Lect 82

Grammar

A grammar G is defined as quadruple

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

where V is a finite set of objects called variables or nonterminal symbols

T is a finite set of objects called Terminal symbols

$S \in V$ is the start symbol (non terminal)

P is a finite set of productions.

Let $G = (V, T, P, S)$ be a grammar. Then the set

Language: $L(G) = \{w \in T^* : S \overset{*}{\Rightarrow} w\}$ is the Language generated by G.

in many steps

set of terminals

Example: Consider the grammar $G = (\{S\}, \{a, b\}, S, P)$ with P given by $S \to aSb \mid \lambda$

$L(G) = \{\lambda, ab, aabb, aaabbb, \ldots\}$

$S \to aSb \to aaSbb \to aabb$

$L(G) = \{a^n b^n : n \geq 0\}$

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Q Consider the Grammar $G = (\{A, S\}, \{a, b\}, S, P)$ with P consisting of the production. Find language generated by Grammar

(i) $S \to aAb$

$A \to aAb \mid \lambda$

(ii) $S \to aA$

$A \to bS$

$S \to \lambda$

(iii) $S \to Aa$

$A \to B$

$B \to Aa$

Ans (i) $S \to aAb \to ab$

$\{ab, aabb, aaabbb \ldots\}$ $S \to aAb$ $aaAbb$

$L(G_1) = \{ab, a^2b^2, a^3b^3 \ldots\}$

$L(G_1) = \{a^n b^n : n \geq 1\}$

(ii) $S \to aA$

$A \to bS$

$S \to \lambda$

$S \to aA \to abS \to ab$

$S \to aA \to abS \to abaA$

$\to ababS \to abab$

$S \to aA \to abS \to ababS \to ababaA$

$\to abababS$

$\to ababab$

$L(G_2) = \{\lambda, ab, abab,$

$= \{\lambda, ab, (ab)^2, (ab)^3 \ldots\}$

$L(G_2) = \{(ab)^n : n \geq 0\}$

(iii) $S \to Aa$

$A \to B$

$B \to Aa$

So $L(G_3) = \{\}$ or ϕ null set..

There is no termination.

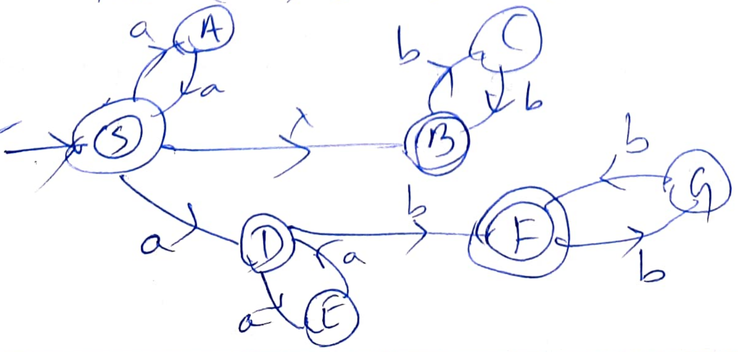
~~Next set~~

~~Q~~ Find a Regular Grammar for a Language

$L = \{a^n b^m : n+m \text{ is even}\}$

$RE = (aa)^*(bb)^* + a(aa)^* b(bb)^*$

FA for this RE



Regular grammar

Right linear grammar

$S \to \lambda \mid aA \mid B \mid aD$

$A \to aS$

$B \to \lambda \mid bC$

$C \to bB$

$D \to aE \mid bF$

$E \to aD$

$F \to \lambda \mid bG$

$G \to bF$

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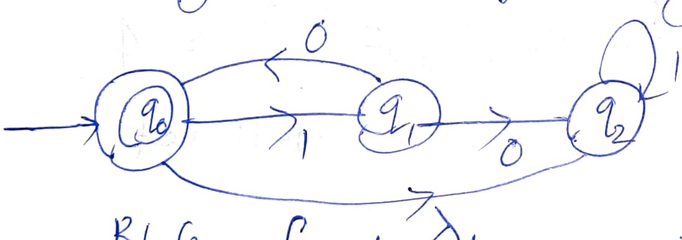
Q Find right linear and left linear grammar for the language accepted by the following nfa.



RLG for the language L

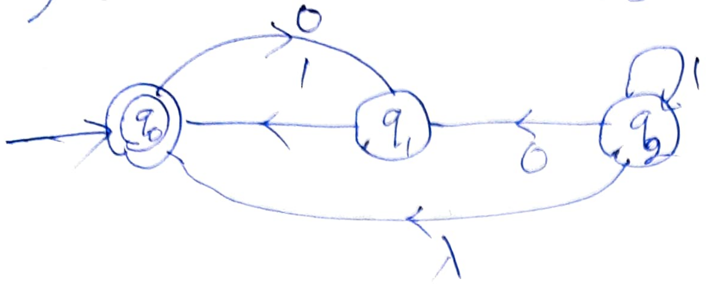
$q_0 \to \lambda \mid 1q_1 \mid 1q_2$

$q_1 \to 0q_0 \mid 0q_2$

$q_2 \to 1q_2$

This is the right linear grammar for the NFA.

I have to take the reverse of NFA to get left linear grammar.



L^R

Right linear grammar for the language L^R

$q_0 \to \lambda \mid 0q_1$

$q_1 \to 1q_0$

$q_2 \to 0q_1 \mid 1q_2 \mid q_0$

Left linear grammar for L

$q_0 \to \lambda \mid q_1 0$

$q_1 \to q_0 1$

$q_2 \to q_1 0 \mid q_2 1 \mid q_0$

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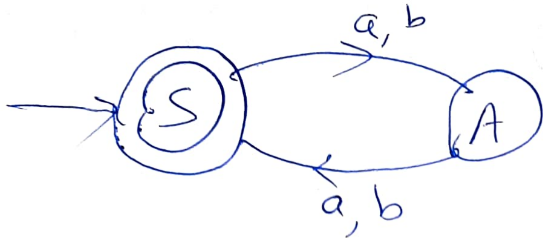
Regular Grammar

Find a regular grammar that generates the language

$L = \{w \in \{a,b\}^* : n_a(w) + 3n_b(w) \text{ is even}\}$

$L = \{\lambda, aa, bb, ab, ba, aaaa, aaab, aabb, \ldots\}$



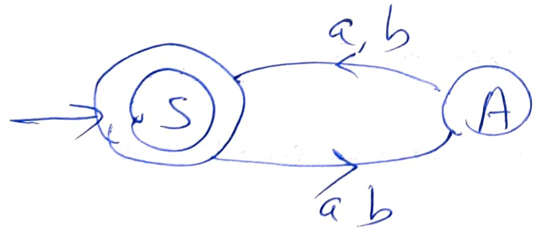
$S \to \lambda \mid aA \mid bA$

$A \to aS \mid bS$

This is the regular grammar for the regular language.

This is the right linear grammar

If I want to get the left linear grammar for the given FA then I will simply reverse the FA.



Right Linear grammar

$S \to \lambda \mid aA \mid bA$

$A \to aS \mid bS$

Left linear grammar will be

$S \to \lambda \mid Aa \mid Ab$

$A \to Sa \mid Sb$

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Left Linear grammar and Right Linear grammar

A grammar $G = (V, T, P, S)$ is said to be left linear grammar if it is of the form

$A \to Bx \mid x$

and it is said to be right linear if it is of the form

$A \to xB \mid x$

where $A, B \in V$ and $x \in T^*$

Note

A grammar is said to be regular if it is either left linear or right linear.

Ex

$S \to aA$

$A \to bA \mid \lambda$

This is right linear grammar

It is a regular grammar as it is right linear

Ex

$S \to Ba$

$B \to ab$

This is left linear grammar.

It is also a regular grammar as it is left linear.

Ex 3 $\quad S \to aA \quad$ right linear

$A \to bB \quad$ right linear

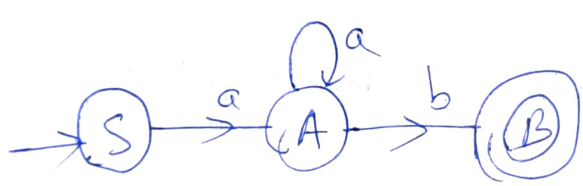
$B \to Cd \quad$ left linear

$C \to e$

This grammar is neither left linear or right linear. This is not a regular grammar.

Ex $\quad S \to aA$

$A \to aA \mid b$



RE. $aa^* b = a^+ b$

$S \to Aa$

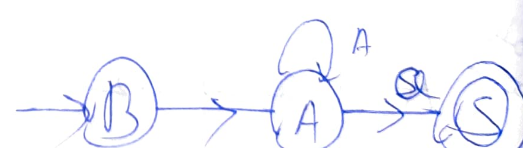
$A \to Aa \mid b$

R.E baa^*

$= ba^+$

FA $\to$ RLG $\to$ Rev FA $\to$
(L) (L) (L)

$\to$ RLG (Rev FA) $\to$ LLG
(L^R) (L)



$B \to bA$	$B \to Ab$
$A \to aA \mid a$	$A \to Aa \mid a$

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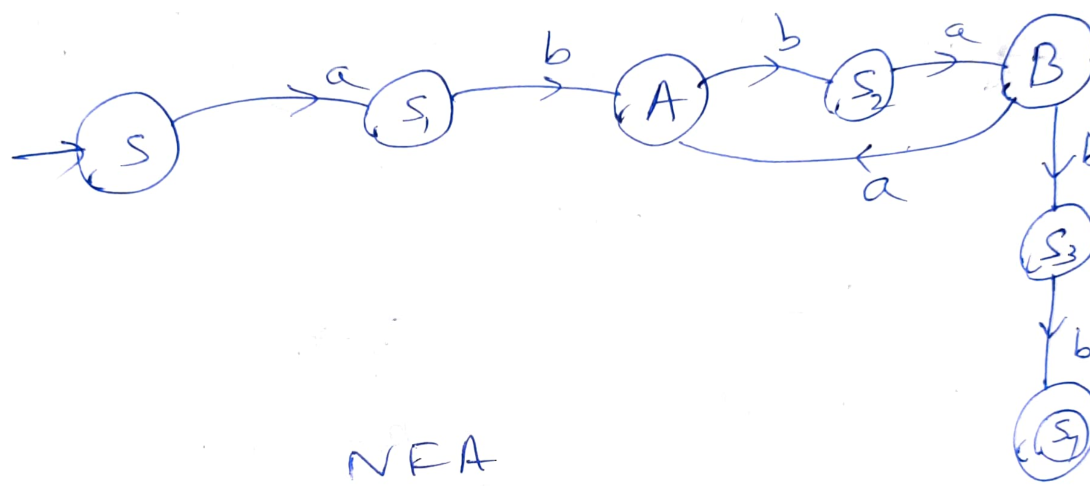
Q Construct a DFA that accepts the language generated by the grammar.

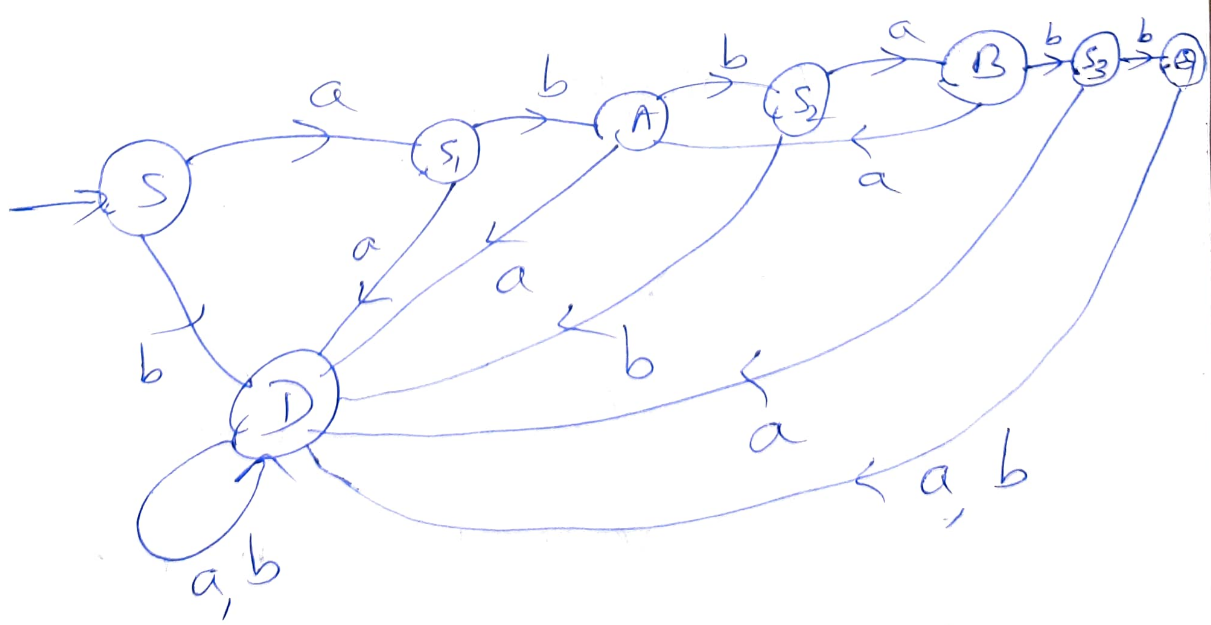
$S \to abA$

$A \to baB$

$B \to aA \mid bb$

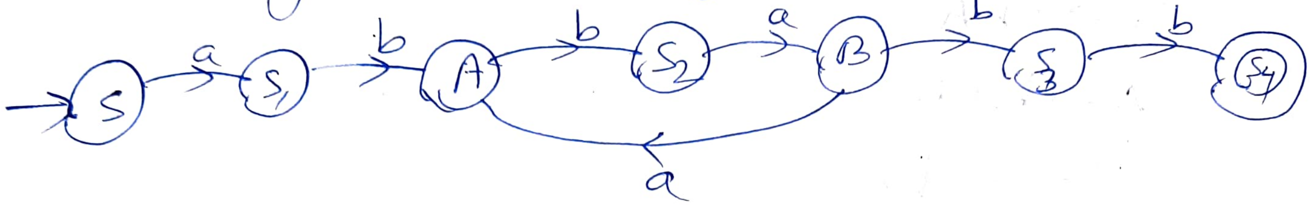


NFA

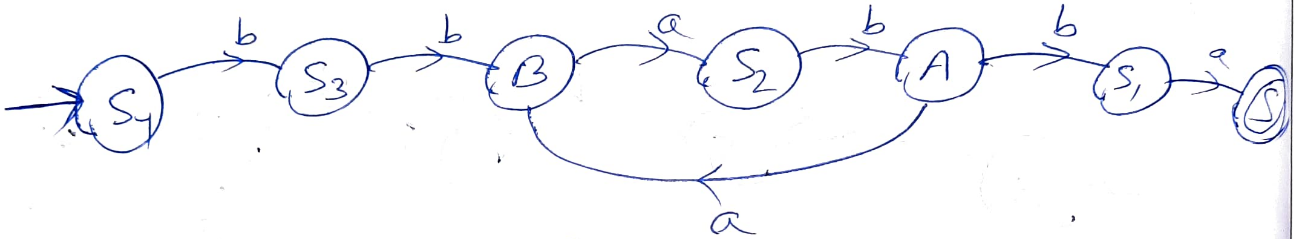


DFA for this right linear grammar

Find the left linear grammar equivalent to the right linear grammar.



(L)



(L^R)

$S_4 \to bS_3$	$S_4 \to bbB$
$S_3 \to bB$	$B \to abA$
$B \to aS_2$	$A \to aB \mid baS$
$S_2 \to bA$	$S \to \lambda$
$A \to bS_1 \mid aB$	
$S_1 \to aS$	
$S \to \lambda$	

Both are Correct

If I reverse this right linear grammar then

$S_1 \to Bbb$

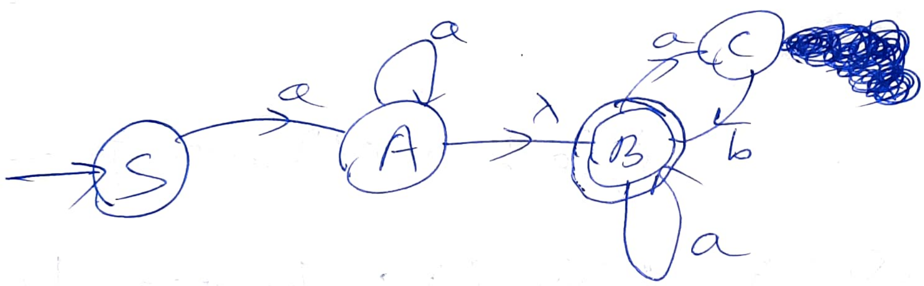
$B \to Aba$

$A \to Ba \mid Sab$

$S \to \lambda$

This is the left linear grammar.

Lect-89 Find a regular grammar that generates the language $L(aa^*(ab+a)^*)$



Right linear grammar or Regular grammar for $L(aa^*(ab+a)^*)$ is

$S \to aA$

$A \to aA \mid B$

$B \to \lambda \mid aB \mid aC$

$C \to bB$