
B--->A
B--->bb
S0--->S

B become ε

S--->ASB | SB | S|AS

A--->aAS | as | a

B---> SbS | A | bb

S0----->S remove unit prd
B-->A , S0--->S,S--->S

S0--->AS | ASB | SB

S--->AS | ASB | SB

A---> .aAS | aS | a

B---> SbS | bb | a | aAs | aS

step 3: apply production rule

a--->A1

b--->B1

A---> A1AS | A1S | A1

B---> SB1S | B1B1 | A1AS | A1S

S0---> AS | ASB | SB

S--->AS | ASB | SB

A--->a B---->b

replace

A1A--->X
SB1--> Y

AB--->Z

A-->XS A1S A1

B--->YS B1B1 XS A1S

S0--->AS ZS SB

S--->AS ZS SB

A--->a x1--->

B--->b

Practise Problems

convert the following grammer to CNF

S--->bA| aB

A---> bAA |aS | a

B--->aBB | bs | b

Convert the given CFG to CNF. Consider the given grammar G1:

S → a | aA | B A → aBB | ε B → Aa | b

Greibach Normal Form (GNF)

GNF stands for Greibach normal form. A CFG(context free grammar) is in GNF(Greibach normal form) if all the production rules satisfy one of the following conditions:

A start symbol generating ε. For example, S → ε.
A non-terminal generating a terminal. For example, A → a.
A non-terminal generating a terminal which is followed by any number of non-terminals.
For example, S → aASB.

check this :

G1 = {S → aAB | aB, A → aA| a, B → bB | b}

G2 = {S → aAB | aB, A → aA | ε, B → bB | ε}

g2 is GNF

Steps for converting CFG into GNF

1. Eliminating □ productions
   Eliminating unit productions

2. RHS of production in Grammer G is restricted to be either a terminal or a terminal followed by one or more non terminal

   eg : -->aABC

3. if the RHS of a production does not begin with a terminal,the first non terminal

   in the production is replaced by its RHS with a terminal

convert the CFG with the following

to GNF

S--->ABA A--->aA | ∈

B--->bB | ∈

step 1: remove ∈ production

S---> ABA | AB | BA | AA | A | B

A--->aA | a

B--->bB | b

A2--->b

step 2: remove unit production

S--->A S---> B

A3---> a

S---> ABA | AB | BA | AA | a | b | aA | bB

A---> aA | a

B---> bB | b

step 3:

S--->a b aA bB

A--->aA a

b--->bB b

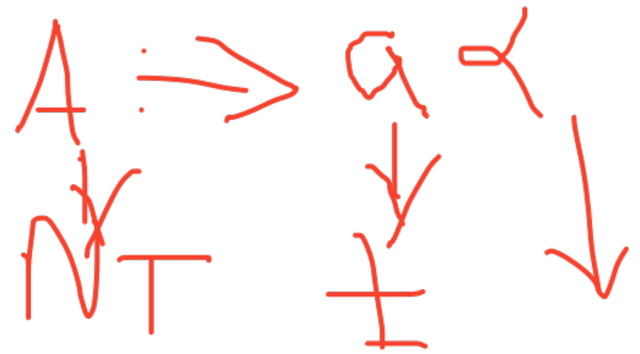
S--->aABA | aBA | aAB | aB | bBA | bA | aA | aAA

Eliminating ∈ productions
Eliminating unit productions

RHS of production in Grammer G is restricted to be either a terminal or a terminal followed by one or more non terminal

if the RHS of a production does not begin with a terminal,the first non te

in the production is replaced by its RHS with a terminal



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

WHERE P CONSIST OF THE FOLLOWING PRODUCTION

A1-->A2A3

A2-->A3A1 | b

A3--->A1A2 | a

s---->A1

A1---->A2A3

S---.>A2A3

A2---->A3S | A3A1 | b

A3---> SA2 | A1A2 | a

S--->bA3

A2--->b

A3--->a

A1--->bA3

A2---aS

A2--->aA1

A3--->bA3A2

A3--->bA3A2

CFG to GNF

$S \to AA \mid a$
$A \to SS \mid b$

$A_1 \to A_2 A_2 \mid a$ ✓
$A_2 \to A_1 A_1 \mid b$

$A_2 \to A_2 A_2 A_1 \mid aA_1 \mid b$

$A_2 \to \underset{A}{A_2} \underset{\alpha}{A_2 A_1} \mid \underset{B}{aA_1} \mid b$

$A \to A\alpha \mid B$

$\alpha : A_2 A_1$, $B : aA_1 \mid b$

$A \to BA'$
$A' \to \alpha A' \mid \epsilon$

$A_2 \to aA_1 Z \mid bZ$
$Z \to A_2 A_1 Z \mid \epsilon$

Eliminate ϵ production:

$A_2 \to aA_1 Z \mid bZ \mid aA_1 \mid b$ in GNF
$Z \to A_2 A_1 Z \mid A_2 A_1$

Sub. A_2 in Z & A_1.

$Z \to aA_1 ZA_1 Z \mid bA_1 Z \mid aA_1 A_1 Z \mid bA_1 Z \mid aA_1 ZA_1 \mid bA_1 A_1 \mid aA_1 A_1 A_1 \mid bA_1 A_1$

$A_1 \to aA_1 ZA_2 \mid bZA_2 \mid aA_1 A_2 \mid bA_2 \mid a$

$A_2 \to aA_1 Z \mid bZ \mid aA_1 \mid b$.

3 Remove unit productions

$S \to B$

$S \to Aa \mid a \mid b$.

New $S \to a \mid aA \mid a \mid Aa \mid b$

$A \to aBB$

$B \to Aa \mid a \mid b$

4) Find out production that has more variable

$A \to aBB$

$A \to aX$

$X \to BB$

New Prod

$S \to a \mid aA \mid \cancel{a} \mid Aa \mid b$

$A \to aX$

$B \to Aa \mid a \mid b$ $\quad Y \to a$.

$X \to BB$

5) No check $S \to aA$, $A \to aX$

$S \to \cancel{a}A$, $A \to \cancel{a}X$ $\quad Y \to a$.

$S \to A\cancel{a}$, $B \to A\cancel{a}$

$S \to A\cancel{a}$, $B \to A\cancel{a}$

Final grammar is,

$S \to a \mid BA \mid a \mid BB \mid b$ $\quad S \to a \mid \cancel{YA} \mid \cancel{A} \mid AY \mid b$

$A \to BX$ $\quad S \to a \mid YA \mid AY \mid b$

$B \to AB \mid a \mid b$ $\quad A \to YX$

$X \to BB$ $\quad B \to AY \mid a \mid b$

$X \to BB$ $\quad Y \to a$