Normal forms for context free Grammer:

- A given CFG can be normalized by:
- a) Eliminating E-productions
- b) Eliminating unit productions
- c) Eliminating useless symbols.

Elimation of E-paroductions: [A > E] variable/Non-terminal

Step :- Identify nulable variable

- a) $A \longrightarrow \varepsilon$ (A) (derectly)
- b) $A \rightarrow aA|B$ (A,B) $B \rightarrow \epsilon$ Indirectly

Step II: Elemination procedure

 $S \rightarrow ABA$ $A \rightarrow E$ $B \rightarrow a$ $S \rightarrow ABA$ Obtained by $\leftarrow BA$. ABAB

Replacing leftmost $A \rightarrow B$ $A \rightarrow B$ Replacing Rightmost $A \rightarrow B$ $A \rightarrow B$

S → ABAIBAIABIB → obtained by replacing every occurance of A with E.

Eliminate E-production from the following:

some frames for contract forms

SElmmothy separations

(0

another time particularity in

it is thought in ideal of the most

1) Given,

S - ABAC

A -> aAlE

B -> bBlE

c -> d.

Solt Stepit Edentify nullable variable

NV = {A.B}

Stepa: Eleminating E-paoductions.

	V	
Paoduction	Nullable	Production after E- elemenation
S-> ABAC	A	5-> ABACIBACIABCIBC
	В	S-ABACIAACIBACIACIABCIBCIC
$A \rightarrow a A$	A	A → aAla
	В	8 Application papereduse -
B→ bB	A	B→ bBlb AdA C
	A	c→d . 3 ←A
€->a	Α	$c \rightarrow d$
utad Sut	В	ed by 2 - 34 KB 1-

. Final Grammer is

S -> ABACIAACIBACIACIABCIBCIC

A -> aAla

 $C \rightarrow d$

A -> Bala

B > bAcle

C-> dABLE

soli Nullable variables = { B, C}

Elemenating E- productions:

Production	N.V	Peroduction after	r e-elemenation
$s \rightarrow AB$	В	S -> ABIA	- VIC
	c	11 X (-1)	
A -> Bd	Blakla	A→ Bdld	V
	С	120 = 2	
A→a	В .	A→a	
	С		· ·
B → bAC	В		X
	С	B→ baclba	Y
C→ dAB	В	C→ dABldA	
	c	_	ST William 15

7 enal grammer is

S-> ABIA

A → Boldla

B -> bACLBA

C -> dABldA

3). Given,

 $S \longrightarrow XYO$

 $x \rightarrow 0x | \varepsilon$

Y → 14/ E

Solr

 $N.v = \{X,Y\}$

Parduction	N.V	Paoduction after E-	demenation
$S \rightarrow XYO$	×	S→ XY0 Y0	3/1 ←
	y	s-> xyolxolyolo	L8 ← 3
x→0x	X	s-> oxlo	
	Y	A - 14	10 K- A
Y→17	X		
	У	Aquay - 17/1	

.. Final grammer is

S-> XYO | XO | YO | O

 $x \rightarrow oxlo$

1/11 E-K

AlaA ← 3

nallad ed

na lean 2

Elemenating E-productions:

Paoduction	N.V	Paroduction after E-elemenation
A -> OBI	В	A -> OBILOI
A > 1B1	В	A -> 1B1111
B→ 0B	B	$B \rightarrow OBIO$
$B \rightarrow IB$	В	B → 1811

.. Final grammer is

there in the given no E-paoduction,

SI:- No- & parductions

52: Edentifying unet productions

A -> B

33: Removal of unit productions

unet paoduction	Replacement symbol	Paoduckaffer elimination
$A \longrightarrow B$	В	$A \rightarrow alb$

Final grammes: A-alb B-> alb_ 2) S→ AB $A \rightarrow a$ B -> elb $c \rightarrow D$ $D \rightarrow E$ $E \rightarrow a$ Sol: SI:- No- & paroductions A H RELEGIET | Replacement sa: unit productions 199(41)5 D -E B -> C -> D -> E & Ty there is dependency, 90 from backwould } unit paoductions Replacement Paduction after elimination symbol 5- alba bb nak a E D->E dalle n = 3 $C \rightarrow q$ $C \rightarrow D$ D B- alb C B -c .. Final gaammer is S -> AB $A \rightarrow a$ B → alb

3) S -> Aal Bld.

B -> Albb

A -> albd.

Sol; *) No . E-paoductions.

*) Removal of unit productions:

SI'r Edentifying unit productions

$$S \rightarrow B$$
, $B \rightarrow A = > S \rightarrow B \rightarrow A$.

S2: Removal of unit production.

Unet paoduction	Replacement symbol	Production after Elemenation
$\beta \longrightarrow \beta$.	Α	B → albdlbb
$S \longrightarrow B$	В	s-albdlbblAald

fenal grammer 18:

 $S \longrightarrow a|bd|bb|Aa|d$

 $B \rightarrow a | b a | b b$

A -> albd

4) Given, S -> ACAlAa	101111111111111111111111111111111111111	in disabolity in
$A \longrightarrow BB1E$ $B \longrightarrow A1bc$		J 4 (
$C \rightarrow b$	A	4 = 8
solt there is an E-paroduction. N. V = {A,B}	а	8-4

Production	N.V	Paroduction after E- Elemination
S→ACA	AIB	s-) ACAICAIACIC
s→ Aa	AIB	s-Aala
$A \rightarrow BB$	ArB	A -> BBIB
$B \rightarrow A$	AIB	B→A pldA ← 2 of
B→bC	AIB	B→b€
с→Ь	A,B	C→Broduction 3 ← 29 2001

modified grammer is:

S - ACA | CA | ACI C | Aala

A -> BBIB

B -> AlbC

 $c \rightarrow b$

unit paoduct	tons:-	s-salbihela	· A	l ac-
$S \longrightarrow C$	_\	$c \rightarrow c$	27, permitted f	1 3000174
$A \rightarrow B$ $B \rightarrow A$	<i>-</i> >	$S \rightarrow C$ $A \rightarrow B \rightarrow A$	anidine	

Unit paoduction	Replacement sym	bol Paod	uction aft	er Elemination
$S \rightarrow C$	С	S-	→ b,	
$B \rightarrow A$	A	β →	BB1₽€	
$A \rightarrow B$	В	$A \rightarrow$	вв вьс	ν.и.,
tenal gramme	Ng ts we'll be recipio	50-4	J. 14	naliant.
S- ACA ICA	AlAclblaala		a,A	A)A←
$A \rightarrow BB bC$ $B \rightarrow BB bC$	o la	A ← 2	a.a	₩A ← E
$C \rightarrow b$	alac	964	3.0	30 < 11
5) Geven, 8 -> A E		a←a	difi	45-8
A→all B→ Eld		d - 8	a a	0000
Solir *> There is	a E-paroduction	2-5	g . A	de-5
$S \rightarrow AB A C$ $A \rightarrow a b$ $B \rightarrow d$	immer after Etyp		isalasi 86 SC	
S->A A	$\frac{s \to A}{ s \to a b }$	tBla	E te though	cost t rail
s—alb B—d	ner is			S S S S S S S S S S S S S S S S S S S

Removal of useless symbol:

13/12/2024

control of asserts sampulsi-

Remount prompension was contained

Step 1: Remove non-generating symbols/variables.

step 2: Remove unreachable symbols

Remove non-generating symbols:

NGV -> those variables which do not produce terminals

$$(\lambda \rightarrow a)$$

-> Remove all production that contain NGVs.

Retmove unreachable symbols:

Unreachable symbols -> those symbols that cannot be treached from 's'

L> start symbol.

1) Given,

Sol: *> Noe &- production.

Removal of unit paoduction:

stepi: Identify the unet production:

$$B \rightarrow C$$
 $C \rightarrow B$

$$\Rightarrow B \rightarrow C \rightarrow B$$

Stepz: Removal of unit production:

Unet production	Replacement symbol	production after Elemenation
$C \longrightarrow B$	В	C→aC aB
$B \rightarrow c$	C ·	B→ aBlaC

modefeed grammer:

S-> ABla

A -> BClb January Kote 4

C→ ACLAB

Removal of useless symbols:

Step 17 Removeng non-generating variables:

variables	Generating Variables	NGV = V- GV
[S,A,B,C]	£5, A3	{B,C} Subsci Hau

+ C COURT PRODUCTION:

modefied quammer! S→a A→b. Stepa! Removing und Variables Reach {s, A} Final grammer!

unseachable	gumbals
in soachable	SUMBOIS.

Variables	Reachable symbols	unveachablesymbols
	made at le 823 phols	Krachalton KA3

 $S \rightarrow a$.

2) Given,

S - ABLAC

A -> aAblbAala

B -> bbA laabl AB

c -> ab CA labb

D -> bDlac.

Solt *> There is no E-paroductions and unet paroductions.

T -> aat lab filaat

Removing of useless symbols:

Sli Removing non-generating variable:

variables	Generating variables	NGV= N-GV
{s,A,B,C,D}	& A, B, S } & uday	Removing non Earl & C. D. Fring

modefred grammer:

S-AB

A -> aAb| bAala

B -> bbAl aaBl AB.

Sa! Removing unreachable stambols:

vartables	Reachablesymbols	unreachable symbols
{S, A, B}	&S, A, B}	ø

final grammes:

 $S \rightarrow AB$

A -> aAblbAala

B -> bbA | aaBlAB.

3) T-> aaBlabAlaaT

 $A \rightarrow aA$

 $B \rightarrow ablb$

 $C \rightarrow ad$

δο1: *> No = ε-production.

*) Remove un No-unit puoduction.

Removal of usedess symbol:

SI: Removing non-generating symbols:

		1	The state of the s
variables	Generating variables	NGV= V-	-6V
{T, A, B, C}	{B,C,T}	EA3.	
modified o	geammas!		11.
T→aal	BlaaT		in to remain
B -> abl	Pile perpensis		instances the
$C \rightarrow ad$		Inauths	
SZ: Remove	ng unreachable sym	bols:	n 3
variables	Reachable symbols	Unreachable	e symbols
{TiB, C}	{T,8}	{ c }	3/82/15-
trnal gic T→ αα B → ab	Blaat 1b		B→ sersia B→ spalansia serve of eselve Bemouther non-
Simplefu	the following CFG.	the france of	
$S \longrightarrow ASB$	V= V-6V 31	cating NE	Monata Janear
A -> aAS			MIAS FERMI
$B \longrightarrow SbS$	IAIDD		
Sol: * Here	of E-paoduction:	ate derives	E and no other
	es are desiveng &		
	d to remove the E	-production.	$S \Rightarrow ASB E$ $A \Rightarrow aBS a$
		dd/	B + Sbslansla

Removal of unit production:

SI: Identify the unit production.

 $B \longrightarrow A$.

SE: Removal of unit paoduction.

unet paoduction	Replacement	paoduction after Elimination
	symbol	DB C
$B \longrightarrow A$	A Soda	B- ansla.
Start rows		hommuz erinneen zillinan

Food 100 61

aldota

modefred geammes:

S-ASBIE

 $A \rightarrow aAsla$

B→sbslaAslalbb

Removal of useless grammer:

SIF Removing non-generating symbols.

variables	generating variables	NGV= V-GV	alog off programs 3 lach - c
{AIB,S}	{A1B,5}	\$	m → ansla— s → spsinibb=

modified grammer:

S-> ASBLE

A -> aAs|a . notionbodg-3 ont overtoo of been one.

B→SbslaAs/albb

variables	unreachable symbols	unveacha symt		Cl .	91.0 31.4-2
55,A,B\$	{s, A, B}	S & Acc		1	
tenal au	ammel:			- 0	- 0.4 8 FR
final ga	Sial Bag .	JA8-6		8	
$S \longrightarrow ASE$ $A \longrightarrow \alpha A$	Serger Services	as← A		ava	h A
B → Sbs	laaslalbb	h→ Bac		-a,0	Jea ← A
Given,		$\Lambda \longrightarrow aa$		849	1000 e 11
$S \longrightarrow ABC$ $A \longrightarrow AA E$		d dad < 8)	DiB	650 TE C
$B \rightarrow 6Bb$		p ← 8		310	1a ←8
$C \rightarrow CAIB$ $D \rightarrow E$		A) ← 3		8.0	HJ€ ←J
Remov	al of E-produc	teon:		8,0	- one
SI- Ident	thy the nullab	ne variable	2.		
N	$\forall = \{ D, B \}$			tanyno:	ob pattigan

B-> babibblalD

C-> (n/AC

Production	Nullable	Production after E-elemenation
	variable	
S -> ABC BaB	D	Control of the State of the Sta
	В	S -> ABC AC.
5 → BaB	D	- management to
	В	S-BalaBlalBaB
$A \rightarrow \alpha A$	D, B	A -> aA plante
A → BaC	DIB	A→Baclac
$A \rightarrow aaa$	DiB	$A \longrightarrow aaa$
$B \rightarrow bBb$	DiB	B → bBb bb Resident Ade
B→al	DiB	$B \rightarrow a$ $SAIAI \leftarrow$
€→ DCA	D.B	C → CA
C→ AC	DiB	$C \longrightarrow AC$

(4 = (0) B)

modified grammes:

S-> ABCLACIBALABIALBAB

A -> aAlbaclaclaaa

B -> bBblbblalD

C-> CALAC

Removal of unit production?

Identify the unit paoduction.

 $B \longrightarrow D$.

SZT Removal unit paoduction.

Unit paoduction	Replacement symbol	Puoduction after Elimination		
$\mathbb{B} \longrightarrow \mathbb{D}$.	D	ø statistadid e		

are preductions are of the form

is that cfg which is less of

a) E-popdactions

modified grammer:

S-> ABCIACIBA | BAB | a.

A -> AA | Ba Claclaaa - Dibe et estatute

B→ bBblbbla

C-> CA I AC

Mon-Tominal - Alm: Teaminal - Non-T Removal of usedess production!

SI'- Removing non-generating symbols.

SIE KEMOUT	ig non-generating symp	DD15 .	8A - 2	-33
variables	Generating variables	NGV = V-GV	D =-H	
{s,A,B,c}	{S,A,B}	yot CEG In	- 00-3	1 1 1 1

modefred grammer:

S-> BaBlBalaBla

A -> aA laaa

B → bBblbbla

S2: Removing unreachable symbols. unreachable variables reachable variables Varrables SAY &S,A,B} 25, B3 Replacement final grammer: S -> Bab| BalaBla B -> 6Bb/6b/a Chomsky Normal form (CNF): 1908 190 198 198 198 A context free grammer is said to be in Chamsky normal form, R > beblebla if all productions are of the form Non-Termenal ---> Non: Terminal. Non-Termenal Non-Termenal -> Termenal elading profession province it EXT S - AB $A \rightarrow a$ volution for examing vastables NEV = V- AV B-b 18,000 Note: To convert CFG ento CNF, we need a reduced CFG te., that CFG which is free of a) E-paroductions

A DAP/AGG

b) unet - paroductions

c) useless symbols.

Ext Consider, S-aaaaA $A \rightarrow aaaa$. Conversion Paoduction Solt $S \longrightarrow aaaa A$ S->CA C -> BB $B \rightarrow XX$ $X \rightarrow a$ A -> aaaa del A-BB B -> XX $x \rightarrow a$ fenal grammer in CNF: S->CA C-> BB (1) d-2 B-XX dfi 50 $x \rightarrow a$ D - Q A -> BB A-VEF 1) Grven, S-> ABa A -> aab h÷ B B -> Ad Sol? * no E-paoducteon

* no unet-paoducteon * no usedess symbols.

Paroduction	Conversion	_	nsides.
$S \longrightarrow ABa$	S→CD		national s
	$c \rightarrow AB$	-2	1. mar. 26 - 8
	$D \rightarrow a$	100	
A → aab	A→EF E→XX	xx - 8	
	$x \rightarrow a$ $F \rightarrow b$	80←A	A→adaa
$B \rightarrow Ad$	$B \rightarrow AY$	x +a	
	Y→d	HIA (I	i za mmuseg k
enal grammer	in CNF:		3 → (A)
			(→ 88

fenal grammer in CNF:	3 → (A)
	(→ 88
$S \rightarrow CD$	$B \rightarrow X \dot{X}$
$C \rightarrow AB$	$\chi \rightarrow \alpha$
$D \rightarrow \alpha$ $A \rightarrow EF$	A → BB
$E \rightarrow XX$	
$x \rightarrow a$	Stren.
$F \rightarrow b$	S-AFBQ
$B \rightarrow A \gamma$	100,000
$Y \rightarrow d$	$B \rightarrow Ad$

* No weless symbols.

2) S-> aBalabba A -> abl AA 1XX $B \rightarrow aBla$ Removal of useless symbols: Solt = Davis e-1 symbols. non-generating Remove voueable Generating NGV = V-GV vartable (SIA, B) ds, A, Bb Ø modified grammer: DX-Y S-> aBalabba B -> a A -> ablaA B → aBla CNF: symbols sat Remove unreachable states. golly - 2

Vastable	reachable	unreachable	$g_A \leftarrow x$
	reachable symbols	symbols	0<-1
{5,A,B}	€5,86	4 A Z	$\Xi V \leftarrow 0$
(31H103	1 (3.03		$YZ \leftarrow C$

modified goammer:

s→aBa labba

B -> aBla

		Lauf. L	010 e-
Paoduction	Conversion	HA	ldm (-
Ѕ→ава	$S \rightarrow XY$ $6X \rightarrow YB$ $Y \rightarrow a$	A TO JONE	Rep. Rep.
$S \rightarrow abba$	$S \rightarrow CD$ $C \rightarrow YZ$	28309p-1011 91	
	$\begin{array}{c} D \rightarrow Z Y \\ Y \rightarrow a \end{array}$	Cienesating	sldoton
	. 2→6	{a,a,2}	Edian.
$B \rightarrow aB$	$B \rightarrow YB$ $Y \rightarrow a$	gammes:	med († ted
$B \rightarrow a$	$B \rightarrow \alpha$	Balakba blaa	p ←2 p ← A
		0/0	

Final grammer en CNF:

S -> XY CD	eladm yz	unseachable	- Remove
$x \rightarrow yB$	unsuachable	acachable	Vostable
$\gamma \rightarrow a$	- stod whs	stag whs	
$C \rightarrow YZ$	fak.	18.83	farais)
$D \rightarrow ZY$			Ceratic
Z→b		goamnes	inedffed
$B \rightarrow YBIa$		1	

s-abalabba

p18n ← 3

3) Geven, $S \rightarrow asblablaa$ $A \rightarrow aab$.

Solt *> no E-parduction, unit paroduction, use symbol.

=> the grammer is in reduced form

	ts in oudice four
Production	Conversion
$S \longrightarrow aSb$	$S \rightarrow X Y$
	$X \rightarrow a$
	Y→S Z
	Z→b
δ→ab	$S \rightarrow X7$
s→ Aa	S -> 197
	V/+b/A
A→aab	A→C DZ
	$C \rightarrow XX$

$$X \rightarrow \alpha$$

$$C \rightarrow XX$$