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Tutorial CfG (Part 1)

(1) Convert the following CfG $G = (\{E\}, \{+, *, (,), a\}, P, \{E\})$ into CNF where P is as follows

$$E \to E+E \mid E*E \mid (E) \mid a$$

Ans

$E \to E+E \mid E*E \mid (E) \mid a$

removing unit production

$S0 \to E+E \mid E*E \mid (E) \mid a$

$E \to E+E \mid E*E \mid (E) \mid a$

removing min h

$P \to +$
$M \to *$
$O \to C$
$C \to)$
$V \to a$

$S0 \to EPE \mid EME \mid OEC \mid aV$
$E \to EPE \mid EME \mid OEC \mid aV$

Removing two Sums

$A \to EP$
$B \to EM$
$D \to OE$

$S0 \to AE \mid BE \mid DC \mid a$
$E \to AE \mid BE \mid DC \mid a$

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Find CNF

$S_0 \rightarrow AE \mid BE \mid DC \mid a$
$E \rightarrow AE \mid BE \mid DC \mid a$

$A \rightarrow EP$
$B \rightarrow EM$
$D \rightarrow OE$
$P \rightarrow +$
$M \rightarrow *$
$O \rightarrow C$
$C \rightarrow)$

Q.2 Using CYK algorithm, check the membership of the string $w = aabb$ for the following CFG

$S \rightarrow AB \mid BB$
$A \rightarrow CC \mid AB \mid a$
$B \rightarrow BB \mid CA \mid b$
$C \rightarrow BA \mid AA \mid b$

Ans

aabb {S,A,C}			
aab A	abb C,S,A		
C	ab S	bb S,B,A	
A^a	A^a	b B,C	B,C^b
a	a	b	b

$w = aabb$
$|w| = 4$

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a a

(A) (A)

a b

(A) (B,C)

b b

(B,C) (B,C)

aab

aa b a ab

(C) (B,C) (A) (S)

(CB, CC) (AS)

{∅, A} ∪ {∅}

= {A}

abb

ab b abb

(S) (B,C) (A), (S,B,A)

(SB, SC) (AS, AA, AB)

{∅, ∅} ∪ {∅, C, S, A}

= {C, S, A}

aabb

aab b a abbb aa bb

(A) (B,C) (A) (C,S,A) (C) (S,A)

(AB, AC) (AC, AS, AA) (CS, CA)

{S, A, ∅} ∪ {∅, C} ∪ {∅, B} = S, A, B, C

at aabb

a abb

(A) (S, A, C)

(AS, AA, AC)

C

aaab b

(A) (B, C)

(AB, AC)

{S, A}

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Since starting symbol is a non-terminal for $w = aabb$ hence it is accepted

Q.2) Since starting symbol is a non-terminal for $w = aabb$ hence it is accepted.

Q.3 Simplify the following CFG.

$S \to ABaC$
$A \to BC$
$B \to B/\varepsilon$
$C \to D/F$
$D \to d$

Ans (i) $S \to ABaC$
$\to ABaC \mid AaC \mid ABa$
$\to AaBaC \mid AbaC \mid ABaC$
$\to AadaC \mid ABaC \mid ABaC$

(ii) $A \to BC$
$BC \mid C \mid B$
$BD \mid D \mid B$
$bD \mid D \mid b$
$dd \mid d \mid b$

(iii) $B \to b \mid \varepsilon$

(iv) $C \to D \mid E$
$\to d \mid E$

(v) $D \to d$

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Q.4 Construct the CFG for the CFL $L = \{a^n \mid n \geq 1\}$

(a) Construct the ambigous grammer G_1 for L

(b) construct the ambigous grammer G_2 for L

Ans (a) $S \rightarrow aS \mid a$

(b) $S \rightarrow Sa \mid as$

Q.5 Convert the following into GNF

(a) $S \rightarrow aSa \mid bSb \mid a \mid b$

(b) $S \rightarrow ABa \mid a$

$A \rightarrow aaA \mid B$

$B \rightarrow bA \mid B$

(c) $S \rightarrow ab \mid as \mid aas$

(a) $S \rightarrow aSa \mid bSb \mid a \mid b$

$S \rightarrow Aa \mid Bb \mid a \mid b$

$A \rightarrow aS$

$B \rightarrow bS$

(c) $S \rightarrow ab \mid as \mid aaas$

$S \rightarrow ab \mid aas \mid BS$

$B \rightarrow aa$

(b) $S \rightarrow ABa \mid a$

$A \rightarrow aaAB$

$B \rightarrow bAB$

$S \rightarrow Ca \mid a$

$C \rightarrow AB$

$A \rightarrow DA \mid B$

$B \rightarrow EB$, $D \rightarrow aa$, $E \rightarrow bA$