CS & IT ENGINEERING

THEORY OF COMPUTATION

Grammar

Lecture - 02

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Recap of Previous Lecture

Topic ?????

1. Grammar
2. Grammar Construction
3. Grammar ⇄ language

Topics to be Covered

Topic Types of Grammar

Topic ?? Ambiguous Grammar

Topic ?? Simplification of Grammar

Topic ?? Normalform of Grammar.

Topic : Grammar

- Set of rules used to describe strings of a language is known as grammar.
- Formal definition of grammar is

G=(N, T, P, S)

- **N :-** non terminals or variables
- **T :-** Terminals
- **P :-** no. of productions
- **S :-** Starting symbol

Topic : Derivation

- The process of deriving strings from the given grammar known as derivation.
- The derivation can be either left most derivation or right most derivation

- **Left most derivation:**
  It is the derivation in which left most non terminal is replaced by its R.H.S part at every step.

- **Right most derivation:**
  It is a derivation in which right most non terminal is replaced by its R.H.S part at every step.

Derivation Tree (or) Parse Tree

- Tree representation of the derivation is known as derivation tree.
- All leaf node of the parse tree is known as yield of parse tree .
- while reading yield from left to right sentence of the grammar can be generate.

Regular Language ⟶ Regular Grammar

1. Context free language there exist a grammar known as context free grammar.
2. Context sensitive language there exist a grammar known as context sensitive grammar.
3. For recursive enumerable language there exist a grammar known as unrestricted grammar.

[NAT]

#Q. Identify language generated by following grammar.

[NAT]

#Q. Construct grammar for the following languages.

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow b$

$L = \{ab\}$

× not regular

× (3) Regular ?

(2) CFG ?

R.L.G

(2) $S \to aS \mid bS \mid a$ — 3

(3) CFG: $S \to AaB$, $A \to a$, $B \to bb$

(4) $S \to aAbB$, $aA \to a$, $bB \to bba$

× (a) Reg

× (b) CFG

× (c) C.S.G

✓ (d) U.G

Types of Grammar

Type	Language (Grammers)	Form of Productions	Accepting Automata
3	Regular Gram	$A \to xB \mid x$; $A \to Bx \mid x$	Finite Automaton
2	Context –free Grammar	$A \to \alpha$; $\alpha \in (V+T)^*$	Pushdown Automaton
1	Context sensitive Gram	$\alpha \Rightarrow \beta$, $\lvert\alpha\rvert \le \lvert\beta\rvert$; $\alpha, \beta \in (V+T)^*$	LBA
0 (R.E.G)	Unrestricted Gram	$\alpha \to \beta$; $\alpha \in (V+T)^+$, $\beta \in (V+T)^*$	Turing machine

Lang: Reg La | C.F.L | C.S.L | R.E

Type 0: $S \to AaBb$, $Aa \to aa$, $Bb \to b$ (2 / 1)

Type 1 (C.S.G): $S \to aAbB$, $aA \to aa$, $bB \to aba$

Type 2 (CFG): $S \to AaABa$, $A \to aBa \mid b$, $B \to ba$

Type 3

Regular Grammar

Right Linear Grammar

Left Linear Grammar

$\{x \in \Sigma^*, A, B \in N.T\}$

$A \to xB \mid x$

$A \to Bx \mid x$

1. $S \to aS \mid b$ ✓

2. $S \to Sa \mid b$ ✓

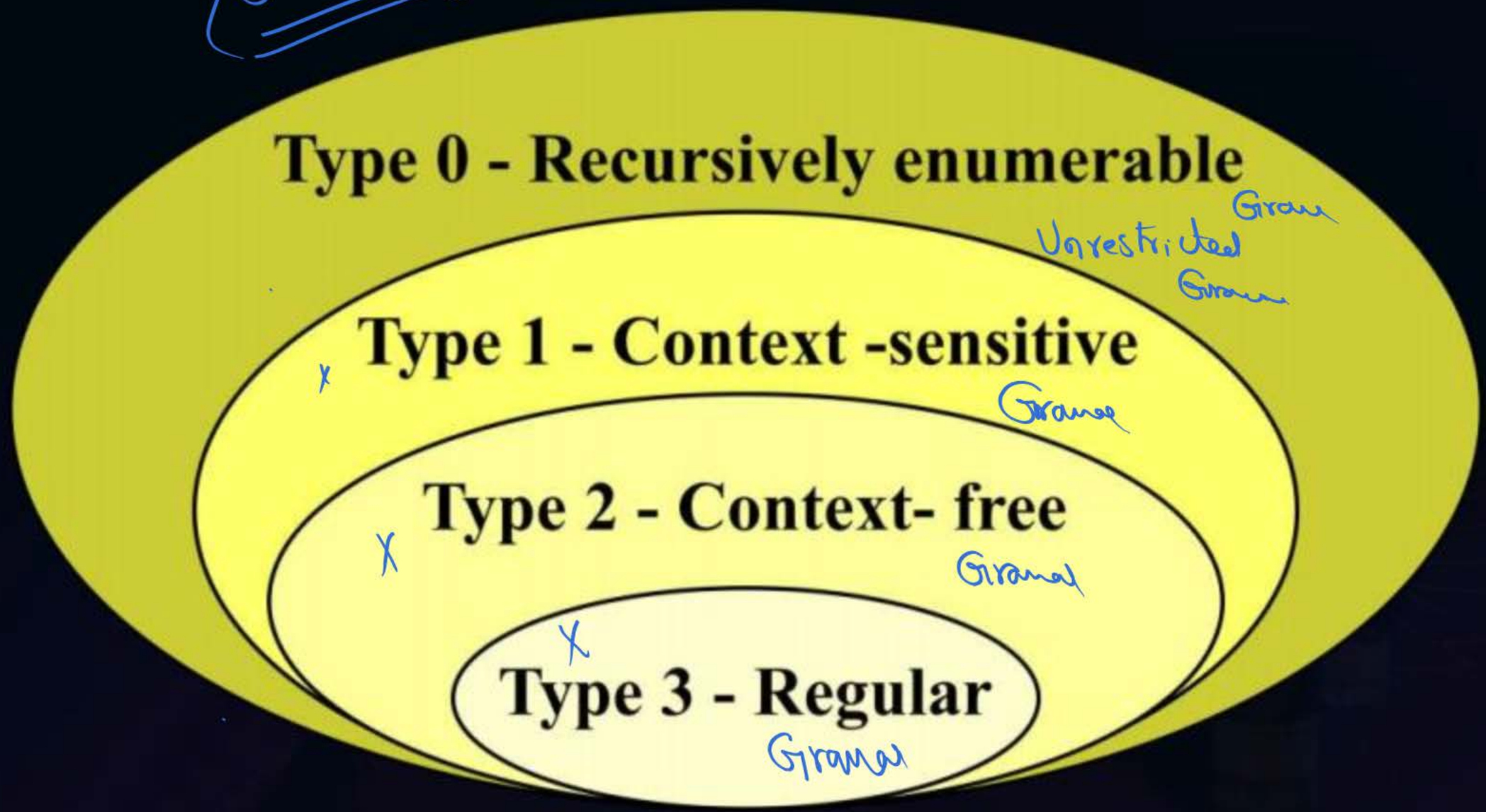
3. $S \to aS \mid Sb \mid a$ not regular

{L: Gr but not regular}

4. $S \to Sa \mid Sb \mid \epsilon$

5. $S \to aSb \mid ab$

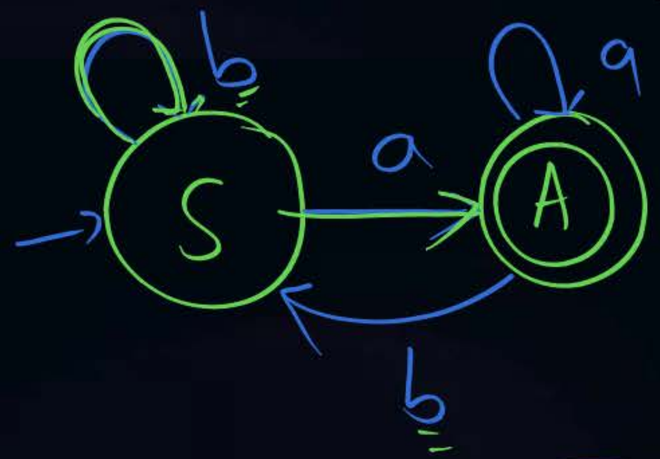
{Linear but not regular}


Chomsky Hierarchy
Type 0 - Recursively enumerable
Grammar
Unrestricted Grammar
Type 1 - Context -sensitive
Grammar
Type 2 - Context- free
Grammar
Type 3 - Regular
Grammar


Finite Automata
Regular Grammar

(Q) Construct Regular Grammar for given F.A

(1)



$S \rightarrow bS \mid aA$

$A \rightarrow aA \mid bS \mid \epsilon$

Grammar

(N, T, P, S)

$(N \cdot T) \Rightarrow \{state\}$

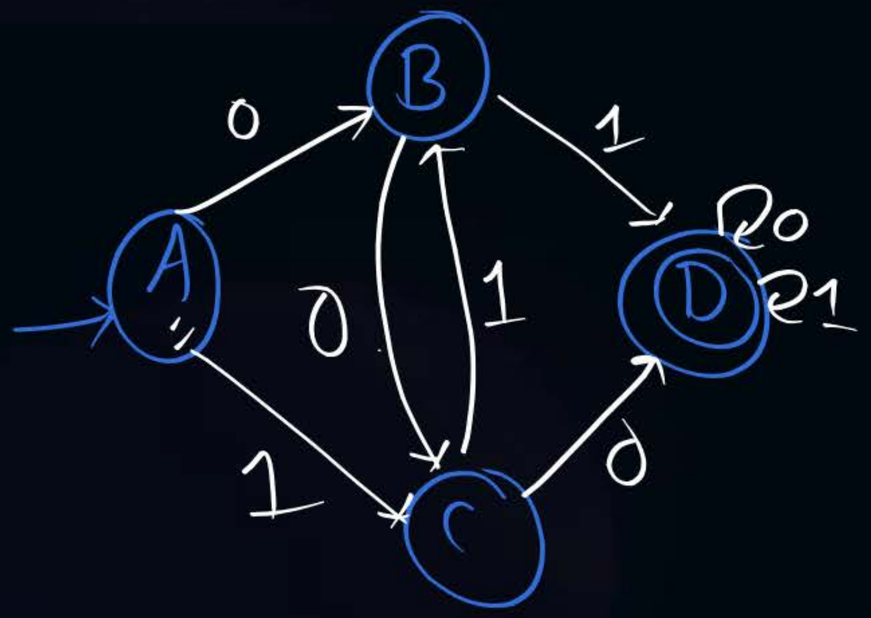
$T \Rightarrow \epsilon$

$P =$ transition

$S =$ Initial state

(Q) Construct Regular Grammar for given F.A

(2)



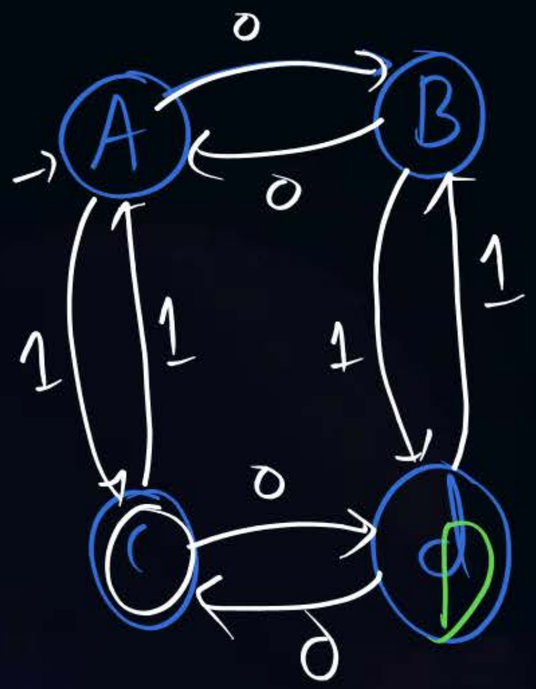
$$\Longrightarrow$$

$$A \to 0B \mid 1C$$
$$B \to 0C \mid 1D$$
$$C \to 0D \mid 1B$$
$$D \to 0D \mid 1D \mid \epsilon$$

9 productions

(Q) Construct Regular Grammar for given F.A

(3)

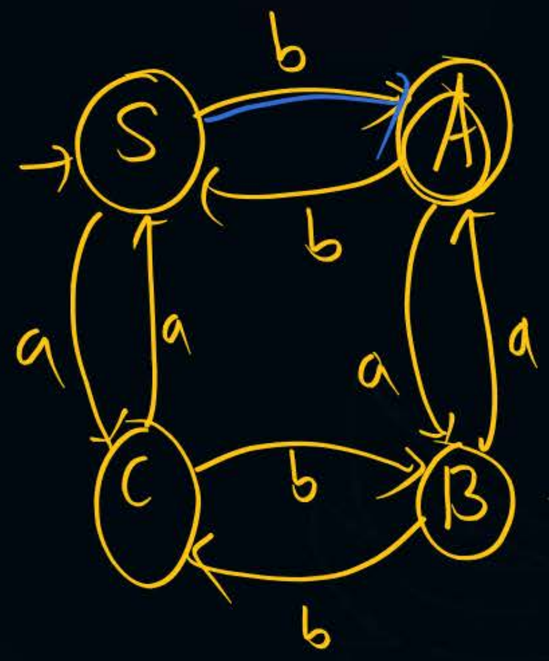


$$\Rightarrow \begin{cases} A \to 0B \mid 1C \\ B \to 0A \mid 1D \\ C \to 0D \mid 1A \mid \epsilon \\ D \to 0C \mid 1B \end{cases}$$

9 productions

(Q) Identify language of given Grammar

$$S \to bA \mid aC$$
$$A \to bS \mid aB \mid \epsilon$$
$$B \to aA \mid bC$$
$$C \to bB \mid aS$$

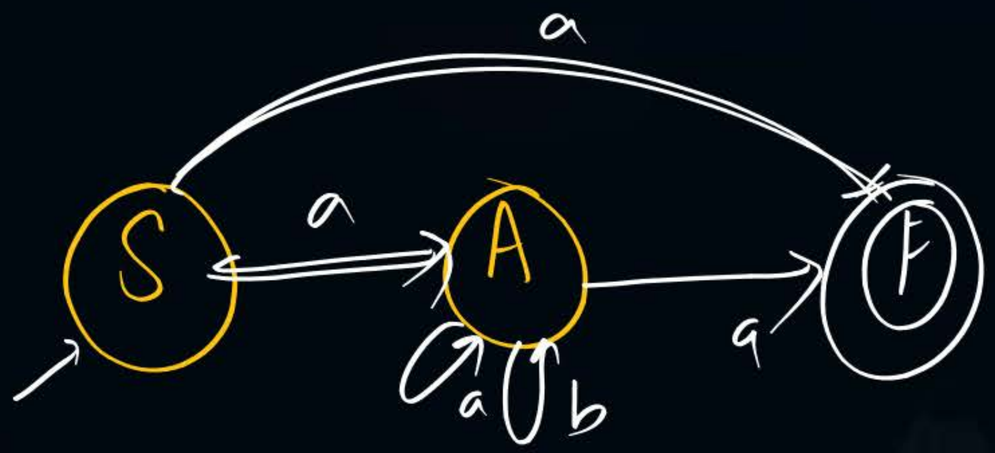


a's even (and) # b's odd

(Q) Identify Regular Expression from given F.A ?

$S \to aA \mid a$

$A \to aA \mid bA \mid a$



F.A

$a(a+b)^* a + a$

Ambiguous Grammar

A Grammar is said to be ambiguous for atleast one String if there exist more than one

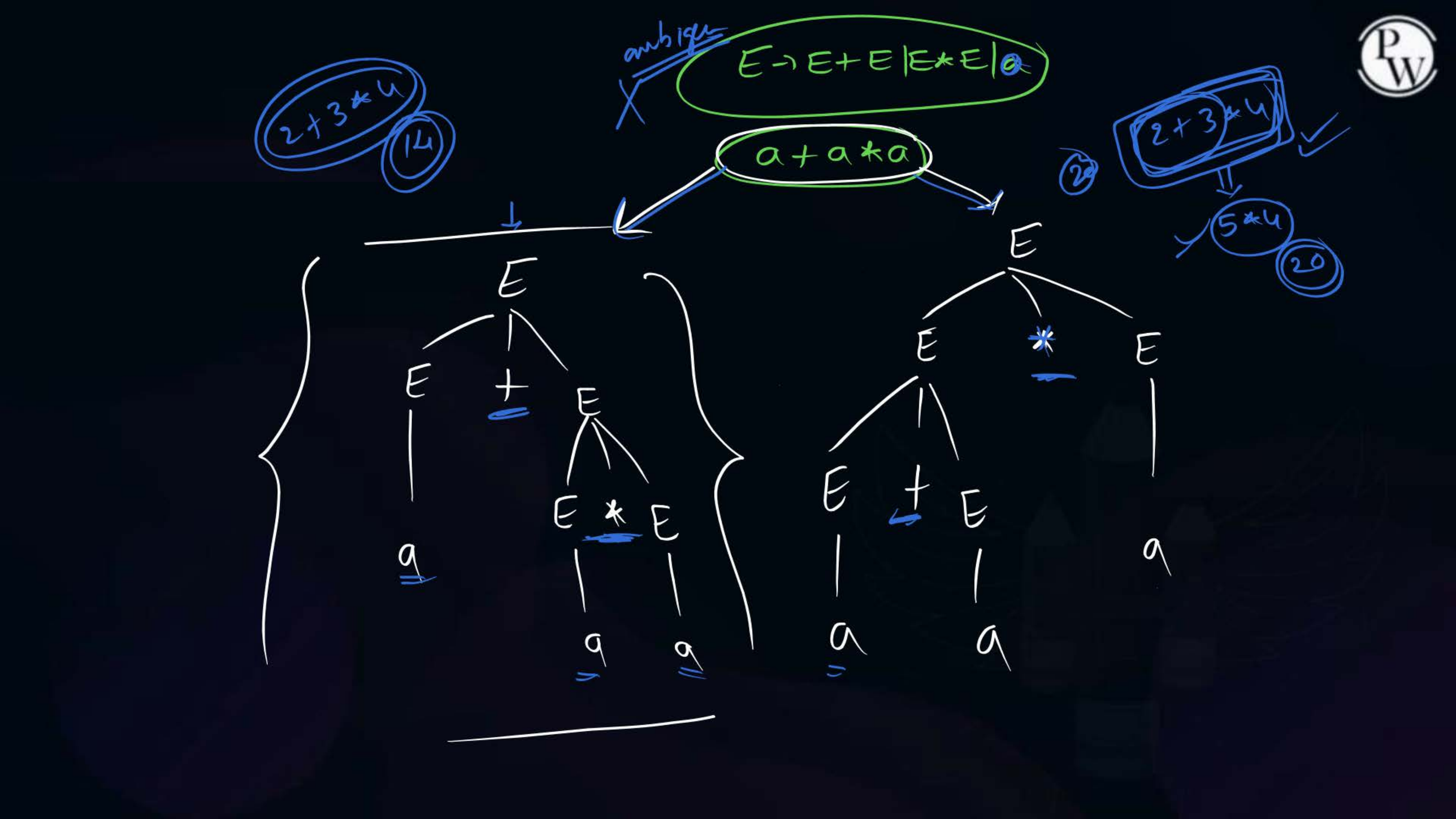
→ L.M.D

(or)

→ R.M.D

(or)

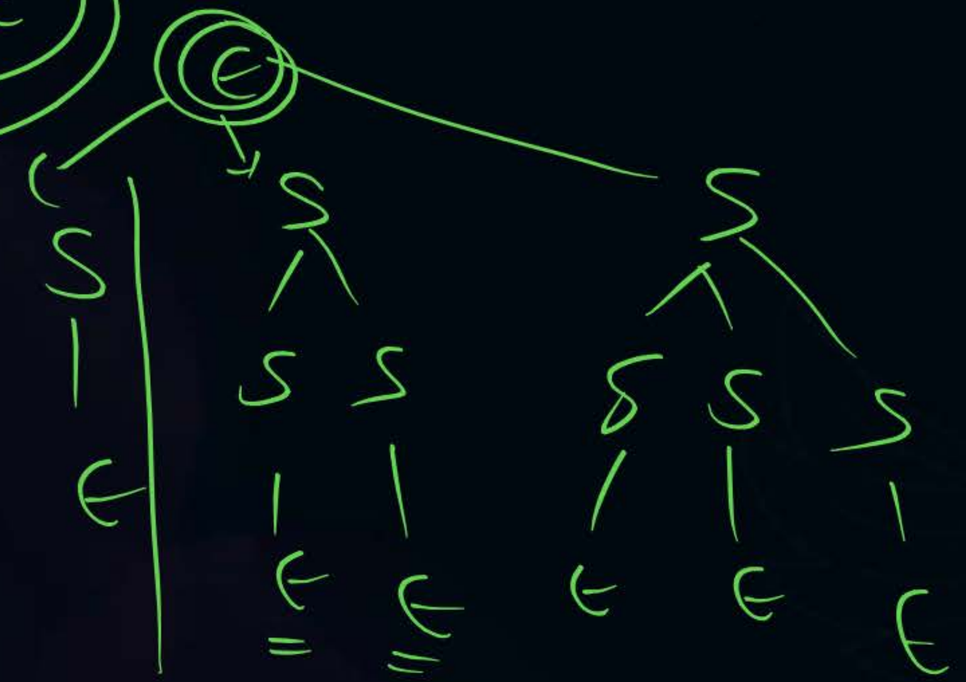
→ Parse tree


ambiguous
E → E+E | E*E | a
a+a*a
2+3*4
14
2+3*4
5*4
20
E
E + E
a
E * E
a a
E
E * E
E + E
a a
a

(Q) Verify given grammar is ambiguous (or) not?

$S \to SS \mid \epsilon$

ambiguous grammar



(Q) Verify given grammar is ambiguous (or) not?

$S \to AA$

$A \to aA \mid a$

ambiguous Grammar

aaa

(Q) Verify given grammar is ambiguous (or) not?

$$\left\{\begin{array}{l} S \to AaAb \mid BbBa \\ A \to \epsilon \\ B \to \epsilon \end{array}\right\}$$

Home Work

NOTE

Verifying given grammar ambiguous (or) not is Undecidable Problem. [No Algorithm exist]

(Q) Construct Regular Grammar for given F.A

2 mins Summary

- Topic One
- Topic Two
- Topic Three
- Topic Four
- Topic Five

Types

F.A.Q's

Ambiguity

THANK - YOU