Greibach Normal Form (GNF)

If all the production are of form $\boxed{A \to a\alpha}$ where $\boxed{\alpha \in V^*}$ then it is called GNF.

Advantages

(i) The no of steps required to generate a string of length $|w|$ is $|w|$

(ii) GNF is useful to convert CFG to PDA

Closure Properties of CFL

CFG to PDA

Case 1: CFG is not in GNF form (TV^*)

Case 2: CFG is in GNF form (TV^*)

Case 1: CFG is not in GNF form

- stack start symbol will be S
- Top of the stack can be Variable or Terminal
- No final state
- If input and top of the stack is same then we move the pointer forward.
- If top of the stack is variable then we don't move the pointer.

eg. $S \to aSb$

$S \to ab$

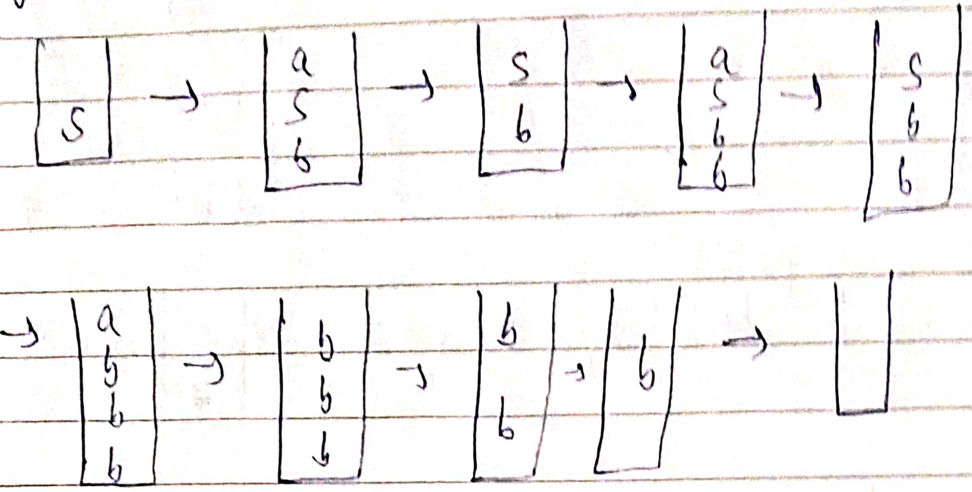
#Rule

$\left.\begin{aligned} \delta(q, \epsilon, S) &= \delta(q, aSb) \\ \delta(q, \epsilon, S) &= \delta(q, ab) \end{aligned}\right]$ For Variable

$\left.\begin{aligned} \delta(q, a, a) &= \delta(q, \epsilon) \\ \delta(q, b, b) &= \delta(q, \epsilon) \end{aligned}\right\}$ For Terminal

eg. String w = aaa bbb

eg. a a a b b b



Case 2: CGF is in GNF form

- ★ GNF form → TV^* where T is terminal and V is variable
- ★ Stack symbols are only variables
- ★ We move the pointer in each case
- ★ Stack start symbol is S
- ★ Input symbol is terminal

eg.

$S \to 0BB$

$B \to 0S \mid 1S \mid 0$

#Rule

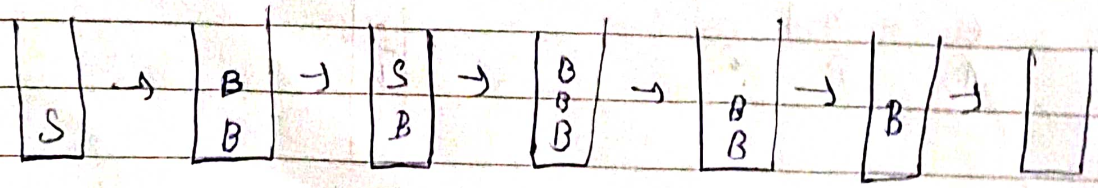
$\delta(q, 0, S) = \delta(q, BB)$

$\delta(q, 0, B) = \delta(q, S)$

$\delta(q, 1, B) = \delta(q, S)$

$\delta(q, 0, B) = \delta(q, \epsilon)$

eg. 010000



1. $\delta(q_0, a, Z_0) = (q_0, XZ_0)$

2. $\delta(q_0, a, X) = (q_0, XX)$

3. $\delta(q_0, b, X) = (q_1, \epsilon)$ $\quad a^n b^n | n \geq 1$

4. $\delta(q_1, b, X) = (q_1, \epsilon)$

5. $\delta(q_1, \epsilon, Z_0) = (q_1, \epsilon)$

$$M = (\underset{Q}{\{q_0, q_1\}}, \underset{\Sigma}{\{a, b\}}, \delta, \underset{\Gamma}{\{Z_0, X\}}, q_0, Z_0, \underset{F}{\phi})$$

N.T.

$\underline{S} \cup [q, A, P]$ $\quad q, P \in Q$, $A \in \Gamma$

1) $S \rightarrow [q_0, Z_0, P]$ for each P.

2) if $\delta(q, x, A) = (P, B_1 B_2 \ldots B_m)$

$$[q, A, q_{m+1}] \rightarrow x [P, B_1, q_2][q_2, B_2, q_3] \ldots [q_m, B_m, q_{m+1}]$$

3) if $\delta(q, x, A) = (P, \epsilon)$

$[q, A, P] \rightarrow x$ $\quad x \in (\Sigma \cup \{\epsilon\})$

$G(V, T, P, S) \leftarrow$

① $S \to [q_0, Z_0, q_1]$ A

① ~~$S \to [q_0, Z_0, q_0]$~~ , $S \to [q_0, Z_0, q_1]$

1. $\delta(q_0, a, Z_0) = (q_0, XZ_0)$
2. $\delta(q_0, a, X) = (q_0, XX)$] push
3. $\delta(q_0, b, X) = (q_1, \epsilon)$
4. $\delta(q_1, b, X) = (q_1, \epsilon)$
5. $\delta(q_1, \epsilon, Z_0) = (q_1, \epsilon)$

$a^n b^n | n \geq 1$

— ~~$[q_0, Z_0, q_0] \to a [q_0, X, q_0] [q_0, Z_0, q_0]$~~

— ~~$[q_0, Z_0, q_0] \Rightarrow a [q_0, X, q_1] [q_1, Z_0, q_0]$~~ ✗

— ~~$[q_0, Z_0, q_1] \to a [q_0, X, q_0] [q_0, Z_0, q_1]$~~

$M = (\underbrace{\{q_0, q_1\}}_{Q}, \underbrace{\{a, b\}}_{\Sigma}, \delta, \underbrace{\{Z_0, X\}}_{\Gamma}, q_0, Z_0, \underbrace{\phi}_{F})$

② $\underset{A}{[q_0, Z_0, q_1]} \to a [q_0, X, q_1] [q_1, Z_0, q_1]$ N.T

— ~~$[q_0, X, q_0] \to a [q_0, X, q_0] [q_0, X, q_0]$~~ 1)

— ~~$[q_0, X, q_0] \to a [q_0, X, q_1] [q_1, X, q_0]$~~ 2)

— ~~$[q_0, X, q_1] \to a [q_0, X, q_0] [q_0, X, q_1]$~~ ✗

③ $[q_0, X, q_1] \to a [q_0, X, q_1] [q_1, X, q_1]$

3. $\underset{B}{[q_0, X, q_1]} \to b$ 4
4. $\underset{C}{[q_1, X, q_1]} \to b$ 5
5. $\underset{D}{[q_1, Z_0, q_1]} \to \epsilon$ 6.

$= \boxed{|Q|^2 \times |\Gamma| + 1}$