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FLAT - Tutorial 4

Q. 1) Eliminate useless productions/symbols for given CFG.

(a) $S \rightarrow AB \mid a$
$A \rightarrow BC \mid b$
$B \rightarrow aB \mid C$
$C \rightarrow aC \mid B$

B, C forms a cycle and neither of them terminate. B and C terms can be removed.

$\therefore S \rightarrow a$
$A \rightarrow b$

A is not reachable and can be removed.
$\therefore S \rightarrow a$

(b) $S \rightarrow AB \mid Ca$
$B \rightarrow BC \mid AB$
$A \rightarrow a$
$C \rightarrow aB \mid b$

B creates cycle and also doesn't terminate. $\therefore$ B can be removed.
$\therefore S \rightarrow Ca$
$A \rightarrow a$
$C \rightarrow b$

A is not reachable and thus can be removed.
$\therefore S \rightarrow Ca$
$C \rightarrow b$

Q.2) Express the following grammar using CNF.

$S \rightarrow ABA$

$A \rightarrow aA \mid \epsilon$

$B \rightarrow bB \mid \epsilon$

→ No, useless productions.

Elimate ϵ- productions.

$S \rightarrow ABA \mid BA \mid AB \mid AA \mid A \mid B$

$A \rightarrow aA \mid a$

$B \rightarrow bB \mid b$

Eliminate unit productions.

$S \rightarrow ABA \mid BA \mid AB \mid AA \mid aA \mid a \mid bB \mid b$

$A \rightarrow aA \mid a$

$B \rightarrow bB \mid b$

Following is the productions format for CNF.

$A \rightarrow BC \mid a$

$\therefore$ Let $C = a$, $D = b$, $E = AB$

$\therefore S \rightarrow EA \mid BA \mid AB \mid AA \mid CA \mid a \mid DB \mid b$

$A \rightarrow CA \mid a$

$B \rightarrow DB \mid b$

$C \rightarrow a$

$D \rightarrow b$

$E \rightarrow AB$

Thus, the above grammar satisfies CNF constraints.

Q. 3 Show following grammar is ambigous.

→ Given grammer:

$S \rightarrow a \mid abSb \mid aAb$

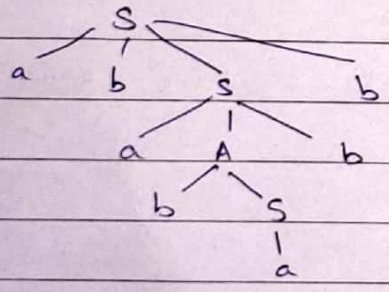
$A \rightarrow bS \mid aAAb$

Consider the string "abababab" which can be processed by above grammar.

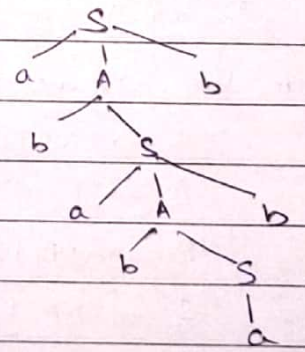
$S \rightarrow abSb$		$S \rightarrow aAb$	
$\xrightarrow{lmd}$ $abaAb$	$(S \rightarrow aAb)$	$\xrightarrow{lmd}$ $abSb$	$(A \rightarrow bS)$
$\xrightarrow{lmd}$ $ababSb$	$(A \rightarrow bS)$	$\xrightarrow{lmd}$ $abaAb$	$(S \rightarrow aAb)$
$\xrightarrow{lmd}$ $abababab$	$(S \rightarrow a)$	$\xrightarrow{lmd}$ $ababSb$	$(A \rightarrow bS)$
		$\xrightarrow{lmd}$ $abababab$	$(S \rightarrow a)$

Parse tree:

For LMD (i)



For LMD (ii)



It can be observed that two different parse tree exist for a string and thus, the given grammar is ambiguous.

Q. 4) Consider the following CFG into GNF.

$S \rightarrow AB \mid 0$
$A \rightarrow Bx \mid 1$
$B \rightarrow CD \mid 2$
$C \rightarrow AD \mid 0$
$D \rightarrow 1$

→ There is no rule for 'x'. Thus all productions containing x can be removed.

$\therefore S \rightarrow AB \mid 0$
$A \rightarrow 1$
$B \rightarrow CD \mid 2$
$C \rightarrow AD \mid 0$
$D \rightarrow 1$

D can be removed, since A and D produce same string.

$\therefore S \rightarrow AB \mid 0$
$A \rightarrow 1$
$B \rightarrow CA \mid 2$
$C \rightarrow AA \mid 0$

CFG can be simplified now,

$C \rightarrow 1A \mid 0$
$B \rightarrow 1AA \mid 0A \mid 2$
$S \rightarrow 1B \mid 0$

Thus, $S \rightarrow 1B \mid 0$
$A \rightarrow 1$
$B \rightarrow 1AA \mid 0A \mid 2$
$C \rightarrow 1A \mid 0$

Thus, all terms are in $A \rightarrow a\alpha$ form. Thus, it is in GNF.

Q. 5) Write an equivalent left-linear grammar for the right linear grammar, which is defined as

→

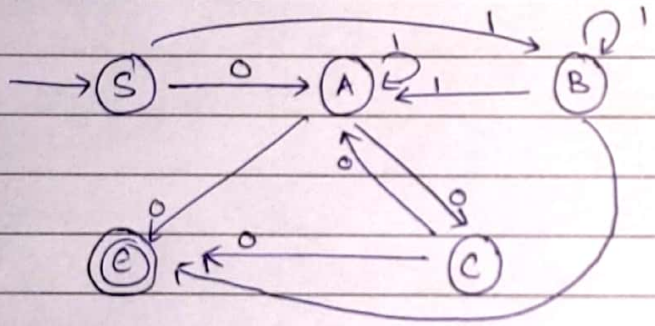
$S \rightarrow 0A|1B$

$A \rightarrow 0C|1A|0$

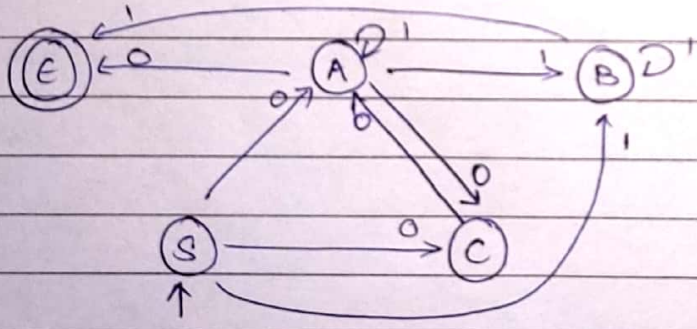
$B \rightarrow 1B|1A|1$

$C \rightarrow 0|0A$

Transition graph:



Replace ϵ with S and change the direction of arrows.



$\therefore S \rightarrow A0|B1|C0$

$A \rightarrow A1|B1|C0|0$

$B \rightarrow B1|1$

$C \rightarrow A0$

The above is left linear equivalent grammar for the given right linear grammar.