

DFA, NFA, or ϵ -NFA: $A = (Q, \Sigma, \delta, q_0, F)$

- Example of the extended transition function, supposing the existence of the states p and q , the string w and transitions q to p in the automaton with w : $\delta^*(q, w) = \{p\}$
- Conversion of the FA (finite automaton) to regular expression, using the path construction technique: $R_{ij}^{(k)} = R_{ij}^{(k-1)} + R_{ik}^{(k-1)} (R_{kk}^{(k-1)})^* R_{kj}^{(k-1)}$, where $1 \leq k \leq N$ e $1 \leq i, j \leq N$ (it is assumed that the FA states are enumerated from 1 to N)

PDA (Pushdown Automaton): $A = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)$

- Example of a computing trace in a given PDA using instantaneous descriptions: $(q, aw, X\beta) \vdash^* (p, w, \alpha\beta)$
- Theorem 1: If $(q, x, \alpha) \vdash^* (p, y, \beta)$ then $(q, xw, \alpha\gamma) \vdash^* (p, yw, \beta\gamma)$
- Theorem 2: If $(q, xw, \alpha) \vdash^* (p, yw, \beta)$ then $(q, x, \alpha) \vdash^* (p, y, \beta)$

TM (Turing Machine): $A = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$

- Example of a step in a Turing Machine: $qX_1X_2\dots X_n \vdash pBYX_2\dots X_n$ (in this case, the TM is at q state, replaces X_1 for Y , goes to the p state, and moves in tape to the left side)

Cocke-Younger-Kasami Algorithm (CYK): used to test if a string is in a CFL represented by a grammar in CNF.

Regular expression operators:

- $*$ (zero or more occurrences)
- $.$ (concatenation: symbol can be omitted)
- $+$ (or $|$ or \cup)
- Precedence (from the highest to the lowest): $*$, $.$, $+$
- Curve brackets can be used to change the usual precedence order.

Pumping Lemma for Regular Languages:

Given an infinite regular language L . There exists a constant n (dependent of L) such that for every string w in L with $|w| \geq n$, it is possible to break w in 3 substrings $w=xyz$ where:

- $y \neq \epsilon$
- $|xy| \leq n$
- For every $k \geq 0$, the string xy^kz is also in L .

Chomsky Normal Form (CNF):

All the CFLs without ϵ (the empty string) has a grammar in the normal form of Chomsky, without useful symbols and in which all the productions are in the form:

- $A \rightarrow BC$ (A, B, C are variables) or
- $A \rightarrow a$ (A is a variable and ' a ' is a terminal)

Pumping Lemma for regular Languages without context (CFLs):

Consider L an infinite CFL. Then exists a constant n such that, for any string z in L with $|z| \geq n$ we can break z in $z=uvwxy$ such that:

- $|vwx| \leq n$
- $vx \neq \epsilon$
- For every $i \geq 0$, $uv^iwx^iy \in L$