Chomsky hierarchy –

It is a classification of granners which generates formal languages.

$G = (V, T, P, S)$

V = set of non terminal sym. / variables
A, B ...

P = production rules

T = set of terminal symbols.
a, b ...

S = start symbol.

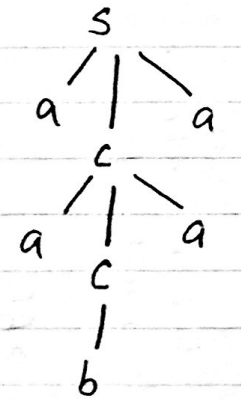
$Lang = \{ a^n b a^n \mid n \geq 1 \}$

aba
aabaa
aaabaaa

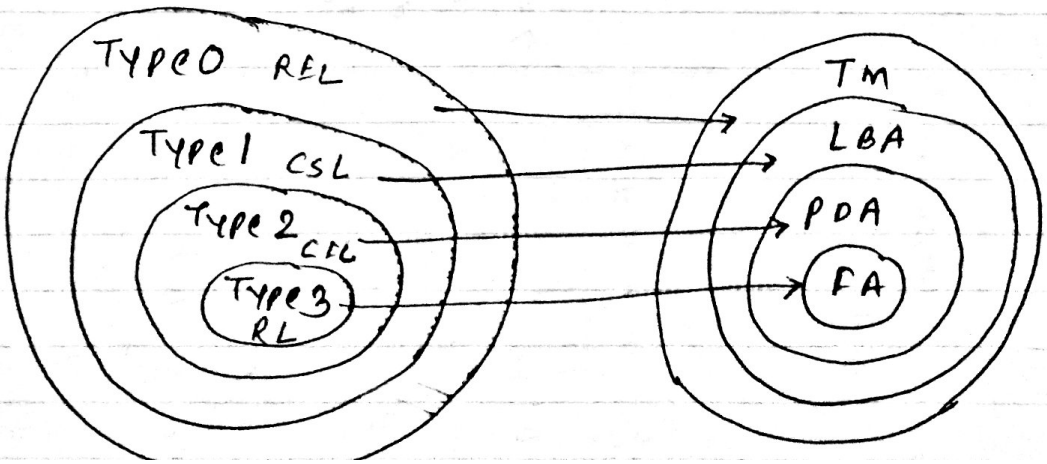
$P = \{ S \rightarrow aCa$
$C \rightarrow aCa \mid b \}$

$V = \{S, C\}$ $T = \{a, b\}$

$S \rightarrow aCa \rightarrow aaCaa \rightarrow aabaa$



Parse tree



Type 0 — any computable funn.

① unrestricted grammar

② Recursively enumerable language

③ TM

④ $\boxed{\alpha \to \beta \text{ with } \alpha \neq \wedge}$

$S \to SB \mid ab$

$SB \to BC \mid C$

$B \to b$

[Recursive lang. TM that halts]

Type 1 — $a^n b^n c^n$

CSG

CSL

LBA / NDTm
tape bounded by constant times length of input

→ $\alpha A \beta \to \alpha \gamma \beta$

A = non Terminal

α, β, γ = variables.

→ $\boxed{\alpha \to \beta}$ length of β is at least as much as α. except $S \to \wedge$

(at least of α)

→ S does not appear to right side.

eg.

$S \to AB$

$AB \to BC$

$C \to ab$

$B \to b$

Type 2 — $a^n b^n$

CFG

CFL

NDPDA

① $\boxed{A \to \alpha}$ $\quad A = NT$ $\quad \alpha = (V \cup T)^* \in V$

② LHS only one non T.

③ Start sym. can appear to right side

$S \to aSa \mid bSb \mid a \mid b$

$S \to aSa$

$S \to bSb$

$S \to a$

$S \to b$

Type 3 — a^+

Regular Grammar
- Right linear G
- left linear G

Regular lang.

FA — DFA / NFA

$a \in \Sigma$, $A, B \in V$

$A \to \in$

$A \to a$

$A \to aB$

$A \to Ba$

① LHS = RHS
- LHS: only one non T
- RHS: at most one non T as rightmost or leftmost.

$\boxed{\begin{matrix} A \to aB \\ A \to a \end{matrix}}$

② $S \to Ba \mid Ab$

$B \to Ab$

$A \to Aa \mid b$

$S \to aA \mid bB$

$A \to aA \mid \wedge$

$B \to bA \mid a$

① $A \to Ba$
$B \to c/Ca$
$C \to abc$
type 2

② $B \to aB$
$A \to BAC/abc$
type 2 Grammar

③ $A \to aA$
$A \to ab$
type 2

④ $S \to a/aAS$
$A \to bS$
type 2 CFG

⑤ $S \to Aa/Bb$
$A \to a/b$
$B \to a/b$
Type3
RL

⑤ $L = \{a^n b^n c^n / n \geq 1\}$
type1
CSG
$S \to abc/aAbc$
$Ab \to bA$
$AC \to Bbcc$
$bB \to Bb$
$aB \to aa/aaA$

⑥ $S \to baS/\epsilon$
$S \to Sba/\epsilon$
Regular grammar
type3

⑦ $S \to bA/aB$
$A \to bAA/aS/a$
$B \to aBB/bS/b$
CfG type 2

⑧ $S \to 1OA/01$
$A \to 00A/1$
Regular grammar
type 3