CFG

Grammer - set of formal rules generating syntactically correct sentence

$G = (V, T, P, S)$

V = set of variables
A .. Z

CFG = TYPE 2
↳ lang CFL
↓ of
PDA

T = set of terminals
a, b .. or 1, 2 ...

P = set of production rules

S = start symbol.

rules are of type

$A \rightarrow \alpha \rightarrow (V \cup T)^*$

(left side = single var)

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*

$L = \{0^n 1^n \mid n \geq 0\}$ is not a regular lang.

Assume $0^n 1^n$ is a regular lang.
then it should follow pumping lemma.

$\rightarrow (q_0) \sim 0^3 1^3 \sim ((q_f))$

$u \quad (v)^i \quad w$

$0^2 \; \underline{(0)^1} \; 1^3$

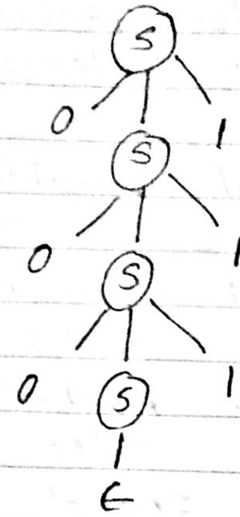
can be repeated zero / 1 / more than 1 times.

if zero

resulting string $= \underline{\underline{0^2 1^3}}$ which is not a part of L. so contradiction,

so $L = \{0^n 1^n$ is not a regular lang.$\}$

$$L = \underline{\underline{0^3 1^3}} \xrightarrow[G]{\text{find}} G = (V\ T\ P\ S)$$



$V = \{S\}$ $\quad S = S$

$T = \{0, 1\}$

$P : \{ S \to 0S1$

$\quad S \to \epsilon \}$

① Identify language.

$S \to aB \mid bA$

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

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

$G = (\{S, A, B\}, \{a, b\}, P, S)$

Identify words.

① $S \to aB$ $\quad S \to aB$ $\quad S \to aB$

$\to ab$ $\quad \to abS$ $\quad \to aaBB$

$\to abaB$ $\quad \to aabB$

$\to abab$ $\quad \to aabb$

② $S \to bA$ $\quad S \to bA$ $\quad S \to bA$

$\to ba$ $\quad \to baS$ $\quad \to bbAA$

$\to baaB$ $\quad \to bbaA$

$\to baab$ $\quad \to bbaa$

③ $S \to aB$

$\to abS$

$\to abbA$

$\to abbaS$

$\to abbaaB$

$\to abbaaaBB$

$\to abbaaabb$

L = set of words where number of a's and number of b's are same.

2) **Q2** design a context free grammar for a string

$L = \{a^{2n} b^m ; n \geq 0 \; m \geq 0\}$

words
ϵ, aab,
aaaabb ...

$\underset{A}{\underline{(aa)^n}} \; \underset{B}{\underline{b}}^m$

$G = (V, T, P, S)$

$P: \rightarrow \quad S \rightarrow \epsilon \mid AB$

$A \rightarrow aaA \mid \epsilon$

$B \rightarrow bB \mid \epsilon$

Grammar $G = (V, T, P, S)$

$V = \{S, A, B\}$ $\quad T = \{a, b\}$ $\quad S = S.$

Q3 Give CFG for $(baa + abb)^*$

baa   abb
A   B

$S \rightarrow AS \mid BS \mid \epsilon$

$A \rightarrow baa$ $\qquad V = \{S, A, B\}$

$B \rightarrow abb.$ $\qquad T = \{a, b\}$

Q4 Give CFG for equal number of a's & b's.

$S \rightarrow aSbS$

$S \rightarrow bSaS$

$S \rightarrow \Lambda.$

ity

3 a) For a given CFG find out Leftmost derivation and rightmost derivation, and parse tree (00110101)

G = (V T P S)   V = {S, A, B} T = {0, 1}

$S \rightarrow 0B \mid 1A$

$A \rightarrow 0 \mid 0S \mid 1AA$

$B \rightarrow 1 \mid 1S \mid 0BB$

Leftmost derivation (LMD) $\cancel{0}\cancel{0}\cancel{1}\cancel{1}\cancel{0}\cancel{1}\cancel{0}1$

$S \rightarrow 0\underline{B}$

$S \rightarrow 00BB$

$S \rightarrow 001B$

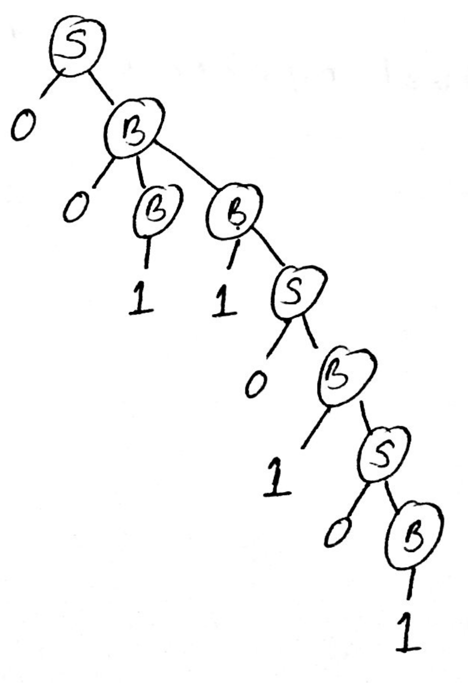
$S \rightarrow 0011S$

$S \rightarrow 00110B$

$S \rightarrow 00110\cancel{1}S$

$S \rightarrow 0011010B$

$S \rightarrow 00110101$



Rightmost derivation (RMD) $\cancel{0}\cancel{0}\cancel{1}\cancel{1}\cancel{0}\cancel{1}\cancel{0}\cancel{1}$

$S \rightarrow 0B$

$S \rightarrow 00BB$

$S \rightarrow 00B1$

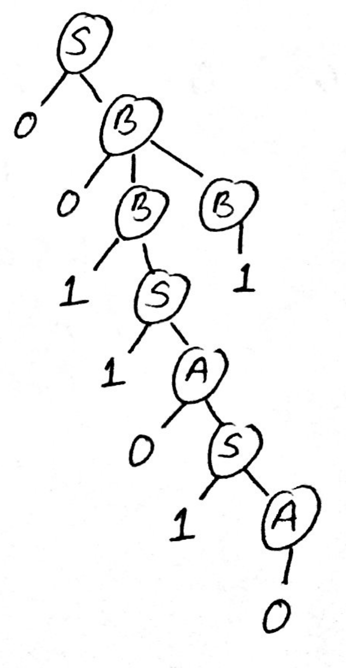
$S \rightarrow 001S1$

$S \rightarrow 0011A\cancel{S}$

$S \rightarrow 00110\cancel{B}1$

$S \rightarrow 0011010A1$

$S \rightarrow 00110101$



Removal of Ambiguity

$G:$ $E \to E+E \mid E*E \mid (E) \mid I$
$I \to a \mid b$

① show that G is ambiguous.
② Remove ambiguity.

solution -

step 1 - Identify a string belongs to lang. of this grammar [* Identify language]
[* not in this Problem]

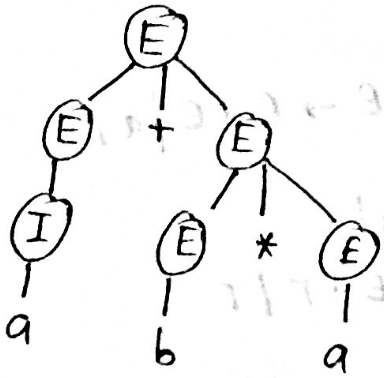
$\underline{a+b*a}$ is a string belongs to this G.

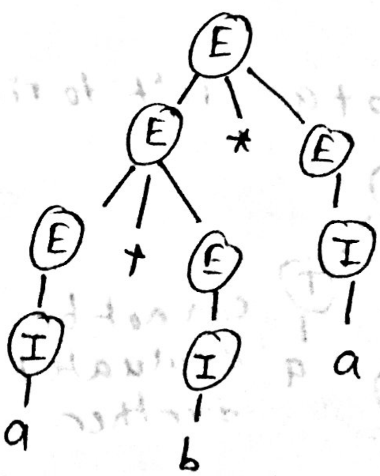
step 2 - Try to find 2 left most derivations ie different parse trees for the string.

~~a+b*a~~

LMD1 →
$E \to E+E$
$E \to I+E$
$E \to a + E$
$\to a+E*E$
$\to a+I*E$
$\to a+b*E$
$\to a+b*I$
$\to a+b*a$

LMD2 →
~~a*b*a~~
$E \to E*E$
$E \to E+E*E$
$\to I+E*E$
$\to a+E*E$
$\to a+I*E$
$\to a+b*E$
$\to a+b*I$
$\to a+b*a$





There are 2 different parse trees for a sentence a+b*a for left most derivation.

So the grammar is ambiguous.
For removing ambiguity for the long. that has precedence of * operator higher than that of + operator, we introduce new variable T (term) that should be evaluated first. F (Factor) for ( )

$E \to E+T \mid T$ $\qquad I \to a \mid b \mid c$

$T \to T*F \mid F$

$F \to (E) \mid \cancel{a+b} \mid I$

LMD a+b*a

$E \to E+T$

$E \to T+T$

$\to F+T$

$\to I+T$

$\to a+T$

$\to a+T*F$

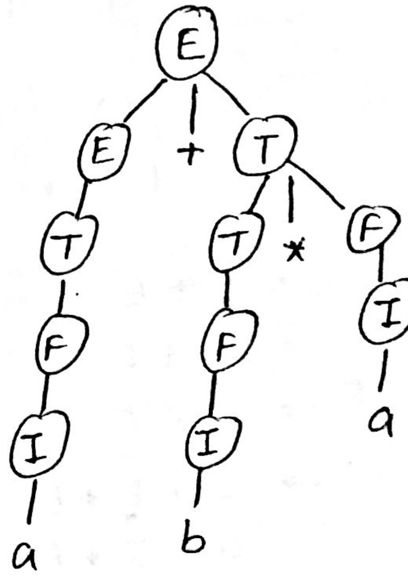
$\to a+F*F$

$\to a+I*F$

$\to a+b*F$

$\to a+b*I$

$\boxed{E \to a+b*a}$

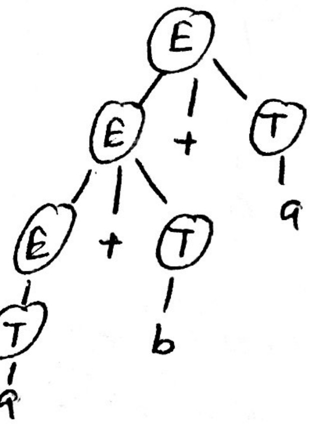


a+b+a left to right

$E \to E+E \mid a \mid b$

$T \to a \mid b$

$E \to E+T \mid T$



can not be evaluated further