AUTOMATA THEORY & FORMAL

Totorial 1: DFA , NFA

Pre Tutoria.

Standay .

Define NFA and DFA normally?

A) DFA:

For each input symbol, one can determine the state to which the machine will move. As it has a finite number of states, the machine is called Deterministic Finite Machine Deterministic Finite Automaton.

THE WALLESS THE SALE

A DFA can be nepnesented by a 5-tuple (9, 2, 8, 90, F) where

Q- finite set of states

E - finite set of symbols called alphabet

S- transition function where S: QXI → Q

90 - Pritial state (90 69)

F - set of gents final state states of a

NFA:-

The finite automata are called NFA when there exist many paths for specific

Popul from the current state to next state Each NFA can be translated into DFA but every NFA B Non OFA (Here d = ax [-> 30) The two exceptions are * It contains multiple next states * It contains & transitions. 2) Construct a DFA that accepts the language L= { w ∈ {0,13* | w contains: 1001 or 0110} Jan a first number of states, the mortions

colled Determine the Fifth making four which Tarte Astomotor

A DIA can be suppressed in a stuple

(6.2 d. 2. 1) where

5- Harte set of states

2 - Gille set of squite collect office

6 - transition further when 2 612 -6

10 - 2012/ 3606 (40 + 4)

\$ - 50 to 30 / 40 cm. 100 1 100 100 - 1 6126)

The Killer custometo on alled NCE stions there with many police down ander The State of 3) Wrote the steps for converting E- NFA to DFA and vice versa with an example for each? NFA to DFA A) Steps for converting NFA stepl: Instially Q'= p step2: Add, 90 of NFA to Q'. Then find the transitions from this start state. step 3: In Q! , find possible set of states for each input symbol, if this set of Bearing. states is not in q', then add it to from ot nonpoly states step 4: In DFA, the final state will be all state which contain F (Final states of NFA) romal states Ex :-0,1 1 -- 1010,0100,010 ,100,000,10,00 0 £90,9,7 }a,3 * {0,91} {00,91} 200,913

Steps for converting DFA to NFA

step1: Let's assume DFA D has state set

Q = {90,91, ---, 9n3

step2: Now we build NFAN as follows car browness into conte

(1) start with DFA D

(2) Add an additional accepting state for NFA N, such that N will

have n+1 total no. of states

Lebs call new accepting state 2n+1

(3) Now, add an epsilon & transition from all accepting states to new accepting state and make all

the original accepting states just normal states.

DONE

Ex:- 2 = 20,11 starts with '0' 3

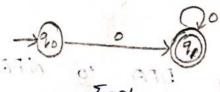
L= 20,00,01,000,001,010,0010,0101,---- g



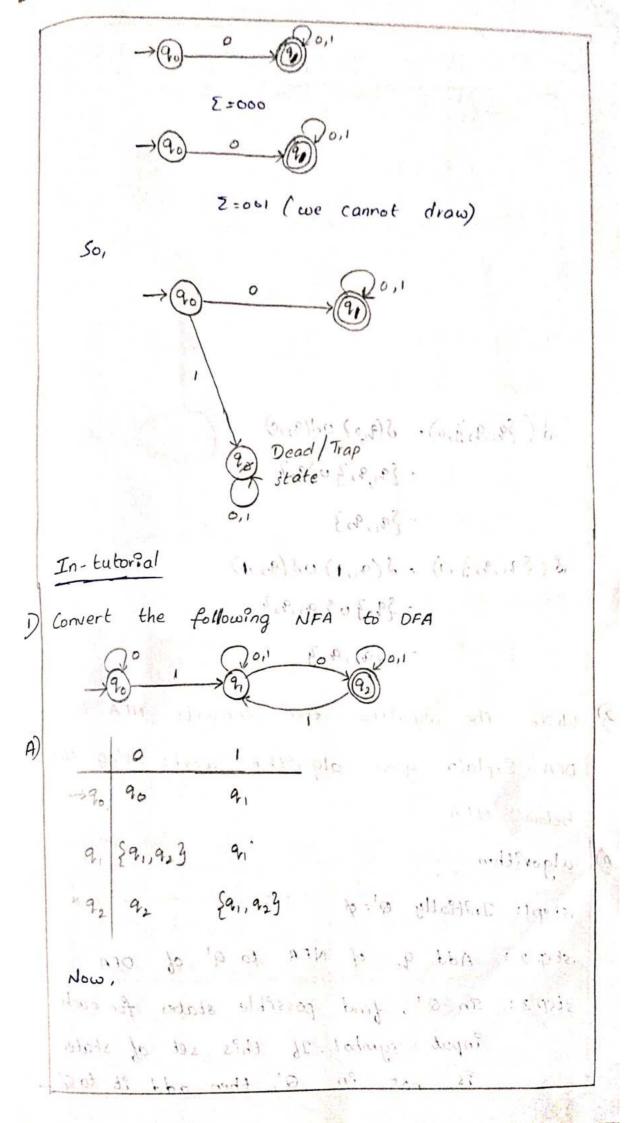
Z=0

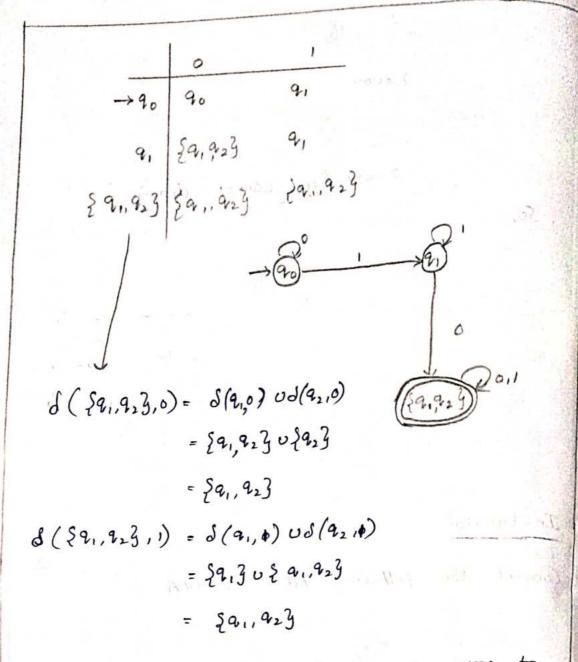


Z =00



198 में अर्थ अर्थिक हिल्में





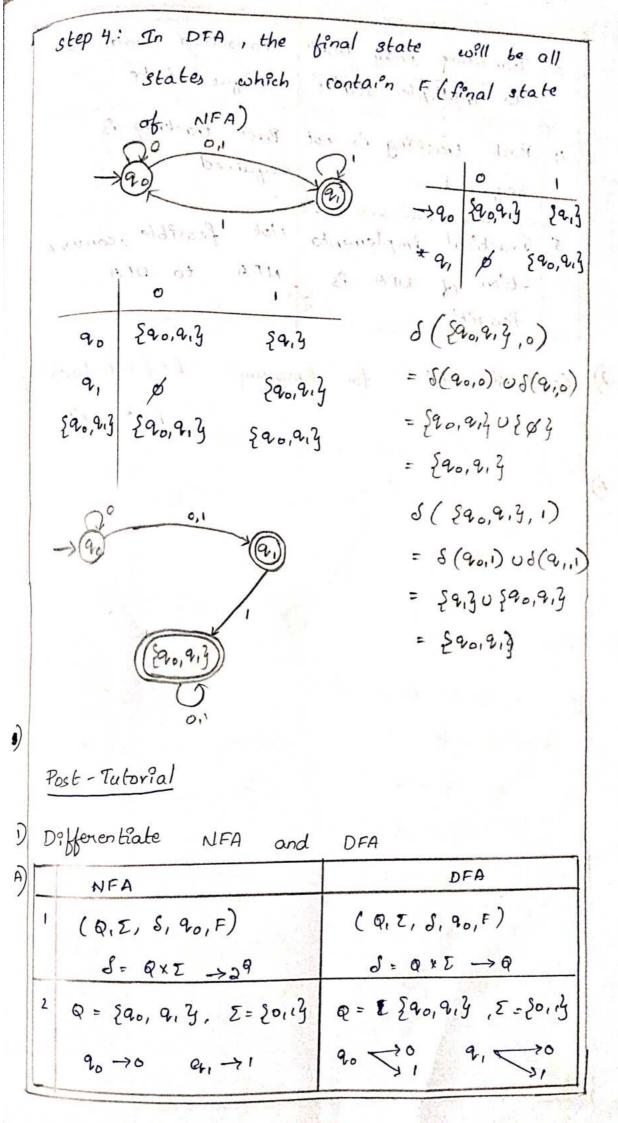
- 2) Write the algorithm that converts NFA to

 DFA · Explain your algorithm works using the

 below NFA?
- algorithm

 step1: Initially Q'= \$

step 2: Add 90 of NFA to 9' of OFA
step 3: In Q', find possible states for each
input symbol. If this set of states
is not in Q', then add it to 9'

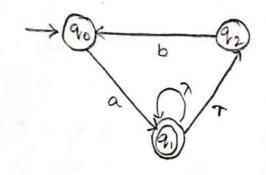


	Transition may leads to multiple states	unique sta
4	Back tracking is not required	Back tracking is
	Practical implementa - tion of OFA is -feasible	Not feasible , conver

2) Construct NFA for language L- 2 wc 20,13.

A)

Convert the following E-NFA to DFA



3

$$\delta(\{a_{1},a_{2}\},a)$$

$$= \delta(\{a_{1},a_{1}\}) \cup \delta(\{a_{2},a_{1}\})$$

$$= \beta \cup \beta = \beta$$

$$\delta(\{a_{1},a_{2}\},b)$$

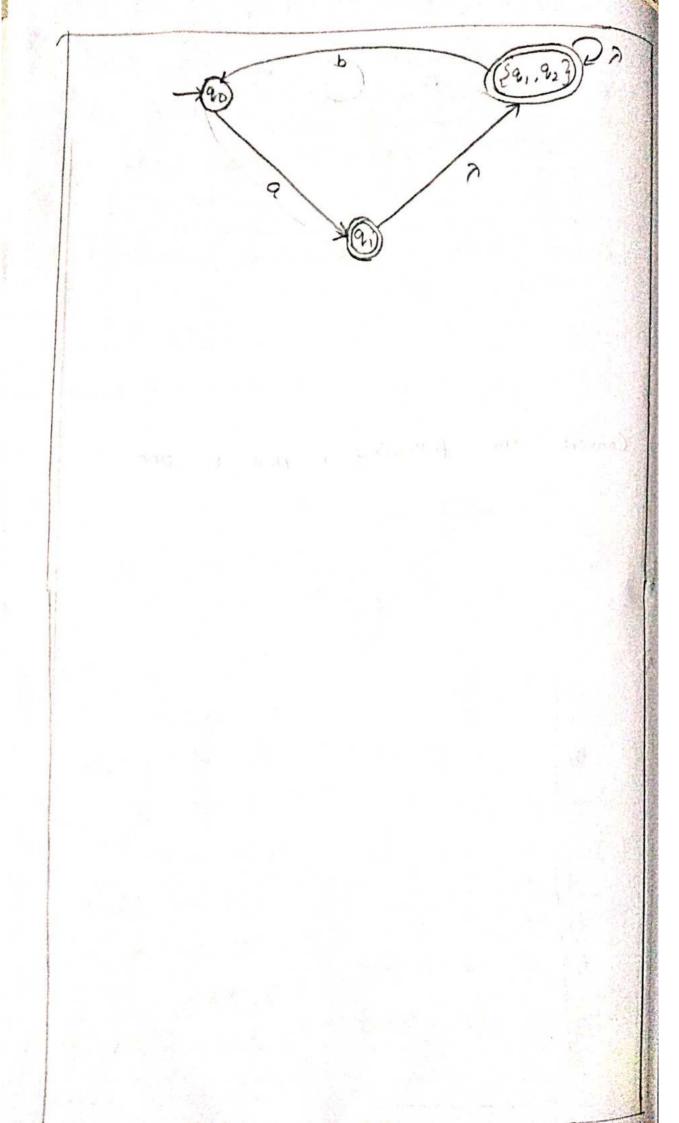
$$= \delta(\{a_{1},b_{1}\}) \cup \delta(\{a_{2},b_{1}\})$$

$$= \delta(\{a_{1},b_{1}\}) \cup \delta(\{a_{2},b_{1}\})$$

$$= \delta(\{a_{1},a_{1}\},a_{2}\},\lambda)$$

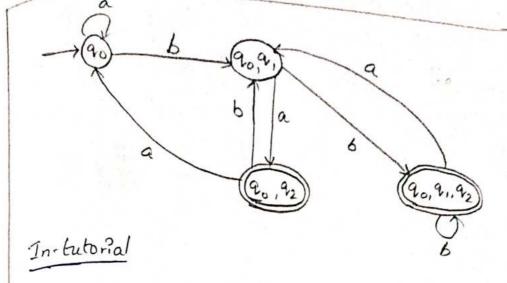
$$= \{\{a_{1},a_{1}\}\} \cup \delta(\{a_{2},a_{1}\})$$

$$= \{\{a_{1},a_{1}\}\} \cup \{\{a_{2},a_{2}\}\}$$

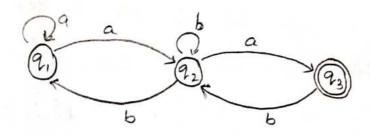


```
Tutorial 2: Regular Expression.
  Pare Tutorial
p explain regular expression and name some of
 edentity nules for the negulari expression?
 Assume a, b and c arie regular expressions
 on the identity rules
A) Regular Expression:
      It is used for nepnesenting certain
  sets of strings on algebraic fundation
  fashion
  Identity rules:
          $ + Y = r
                                (a+b) c = ac+bc
          Ø.r = Ø. Ø = Ø
                                 e* = E
           e.r = r.€ = r and mon / p*o= € 0.10
           7+ r= r
           Y* .Y = Y*
            (n*)* = n*
             R R* = R* R = R+
             E+ ++ + = E+ ++ = 1+
           (ab) a = a (ba)*
            (a+b)* = (a*b*)*
                     = (a* + b*)
```

Consider language L given by regular expre - ssion (a+b) * b(a+b) over the alphabet {a,b} Design a DFA that accepts 1. * convert BE into NFA and the find out DFA from NFA RE = (a+b)* b(a+b) (92) 1,320 is it sets of strings is algebraic Tashien 90 {90,919 Schoolsky rules: 92 DFA table from NFA -> 90 90 Sq0,9,3 {90,913 } 900,923 {90,923 (+;) * 290,923 90 + 3 8,90,923 - 3 3 * 290,9,923 590,9,3 290,9,923

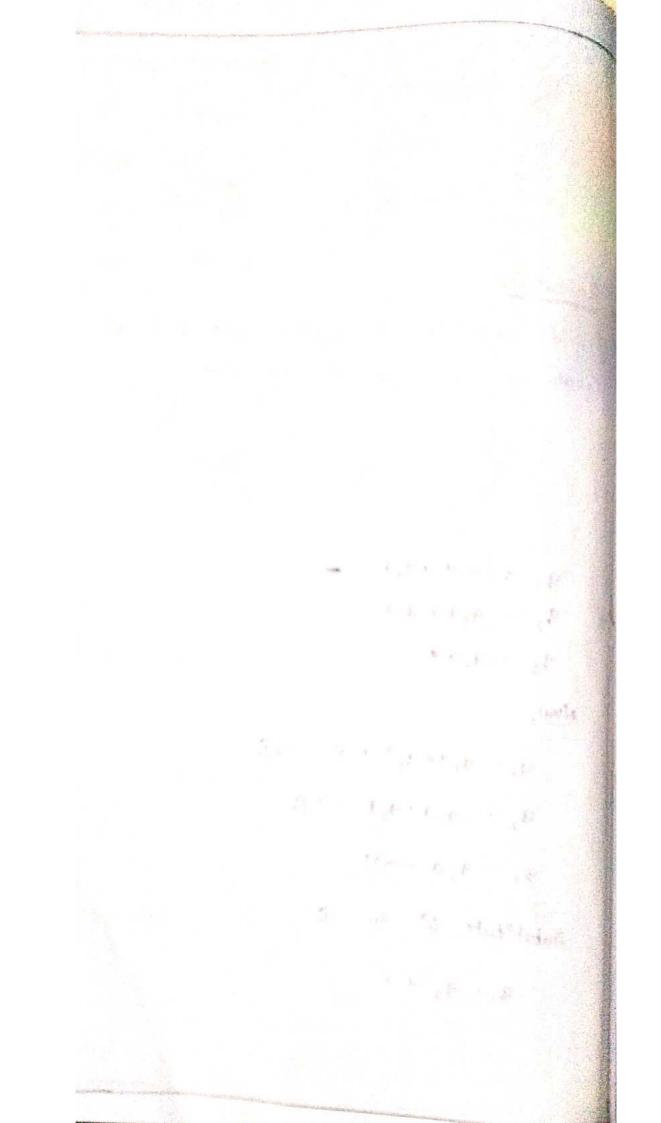


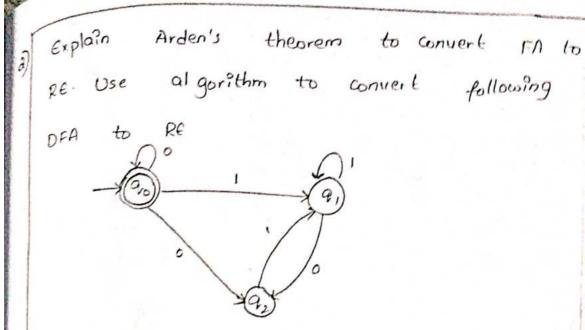
? Provide algorithm to convert NFA into RE Create a Re for following NFA



NOW,

Substitute @ in O





A) Arden's Theorem

If P and Q are D P P over E and if P doesn't contain E then the following equation in P by P = Q + PP has a unique solution i.e., P = PP

steps:

-) For each state a, a, a, a, a, a all exists that comes into state written in equation format
- 2) Add epsilon to initial state
- 3) Calculate all equations
- 4) Result is value of final state

30/ultion for example $q_0 = q_00 + \epsilon \rightarrow 0$ $q_1 = q_01 + q_11 \rightarrow 0$

92 = 900+910 ->3

Comment of the Commen Arten's "Herren 12 may 5 may 99 c may 6 km 1 1 Councille all noth is relations through equation is to by the total so in inches solution ? In april steps: They each state and a confi that come the state we are some Post Tutorial for mat Find RE for .. following DFA colling best (S. Mr 654 (1) 3010 tion - for De : 200 10 - 00 A) Dr - 1,0 + 10P - 1P 10 - 900 + 00 P = (P

the state of the state of the state of the the whole a social effects a specially and an end with the same in it bloods theret a deposite mean in in with a street with to make the was possed taken for the more for some series Agreed the control of the series For Z = {a,b} let us consider the regular language $L = 2x/x = a^{2+3k}$ or $x = b^{10+12k}$, $k \ge 3$ What could be the minimum pumping length (the constant guaranteed by the pumping L= {x|x = a2+3k or x=b10+12k, k>03

1 : {a', a', a', a'' U 6'0, b'', b''

Pumping Lemma :

Let I be an infinite RL. Then there exists some positive integer on such that any coe I with /w/x m can be alreamposed as

 $\omega = xyz$ with $|xy| \le m$ such that $\omega_i = xy^iz$ is also L for all $i^2 = 0,1/2, ---$

in minimum pumping length should be 11, because string with length 10 (w=60) does not repeat anything ibut string with length 11 (i.e., w=60) will stepeat states length of pumping lema is 24

the second secon

or of Comme

Jerro Wie C

4 010 4 . 1100

C VC

Context Free Grammar, left most and Right most deviation.

Pne Tutorial

A

D what is context free grammar Explain with

Context Free Grammar

It is a formal grammar which is used to generate all the possible patterns of strings in a given formal language.

G= (V,T,P,S)

9 > grammar, which consists of set of production rules

Tall of

T -> lower case letter; final set of terminal symbols

V > capital letter; timal set of nonterminal symbols

P -> set of production rules, used for neplacing non terminal symbols in (with s) a string with other terminals

S -> start symbol used to derive string

Ex+ Construct CFG of language having any 2 number of a's over set Z=fa) by sol:- R€ = (a + b) * a (a+b) * a (a+b) * S -> Ta TaT T > a T/bT/E Now, let's take and and V= {5,77 T = Saiby more soil is the the state of 12 strings in a given TaTaT to consider $G_{i} = (V_{i} \tau_{i} P_{i} \tilde{c})$ bTaTaT beatat batat " " " " " " batan babtati - T babeat balants or the babat inter latinos 4- 1 babab7 retur moschant In to les co q 1 ... bababe entrelager . the transporter of the In Tutorial Construct a CFG for a language L= {wiwr} Honfrond

```
L= { wcw x / co & (a,6) + 3
         10 1 1 no
     s > a Sa rule 1
              rulez iditadeo
     site die vule 3
    s = abb c bba
    s → a Sa
    s > absba from rule 2
    s -> abbsbba from rule 2
    s→ abbcbba
                    from rule 3
2) Derive string "aabbabba" for left most
 derivation and right most derivation using
  a CFG SYX ...
    5 > aB 16A=
   A > a las bAA
   B > 11 6 6 65 | a BB
 Leftmost derivation
                 = Right most Derivation
   aaBB
                             aaBB
   aa Bbs
                       THEY QUEB
   aa B b bA
```

aa Bbba aa bbs aa b\$ bba aabbabba aabbabba

aabbaB 2 2/11/2 aa bb a bs aabbabba aabbabba

Post Tutorial

A)

D Generate CFG for language L = 20', ioi

j > 1+ k 3

L= {0',1'0" | 3>9+k3

L= {0'130', -- - 3

let 0 = 1, k = 1

⇒ 01 1 10

S -> XYZ

x -> 0 x1 | 01

4 -> 14/1

2 -> 120/10

S -> XYZ

* OKIYZ

AA 10011 42 1

19 6 3 100 HIYZ 1

notor of IIII Zandia

001111120

BOTH THE PARTY OF THE PARTY OF

ad BB

00 865

ad d 8 :00

store l'en : (6r)

olso con x > oxile 25 sor z > 120/E

00 1111100 9=2 3=5 k=1

33 01 9>1+k

	To	Tutorial 4: Panse Tree, Ambiguity In CFG			
	Por	e Tutorial			
7	Differentiate ambiguous and unambiguous grammon?				
		and the state of t	3 3		
A		Ambiguous Grammar	Unambiguous Grammar		
1	1	It generates more	It generates exactly		
		than one-parse tree	one parse-tree		
	2	The leftmost & Right	1,		
		most derivation	most derivations		
		supresents different	the state of the s		
		parse tree	tree		
	3	contains a smaller	Contains a greater		
			number af non-		
		teaminals	term?nals		
	4	length ?s less	length ?s borge		
	5	Example	Example		
		s > S+S/3xs/8d	$S \rightarrow S + \epsilon / \epsilon$		
			e → ex F F		
			F → id		
100			A-26-17 - 1 1407 1		

Intutorial

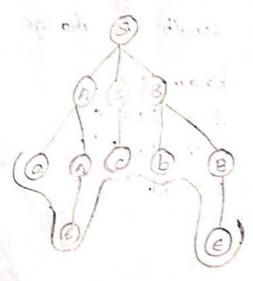
Consider following gramman

S → ASB | C

A → E | aA

Derive string ach using leftmost and adoptions derivation show the parse trees to your derivation

test most derivation	Right most derivation
★ S	S
When the state of	a grand beautiful of
ARB ASB	ASB
assessing aasb.	AS BB
consider a ESB:	1 ASBE
asB.	Asbiran
1 9 2 14 ac 8 1	Ach
achB	T. Carrier and the second seco
ache	e'le aAcb
→ acb	acchimin
The Contract of	acb



A

1)

Consider the following grammar $S \rightarrow a S \mid E$

The language generated by this gramman

L= {an, n> = 0 } or a*

9) Find beftmost derivation and Right most derivation

of) Also, prove all the strings generated from this grammon have their leftmost and sughtmost exactly same. Draw the parse tree for the same

L = {an, n > = 0} or a*

1= 20,00,00,000,0000, --- 3

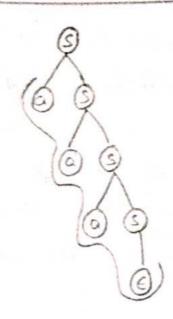
$S \rightarrow as/\epsilon$

Leftmost Derivation	Rightmost Derivati
S → as aas aaas aaae aaae	$S \rightarrow aS$ aas aas aas aaae aaae

Leftmost = Rightmost derivation derivation

Similar is the case for all other strings

Parse Tree is



Past - Tutorial

) Consider the following gramman - $S \rightarrow SaS \mid b$

Is it ambiguous gramman? Generate the string babab" from this gramman to prove your point.

A)

....

dr.

Startlar in the con to it as

3.43

1 dzondjo 4

3 5413

the second of th down the the real of the manual for all all of the state of simplication of granden It means to institute is premier to nemering used sombile. a fact variable and and what of a some go notherwise of a consider a them should not be my production ... X-34 when y and Y are non termining - all a soil is themedous a good of the never not be presented to N - SC and many the second Removal of sellingations for bounds the Light West of the Archestin of wall Might it Francial of Colors Bymboli A variable can be wellow it on the day and

TUTORIAL-5: Simplification of CFG, Normal

Pore Tutorial

Explain Simplication of grammar? Mention it use? Elaborate the steps that are followed in Simplication process?

A) Simplication of gramman:

It means neoluction of grammar by nemoving weless symbols.

* Each variable and each terminal of gappears in the derivation of some word in L

* There should not be any production as $X \rightarrow Y$ where X and Y are non-terminal $X \rightarrow Y$ of Y and Y are non-terminal Y are non-terminal Y and Y are non-terminal Y are non-terminal Y and Y are non-terminal Y are non-terminal Y are non-terminal Y and Y are non-terminal Y a

Removal of Elimination of Removal of Useless Symbol & Production unit Product - Son

Removal of Useless Symbol:

A variable can be useles, if it does not

take part . Pn. derivation of any string.

Es: T -> aaB | ab A | aaT

 $A \rightarrow aA$ $B \rightarrow abld$ $c \rightarrow ad$

Here $C \rightarrow ad$ is usless, $A \rightarrow aA$ is useless to nemove $A \rightarrow aA$, we will first find all variables: which will never lead to a terminal string such as variable 'A'. Then we will nemove all productions in which the variable 'B' occurs.

Elimination of E (elimin) Production:

 $s \rightarrow \epsilon$ are called ϵ productions

stepl: Find out all nullable non-terminal variable which derives e

step 2: For each production $A \rightarrow a$ construct all production $A \rightarrow \alpha$, where α is obtained from a by siemoving one or more non-terminal istep.

step3: Now combine: the result of step2

with original production and nemove

E productions

1 Mest Washing

Beignite the er of G on

Exi S -> XYX

 $x \rightarrow 0x \mid \epsilon$ $4 \rightarrow 14 \mid \epsilon$

```
(x >> xxxx
                                                                3 3 XXX
                                                                           2410
                                       &YX
                                           XX
                                            *
                                          SX
     Sol:
                                         the a contract to the con-
    Let us take
                      S -> XYX
           € YX
       yx --- -
                         S > X4X If you and X are El
                           XEX TOWER S > X
                                            XX
                                 carlidanina a ballon was a comp
       20 both x are E
                              the same state and the same states
                      Now,
          S -> x 4 | 4x | xx | x | Y
                                                                       man's Kartadas
     consider x -70x
 neplace e at RHS1X then
                                              at the state of th
                               \chi \rightarrow 0
                                                                               The House of T.
                              X -> OX O
     Similarly 4 -> 14/1
   Rewrite the CFG as
```

S-> XY | YX | XX | X | Y

XJOX

Y -> 14/1

Removing unit Powduchions:

These are productions in which one nonterminal gives another non-terminal.

Steps 1: To remove X -> Y add production

X -> a to gramman sude whenever

Y-s a occurs in this grammar

step2: Now delete x > 4 ferom geramman

step 3: Repeat step 1 and step 2 until all

unit productions are removed

Ex: S -> OA | IB|C

A -> 0s/00

B -> 1 A

C -> 01

Sol:

S+C is unit production, By removing S-> C 1 add a rules to s

S -> OA [IB] 61

B->A Ps also a unit production

B > 1/05/00

```
VIVIVE INVINE 23
      Rewrite CFG
      S -> OA | 1B | OI
      A -> 05/00
                              1 11 - 4
      B -> 1/05/00
                 Temporing the Property of
       C -> 01
         o day, of restriction of wally
  Find a reduced grammar equivalent to
ه)
  the gramman Gr, having production oules
  S-ACJB, OF C.X
A
  surrough styA > a more of 2. 4
  de al acong = 1 € > 1 € | BC = 14151. ad1 1 € 93/2
  sten sie + caA/e pla toggs 1 & note
      Larrange 200 Enddowlong thus
  Phase 1 -
            W1 = {A, C, ∈ 3 From rules A → à, C→ c
                            C -> aA
     W2 = { A,C, ∈ Z U { S} from eule S→AC
    W3 = { A, CIE, S & O $ ...
     Since W2 = W3, we can derive q'as-
    G' = { { A, C, €, s 3 ; {a, c, e3 , P, }sq }
    where P: S > AC, A >a, C>c, E > aA/e
                        50/20/1 20
```

Phase 2 -Es.3 = 14 - 4 o a la 42 = {s, A, c3 } >AC Y3 = & S,A, C, a, c 3 A → a & C → C Y4 = { S, A, C, a, c} since 43=44, we can derive q" G" = } & A, C, SB, & a, CB, P, & SBB where P: S >Ac, A >a, C >C InTutorial Demove unit production from tollowing grammon S-> AC $\begin{array}{c} A \rightarrow a \\ C \rightarrow x \mid b \end{array}$ son mand x & youthers were son to Fix well redfi turning in 4 7 and war Zara a flow the Bro house only A) There are 3 unit productions in the guammas - $C \rightarrow X$, $X \rightarrow Y$ and $Y \rightarrow Z$ At first gemove Y->Z As z >a, we add y ->a & y >> ?s removed

```
30,
   5 - AC, A - O, E = 11h, Hay, Many
  How gramous Year
  As 4 so we add y so and y sy
   TE VOMENER
  5-> ne, A ->a, e ->1/b, 7->a,
  MOW remove & -7%
  As y -> a we odd (->0 and (->) %
                      gromoved
  5-AC, A-0, C-016, 1-00, 4-00, 2-00
  13000, 14,7 and unrouchable hence we
  con gemove those
  The final OFG Ps until pounduction free
  8->AC, A->0, C->0/b
e) of grammon G 96 defened with outer
  5-11 (88 , 8->6) 58 , x ->6 , A->a
  costs productions obtained often
```

normalized GINT of 9.

 $S \rightarrow XA \mid BB$ $B \rightarrow b \mid SB$ $X \rightarrow b$

A >a

step1: Convert grammar Pho CNF
step2: If grammar exists left necursion, eliminate
step3: convert production rule into GNF form
in the grammar

99 101 6 8

339 133412 - 1

au lag - 1

Sol: step1 and step2 already exist in question, so skepping it.

Substitute $S \rightarrow XA \mid BB \mid Production$ rule $B \rightarrow SB \mid as$

 $S \rightarrow XA | BB$ $B \rightarrow b | XAB | BBB$ $A \rightarrow a$ $X \rightarrow b$

 $S \rightarrow XA$ and $A \rightarrow XAB$ is not in GNF so substitute $X \rightarrow b$ in production rule $S \rightarrow XA$ and $A \rightarrow XBAB$ as:

S -> 6A | BB B -> 6 | 6 AB | BBB Pa x sa Now remove left recursion (B > BBB) 5->60 68 B -> 6C | bABC C → BBC | e e desir the last of $A \rightarrow a$ Now remove null production care S > bales B -> bc | bABC | b | bAB C -> BBC | BB A ->a A P P P P P P P P x → b S-AB & not for GNF, substitute Bbe | bABC | b | bAB Pn production sule S→BB S > ba | bcb | babcb | ba | babb

> B → bcl bABc | bl bAB c→BBC

C → bCB | bABCB | bB | bABB A → a X → b

C→BBC Ps not Po GNF , substitute B >>
bc | bABc | b | bAB Po production rule

C->BBC as'

S > bA | bCB | bABCB | bB | bABB

B -> bc | bABC | 6 | 6AB

C -> 6CB 6ABCB 6B 6ABB

A -> a

X -> b

Hence, this is GINF form for gramman

Post Tutorial

Convert the following CFG PATO CNF $S \rightarrow ASA | aB$, $A \rightarrow B | S$, $B \rightarrow b | \epsilon$

SI -> S

A)

S -> ASA OB

A -> B|S

B -> 6/E

NOW, E is memored

31 151 - 15 | 35 0 A 4 | 50 A 5 5 13 5- 12 S -> ASA) aB (- · · A -> B/S stor without or sad la land 121 030 - DA Jan 3 | 93 | 10 diva | 8 na | Ad e 2 31114 (5 911) 5d cong BEAU DU BEER DE LABE where of mot the in its parents Laborate In and the second second second second property of the a to the wine-3 25-12 10 AZA - 200 : | A -> B | : -13 - 8 byvenne is 3 miles

.

- and unreachable symbols of Explain with an example of your own
 - Same answer Pn 1st Question of Pne Tutorial