Regular language (L)

- FA
  - NFA
  - DFA
- RE

$L \rightarrow$ Set Builder form

$L =$ Set of Strings

Regular Set

Regular Grammar

Starting NT — S → NP VP

Terminals (T)

Non-Terminals (NT) V

production Rules / Rewrite Rules

NP → DET N

VP → V NP

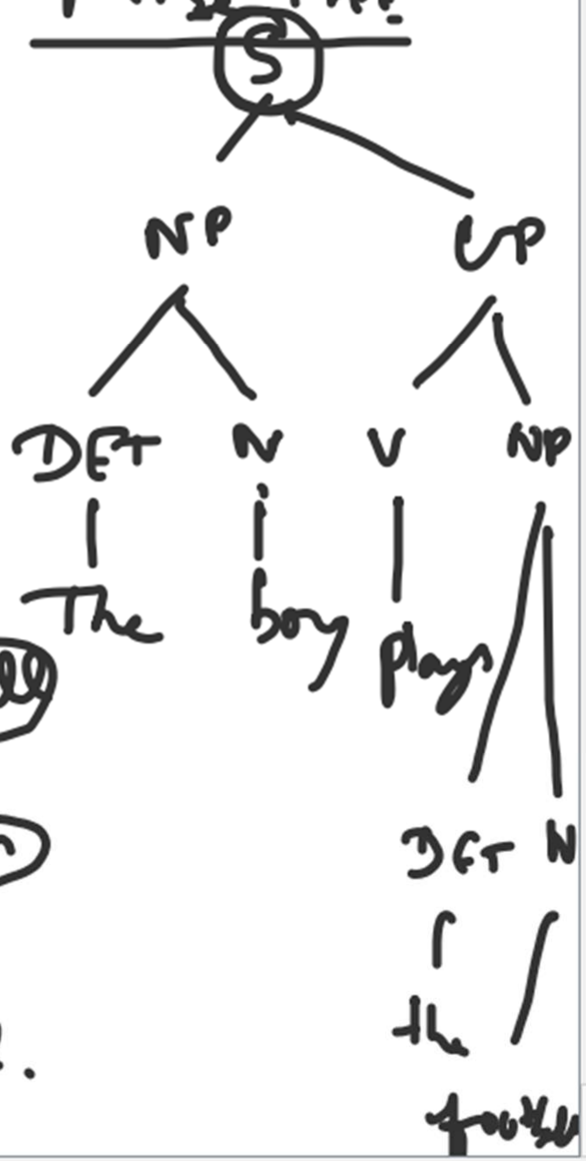
N → boy | football

DET → The | a | an

V → plays

The boy plays the football.

Parse Tree



$$V \longrightarrow \underline{\underline{VUT}} \mid TUV$$

Regular Grammar

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

Set of Production Rules

Starting NT

Set of terminals

Set of NTs

for eg. $\mathcal{L} = \{a, aa, aaa, \ldots\}$ $RE = a^* = aa^* = a^*a$

$S \rightarrow aS$

$S \rightarrow a$

Regular $\boxed{S \rightarrow aS \mid a}$ 1 2

$V = \{S\}$

$T = \{a\}$

$S = S$

$S \to aS \mid a$

$S \Rightarrow aS$

$\Rightarrow aaS$

$\Rightarrow aaaS$

$\vdots$

$\overset{*}{\Rightarrow} a\,a^{n-1}$

$= a^n$

$S \Rightarrow a$ (PR(2))

$a \in L$

$a^* b^*$ (RE) $L = \{\epsilon, a, b, ab, aa, bb, \ldots\}$

$\hookrightarrow ba$ ×

Chomsky Hierarchy
- → Type-0
- → Type-1
- → Type-2
- → Type-3 → FA

$S \longrightarrow$ Most

Regular Grammar

① $S \rightarrow aS \mid bS \mid a \mid b \mid \epsilon$ ×

$S \Rightarrow aS$

$\overset{*}{\Rightarrow} a^n$

a^*

② $S \rightarrow AB$

$A \rightarrow aA \mid \epsilon$

$B \rightarrow bB \mid \epsilon$

③ $S \rightarrow aS \mid Sb \mid a \mid b \mid \epsilon$

④ $S \Rightarrow bS$

$\Rightarrow baS$

$S \rightarrow bS$

$\overset{*}{\Rightarrow} b^n \cdot b^*$

Chomsky

unrestrictive / Recursively enumerable

Regular Grammar

context free Grammar (CFG)

$a^* b^*$ RE

+ - * -

a.b

↳ No substring "ba"

REX

Non Regular Languages

$L = \{ a^n b^n \text{ for } n = 0, 1, 2, \dots \}$

$= \{ a^n b^n \mid n \geq 0 \}$

$= \{ \epsilon, ab, aabb, aaabbb, \dots \}$

$S \longrightarrow AB$

$A \longrightarrow aA \mid \epsilon$

$B \longrightarrow bB \mid \epsilon$

$V = \{S, A, B\}$

$T = \{a, b\}$

$S = S$

$$S \Longrightarrow AB \overset{*}{\Longrightarrow} a^* b^*$$

$$A \Longrightarrow aA \overset{*}{\Longrightarrow} a^*$$

$$B \Longrightarrow bB \overset{*}{\Longrightarrow} b^*$$

Regular Language → L = set of strings

→ FA

→ R.E

Regular Grammar

(V, T, S, P)

Type-3

$\alpha \rightarrow \beta$

$|\alpha| <= |\beta|$

Non-terminal

$A \rightarrow \beta$

Regular language

RE

FA

Can't be constructed

Non-Regular Language

$L = \{\epsilon, ab, aabb, aaabbb, \ldots\}$

pumping lemma (Regular language)

Infinite language

# of states

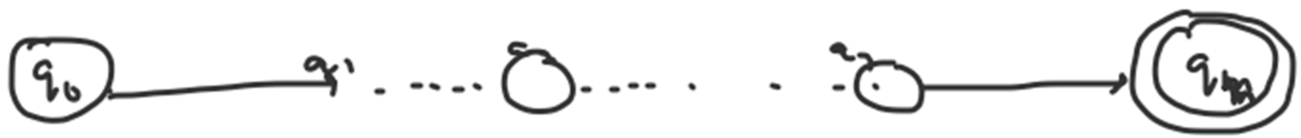
FA = n

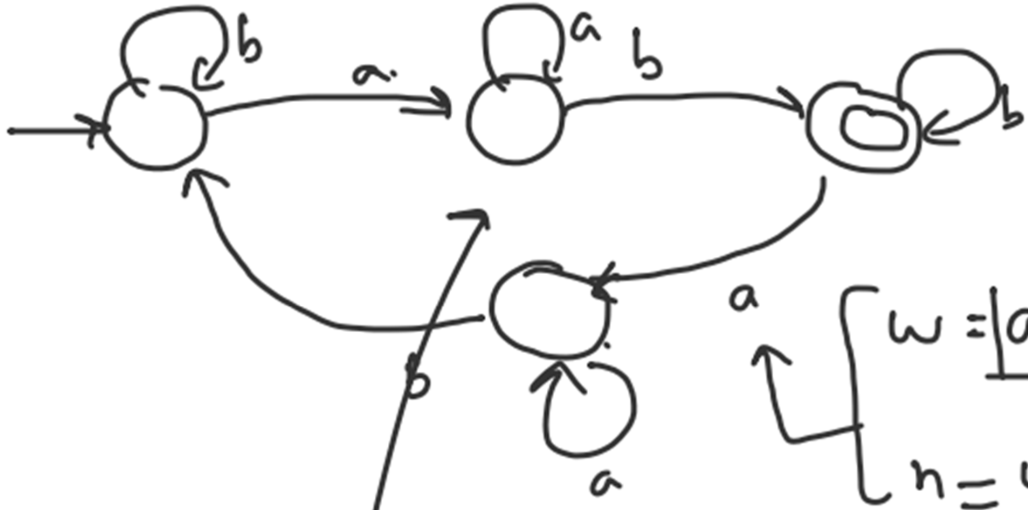
String

m

|w| =

m >= n





$w = |ababab| = 6 = m$

$n = 4 \qquad 6 \geq 4$

Pumping Lemma

$w = xyz$

$xy^i z \in L$

$$w = \begin{array}{ccc} x & y^{(i)} & z \\ \epsilon & (abab) & ab \end{array}$$

$i = 2$

$x\,y^{i}\,z$

$x\,y^2\,z$

$= \epsilon .\ abababab\ ab = ababababab \notin L$

Pumping Lemma is used to prove a language to be

Non-Regular

$L \xrightarrow[\text{Regular}]{\text{To prove: Non}}$ Assume that L is regular

↳ FA

Assumption was Wrong

$w = xyz$

must be in L

$xy^iz \notin L$