F.A
TUTORIAL-5

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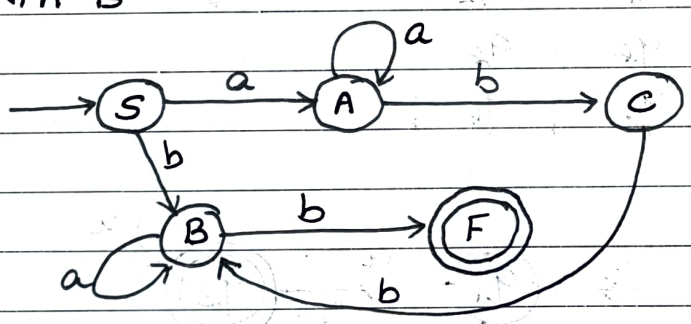
Q1 $S \rightarrow aA \mid bB$
$A \rightarrow aA \mid bC \mid a$
$B \rightarrow aB \mid b$
$C \rightarrow bB$

Convert the given Right linear grammer to DFA

Solution
$S \rightarrow aA$
$S \rightarrow bB$
$A \rightarrow aA$
$A \rightarrow bC$
$A \rightarrow a$
$B \rightarrow aB$
$B \rightarrow b$
$C \rightarrow bB$

The NFA is



Converting NFA to DFA

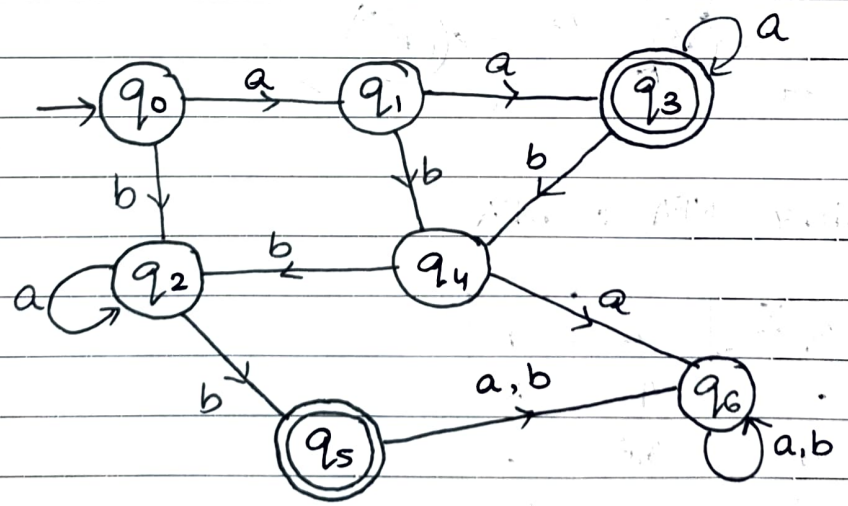
Q \ Σ	a	b
→S	A	B
A	A,F	C
B	B	F
C	{}	B
*F	-	-

	x	$y = \epsilon\text{closure}(x)$	$\delta(y,a)$	$\delta(y,b)$
→	q_0 {S}	{S}	{A} q_1	{B} q_2
	q_1 {A}	{A}	{A,F} q_3	{C} q_4
	q_2 {B}	{B}	{B} q_2	{F} q_5
*	q_3 {A,F}	{A,F}	{A,F} q_3	{C} q_4
	q_4 {C}	{C}	{ } q_6	{B} q_2
*	q_5 {F}	{F}	{ } q_6	{ } q_6
	q_6 { }	{ }	{ } q_6	{ } q_6

TRANSITION DIAGRAM

Q \ Σ	a	b
→q_0	q_1	q_2
q_1	q_3	q_4
q_2	q_2	q_5
* q_3	q_3	q_4
q_4	q_6	q_2
* q_5	q_6	q_6
q_6	q_6	q_6

DFA



Q.2 $S \longrightarrow 0B \mid 1A$

$A \longrightarrow 0 \mid 0S \mid 1AA$

$B \longrightarrow 1 \mid 1S \mid 0BB$

for string "00110101" find

a] LMD

b] RMD

c] derivation tree

Solution

$$P: \begin{cases} S \longrightarrow 0B \mid 1A \\ A \longrightarrow 0 \mid 0S \mid 1AA \\ B \longrightarrow 1 \mid 1S \mid 0BB \end{cases}$$

a) LMD (sentential form)

$S \longrightarrow 0\ B$ [S → 0B]

$\longrightarrow 0\ 0\ B\ B$ [B → 0BB]

$\longrightarrow 0\ 0\ 1\ S\ B$ [B → 1S]

$\longrightarrow 0\ 0\ 1\ 1\ A\ B$ [S → 1A]

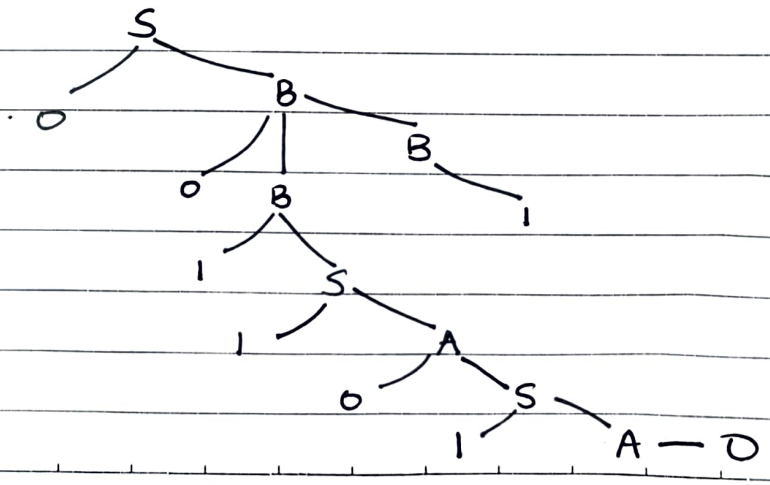
$\longrightarrow 0\ 0\ 1\ 1\ 0\ S\ B$ [A → 0S]

$\longrightarrow 0\ 0\ 1\ 1\ 0\ 1\ A\ B$ [S → 1A]

$\longrightarrow 0\ 0\ 1\ 1\ 0\ 1\ 0\ B$ [A → 0]

$\longrightarrow 0\ 0\ 1\ 1\ 0\ 1\ 0\ 1$ [B → 1]

c) Parse tree



b RMD (Right most Derivation)

$S \rightarrow 0\ B$ $[S \rightarrow 0B]$

$\rightarrow 0\ 0\ B\ B$ $[B \rightarrow 0BB]$

$\rightarrow 0\ 0\ B\ 1$ $[B \rightarrow 1]$

$\rightarrow 0\ 0\ 1\ S\ 1$ $[B \rightarrow 1S]$

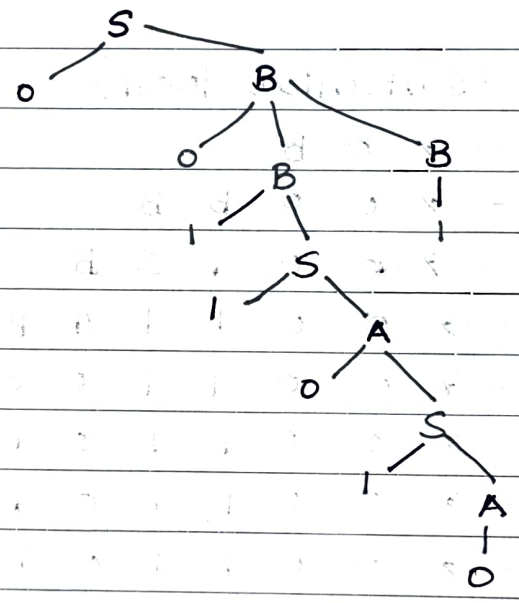
$\rightarrow 0\ 0\ 1\ 1\ A\ 1$ $[S \rightarrow 1A]$

$\rightarrow 0\ 0\ 1\ 1\ 0\ S\ 1$ $[A \rightarrow 0S]$

$\rightarrow 0\ 0\ 1\ 1\ 0\ 1\ A\ 1$ $[S \rightarrow 1A]$

$\rightarrow 0\ 0\ 1\ 1\ 0\ 1\ 0\ 1$ $[A \rightarrow 0]$

Parsee tree



Q3 Show $S \rightarrow SbS \mid a$ is ambiguous

Solution $G = (\{S\}, \{a, b\}, P, \{S\})$

$P : S \rightarrow SbS \mid a$

From the above grammer the string "ababa" can be generated in two ways.

First leftmost derivation

$S \rightarrow SbS$ [$S \rightarrow SbS$]

$\rightarrow abS$ [$S \rightarrow a$]

$\rightarrow abSbS$ [$S \rightarrow SbS$]

$\rightarrow ababS$ [$S \rightarrow a$]

$\rightarrow ababa$ [$S \rightarrow a$]

Second leftmost derivation

$S \rightarrow SbS$

$\rightarrow SbSbS$ [$S \rightarrow SbS$]

$\rightarrow abSbS$ [$S \rightarrow SbS$]

$\rightarrow ababS$ [$S \rightarrow a$]

$\rightarrow ababa$ [$S \rightarrow a$]

Since there are two leftmost derivation for a single string "ababa", the grammer G is ambigious

Q4 Convert to CNF

i) $S \rightarrow ABa$
$A \rightarrow aab$
$B \rightarrow Ac$

Solution

STEP 1: Simplifying Grammer.

i) Removal of ϵ productions
There are no ϵ productions

ii) Removal of unit productions.
There are no unit productions.

iii) Removal of useless variables.
There are no useless variables

STEP 2:

$S \rightarrow ABa$	$S \rightarrow AB C_a$, $C_a \rightarrow a$ $S \rightarrow AC_1$, $C_1 \rightarrow BC_a$
$A \rightarrow aab$	$A \rightarrow C_a C_a C_b$, $C_b \rightarrow b$ $A \rightarrow C_2 C_b$, $C_2 \rightarrow C_a C_a$
$B \rightarrow Ac$	$B \rightarrow A C_c$, $C_c \rightarrow c$

$G(VTPS): \{\{S, A, B, C_1, C_2, C_a, C_b, C_c\}, \{a, b, c\}, P, S\}$

P : $S \longrightarrow A\,C_1$

$A \longrightarrow C_2\,C_B$

$B \longrightarrow A\,C_c$

$C_a \longrightarrow a$

$C_1 \longrightarrow B\,C_a$

$C_b \longrightarrow b$

$C_2 \longrightarrow C_a\,C_a$

$C_c \longrightarrow c$

ii) $S \longrightarrow AB \mid aB$

$A \longrightarrow aab$

$B \longrightarrow bbA$

Solution STEP 1 : Simplifying grammer.

The given grammes is already simplified

STEP 2 :

$S \longrightarrow AB$

$S \longrightarrow aB$	$S \longrightarrow C_aB$, $C_a \longrightarrow a$
$A \longrightarrow aab$	$A \longrightarrow C_aC_aC_b$, $C_b \longrightarrow b$ $A \longrightarrow C_fb$, $C_1 \longrightarrow C_aC_a$
$B \longrightarrow bbA$	$B \longrightarrow C_bC_bA$ $B \longrightarrow C_2A$, $C_2 \longrightarrow C_bC_b$

$G(V, T, P, S)$

$(\{S, A, B, C_a, C_b, C_1, C_2\}, \{a, b\}, P, S\}$

P :
$S \longrightarrow A\ B$
$S \longrightarrow C_a\ B$
$A \longrightarrow C_1\ C_b$
$B \longrightarrow C_2\ A$
$C_a \longrightarrow a$
$C_b \longrightarrow b$
$C_1 \longrightarrow C_a\ C_a$
$C_2 \longrightarrow C_b\ C_b$

Q5 Convert to GNF

i] $E \longrightarrow E + E \mid E * \mid (E) \mid id$

Solution STEP 1: There is only one variable and with 2 left recursive productions.

Remove left recursion

$E \longrightarrow E + E \mid E * \mid (E) \mid id$
$A \quad\quad A\ \alpha_1 \quad A\ \alpha_2 \quad \beta_1 \quad \beta_2$

$A \longrightarrow A\alpha_1 \mid A\alpha_2 \mid \beta_1 \mid \beta_2$

$A \longrightarrow \beta_1 A' \mid \beta_2 A' \mid \beta_1 \mid \beta_2$

$A' \longrightarrow \alpha_1 A' \mid \alpha_2 A' \mid \alpha_1 \mid \alpha_2$

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$E \longrightarrow (E)E' \mid idE' \mid (E) \mid id$

$E' \longrightarrow +EE' \mid *E' \mid +E \mid *$

$E \longrightarrow (E)E' \quad \Longrightarrow \quad E \longrightarrow (EE_1E' \quad E_1 \longrightarrow) \checkmark$

$E \longrightarrow idE' \checkmark$

$E \longrightarrow (E) \quad \Longrightarrow \quad E \longrightarrow CEE_1 \checkmark$

$E \longrightarrow id \checkmark$

$E' \longrightarrow +EE' \checkmark$

$E' \longrightarrow *E' \checkmark$

$E' \longrightarrow +E \checkmark$

$E' \longrightarrow * \checkmark$

$E \longrightarrow (EE_1E' \mid idE' \mid (EE_1 \mid id$

$E' \longrightarrow +EE' \mid *E' \mid +E \mid *$

$E_1 \longrightarrow)$

(ii)

Solution

$S \longrightarrow AA \mid a$

$A \longrightarrow SS \mid b$

STEP 1: ~~Simply~~ Simplifying given grammer

i) Removing ϵ productions
ii) Removing unit productions
iii) Removing useless variables.

The given grammer is already simplified.

STEP 2: Renaming variables

S	A
A_1	A_2

$A_1 \longrightarrow A_2 A_2 \mid a$ ✓

$A_2 \longrightarrow A_1 A_1 \mid b$ ✗

$A_2 \longrightarrow A_2 A_2 A_1 \mid a A_1 \mid b$

STEP 3: Removing left recursion

Formula: $A \longrightarrow A\alpha \mid \beta_1 \mid \beta_2$

$A \longrightarrow \beta_1 A' \mid \beta_2 A' \mid \beta_1 \mid \beta_2$

$A' \longrightarrow \alpha A' \mid \alpha$

$\underset{A}{A_2} \longrightarrow \underset{A}{A_2} \underbrace{A_2 A_1}_{\alpha} \mid \underbrace{a A_1}_{\beta_1} \mid \underbrace{b}_{\beta_2}$

$A_2 \longrightarrow aA_1A' \mid bA' \mid aA_1 \mid b$

$A' \longrightarrow A_2A_1A' \mid A_2A_1$

Putting A_2 in A_1 production

$A_1 \longrightarrow A_2A_2 \mid a$

$A_1 \longrightarrow aA_1A'A_2 \mid bA'A_2 \mid aA_1A_2 \mid bA_2 \mid a$

$A' \longrightarrow aA_1A'A_1A' \mid bA'A_1A' \mid aA_1A_1A' \mid bA_1A' \mid aA_1A'A_1 \mid bA'A_1 \mid aA_1A_1 \mid bA_1$

P: $A_1 \longrightarrow aA_1A'A_2 \mid bA'A_2 \mid aA_1A_2 \mid bA_2 \mid a$

$A_2 \longrightarrow aA_1A' \mid bA' \mid aA_1 \mid b$

$A' \longrightarrow aA_1A'A_1A' \mid bA'A_1A' \mid aA_1A_1A' \mid bA_1A' \mid aA_1A'A_1 \mid bA'A_1 \mid aA_1A_1 \mid bA_1$