DFA $\longleftrightarrow$ NFA $\longleftrightarrow$ regular expression $\longleftrightarrow$ pattern

regular languages

2DFA

Pushdown automata

Context-free grammar (CFG)

$\uparrow$ accepted

Context-free language (CFL)

$G = (N, \Sigma, P, S)$

where

* N is a finite set of NON terminal symbols
* Σ is a finite set of terminal symbols disjoint from N
* P is a finite subset of $N \times (N \cup \Sigma)^*$
* $S \in N$ is the start symbol.

$abcabc \in \Sigma^*$, $a, b, c \in \Sigma$

$S \to a \mid Ba \qquad B \to Ba \mid a \mid \varepsilon$

$S \to a$

$\hookrightarrow Ba \to Baa \to Baaa \to \varepsilon aaa \to aaa$

$\to aaaa$

Consider $\alpha, \beta \in (N \cup \Sigma)^*$, we say that β is derivable from α in one step and write

$$\alpha \xrightarrow[G]{1} \beta$$

if β can be obtained from α by replacing some occurrence of a nonterminal A in α with γ, where $A \to \gamma$ is in P,

if $\exists\ \alpha_1, \alpha_2 \in (N \cup \Sigma)^*$

$A \to \gamma \in P$

s.t. $\alpha = \alpha_1 A \alpha_2$

$\beta = \alpha_1 \gamma \alpha_2$

$S, B \in N$

$a \in \Sigma$

$S \to B$

$B \to a \mid Ba$

abc

abca ccbba $\in \Sigma^*$ $\quad a, b, c \in \Sigma$

$P = \{ S \to A \mid B \mid C$

your final string cannot have any of these symbols

capital symbols $\in N$

$S \to B \to Ba \to Baa \to aaa$

not the final form of the string

Terminal Symbols	Non terminal symbols
1) Denoted by small letters	Denoted by capital letters
2) Can appear in any step of derivation process	Not allowed in the final step of derivation
3) Once it appears, it cannot change into anything else.	Changes into terminal, nonterminal or a combination of both symbols according to production rules.

$S \quad P = \{ S \to A \mid \cancel{BBC} \mid ABC$

$A \to a \mid aA \mid \cancel{ABC}$

$B \to b \mid bB$

$C \to c \mid cC \}$

$a^n b^n \to$ Try to design a CFG to accept this

$S \to A \to aA \to aaA \to aaa$

$\hookrightarrow A \to ABC \to aABC$

$\to aAbBC$

$\hookrightarrow aAbBcC \to$

$aabbcc$

$ABC \to ABCBC$

$\to \cancel{aABCbBC}$

$a^n b^n$

$\hookrightarrow S \to aSb \mid \varepsilon$

palindromes on $\Sigma = \{a, b, c\}$

$S \to aSa \mid bSb \mid cSc \mid a \mid b \mid c \mid \varepsilon$

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legitimate bracketing

$S \to SS \mid (S) \mid \varepsilon$

S_2

S_1

S_3