

# CS & IT ENGINEERING

## Theory of Computation

Regular Languages

Lecture No.- 02

A man with a beard and mustache, wearing a black polo shirt, standing with his arms crossed in front of a bookshelf.

Malleham Devasane Sir

# Topics to be Covered



Topic

Basics of TOC







## TOPIC:



Symbol



Alphabet ( $\Sigma$ ) =  $\{0, 1\}$



String(word)(number)



Language (set)

Symbol

↳ Smallest unit

↳ anything

# Alphabet (Set)

→ Collection of Symbols

→ Non empty set  
→ Finite Set

$$\Sigma_1 = \{0, 1\}$$

$$\Sigma_2 = \{0, 1\}$$

$$\Sigma_3 = \{a, b\}$$

$$\Sigma_4 = \{\underline{0}, 1\}$$

$$\Sigma_5 = \{\text{gate}, \text{exam}\}$$

$|\text{gate}| = 1$  → 1 sym

$$\Sigma_6 = \{a, b, c, \dots, z\}$$

$|\text{gate}| = 4$

$$\Sigma_1 = \{ \underline{ga}, \underline{te} \}$$

$$|\underline{gate}| = 2$$

$$\Sigma_2 = \{ \underline{gate}, \underline{exam} \}$$

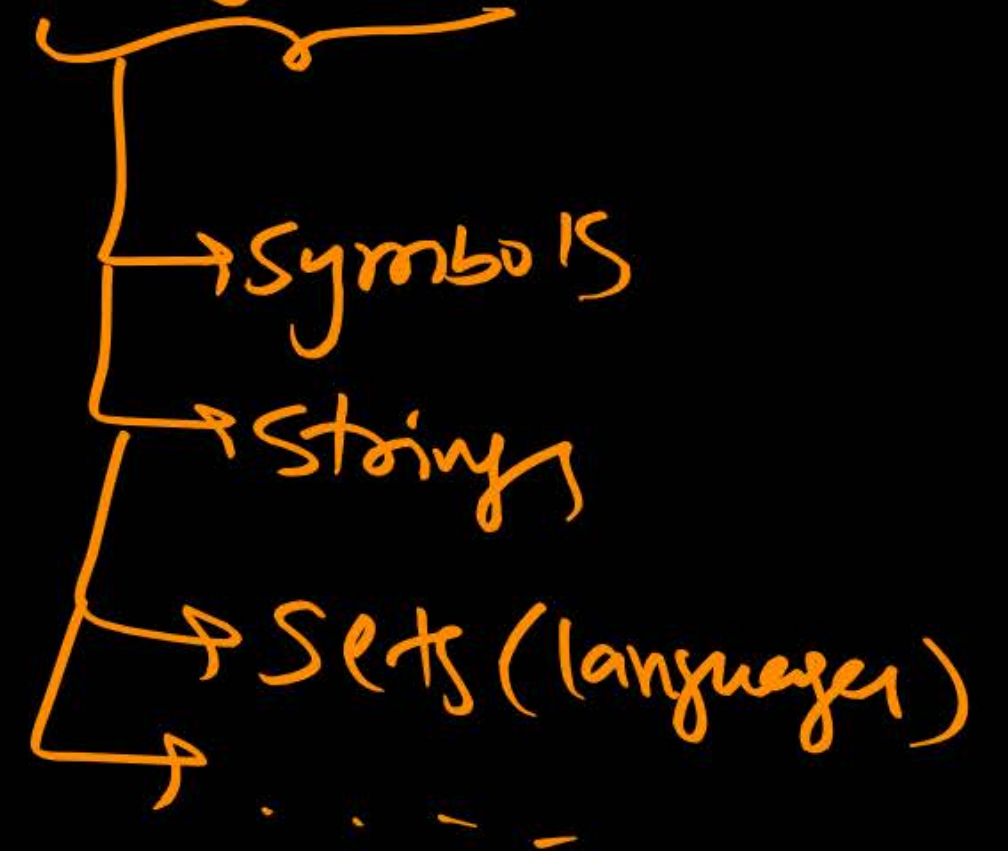
$$|\underline{gate}| = 1$$

$$\Sigma_3 = \{ \underline{g}, \underline{a}, \underline{t}, \underline{e} \}$$

$$|\underline{gate}| = 4$$

# Set

↳ It is collection of Objects





~~$\Sigma = \{a, aa\}$~~   $\times$   $|\overline{aa}| = ?$

$\begin{matrix} & a & aa \\ \nearrow & & \nearrow \\ \{x, y\} & & \{x, y\} \\ \nwarrow & & \nwarrow \\ & a & aa \end{matrix}$



$|xx| = 2$

$|y| = 1$

$\begin{matrix} & x & x \\ \downarrow & & \downarrow \\ |x| & & |x| \end{matrix} = 2$

$|xxx| = 3$

$|x| = 1$





**TOPIC:**



Symbol

→ It is 1 length string



## TOPIC:

String over  $\Sigma = \{0, 1\}$

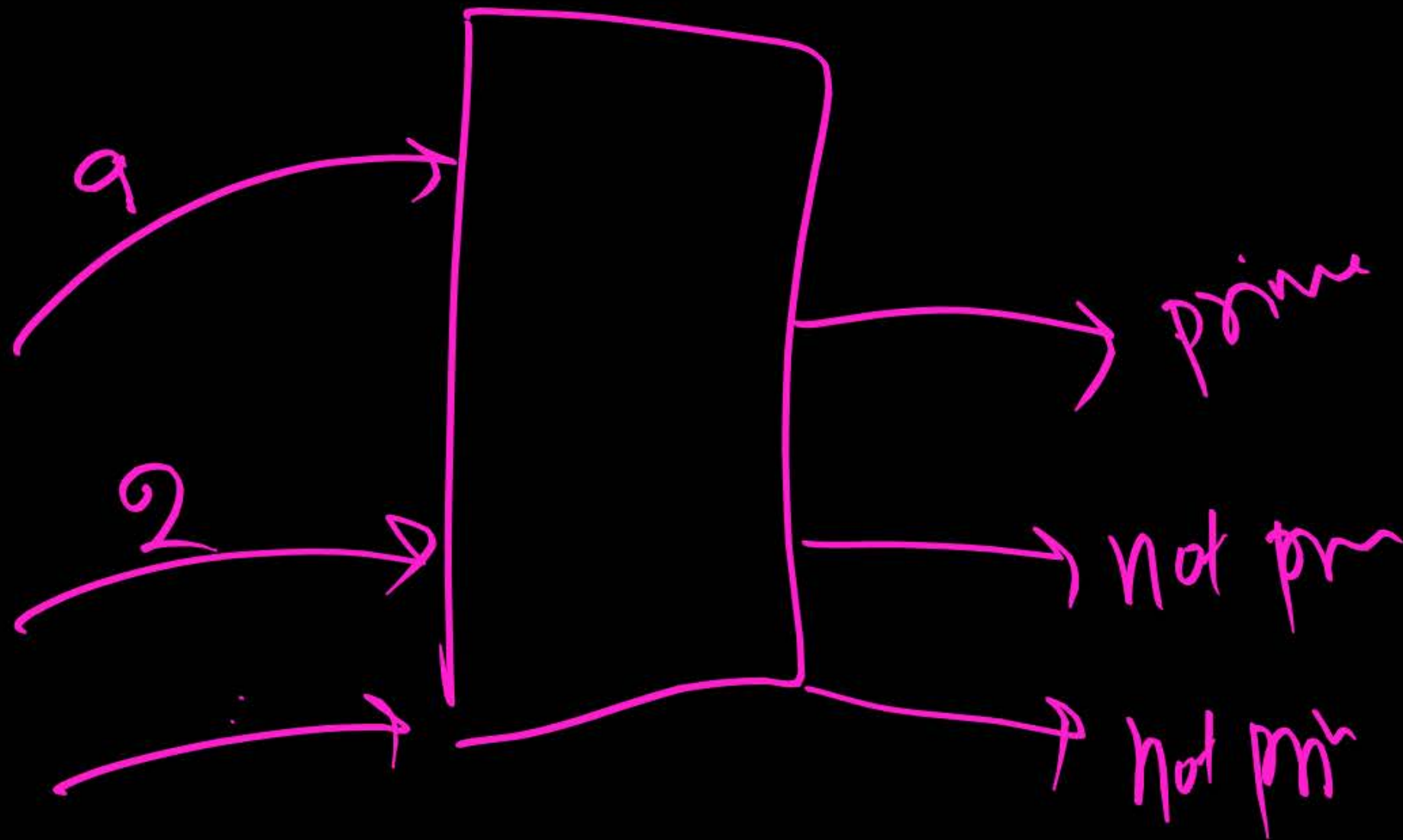
$\epsilon$  or  $\lambda$  or Empty string or null string or zero length string

$\{0, 1\}$  one length-

$\{00, 01, 10, 11\}$  2 length

$\{000, 001, 010, 011, 100, 101, 110, 111\}$  3 length string

 = no symbol but string = zero symbols in string







## TOPIC:



$$\Sigma = \{x, y\}$$
$$\Sigma = \{\underbrace{\text{gate}}_{\rightarrow 1}, \underbrace{\text{top}}_{\rightarrow 1}\}$$

$$1) |\epsilon| = 0$$

$$2) |g| = \text{X} \quad \text{we can't compute}$$

$$3) |\text{gate}| = 1$$

$$4) |\text{gate gate}| = 2$$

$$5) |\text{gate gate top}| = 3$$
$$|xxy|$$



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

Q1) How many 3 length strings over  $\Sigma$  ? = 8

aaa  
aab  
aba  
abb  
baa  
bab  
bba  
bbb

Q2) " " K " " " "  $\Sigma$  ? =  $2^k$



Symbol

↳ any

Alphabet

↳ set of symbols

String

↳ sequence of symbols

Language

↳ collection of strings



## TOPIC:

Language (L) / set :

↳ Collection of strings  
(set)

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

$\epsilon$

a

b

aa

ab

ba

bb

aaa

.

.

.

.

$\{\}$   $\rightarrow$  empty set =  $\phi$   
 $\rightarrow$  empty lang

$\{\epsilon\}$

$\{a\}$

$\{b\}$

⋮

$\{\epsilon, a\}$

$\{\epsilon, b\}$

$\{a, b\}$

$\{a, aa\}$

$\{\epsilon, a, b\}$

$\{\epsilon, a, aa\}$

$\{\epsilon, b, aa\}$

⋮

$\{\epsilon, a, b, aa\}$

⋮







## TOPIC:



Language (set) over  $\Sigma$  :

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

$$L = \{\epsilon, a, abb\}$$

# Language

→ Set

→ Collection

→ Set of strings

# Language

Finite Language

(finite no. of strings)

$$\{a^n \mid n < 3\} = \{a^0, a^1, a^2\}$$

$$= \{\epsilon, a, aa\}$$

Infinite Language

(Infinite no. of strings)

$$\{a^n \mid n > 0\}$$

$$= \{a^1, a^2, a^3, \dots\}$$

$$= \{a, aa, aaa, \dots\}$$

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

empty string  $= \epsilon = \lambda = \text{Zero length string}$

empty set = empty language =  $\{ \} = \phi$

$$|\epsilon| \xrightarrow{\text{length}} = 0$$

$$|aab| = 3$$

$$|\phi| \xrightarrow{\text{size of set}} = |\{ \}| = 0$$

$$|\{ \epsilon, \underline{ab}, \underline{aaba}, \underline{a} \}| = 4$$



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

$$a^0 = \epsilon$$

$$b^0 = \epsilon$$

~~$$a^{-1}$$~~
~~$$b^{-2}$$~~

$$a^2 = aa$$

$$a^3b = aaab$$



## 2 mins Summary



Topic

Operations on Strings

Topic

Types of Languages

Topic

Chomsky Hierarchy

Topic

Grammar

Topic

Automata

Next

**THANK - YOU**