CS & IT ENGINEERING

Theory of Computation
Basics of TOC

Lecture No. 1

By- DEVA Sir

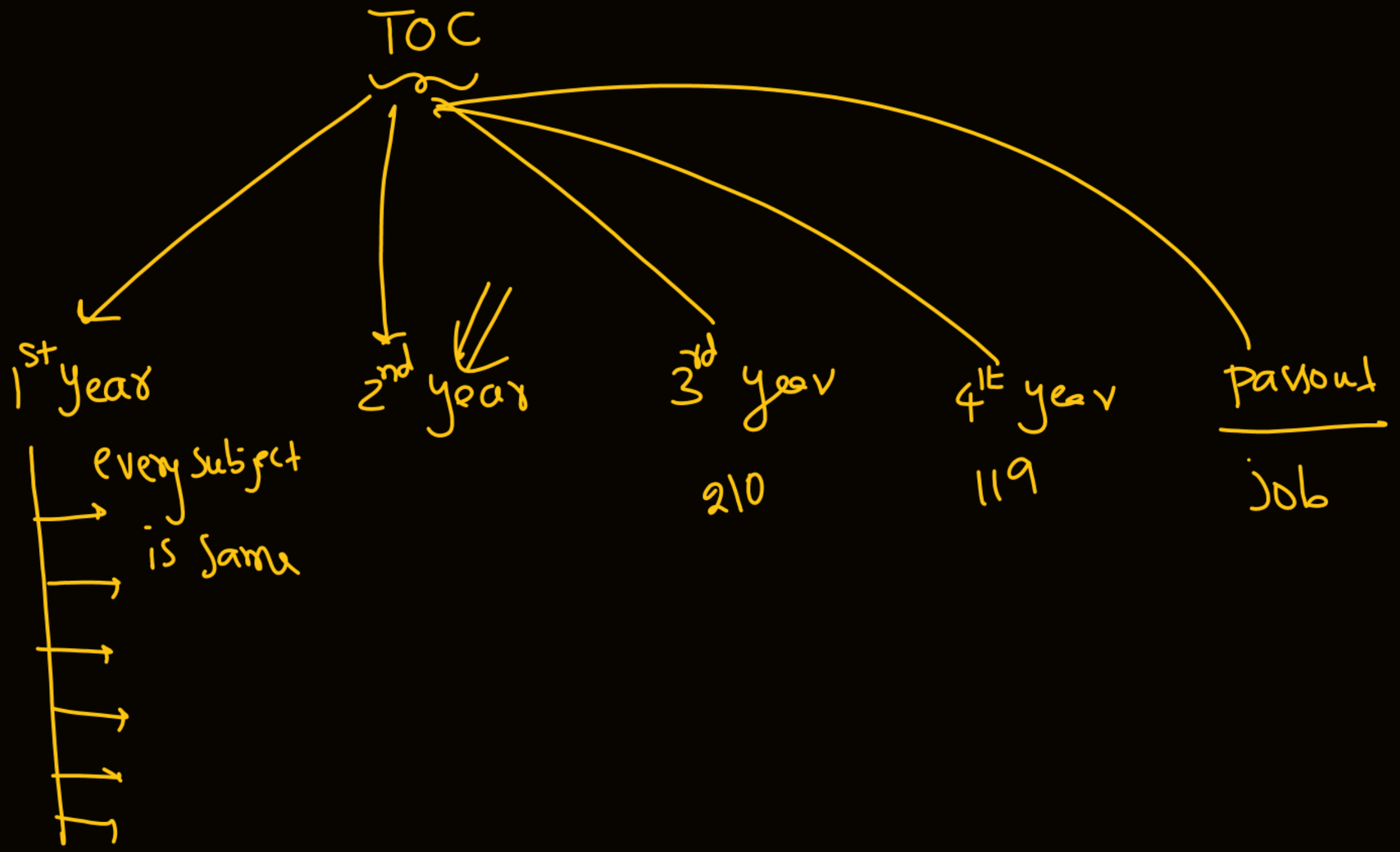
01 Set Vs Language

02 Symbol, String, Language

03 Operations on Strings/Sets

04 What is TOC?

05 Chomsky Hierarchy


TOC
1st year
every subject
is same
2nd year
3rd year
210
4th year
119
passout
Job

TOC

- TOC ✓
- Knowledge ⇒ Next Level ✓
- GATE : 7 – 10 Marks ✓

TOC
- Why to study ?

Application

- Compiler
  - Lexical phase
  - Syntax phase
  - Semantic phase
- program
- Hospital equipments
- AI / ML
- Word Application
- ⋮

EE → Circuit

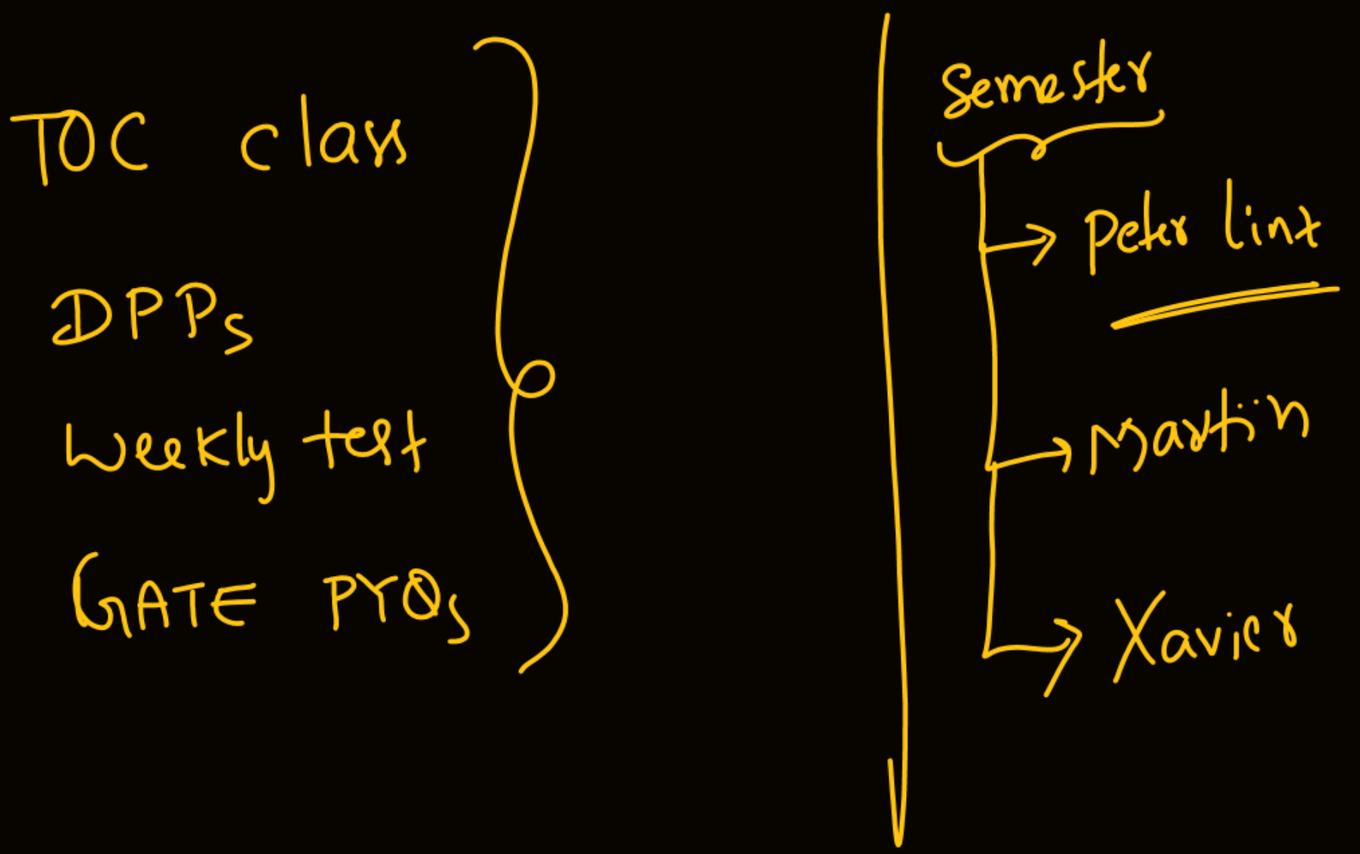
EC → Devices

CS → Computer

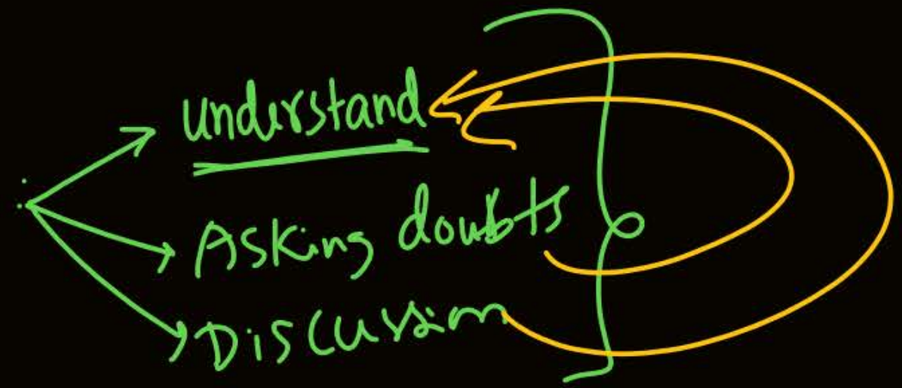
ME → Machines

CE → construction

⋮


TOC class
DPPs
Weekly test
GATE PYQs
Semester
Peter Linz
Martin
Xavier

During Class :



After class ⇨ Revise

After Weekend : ⇒ 4 classes (8 Hrs)
↳ Revision & Practice

Set Vs Language

same

Set : It is collection of objects

(Domain) Well-defined

Distinct

Cardinality (size) (no. of objects in set)

(Language)

$\{2, 3, 5, 7, 11, \ldots\}$

Set of prime numbers

$\{a, 10, \text{gate}, \text{☹}\}$

- Collection of digits
- Collection of Symbols
- " " Strings
- " " Sets
- " " People

Problem

⇓

Set/Language

Symbol

- one length
- Smallest thing
- Basic building block
- Represents Something

a is symbol
$|a| = 1$

10 → is Symbol
$|10| = 1$

gate → is Symbol
$|gate| = 1$

g, a, t, e
Symbols

$|g| = 1$ $|t| = 1$
$|a| = 1$ $|e| = 1$

$|gate| = 4$

gate Symbol, exam symbol, rank Symbol

$|gate| = 1$,

$|gateexam| = 2$
$|gategate| = 2$

Symbol

C Alphabet = {a, b, .. 7, 0, 1, ..., 9, +, -, ...}

Alphabet (Σ)

- It is Set
- It is nonempty set
- It is set of Symbols
- It is set of finite no. of Symbols

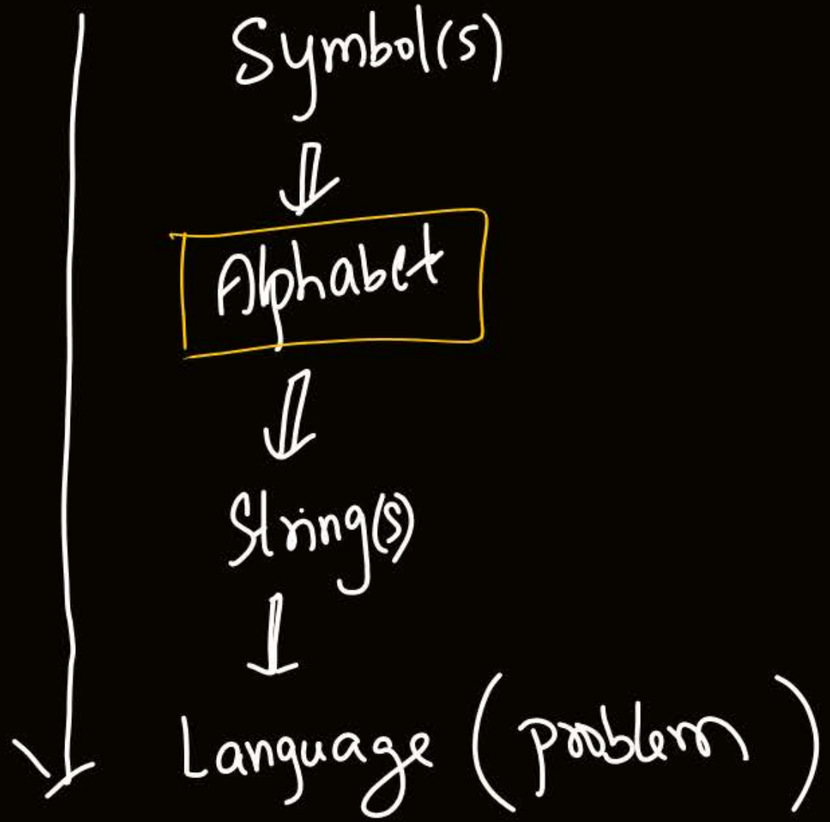
Binary Alphabet = {0, 1} = {a, b} = {x, y} = {gate, exam}
= {$, @}

English Alphabet = {a, b, c, d, ..., z}

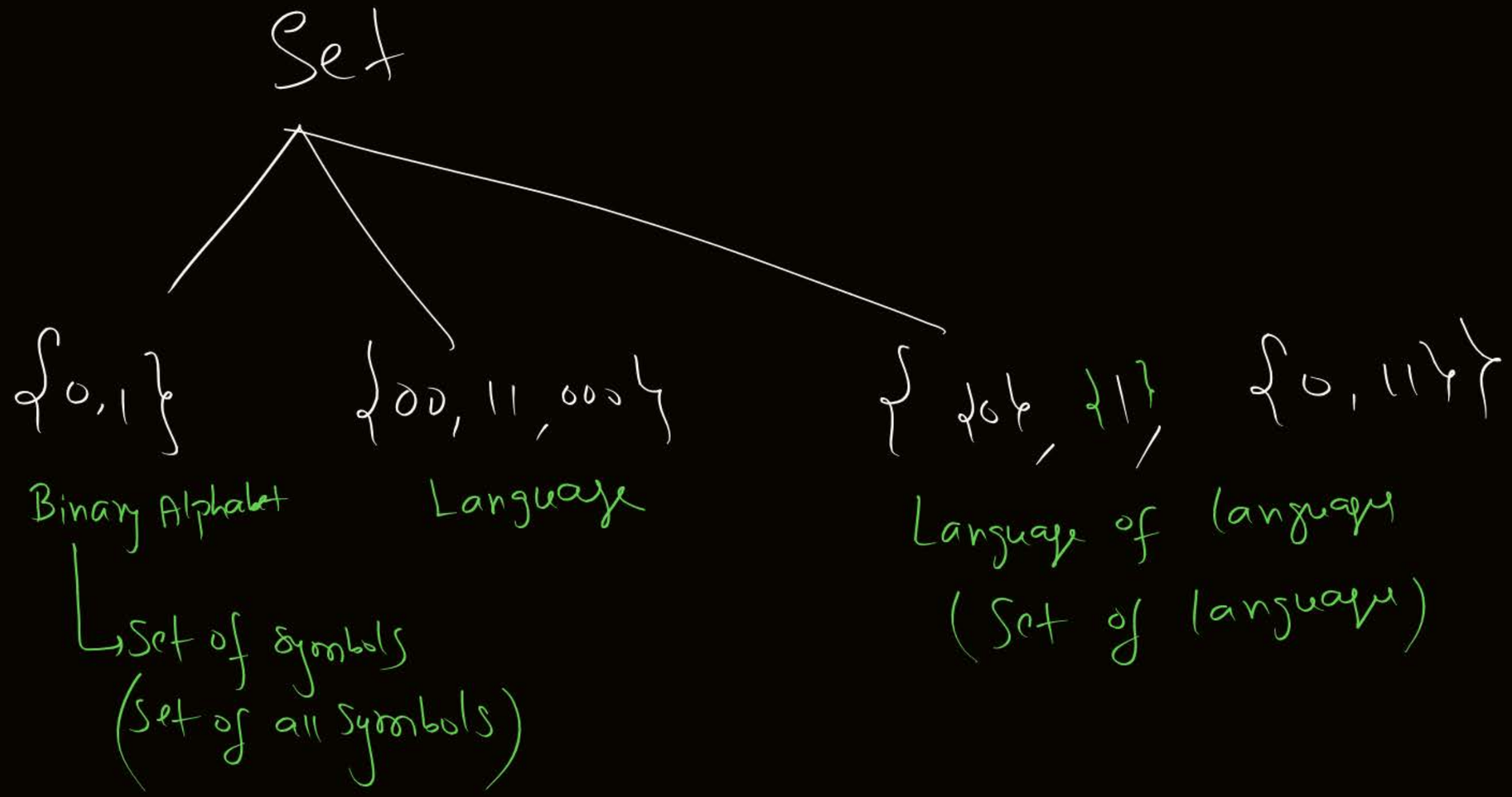
Decimal Alphabet = {0, 1, 2, 3, 4, ..., 9}

Octal Alphabet = {0, 1, 2, 3, .., 7}

Collection
=
Set
=
Language


Symbol(s)
Alphabet
String(s)
Language (problem)

	Symbol	Alphabet	String
English Language	a, b, c, ... z	{a, b, c, ..., z}	ε, a, b, aa, ab, ba, bb, ... (Words)
C Language	a, b, ..., 7, 0, 1, ..., 9, A, ..., Z, +, -, *	{a, b, ..., 7, 0, 1, ..., 9, +, -, ...}	ε, a, b, ..., 0, 1, 9, ..., +, -, a+, a-, 0+, ... (Tokens)
Binary Number System	0, 1	{0, 1}	ε, 0, 1, 00, 01, 10, 11, ... (Numbers)
Decimal number system	0, 1, ..., 9	{0, 1, ..., 9}	ε, 0, 1, ..., 9, 00, 01, ..., 09, 10, 11, ... (Numbers)
ABC Language	gate, exam	{gate, exam}	ε, gate, exam, ...
XYZ language	$, @, #	{$, @, #}	ε, ...
Chinese language		{  }	ε, ...
Telugu language	ఒ, ఆ, ఇ, ...	{ఒ, ఆ, ...}	ε, ...
Hindi language	अ, आ, इ, ...	{अ, आ, ...}	ε, ...


Set
{0,1}
{00, 11, 000}
{ {0}, {1} }
{0, 111}
Binary Alphabet
Language
Language of language
(Set of language)
Set of symbols
(Set of all symbols)

Symbol ⟶ anything in the world
(problem decides)

Alphabet ⟶ Collection of all symbols
(problem decides)

String (ω)

- It is sequence of symbols over Σ
- It is Finite sequence of symbols over Σ

	$\Sigma = \{a\}$	$\Sigma = \{a, b\}$	$\Sigma = \{a, b, c\}$	$\Sigma = \{$ gate, exam$\}$
$\lvert\omega\rvert = 0$	ε	ε	ε	ε
$\lvert\omega\rvert = 1$	a	a , b	a , b , c	gate , exam
$\lvert\omega\rvert = 2$	aa	aa , ab , ba , bb	aa , ab , ac , ba , bb , bc , ca , cb , cc	gategate , gateexam , examgate , examexam
$\lvert\omega\rvert = 3$	aaa	aaa , aab , aba , abb , baa , bab , bba , bbb ,	- - -	- - -

Empty String

- Zero length string
- It is sequence of Zero Symbols

ε or λ

not symbol in Σ

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

No. of 100 length strings over $\Sigma = \{a, b, c\}$

$= 3^{100}$

→ No. of K length strings over $\Sigma = \{a, b\}$

$= 2^K = |\Sigma|^K$ (length of string; = Size of alphabet)

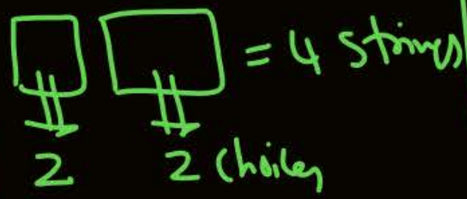
K = 1

|w| = 1

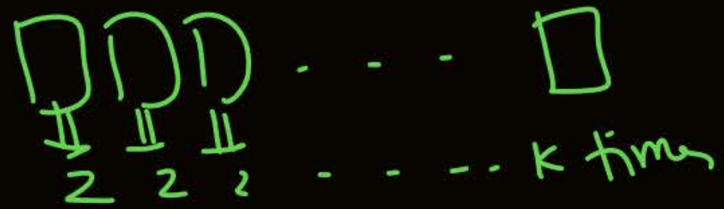
2 choices

a, b

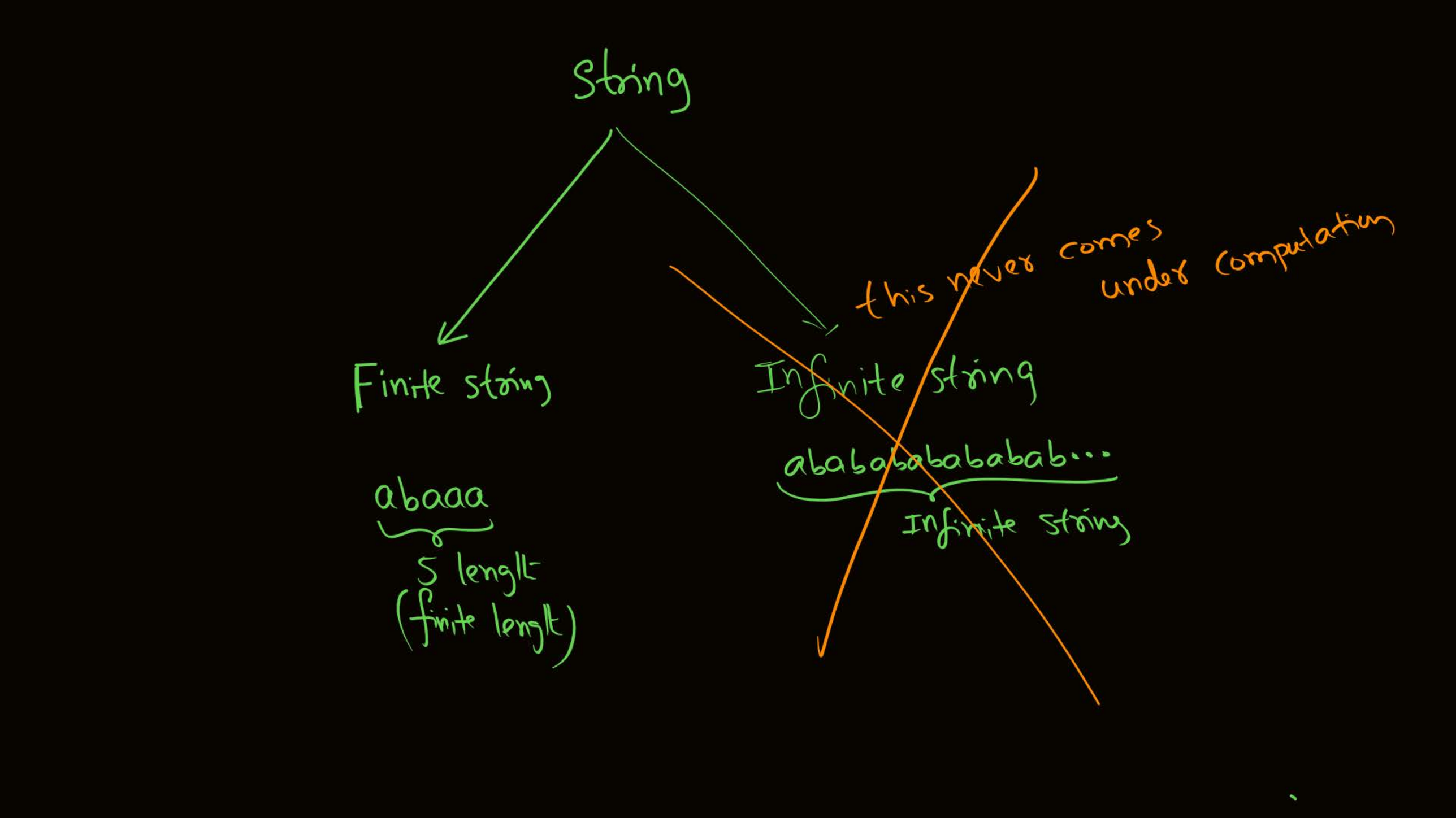
K = 2



aa
ab
ba
bb



$= 2^K = |\Sigma|^K$


String
Finite string
abaaa
5 length
(finite length)
this never comes under computation
Infinite string
abababababab...
Infinite string

Language

→ Set

→ Set of strings

Empty string (null string)
ε

Empty set (null set)
$\{\} = \phi$

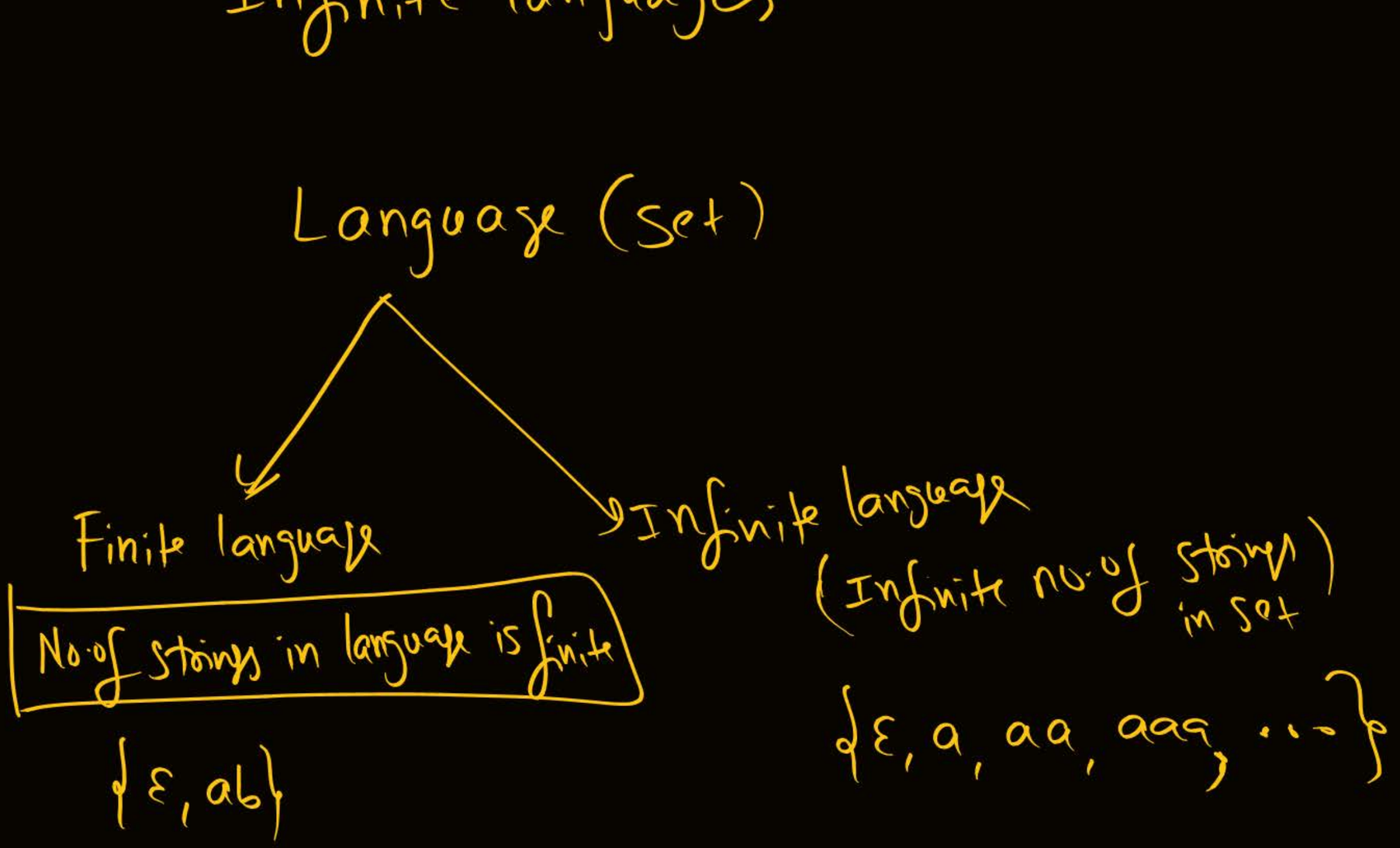
$\Sigma = \{a, b\}$

$\Downarrow$

$\{\} = \phi$ empty language

$\{\varepsilon\}$	$\{\varepsilon, a\}$	$\{\varepsilon, a, b\}$
$\{a\}$	$\{\varepsilon, b\}$	$\{\varepsilon, a, aa\}$
$\{b\}$	$\{a, b\}$	$\{\varepsilon, ab, aa\}$
$\{aa\}$	$\{a, aa\}$	
$\{ab\}$	$\{a, ab\}$	
$\{ba\}$		
.	.	.
.	.	.
.	.	.

Infinite languages



$|\varepsilon| = 0$

length of string

$|\{\phi\}| = |\{\ \}| = 0$

empty set

size of set

Size of empty set
No. of elements in empty set
$= 0$

$|\{\varepsilon\}| = 1$

size of set

$|\{\varepsilon, a, b, aa\}| = 4$

$|\{\varepsilon, ab\}| = 2$

$|abcd| = 4$

$|A|$ = size of set A
= no. of elements in set A

set

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

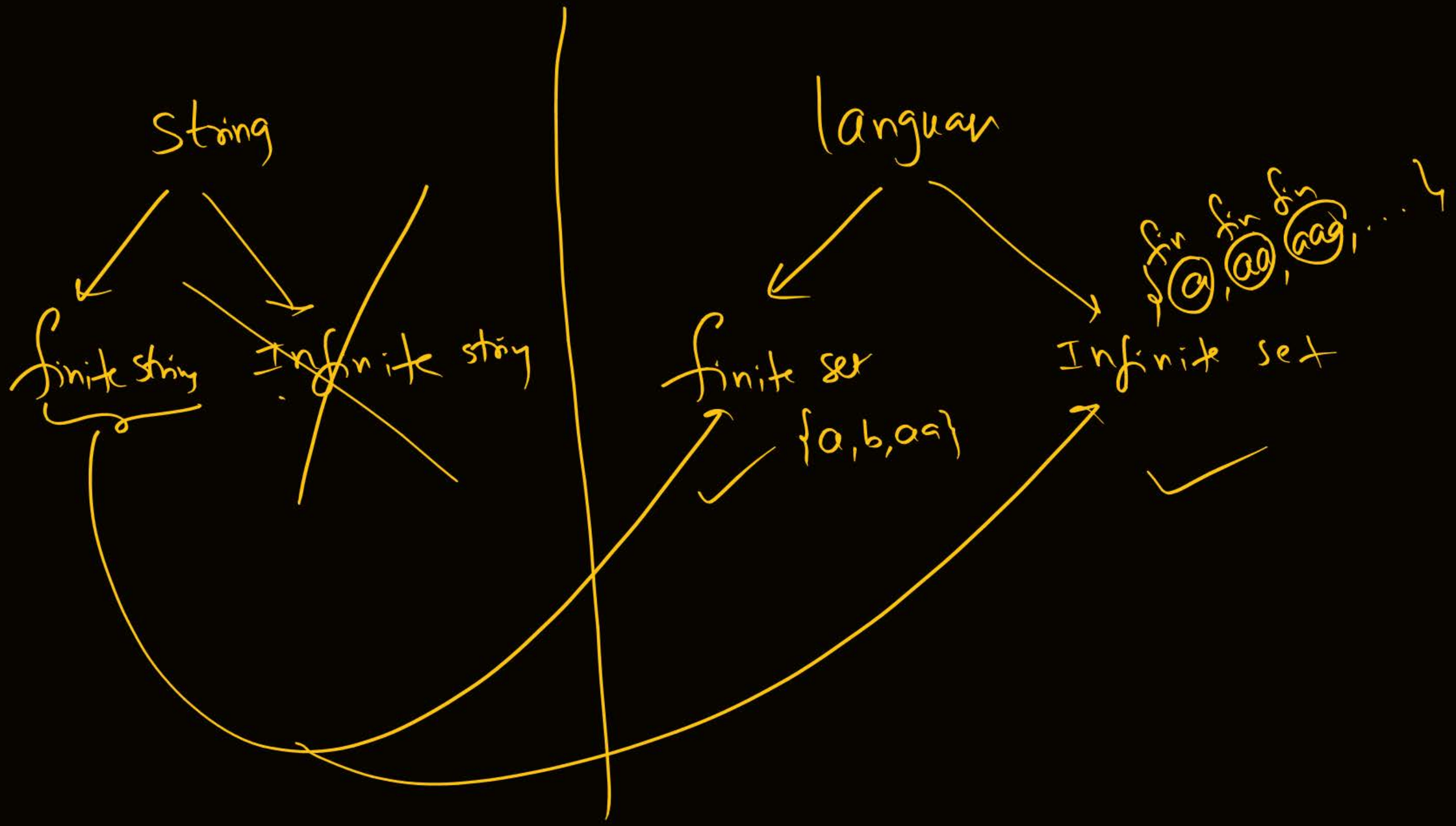
$|abcd| = 4$

$\Sigma = \{ab, cd\}$

$|\underline{ab}\underline{cd}| = 2$

$\Sigma = \{abcd\}$

$|abcd| = 1$


String
language
finite string
Infinite string
finite set
{a, b, aa}
Infinite set
fin
fin
fin
a
aa
aaa
...

Summary

Symbol ✓

Alphabet ✓

Strings ✓

language ✓


THANK YOU GW
SOLDIERS !