"Theory of Automata"

- less practical
- More Mathematical

- plural of automaton.
- Self acting.

Role in other major Areas of CS.

- Compiler Construct.
- Formal Verification.
- Defining Computer languages.
- Parsing.
-

Languages - Informal :- 1) first language.
2) Grammar (Rules).
English, Urdu, ...

- Formal
1) Rules.
2) Strictly following Rules we define language.
C++, Python, Elm,

Basic Elements of formal language:-

1- Alphabets :- Finite non-empty set of Symbols (letters) called alphabets. Σ.

Ex:- $\Sigma = \{1,2,3\}$.

123, 1, 2, 3, 12, 13, 23, 1233,

$\Sigma = \{0, 1\}$.

$\Sigma = \{a, b, c, \ldots z\}$.

2-Strings:- Combination of Symbols.

Ex. $\Sigma = \{0, 1\}$.

0, 1, 00, 01, 10, 11, 000, ...

$\Sigma = \{a, b\}$.

a, b, ab, aa, ba, bb, ...

3-Null String:- A String with no Symbol.

"λ", "Λ" ✓

⇓

Not to confused with logical Conjunction of Discrete Structures.

→ Null String is never part of Alphabets.

$\Sigma = \{\Lambda, a, b\}$ X.

4- Words:- Word are strings that belongs to a Language.

Rules for Defining Alphabets:-

1- $\Lambda \notin \Sigma$.
2- Should be finite.
3- Should not be ambigious.

Ambiguity:- $\Sigma_1 = \{A, Aa, bab, d\}$.

"مجالات ليست" ✓

A ? abab A. X.

Aa bab A ✓ "Grammar".

⟶.

Why Ambiguity:- letters Consisting of more than one symbol should not start with a letter already being. Used.

Ex:-

$\Sigma_1 = \{ A, aA, bab, d \}$. ✓

$= \{ A, aA, bab, ab, d \}$. ✓

Length of a String:- Number of symbols in a String.

Ex:- $\Sigma = \{a, b\}$.

$S =$ aaabb $\quad |S| = 5$

$\Sigma = \{ A, aA, bab, d \}$.

$S =$ AaAbabd.

$|S| = 4 \quad$ TX.

Reverse of a String. reverse (S) S^r

Ex:-

$\Sigma = \{ A, aA, bab, d \}$.

$S =$ AaA babd.

reverse(s) = dbab aAA.

Length of a string over n Alphabets.

$|\Sigma| = n$ Length = m.

" n^m ".

Ex: $\Sigma = \{a, b\}$. $n = 2$.

Length 5 = ? $2^5 = 32$.

Length 4 = ? $2^4 = 16$.

Length 3 = ? $2^3 = 8$.

aaa, aab, aba, abb
baa, bab, bba, bbb.

$\Sigma = \{a, b, c\}$. $n = 3$.

Length 5 = ? $3^5 = ?$