

# FORMAL LANGUAGES & AUTOMATA THEORY

- **Theory of Automata**

Theory of automata is a theoretical branch of computer science and mathematical. It is the study of abstract machines and the computation problems that can be solved using these machines. The abstract machine is called the automata. The main motivation behind developing the automata theory was to develop methods to describe and analyse the dynamic behaviour of discrete systems.

This automaton consists of states and transitions. The **State** is represented by **circles**, and the **Transitions** is represented by **arrows**.

Automata is the kind of machine which takes some string as input and this input goes through a finite number of states and may enter in the final state.

## Formal language

In mathematics, computer science, and linguistics, a formal language is a set of strings of symbols that may be constrained by rules that are specific to it. The alphabet of a formal language is the set of symbols, letters, or tokens from which the strings of the language may be formed; frequently it is required to be finite

A formal language is often defined by means of a formal grammar such as a regular grammar or context-free grammar, also called its formation rule.

## Alphabet

- **Definition** – An **alphabet** is any finite set of symbols.
- **Example** –  $\Sigma = \{a, b, c, d\}$  is an **alphabet set** where 'a', 'b', 'c', and 'd' are symbols.

## String

- **Definition** – A **string** is a finite sequence of symbols taken from  $\Sigma$ .
- **Example** – 'cabcad' is a valid string on the alphabet set  $\Sigma = \{a, b, c, d\}$

## Length of a String

- **Definition** – It is the number of symbols present in a string. (Denoted by  $|S|$ ).
- **Examples** –
  - If  $S = \text{'cabcad'}$ ,  $|S| = 6$
  - If  $|S| = 0$ , it is called an **empty string** (Denoted by  $\lambda$  or  $\epsilon$ )

## Kleene Star

- **Definition** – The Kleene star,  $\Sigma^*$ , is a unary operator on a set of symbols or strings,  $\Sigma$ , that gives the infinite set of all possible strings of all possible lengths over  $\Sigma$  including  $\lambda$ .
- **Representation** –  $\Sigma^* = \Sigma_0 \cup \Sigma_1 \cup \Sigma_2 \cup \dots$ , where  $\Sigma_p$  is the set of all possible strings of length  $p$ .
- **Example** – If  $\Sigma = \{a, b\}$ ,  $\Sigma^* = \{\lambda, a, b, aa, ab, ba, bb, \dots\}$

# Formal Languages Automata Theory Notes

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