05/10/2023

Finite Automata – CSC 371 (Final Exam)

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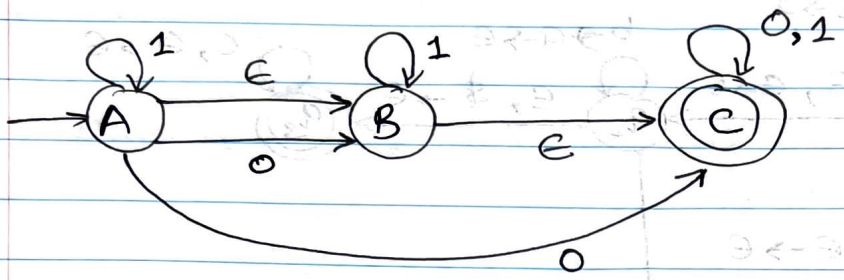
(1)

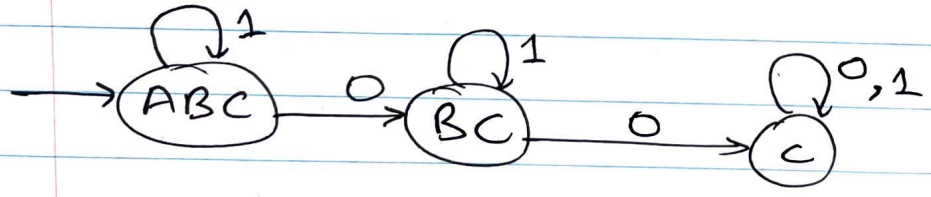


NFA

	0	1	ϵ
→ A, B, C	{B, C}	{A, B, C}	{B, C}
A	{BC}	{A}	{B}
B	—	{B}	{C}
C	{C}	{C}	—

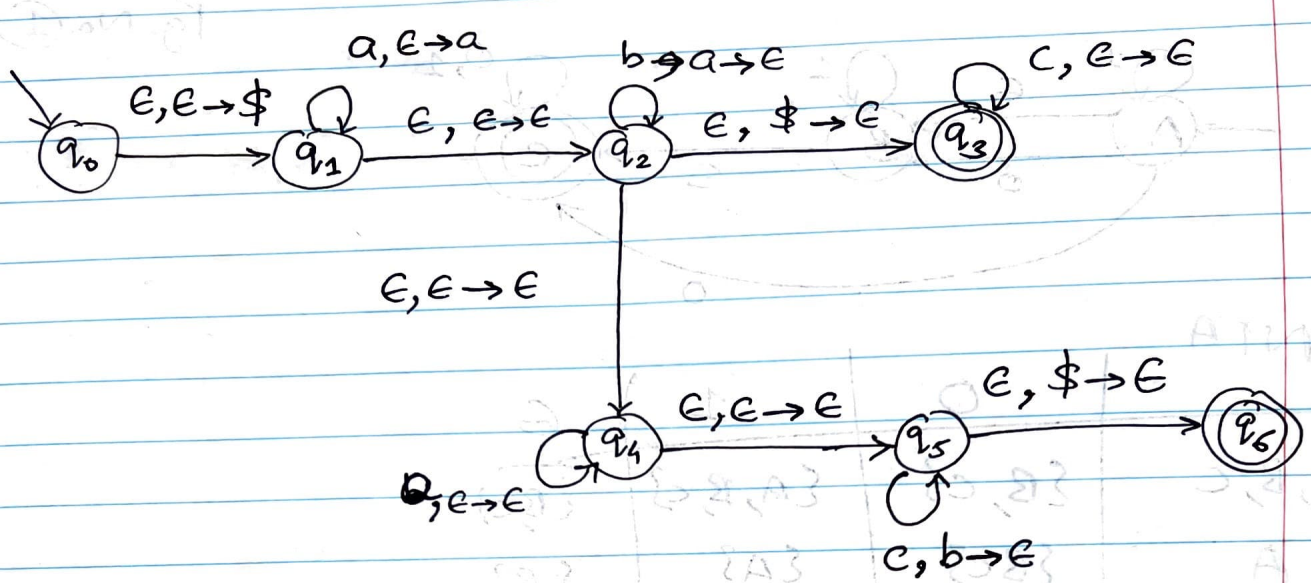
DFA

	0	1	ϵ
→ ABC	BC	ABC	BC
BC	C	BC	C
C	C	C	ϕ
ϕ	ϕ	ϕ	ϕ



Q5) Create a PDA for the following problem.

$\{a^i b^j c^k \mid i=j \text{ or } j=k$



Q3) CFG to CNF

$S \rightarrow ASB$

$A \rightarrow aASA \mid a \mid \epsilon$

$B \rightarrow SbS \mid A \mid bb$

CNF Rules
- AA ✓
- aV ✓
- NO 'S' on RHS ✓
- NO 'ε' on RHS. ✓

Step 1 : Adding a new start variable "S_0" → ∵ 'S' appears on RHS.

$S_0 \rightarrow S$

$S \rightarrow ASB$

$A \rightarrow aASA \mid a \mid \epsilon$

$B \rightarrow SbS \mid A \mid bb$

Step 2 : Removing $A \rightarrow \epsilon$

$S_0 \rightarrow S$

$S \rightarrow ASB \mid SB$

$A \rightarrow aASA \mid a \mid aSA \mid aAS \mid aS$

$B \rightarrow SbS \mid A \mid bb \mid \epsilon$

Step 3: Removing $B \rightarrow \epsilon$

$S_0 \rightarrow S$

$S \rightarrow ASB \mid SB \mid AS \mid S$

$A \rightarrow aASA \mid a \mid aSA \mid aAS \mid aS$

$B \rightarrow SbS \mid A \mid bb$

Step 4: Removing $S \rightarrow S$. ∵ 'S' is single variable.

$S_0 \rightarrow S$

$S \rightarrow ASB \mid SB \mid AS$

$A \rightarrow aASA \mid a \mid aSA \mid aAS \mid aS$

$B \rightarrow SbS \mid A \mid bb$

Step 5 : Remove $B \to A$ ∵ 'A' is single variable.

$S_0 \to S$

$S \to ASB \mid SB \mid AS$

$A \to aASA \mid a \mid aSA \mid aAS \mid aS$

$B \to SbS \mid bb \mid aASA \mid a \mid aSA \mid aAS \mid aS$

Step 6 : Removing $S_0 \to S$

$S_0 \to ASB \mid SB \mid AS$

$S \to ASB \mid SB \mid AS$

$A \to aASA \mid a \mid aSA \mid aAS \mid aS$

$B \to SbS \mid bb \mid aASA \mid a \mid aSA \mid aAS \mid aS$

Step 7 : Substituting $M_1 \to AS$

$S_0 \to M_1B \mid SB \mid AS$

$S \to M_1B \mid SB \mid AS$

$A \to aM_1A \mid a \mid aSA \mid aM_1 \mid aS$

$B \to SbS \mid bb \mid aM_1A \mid a \mid aSA \mid aM_1 \mid aS$

$M_1 \to AS$

Step 8 : Substituting $M_2 \to aM_1$

$S_0 \to M_1B \mid SB \mid AS$

$S \to M_1B \mid SB \mid AS$

$A \to M_2A \mid a \mid aSA \mid aM_1 \mid aS$

$B \to SbS \mid bb \mid M_2A \mid a \mid aSA \mid aM_1 \mid aS$

$M_1 \to AS$

$M_2 \to aM_1$

Step 9 : Substitute $M_3 \to aS$

$S_0 \to M_1B \mid SB \mid AS$

$S \to M_1B \mid SB \mid AS$

$A \to M_2A \mid a \mid M_3A \mid aM_1 \mid aS$

$B \to SbS \mid bb \mid M_2A \mid a \mid M_3A \mid aM_1 \mid aS$

$M_1 \to AS$

$M_2 \to [illegible] aM_1$

$M_3 \to aS$

Step 10 : Substitute $M_4 \to Sb$

$S_0 \to M_1B \mid SB \mid AS$

$S \to [illegible] M_1B \mid SB \mid AS$

$A \to M_2A \mid a \mid M_3A \mid aM_1 \mid aS$

$B \to M_4S \mid bb \mid [illegible] M_2A \mid a \mid M_3A \mid aM_1 \mid aS$

$M_1 \to AS$

$M_2 \to aM_1$

$M_3 \to aS$

$M_4 \to Sb$

Step 11 : Substitute $P_1 \to a$ and $P_2 \to b$

$S_0 \to M_1B \mid SB \mid AS$

$S \to M_1B \mid SB \mid AS$

$A \to M_2A \mid a \mid M_3A \mid P_1M_1 \mid P_1S$

$B \to M_4S \mid P_2P_2 \mid M_2A \mid a \mid M_3A \mid P_1M_1 \mid P_1S$

$M_1 \to AS$

$M_2 \to P_1M_1$

$M_3 \rightarrow P_1 S$

$M_4 \rightarrow S P_2$

$P_1 \rightarrow a$

$P_2 \rightarrow b$

∴ CNF ගම:

$S_0 \rightarrow M_1 B \mid SB \mid AS$

$S \rightarrow M_1 B \mid SB \mid AS$

$A \rightarrow M_2 A \mid M_3 A \mid P_1 M_1 \mid P_1 S \mid a$

$B \rightarrow M_4 S \mid P_2 P_2 \mid M_2 A \mid M_3 A \mid P_1 M_1 \mid P_1 S \mid a$

$M_1 \rightarrow AS$

$M_2 \rightarrow P_1 M_1$

$M_3 \rightarrow P_1 S$

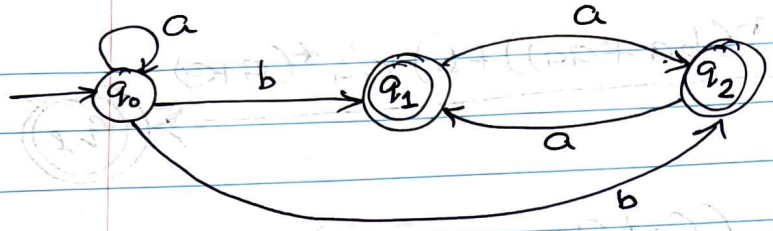
$M_4 \rightarrow S P_2$

$P_1 \rightarrow a$

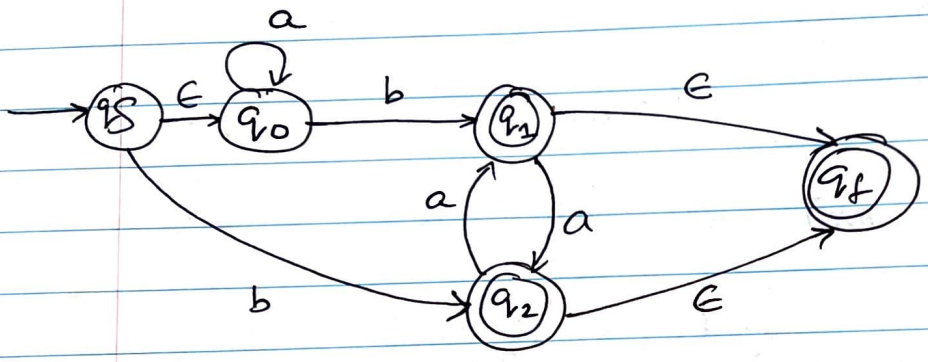
$P_2 \rightarrow b$

//

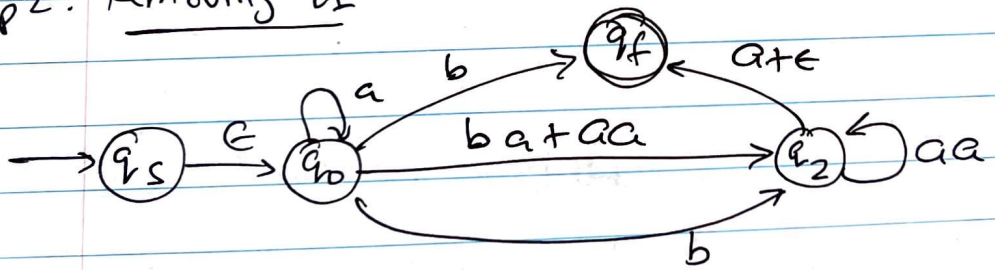
Q2) Reg. Exp.



Step1 : Adding start and stop state.

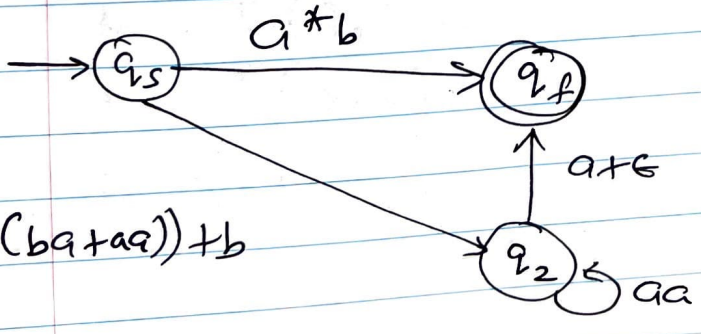


Step2 : Removing q_1



q_1 in	out
q_0	q_2
q_2	q_f

Step3 : Removing q_0

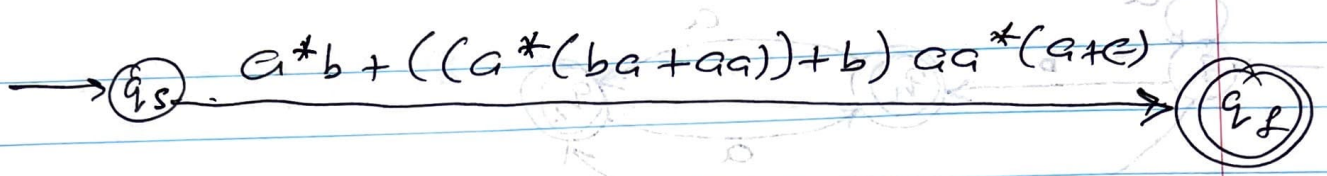


q_0 in	q_0 out
q_s	q_f
	q_2

$(a^*(ba+aa))+b$

Step 4: Removing q_2

q_2 in	out
q_s	q_f



Regular Exp $= a^*b + ((a^*(ba+aa))+b)\,aa^*(a+\epsilon)$

Q4) CFG to PDA

$S \rightarrow 0S1 \mid A$

$A \rightarrow 1A0 \mid S \mid \epsilon$

Step 1: Simplify by eliminating ϵ and subst. value of A.

$S \rightarrow 0S1 \mid 1S0 \mid \epsilon$

Step 2: Converting CNF to GNF

$S \rightarrow 0Sx \mid 1Sy \mid \epsilon$

$X \rightarrow 1$

$Y \rightarrow 0$

Step 3: The PDA is of the form:

$R_1 : \delta(q, \epsilon, S) = \{(q, 0Sx) \mid (q, 1Sy)\}$

$R_2 : \delta(q, \epsilon, x) = \{(q, 1)\}$

$R_3 : \delta(q, \epsilon, y) = \{(q, 0)\}$

$R_4 : \delta(q, 0, 0) = \{(q, \epsilon)\}$

$R_5 : \delta(q, 1, 1) = \{(q, \epsilon)\}$

Q6) Turing Machine

$2^n 0^n 1^n 2^n \quad (n \geq 0)$