

# Theory of Automata

## Automata

The term "Automata" is derived from the Greek word "αὐτόματου" which means "self-acting".

An automaton with a finite number of states is called a **Finite Automaton (FA)** or **Finite State Machine (FSM)**.

## Introduction to languages

There are two types of languages

- Formal Languages (Syntactic languages)
- Informal Languages (Semantic languages)

## Alphabets

A finite non-empty set of symbols (called letters), is called an alphabet. It is denoted by  $\Sigma$  (Greek letter sigma).

## Note

Empty string or null string Sometimes a string with no symbol at all is used, denoted by (Small Greek Letter Lambda)  $\lambda$  or (Capital Greek letter Lambda)  $\Lambda$ , is called an empty string or null string.

## Strings

Concatenation of finite number of letters from the alphabet is called a string.

### Example

If  $\Sigma = \{a,b\}$  then

a, abab, aaabb, ababababababababab

## Words

Words are strings belonging to some language.

### Example

If  $\Sigma = \{x\}$  then a language L can be defined as

$L = \{x^n : n=1,2,3,\dots\}$  or  $L = \{x,xx,xxx,\dots\}$

Here x,xx,... are the words of L.

- All words are strings, but all strings are not words.

While defining an alphabet of letters consisting of more than one symbols, no letter should be started with the letter of the same alphabet i.e. one letter should not be the prefix of another. However, a letter may be ended in a letter of same alphabet.

$\Sigma_1 = \{B, aB, bab, d\}$

$\Sigma_2 = \{B, Ba, bab, d\}$

$\Sigma_1$  is a valid alphabet while  $\Sigma_2$  is an in-valid alphabet.

## Length of Strings

The length of string s, denoted by  $|s|$ , is the number of letters in the string.

### Example

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

$s = ababa$

$|s| = 5$

## Reverse of a String

The reverse of a string s denoted by  $Rev(s)$  or  $s^r$ , is obtained by writing the letters of s in reverse order.

## Defining Languages

The languages can be defined in different ways, such as Descriptive definition, Recursive definition, using Regular Expressions(RE) and using Finite Automaton(FA) etc.

## Descriptive definition of language

The language is defined, describing the conditions imposed on its words.

# Automata Theory Lecture Notes

**Roman Wölfel**



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