CS & IT ENGINEERING

THEORY OF COMPUTATION

Grammar

Lecture - 03

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Recap of Previous Lecture

Topic ?????

- Grammar Construction
- Grammar ⇒ language
- Types of Grammar
- ⇒ F.A ⟺ Regular grammar ⟺ Regular Expression
- ⇒ Ambiguous Grammar

Topics to be Covered

{PDA}

Topic — Ambiguous Grammar

Topic — ?? Simplification of grammar

Topic — ?? Normalform of grammar

Topic — ?? Decision Properties of Grammar

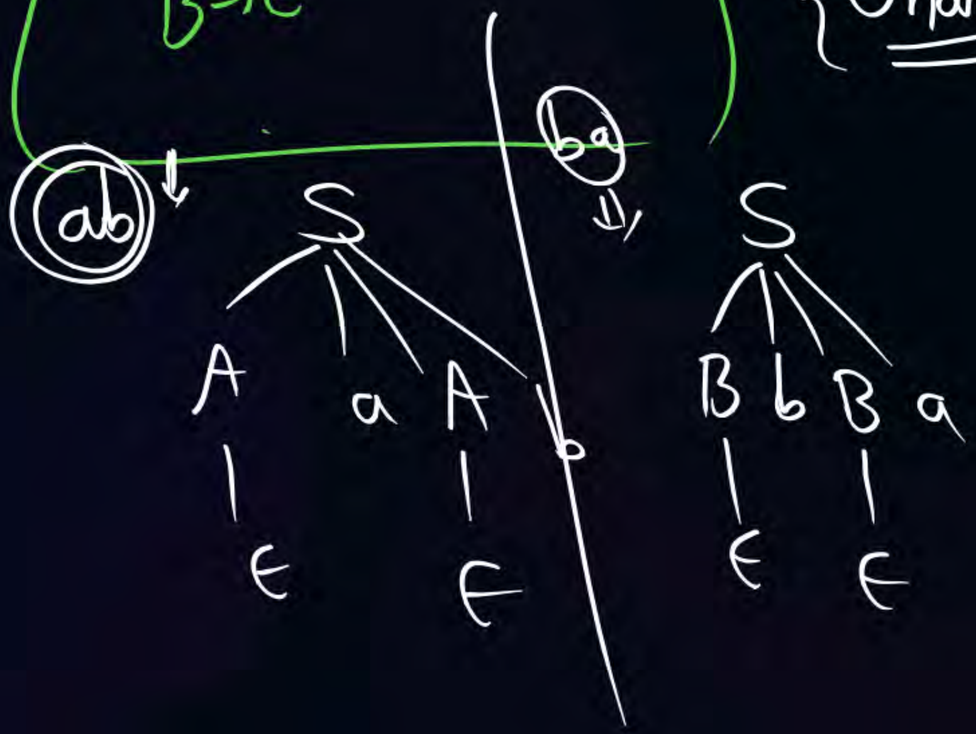
Ambiguous Grammar

Ex :- $S \to AaAb \mid BbBa$ $= \{ab, ba\}$

$A \to \epsilon$

$B \to \epsilon$

{Unambiguous Grammar}



Ambiguous Grammar

(2)

$S \rightarrow AB \mid BC$

$A \rightarrow BA \mid a$

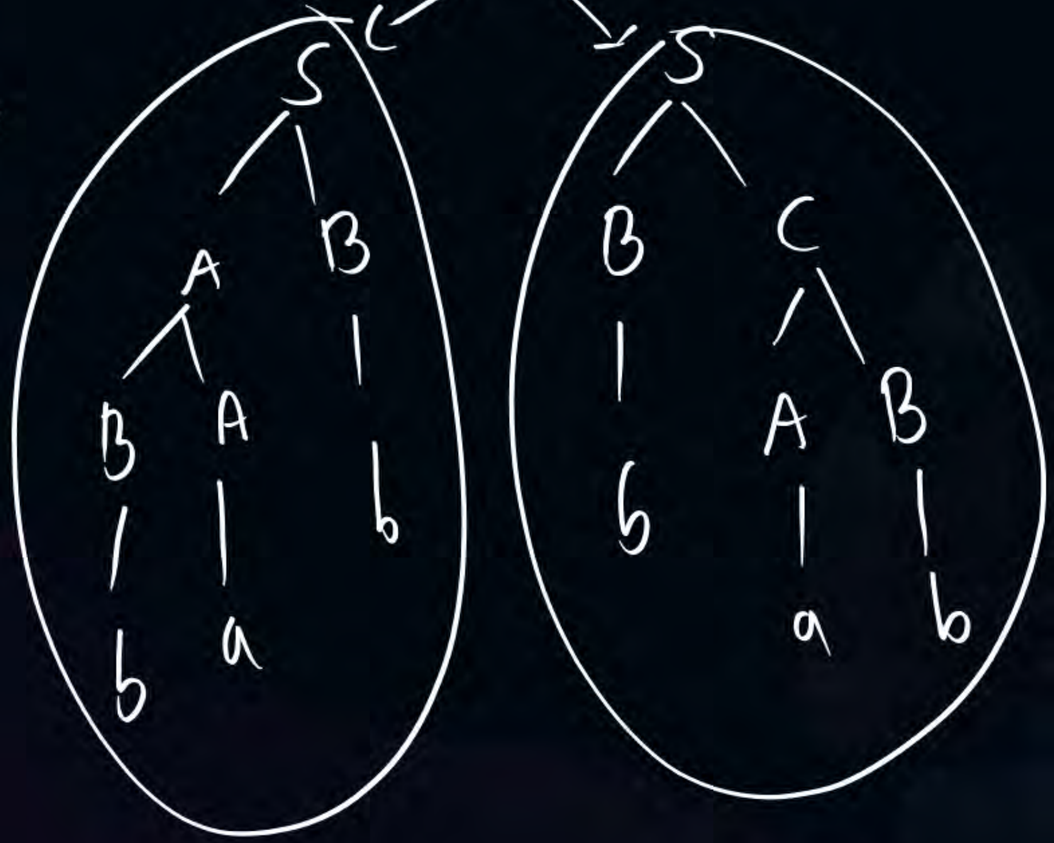
$B \rightarrow CC \mid b$

$C \rightarrow a \mid AB$

Ambiguous or not?

Yes

baab



① {Ambiguity checking is Undecidable Problem}

② Eliminating ambiguity is also Undecidable Problem

C·F·G $(A \to \alpha)$ $\alpha \in (V+T)^*$

G : not regular

① CFG

$S \to AB$

$A \to a$

$B \to b$

{regular} $L = \{ab\}$

② $S \to aSb \mid ab$

$L = \{a^n b^n \mid n \geq 1\}$

non regular

{CFG}

③ $S \to AB \mid BC$

$A \to BA \mid a$

$B \to CC \mid b$

$C \to AB \mid a$

= Langug = Regul (or) not ?

Regularity Problem

Undecidable Problem

Simplification of CFG

Removal of

1. useless Variable (N.T)
2. Unit Productions ($A \to B$)
3. Null Productions ($A \to \epsilon$)

Unit Production $(A \to B)$

① $S \to A$

② $A \to B$

③ $B \to C$

④ $C \to D$

$D \to a$

$S \to a$

✗ $A \to a$

✗ $B \to a$

✗ $C \to a$

✓ $D \to a$

$S \to a$

4

Null Productions ($A \to \epsilon$)

1. Null
2. Unit
3. Useless Variable

$S \to AaB$

$A \to a \mid \epsilon$

$B \to b \mid \epsilon$

$S \to AaB \mid Aa \mid aB \mid a$

$A \to a$

$B \to b$

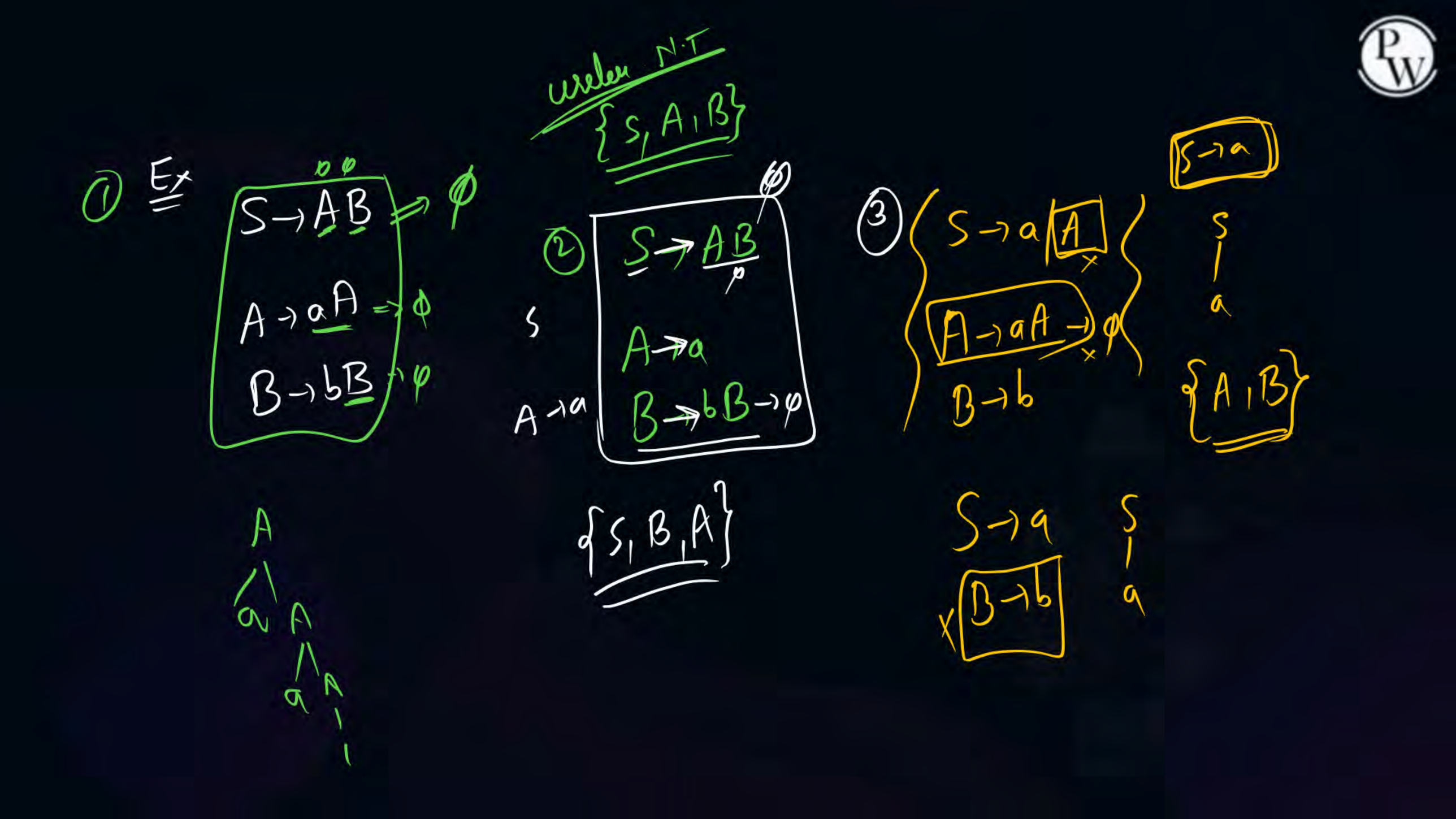
Elimination of useless Variables

Remove

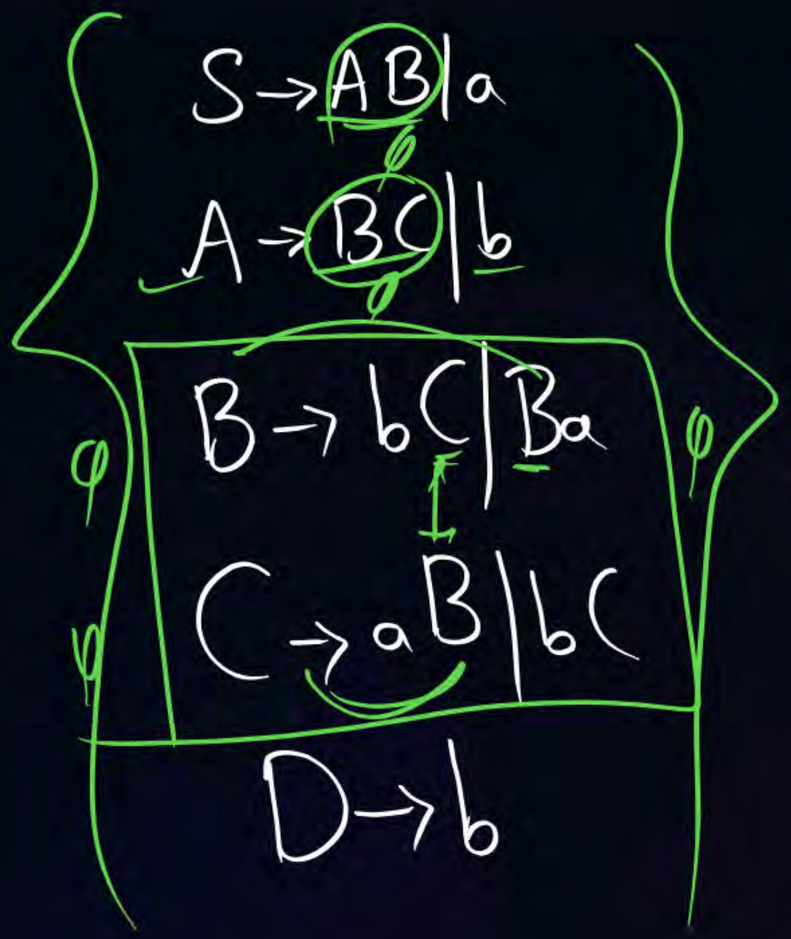
(useless variables)

① Any Variable not generating string

② Any variable not required for derivation


useless N.T
{S, A, B}
① Ex
S → AB
A → aA
B → bB
ϕ
ϕ
ϕ
② S → AB
A → a
B → bB → ϕ
S
A → a
{S, B, A}
③
S → a
A
A → aA → ϕ
B → b
S → a
S
i
a
{A, B}
A
a
A
a
A
i
S → a
B → b
S
i
a

(4) How many useless Variables Present in following grammar



S → a
A → b
D → b

S
|
a

{A, B, C, D}

Normal form of CFG ($A \to \alpha$)

- $A \to BC$
- $A \to a$

{Chomsky N.F}

- $A \to aV^*$

{Greibach N.F}

$A \to aBCDEF$

$A \to a$

$S \to aSb \mid ab$

$S \to aSB \mid aB$

$B \to b$

(Q) Convert following Grammar into CNF Grammar?

$S \to aSb \mid ab$

① Convert total R.H.S into only N.T by assuming terminals as new N.T

① $S \to ASB \mid AB$

$A \to a$ ✓

$B \to b$ ✓

$S \to AX \mid AB$

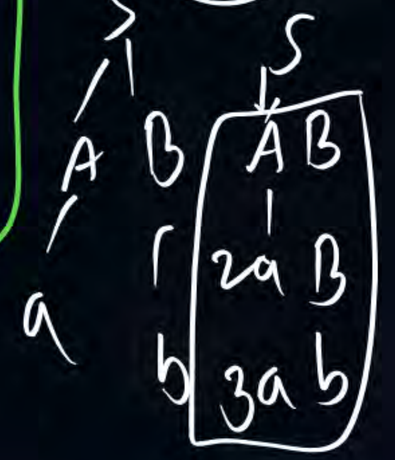
$X \to SB$ ✓

$A \to a$ ✓

$B \to b$ ✓

ab $(2 \times 2 - 1) = 3$ (123)

aabb



② $S \to ASB$

$S \to AY \mid AB$

$Y \to SB$

$A \to a$

$B \to b$

(Q) Convert following Grammar into CNF Grammar?

$S \to bA \mid aB$

$A \to bAA \mid aS \mid a$

$B \to aBB \mid bS \mid b$

①

$S \to YA \mid XB$

$A \to YAA \mid XS \mid a$

$B \to XBB \mid YS \mid b$

$X \to a$ ✓

$Y \to b$ ✓

②

$S \to YA \mid XB$

$A \to YP \mid XS \mid a$

$P \to AA$

$B \to XQ \mid YS \mid b$

$Q \to BB$

$X \to a$

$Y \to b$

③

NOTE

$(2*4-1)$
$(8-1)=7$ aabb

① For generating n length string from CNF grammar total number of productions required is $2n-1$
(Derivation steps)

② For generating n length string from GNF grammar total number of productions required is n only.

(Q) Convert following Grammar into CNF Grammar?

Decision Properties of CFG

Decidable

1. Emptyness Problem [is $L(CFG) = \phi$?]
2. Finiteness Problem [is $L(CFG)$ = finite?]
3. Membership Problem [is $w \in CFG$?]

① $S \rightarrow AB$ — ϕ → empty (or) not?

$A \rightarrow a$

$B \rightarrow bB$ — ϕ → empty

Thank You!