Lect-102

Greibach Normal Form

A Context Free Grammar is said to be in GNF if all productions are of the form.

$A \rightarrow a X$

where $A \in V$, $a \in T$, $X \in V^*$ → V closure

X may be λ, 1 non terminal, 0 non terminal, or any combination of non terminal

Q-1 $S \rightarrow AB$

$A \rightarrow aA \mid bB \mid b$

$B \rightarrow b$

Not in GNF bcoz A is Nonterminal.

Convert this Grammar into GNF.

$S \rightarrow aAB \mid bBB \mid bB$

$A \rightarrow aA \mid bB \mid b$

$B \rightarrow b$

Q-2 $S \rightarrow absb \mid aa$

Not in GNF

$S \rightarrow aYSY \mid aX$

$Y \rightarrow b$

$X \rightarrow a$

Q-3 $S \to aSb \mid bSa \mid a \mid b$

Not in GNF

$S \to aSY \mid bSX \mid a \mid b$

$X \to a$

$Y \to b$

This is in GNF

Q-4 $S \to abSa \mid bSab \mid aa \mid bb$

This is not in GNF

Convert them to GNF.

$S \to aYSX \mid bSXY \mid aX \mid bY$

$X \to a$

$Y \to b$

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Q-1 $S \to ab \mid aS \mid aaS$

This grammar is not in GNF

Convert this to GNF.

$S \to aY \mid aS \mid aXS$

$X \to a$

$Y \to b$

This is in GNF

Q-2 $S \to ABb \mid a$

$A \to aaA \mid B$

$B \to bAB$

Eliminating unit productions

$S \to ABb \mid a$

$A \to aaA \mid bAB$

$B \to bAB$

Convert it TO GNF

Substituting A in S

$S \to aaABb \mid bABBb \mid a$

$A \to aaA \mid bAB$

$B \to bAB$

$S \to aXABY \mid bABBY \mid a$

$A \to aXA \mid bAB$

$B \to bAB$

$X \to a$

$Y \to b$

Simple grammar or S-grammar

A Context free Grammar $G = (V, T, P, S)$ is said to be a simple grammar or S grammar if all its Productions are of the form

$$A \rightarrow ax$$

where $A \in V$, $a \in T$, $x \in V^*$ and any pair (A, a) occurs at most once

$V^* \rightarrow$ V closure means set of non terminals and λ

Ex

$S \rightarrow aS \mid bSS \mid cS \mid d$ is S grammar

Ex

$S \rightarrow \underline{aSS} \mid bS \mid \underline{aSSS} \mid cSS \mid d$

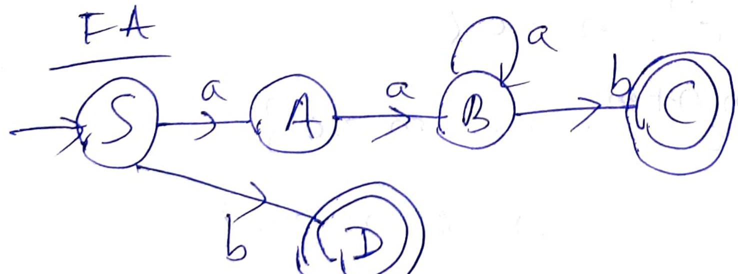
The Pair (S, a) is being produced twice here.

So this is not S grammar.

Q Find the S-grammar for

Q1- $L(aaa^*b + b)$

FA



Right Linear grammar

$S \rightarrow aA \mid bD$

$A \rightarrow aB$

$B \rightarrow aB \mid bC$

$C \rightarrow \lambda$

$D \rightarrow \lambda$

This is not in S grammar becoz of λ productions. form

So I have to eliminate λ production.

$S \to aA \mid b$

$A \to aB$

$B \to aB \mid b$

So this is the simple grammar.

Q-2 Find S-grammar for

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

Smallest string is ab.

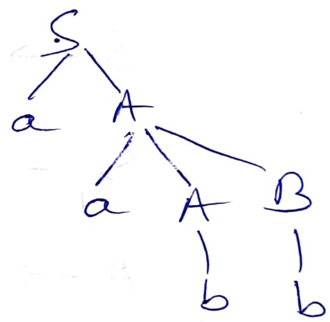
$L = \{ab, a^2b^2, a^3b^3 - - - \}$

Right linear grammar is

$S \to aA$

$A \to b \mid aAB$

$B \to b$



This is S-grammar.

Q-3 Find S-grammar for

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

$L = \{$

$S \to aAC$

$A \to b \mid aAB$

$B \to b$

$C \to b$

This is a S grammar.

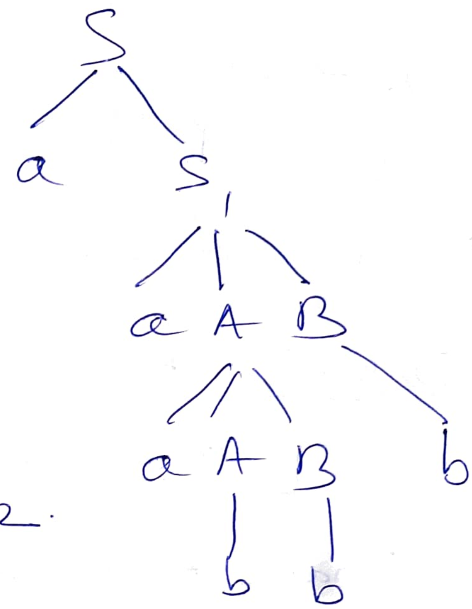
Q-4 $L = \{a^n b^n : n \geq 2\}$

$S \to aS_1$

$S_1 \to aAB$

$A \to b \mid aAB$

$B \to b$



This is S grammar.

Q-5 $L = \{a^n b^{2n} : n \geq 2\}$

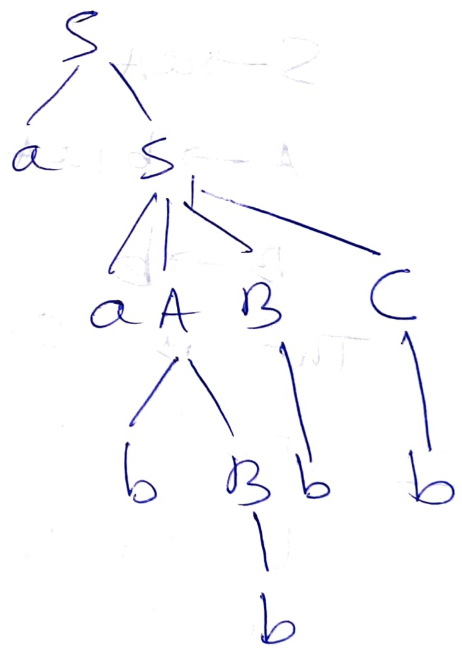
$S \to aS_1$

$S_1 \to aAB$

$A \to bB \mid aABC$

$B \to b$

$C \to b$



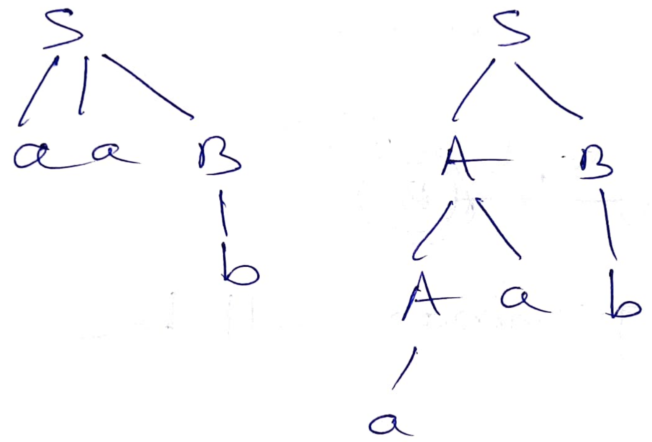
This is the S grammar.

Eliminating Ambiguity from the Grammar

Ex-1 $S \rightarrow AB \mid aaB$

$A \rightarrow a \mid Aa$

$B \rightarrow b$



$w = aab$

If for a string, I will get two or more parse tree or derivation tree, it is called Ambiguous grammar.

Unambiguous grammar will be

$S \rightarrow AB$

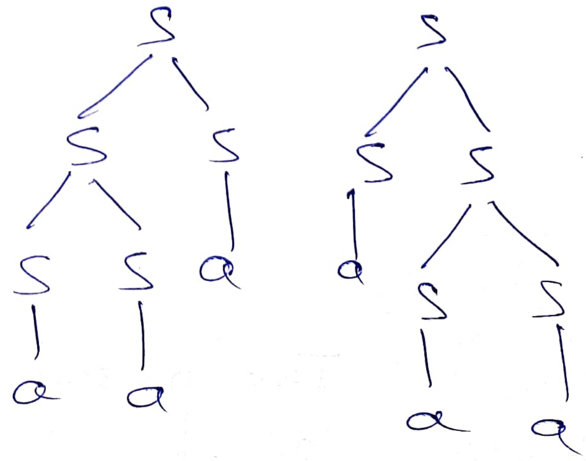
$A \rightarrow a \mid Aa$

$B \rightarrow b$

Q-2 $S \rightarrow SS \mid a \mid b$

For the string

$w = aaa$



for the string aaa, we have two parse tree.

So this grammar is ambiguous grammar

unambiguous grammar will be

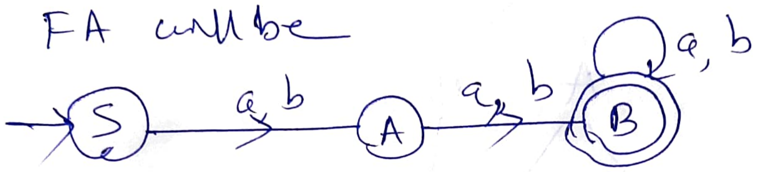
Language generated by this grammar will be

$L(G) = L((a+b)^2 (a+b)^*)$

$L = \{aa, ab, ba, bb, aaa - - - - - \}$

two or more

FA will be



Right linear grammar will be

$S \to aA \mid bA$

$A \to aB \mid bB$

$B \to aB \mid bB \mid \lambda$

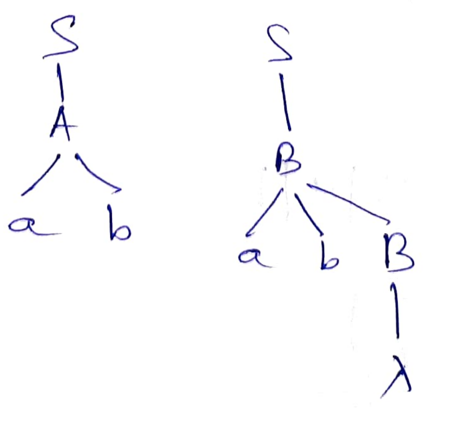
This is the grammar which is unambiguous.

Q-3 $S \to A \mid B$

$A \to aAb \mid ab$

$B \to abB \mid \lambda$

$W = ab$



Two parse trees are generated.

So it is a Aonbiguous grammar.

Language generated by grammar.

$L(G) = \{a^n b^n : n \geq 1\} \cup \{(ab)^m : m \geq 0\}$

$S \to A \mid B$

$A \to aAb \mid aabb$

$B \to abB \mid \lambda$

Q-4 $S \to S\#S \mid S@S \mid a$

given that # is right associative

@ left associative and

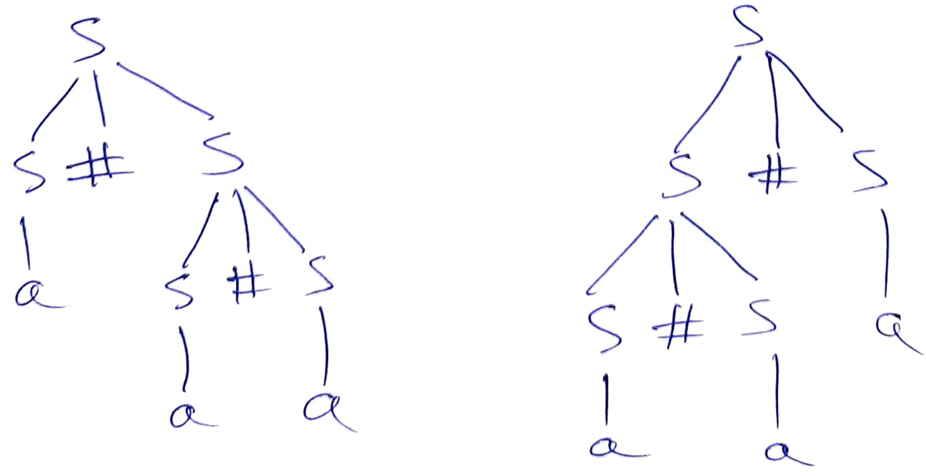
the precedence of # > @

unambiguous grammar

$S \to S@T \mid T$ — @ is lower precedence and left associative → solved first

$T \to P\#T \mid P$ → # is higher precedence and right associative

$P \to a$



Ambiguous grammar.

Closure Properties of Context Free Language

1. The intersection of two context free languages is not context free.
2. The complement of CFL is not closed.
3. The intersection of a CFL and regular language is context free.

Ex

$L_1 = \{a^n b^m c^m : n \geq 0, m \geq 0\}$

$L_2 = a^m b^n c^n : n \geq 0, m \geq 0\}$

For L_1, the grammar will be

$S \to AB$

$A \to aA \mid \lambda$

$B \to bBc \mid \lambda$