Experiment # 11 Date 11/9/24 Student ID 30642 Student Name

Introduce New Non-terminals: For terminal symbols in longer productions, introduce new non-terminal symbols to ensure all rules fit the binary or terminal production form.

Pre-Tutorial (To be completed by student before attending tutorial session)

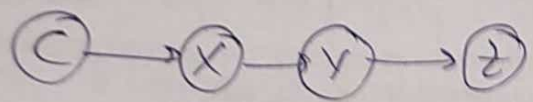
1. Remove unit productions from the following grammar

$$S \to AC,\ A \to a,\ C \to X|b,\ X \to Y,\ Y \to Z,\ Z \to a$$

Solution:

C → X
X → Y
Y → Z

Dependency graph:



C → Y
X → Z

C → X
C → Y
→ Z
C → a

X → Y
→ Z
→ a
X → a

Y → Z
Y → a

C → Y
C → Z
C → a

X → Z
X → a

∴ { S → AC
A → a
C → a/b
X → a
Y → a Z → a }

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emove useless productions and symbols from the following CFG:

$S \rightarrow AB \mid CA, B \rightarrow BC \mid AB, A \rightarrow a, C \rightarrow aB \mid b$

ion:

1) $S \rightarrow AB$ $S \rightarrow CA$ $B \rightarrow BC$ $C \rightarrow aB$

$\rightarrow aB$ $\rightarrow bA$ ✗ ✗

$\rightarrow aBC$ $\rightarrow ba$

$\rightarrow aBb$

✗

2) $S \rightarrow AB$ $S \rightarrow CA$

✗ $\rightarrow ba$

$\therefore$ $S \rightarrow CA$

$A \rightarrow a$

$C \rightarrow bA$

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3. Remove unit production from the following CFG:

$S \rightarrow 0A \mid 1B \mid C,\ A \rightarrow 0S \mid 00,\ B \rightarrow 1 \mid A,\ C \rightarrow 01$

Solution:

$S \rightarrow C$

$B \rightarrow A$

$S \rightarrow C$ $\quad B \rightarrow A$ $\quad$ (ii) $B \rightarrow 0S \rightarrow D \rightarrow 00A$

$S \rightarrow 01$ $\quad$ (iii) $B \rightarrow 00$ $\quad$ 0000

$\therefore S \rightarrow 0A \mid 1B \mid 0$

$A \rightarrow 0S \mid 00$

$B \rightarrow 1 \mid 00$

$C \rightarrow 01$

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TUTORIAL (To be carried out in presence of faculty in classroom)

Convert the given grammar to CNF

$S \to aAD$, $A \to aB \mid bAB$, $B \to b$, $D \to d$

lution:

1) Simplification of CNF: NIL

2) Already in CNF

$B \to b$

$D \to d$

Introduce two new variables $C_a \to a$

$C_b \to b$

$S \to aAD$ $A \to aB$ $A \to bAB$

$\to C_aAD$ $\to C_aB$ $\to C_bAB$

(CNF)

introduce $(m-2)$ variable D_1,

$S \to C_aD_1$

$D_1 \to AD$

introduce $(m-2)$ variable D_2,

$A \to C_bD_2$

$D_2 \to AB$

$P = \{ S \to C_aD_1$ $C_b \to b$ $G = (\{S, A, B, C_a, C_b, D, D_1, D_2\}, \{a, b\},$

$A \to C_aB \mid C_bD_2$ $D \to d$ $P, S)$

$B \to b$ $D_1 \to AD$

$C_a \to a$ $D_2 \to AB \}$

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2.Convert the following CFG to CNF

S →XSY, X→ aXS | a | ε, Y →SbS | X | bb.

Solution:

Step1 :

∈-productions:

X → ∈

S → XSY X → aXS

S → SY X → aS

unit-productions :

Y → X

i) → a

Y → a

useless productions :

1) S → XSY

→ aSbb

(X)

useless : {S}

X → aXS

(X)

Y → SbS

→ (X)

Y → X

→ a

S → SY (CNF)

P = { X → a | aS

Y → bb | a }

2) S → XSY

(X)

Let $C_a \to a$, $C_b \to b$

X → aS Y → bb

→ C_aS → $C_b C_b$

G. ({S, X, Y, Y}, {a, b}, P', S)

C_a, C_b

P' = { S → SY

X → a | C_aS

Y → a | $C_b C_b$

$C_a \to a$

$C_b \to b$

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3. Convert the following grammar into CNF.

$S \rightarrow aAB$, $A \rightarrow aB \mid bAB$, $B \rightarrow aBB \mid bS \mid b$.

Solution:

Step1 Simplification: NIL

Step2: $B \rightarrow b$ already CNF

introduce two new variables $C_a \rightarrow a$, $C_b \rightarrow b$

$S \rightarrow C_aAB$

$A \rightarrow C_aB$ (CNF)

$A \rightarrow C_bAB$

$B \rightarrow C_aBB$

$B \rightarrow C_bS$ (CNF)

introduce $(m-2)$ variables D_1, D_2

$S \rightarrow C_aD_1$

$A \rightarrow C_bD_1$

$D_1 \rightarrow AB$

$B \rightarrow C_aD_2$

$D_2 \rightarrow BB$

$G = (\{S, A, B, C_a, C_b, D_1, D_2\}, \{a, b\}, P, S)$

$P = \{ S \rightarrow C_aD_1$

$A \rightarrow C_aB \mid C_bD_1$

$B \rightarrow C_aD_2 \mid C_bS \mid b$

$C_a \rightarrow a$

$C_b \rightarrow b$

$D_1 \rightarrow AB$

$D_2 \rightarrow BB \}$

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Post-Tutorial (To be carried out by student after attending tutorial session)

1.Convert the following CFG to CNF: S-->A0B, A-->AA | 0S | 0, B--> 0BB, | 1S | 1

Solution:

$A \to AA$
$B \to 1$ } already CNF
$A \to 0$

$S \to A0B$

let $C_a \to a0$
$C_b \to 1$

$\Rightarrow S \to A C_a B$

$A \to C_a S$ (CNF)

$B \to C_a BB$

$B \to C_b S$ (CNF)

let D_1, D_2 (m-2) variable,

$S \to AD_1$ $B \to C_a D_2$

$D_1 \to CaB$ $D_2 \to BB$

$G = (\{S, A, B, C_a, C_b, D_1, D_2\}, \{0, 1\}, P, S)$

$P = \{ S \to AD_1$
$A \to AA \mid C_a S \mid 0$
$B \to C_a D_2 \mid C_b S \mid 1$
$C_a \to 0$
$C_b \to 1$

$D_1 \to CaB$
$D_2 \to BB \}$

2.Convert the following CFG to CNF: S --> AB, A--> aab, B --> aAc

Solution:

$S \to AB$ (already CNF)

let $C_a \to a$, $C_b \to b$, $C_c \to c$

$B \to aAc$

$CaA\,C_c$

$A \to C_a C_a C_b$

$G = (\{S, A, B, C_a, C_b, C_c, D_1, D_2\}, \{a, b, c\}, P, S)$

let D_1, D_2 (m-2) variable

$B \to CaD_1$ $A \to CaD_2$

$D_1 \to AC_c$ $D_2 \to CaC_b$

$P = \{ S \to AB$
$A \to C_a D_2$
$B \to CaD_1$
$C_a \to a$
$C_b \to b$
$C_c \to c$

$D_1 \to AC_c$
$D_2 \to C_a C_b \}$

Week # 11 Student ID 30642
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Convert the following CFG into CNF: S → ASA | aB, A → B | S, B → b | ε

Solution: (i) $B \to \epsilon$

$S \to aB$

$\boxed{S \to a}$

(ii) $A \to B$

$A \to S$

$\boxed{A \to b}$

$A \to aB$

$\boxed{A \to ab}$

(iii) 1) $S \to ASA$ $S \to aB$ $A \to B$ $A \to S$

$\to BaBB$ $\to aB$ $\to b$ $\to AB$

$\to baBb$ $\to ab$

2) $S \to ASA$ $S \to aB$

✓ ✓

$P = \{ S \to ASA \mid aB \mid a$

$A \to b \mid ab$

$B \to b \}$

$S \to a$
$A \to b$
$B \to b$
} already CNF.

let $C_a \to a$, $C_b \to b$

$S \to CaB$

$A \to CaCb$

$S \to ASA$

let D_1 (m-2) variable

$S \to AD_1$

$D_1 \to SA$

$P' = \{ S \to AD_1 \mid a \mid CaB$

$A \to CaCb \mid b$

$B \to b$.

$Ca \to a$

$Cb \to b$

$D_1 \to SA \}$

$G = (\{S, A, B, Ca, Cb, D\}, \{a, b\}, P', S)$.

Experiment #	11	Student ID	2300030642
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Viva Questions

1. What is Chomsky Normal Form (CNF) in the context of context-free grammars, and what are its key characteristics?

Answer:

Any CFG without 'ϵ' is generated by a grammar in which all productions are of the form $A \rightarrow BC$ or $A \rightarrow a$. Here A, B and C are variables and 'a' is terminal.

$V \rightarrow VV$

$V \rightarrow T$

2. Why is it necessary to remove ε-productions when converting to Chomsky Normal Form?

Answer:

Let G be any CFG with ϵ is not in L(G) then there exist an equivalent grammar 'G' having no ϵ-productions.

(For Evaluator's use only)

	Comment of the Evaluator (if Any)	Evaluator's Observation
		Marks Secured: out of 50
		Full Name of the Evaluator:
		Signature of the Evaluator Date of Evaluation: