CS & IT ENGINEERING

Theory of Computation

Finite Automata

Lecture No. 01

By- DEVA Sir

01 Weightage ?

02 Text Books ?

03 Practice ?

04 Motivation ?

05 Best Rank ?

Weightage of TOC

(Theory of computation)

↳ 8 to 10 M

Text Books:

Practice

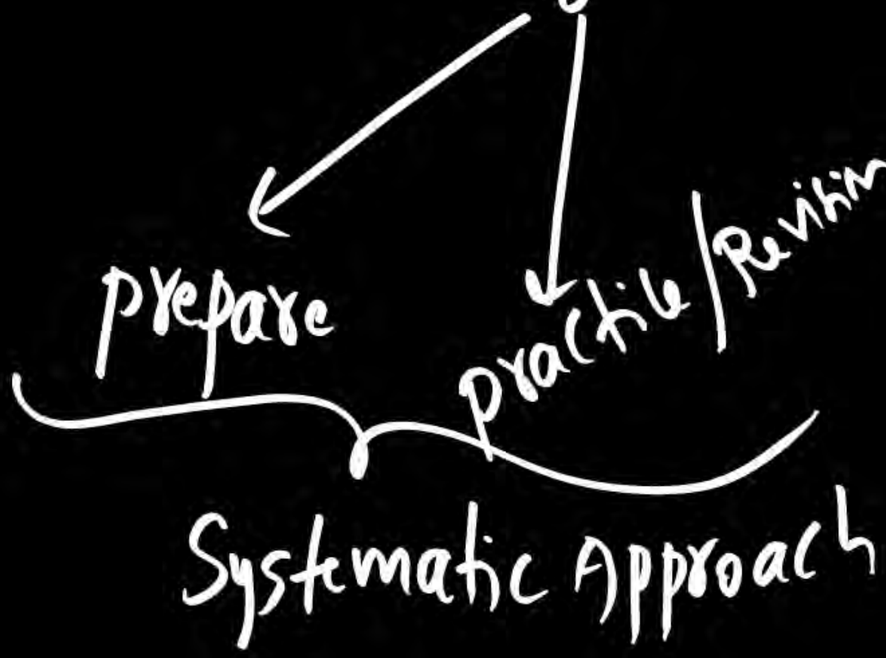
- class Examples → 1st
- class Assignment → 2nd
- class DPPs → 3rd
- GATE PYQs → 4lk
- Test Series → 5lk

Motivation ?

Hard Work + Time Mgmt

Best Rank ?

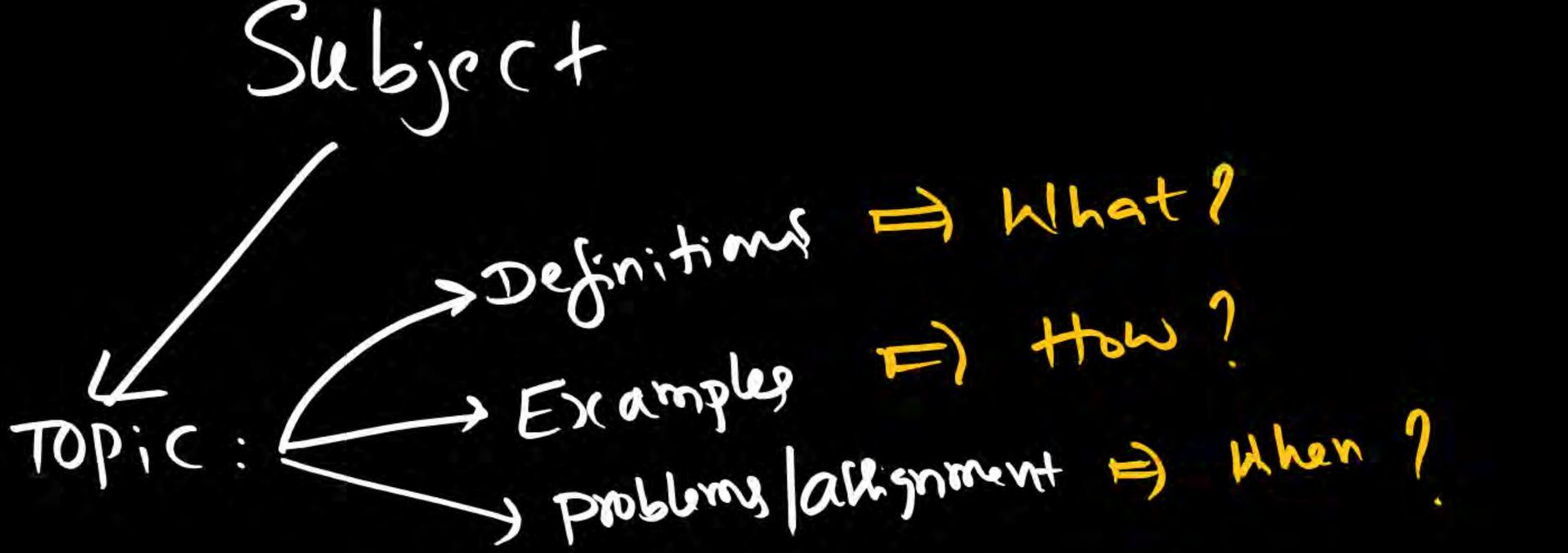
↳ GATE Syllabus



Theory of Computation: [syllabus]

1. Basics
2. *** Regular Languages
3. * DCFLs & CFLs
4. Recursive & RE languages
5. * Decidable & Undecidable problems / languages

IS TOC Easy / Hard ?



Basics of TOC :

1. Symbol
2. Alphabet
3. String
4. Language

Symbol :

- It is anything
- It is one length

English Language
Hindi Language
C Language
:

o

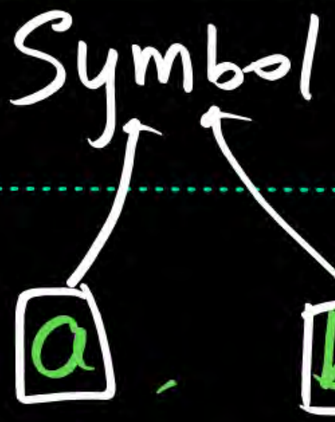
|o| = 1

gate
(symbol)

|gate| = 1

@

|@| = 1



① English Lang : (Letters) a, b, . . . , z

② Hindi Lang : (Letters) अ, आ, इ, . . .

③ Decimal Lang : (Digit) 0, 1, 2, . . . , 9

④ Binary Lang : (Bit) 0, 1

⑤ C lang : (character) 0,1,…,9, a,b,…z, A,B,…Z, +,-,:,;,…

Symbol

⑥ DEVA sir lang

gate , rank , exam

|gate| = 1
|rank| = 1
|exam| = 1

Alphabet (Σ)

- It is a set
- Set of all symbols

Set
- collection of objects
  - well-defined
    - Domain ?
    - Distinct
    - Unordered

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

↳ should not repeat

Alphabets in TOC :

$\Sigma \longrightarrow$ Input Alphabet : Set of i/p symbols

$\Delta \rightarrow$ O/p Alphabet : Set of o/p symbols

$\Gamma \longrightarrow$ Stack Aphabet : Set of stack symbols

$T \rightarrow$ Tape Alphabet : Set of tape symbols

English Alphabet

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

Decimal Alphabet

$$\Sigma = \{0, 1, \ldots, 9\}$$

Binary Alphabet

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

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

$|gate| = 4$

↳ String

$|g| = 1$

$\Sigma = \{gate, exam\}$

$|gate| = 1$

↳ symbol

$|g|$ → no meaning

→ not defined

String over Σ

↳ It is a sequence of symbols over Σ

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

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

→ Zero length string : λ or ε (empty string)

λ : not a symbol

ε : empty string

$|\varepsilon| = 0$

→ one length strings : 0 , 1

$|0| = 1$

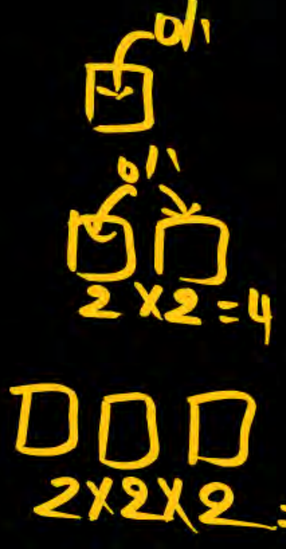
$|1| = 1$

→ Two length strings : 00, 01, 10, 11

$|00| = |10| = |11| = |01| = 2$

→ 3 length strings : 000, 001, 010, 011, 100, 101, 110, 111

$|000| = |001| = |100| = 3$



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

How many K length strings ?

↳ $2^K = |\Sigma|^K$

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

↳ How many 100 length strings ? $= 3^{100}$

Set : Collection of objects

ϕ

Empty set

$\{\ \}$

$|\phi| = 0$ (set)

Size of ϕ

String : Sequence of symbols

ε

Empty string

$|\varepsilon| = 0$ (string)

Length of ε

$\Sigma = \{\varepsilon, \lambda\}$

$|\varepsilon| = 1$

$|\lambda| = 1$

→ Empty string : @

$|@| = 0$

Language [Set] over Σ

- Set
- Set of strings
- collection of strings

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

Languages over Σ :

Language with Zero strings : $L = \phi = \{\}$ Empty set / Empty language

Languages with only 1 string : $L_1 = \{\varepsilon\}$ $L_3 = \{1\}$ $L_5 = \{01\}$
$L_2 = \{0\}$ $L_4 = \{00\}$ $L_6 = \{10\}$, ...

Languages with only 2 strings

$L_1 = \{\varepsilon, 0\}$ $L_3 = \{0, 1\}$ $L_5 = \{11, \varepsilon\}$
$L_2 = \{\varepsilon, 1\}$ $L_4 = \{0, 00\}$ $L_6 = \{000, 11111\}$

00
↳ one string having 2 length

{00, 1} ⇒ 2 strings are there in language

given Σ

- No. of strings over Σ $\Rightarrow$ Infinite
- No. of languages over Σ $\Rightarrow$ Infinite
- No. of K length strings $\Rightarrow$ $|\Sigma|^K$
- No. of languages having 10 strings $\Rightarrow$ Infinite

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

$00000\,00000 = 0^{10}$

Finite Languages

$0^2 = 00$

$1^2 = 11$

$0^3 = 000$

ϕ

$\{0\}$

$\{0, 10\}$

$\{0^n 1^n \mid n \leq 10\}$

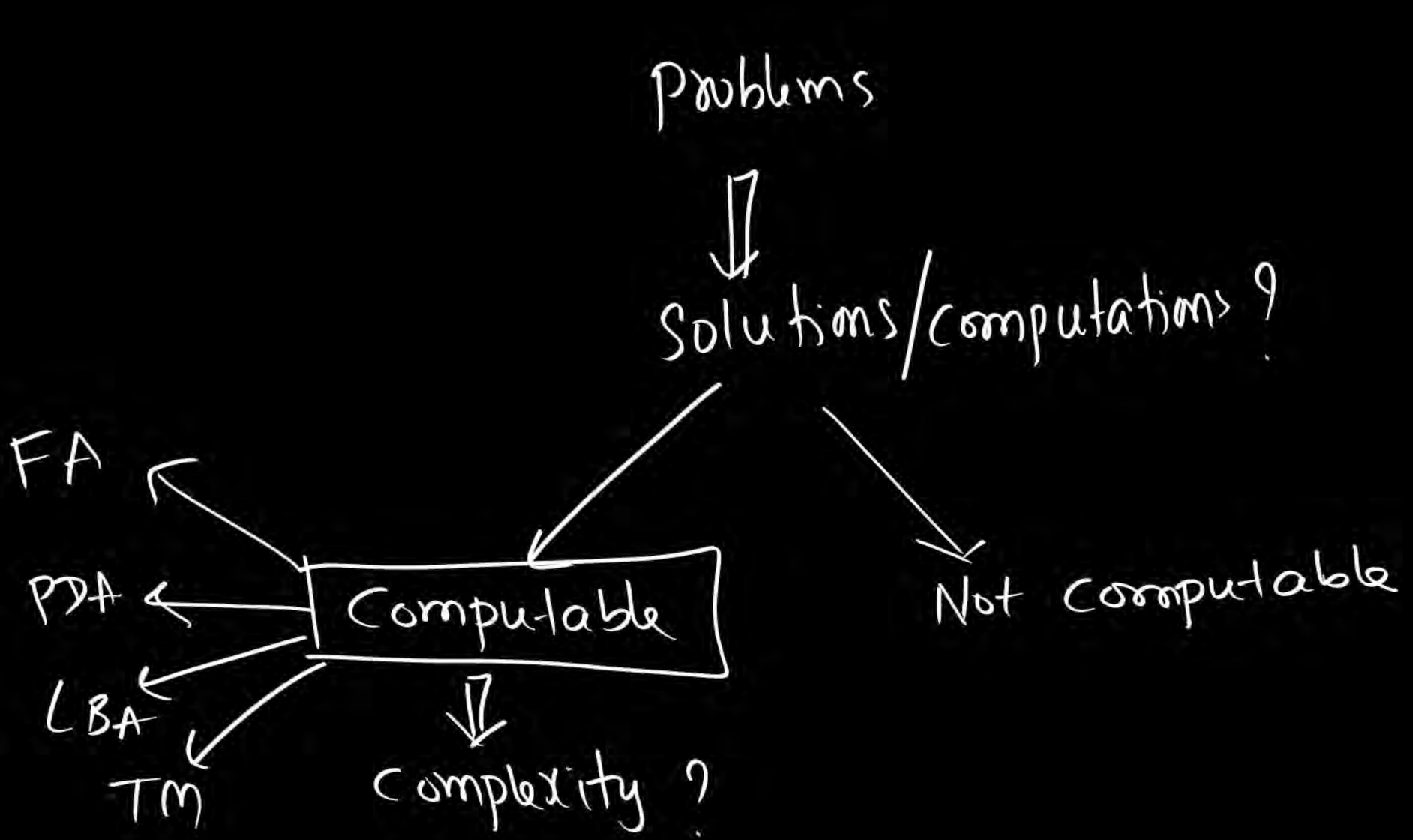
$\Sigma = \{0, 1\}$

Infinite languages

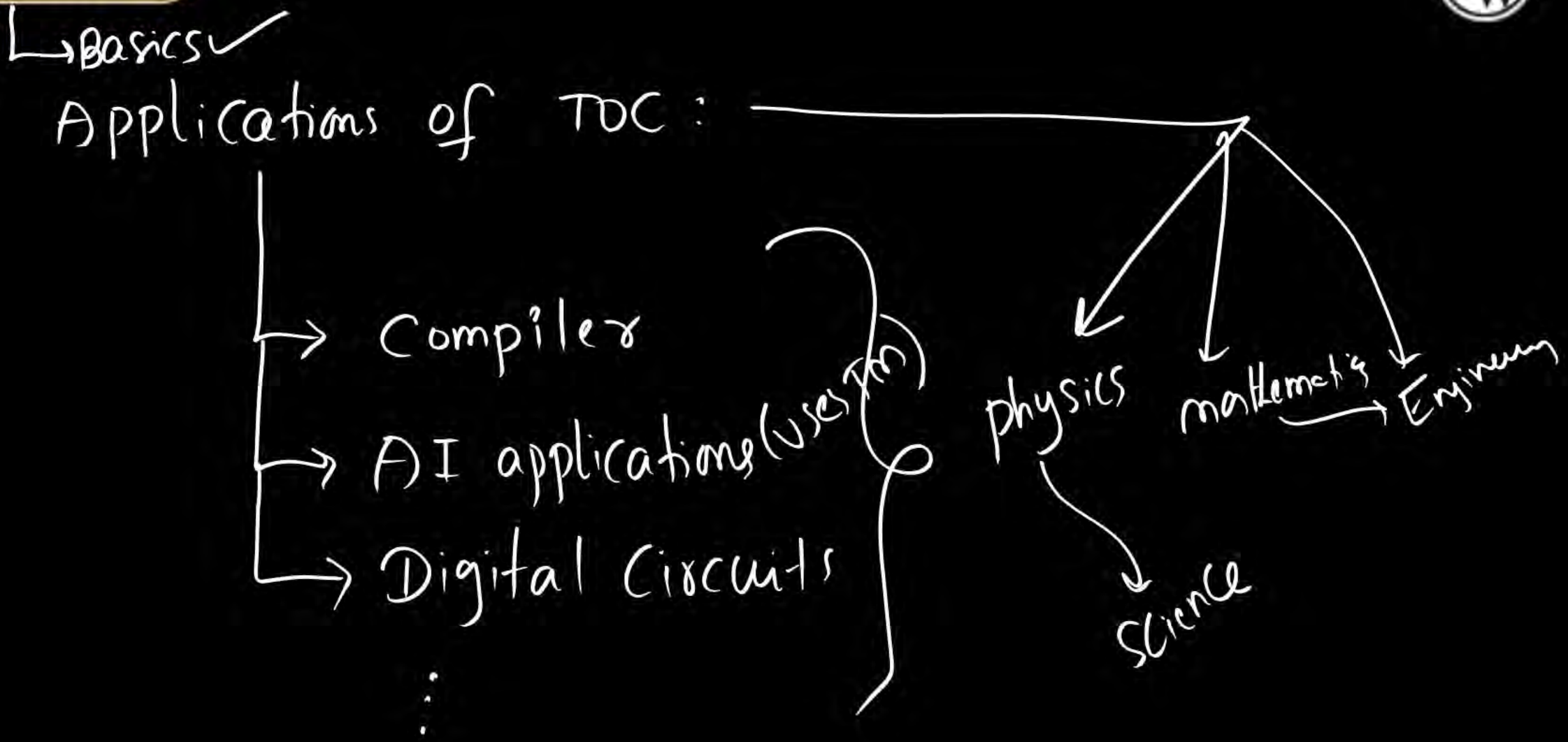
$\{0^n \mid n \geq 10\} = \{0^{10}, 0^{11}, 0^{12}, \cdots\}$

$\{\underbrace{0^n 1^n}_{\text{form of a string}} \mid n \geq 1\} = \{01, 0011, \cdots\}$

	English	Binary Number System	C Language
Symbols	a, b, ... z	0, 1	characters
⇓ Alphabet	{a, b, . . . , z}	{0, 1}	character set
⇓ Strings	Words	Numbers	tokens
⇓ Languages	Sentences	Binary language	programs


Problems
Solutions/computations ?
FA
PDA
LBA
TM
Computable
Complexity ?
Not computable

Summary


Basics
Applications of TOC :
Compiler
AI applications (use)
Digital Circuits
physics
mathematics
Engineering
Science

$11 + 111 = 11111$

$2 + 3 = 5$

calculator → Basic
calculator → Scientific

mobile, Computer, Robots

String $\Leftarrow \varepsilon \Rightarrow |\varepsilon| = 0$

non empty set $\Leftarrow \{\varepsilon\} \Rightarrow |\{\varepsilon\}| = |\{\text{one string}\}| = 1$

empty set $\Leftarrow \{\} \Rightarrow |\{\}| = |\phi| = 0$

no element

$\{ab, bc, ca\} = \{x, y, z\}$

$x = ab$
$y = bc$
$z = ca$

$\Sigma = \{0,1\} \Rightarrow \{0,1\} \rightarrow$ Set

Finite lang

not a string

Symbol

a

Alphabet

Set of symbols

Symbols

a, b, . . ., z

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

String

Language

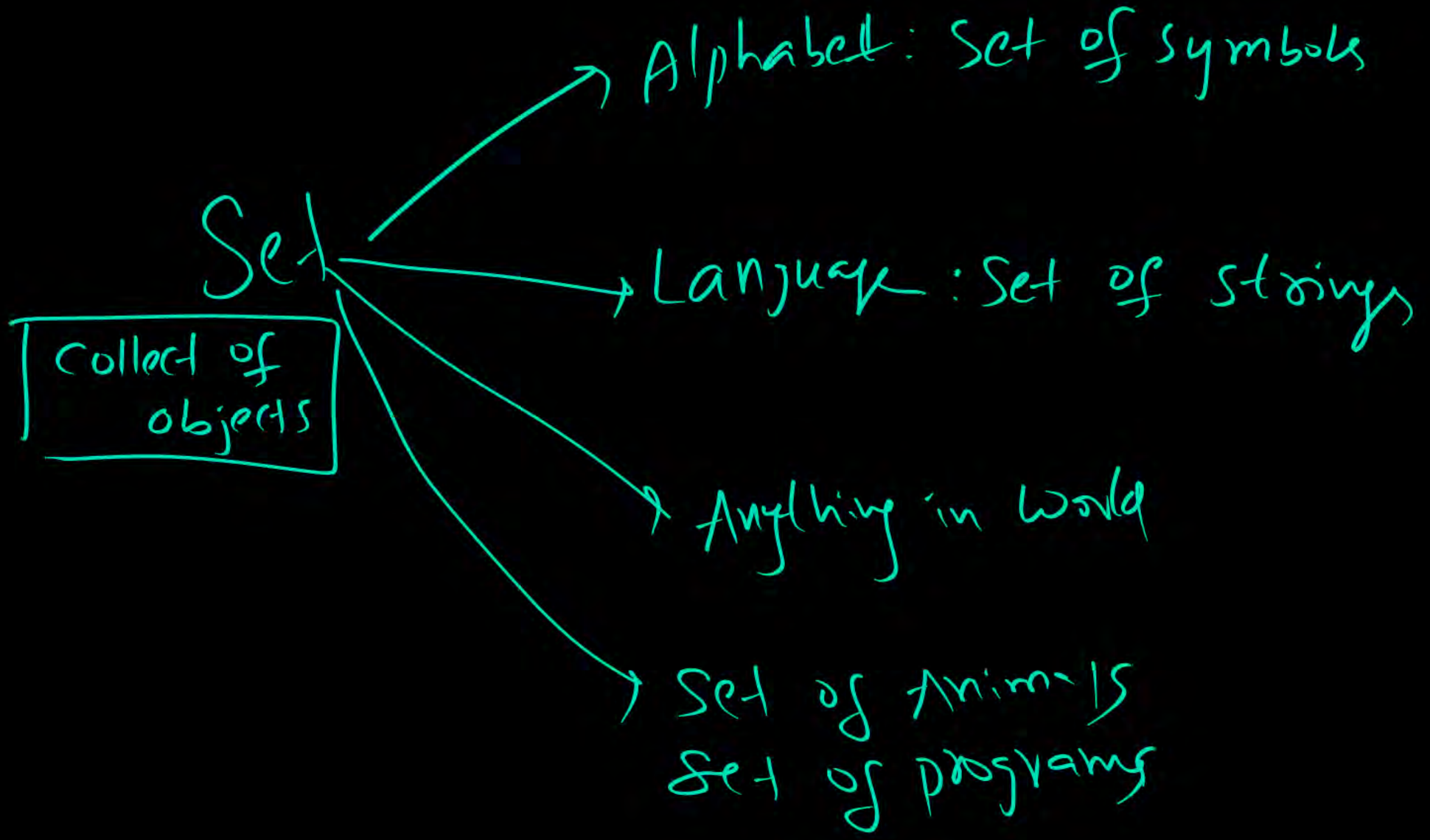
sequence of symbols

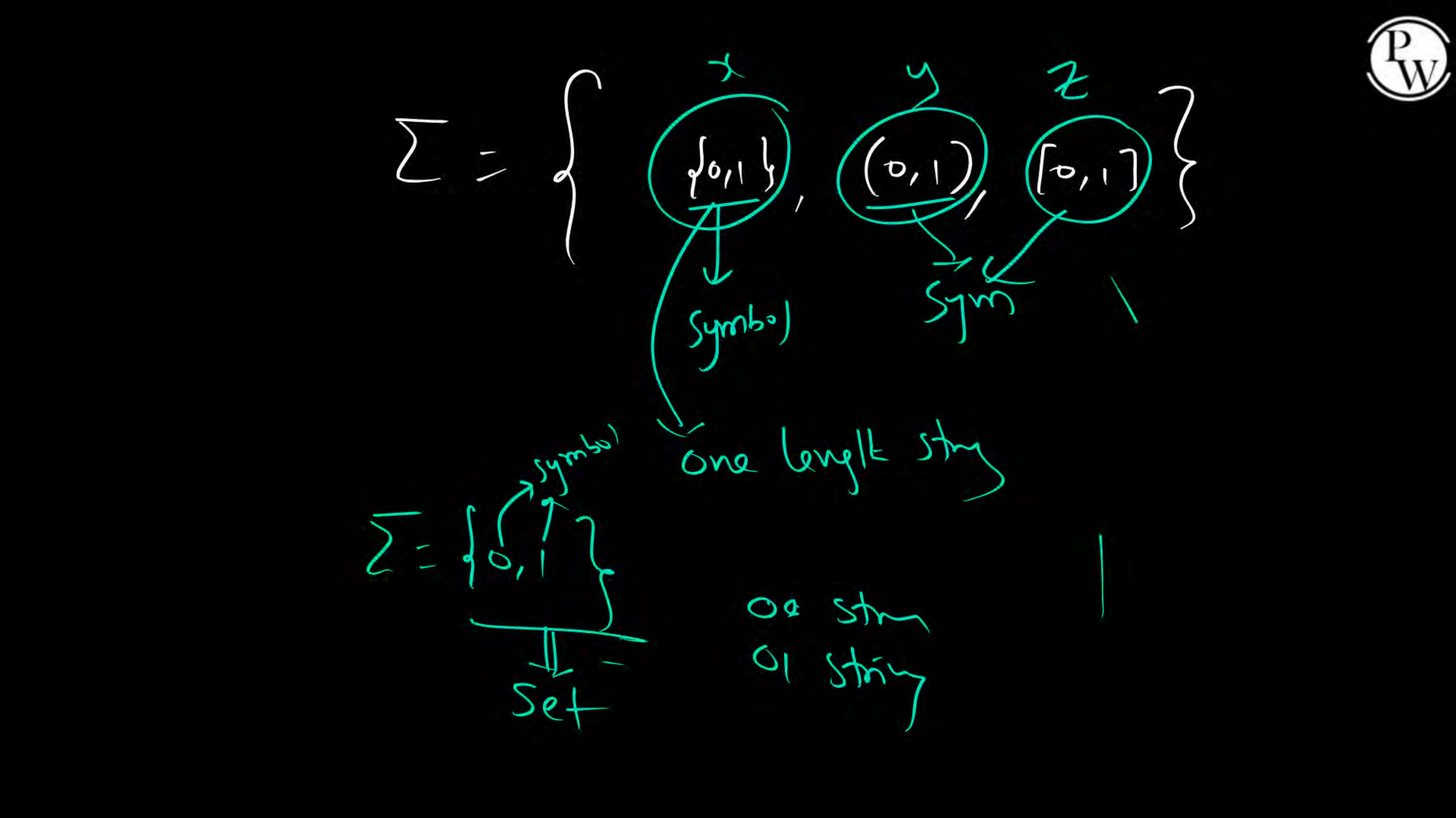
aababab

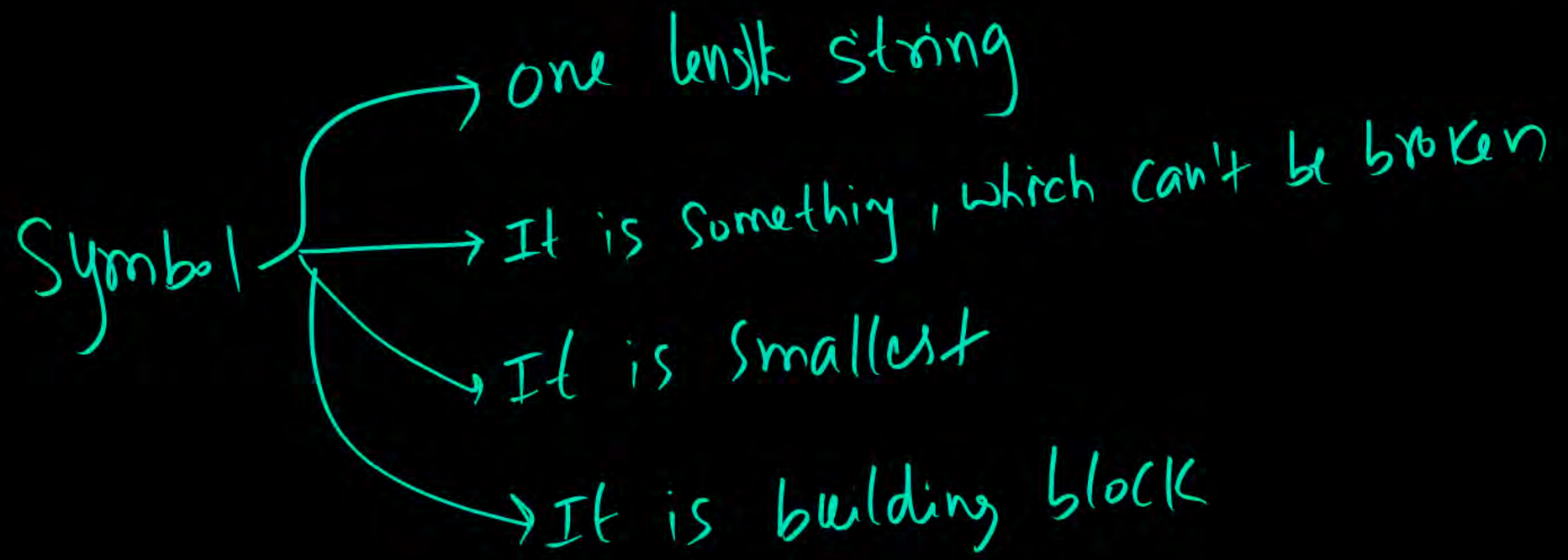
String

$\{String_1, String_2, String_3\}$

$\{ab, \varepsilon, aaaab\}$


Set
Collect of objects
Alphabet: Set of symbols
Language: Set of strings
Anything in world
Set of animals
Set of programs


Σ = { {0,1} , (0,1) , [0,1] }
x
y
z
Symbol
Sym
1
Symbol
One length string
Σ = {0, 1}
Set
0 a string
01 string
1


Symbol
one length string
It is something, which can't be broken
It is smallest
It is building block

No. of languages with 2 strings : Infinite

$L_1 = \{\varepsilon, a\}$

$L_2 = \{\varepsilon, b\}$

$L_3 = \{a, b\}$

$L_4 = \{\varepsilon, aa\}$

$L_5 = \{\varepsilon, ab\}$

$L_6 = \{aa, a\}$ . . .

Theory of Computation

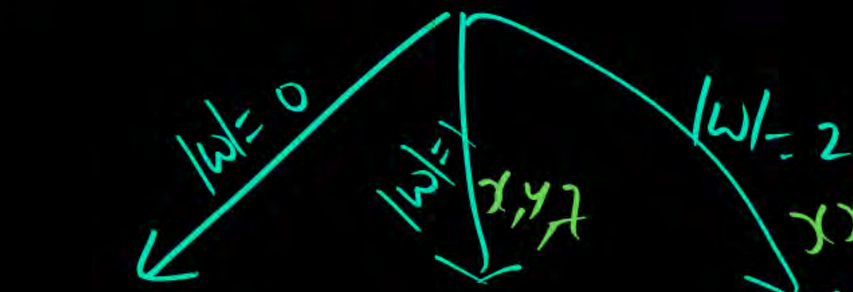
Formal Languages

Automata Theory

Formal Grammars

} same

$\Sigma = \{x: gate, y: exam, z: topper\}$



ε

gate
exam
topper

gategate
gateexam
gatetopper
examgate
examexam
examtopper
topperset
toppertopper
topperexam


THANK YOU
GW
SOLDIERS !