CS & IT ENGINEERING

Theory of Computation

Lecture No.- 05

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Topics to be Covered

Topic Regular Languages

Topic Context Free Grammars

Regular Languages : MSQ

Q56. If G is a grammar with productions

$$S \rightarrow Sa \mid Sb \mid Saa$$

where S is the start variable, then which one of the following strings is not generated by G?

$L = \phi$

A. abab

B. aaab

C. abbaa

D. babba

$S \rightarrow Sa \mid Sb \mid Saa$

Useless

Regular Languages : NAT

Q57. How many of the following languages are regular?

Reg $(a+b)^*$ ⇐ $L_1 = \{wxw^R \mid w, x \in \{a, b\}^*, w^R$ is the reverse of string $w\}$

Reg $a^* b^*$ ⇐ $L_2 = \{a^n b^m \mid m, n \geq 0\}$

Reg $a^* b^* c^*$ ⇐ $L_3 = \{a^p b^q c^r \mid p, q, r \geq 0\}$

$L_4 = \{\omega \mid \omega \in \{0,1\}^*, \omega$ has equal number of (00)'s and (11)'s$\}$.

Not Reg

= 3

Regular Languages : NAT

$= a^*$ $\quad$ $= b^*$

Q58. If $L_1 = \{a^n \mid n \geq 0\}$ and $L_2 = \{b^n \mid n \geq 0\}$, then how many of the following statements are TRUE?

I. $L_1 \cdot L_2$ is a regular language
II. L_1/L_2 is a regular language
III. $L_1 \cup L_2$ is a regular language

$= 3$ //

Regular Languages : MSQ

Q59. Which one of the following is TRUE?

A. Kleene closure of $\{a^n b^n \mid n \geq 0\}$ is regular. $\{a^n b^n\}^*$ is not reg

B. Kleene closure of $\{a^n \mid n \text{ is prime}\}$ is regular. $\{a^{prime}\}^*$ is Reg

C. Kleene closure of $\{ww \mid w \in \Sigma^* \text{ with } \Sigma = \{0, 1\}\}$ is regular.

D. Kleene closure of $\underbrace{\{wxw \mid w, x \in \Sigma^* \text{ with } \Sigma = \{0, 1\}\}}_{(0+1)^*}$ is regular.

$$\{wxw \mid w, x \in \{0,1\}^*\} = (0+1)^*$$

$w = \varepsilon, 0, 1, 00, 01, 10, \ldots$

$\varepsilon x \varepsilon \Downarrow x \Downarrow (0+1)^*$

$0x0 \Downarrow 0(0+1)^*0$

$1x1 \Downarrow 1(0+1)^*1$

$$\left((0+1)^*\right)^* = (0+1)^*$$

$$\{a^{prime}\}^* = \{a^2, a^3, a^5, a^7, a^{11}, \dots\}^*$$

$$= \{\varepsilon, a^2, a^3, a^4, a^5, a^6, a^7, a^8, \dots\}$$

$$= \varepsilon + aaa^*$$

$$= \{a^n \mid n \neq 1\}$$

$$L = \{\underset{\Sigma}{w}\underset{\Sigma}{w} \mid w \in \{0,1\}^*\} = \{\varepsilon, 00, 11, 0000, 0101, 1010, \ldots\}$$

$$L^* = \{ww\}^* = \{\varepsilon, 00, 11, 0000, 0101, 1010, \ldots\}^*$$

$$= \{w_1w_1\ w_2w_2\ w_3w_3\ w_4w_4 \ldots w_kw_k\}$$

$$k \geq 1$$

$$L = \{a^n b^n\} = \{\varepsilon, ab, aabb, a^3b^3, \dots\}$$

$$L^* = \{a^n b^n\}^* = \{\varepsilon, ab, aabb, a^3b^3, \dots\}^*$$

$$= \{\varepsilon, ab, \underline{abab}, \underline{aabb}, \dots\}$$

$$= \{a^{n_1} b^{n_1} \, a^{n_2} b^{n_2} \, a^{n_3} b^{n_3} \, a^{n_4} b^{n_4} \dots a^{n_k} b^{n_k}\}$$

$k \geq 1$

Regular Languages : NAT

Q60. Consider the following FSM with output. It takes binary input in reverse order of actual binary number and produces binary output. To see actual output, produced output should be considered in reverse. Identify TRUE statement.

001 → 100

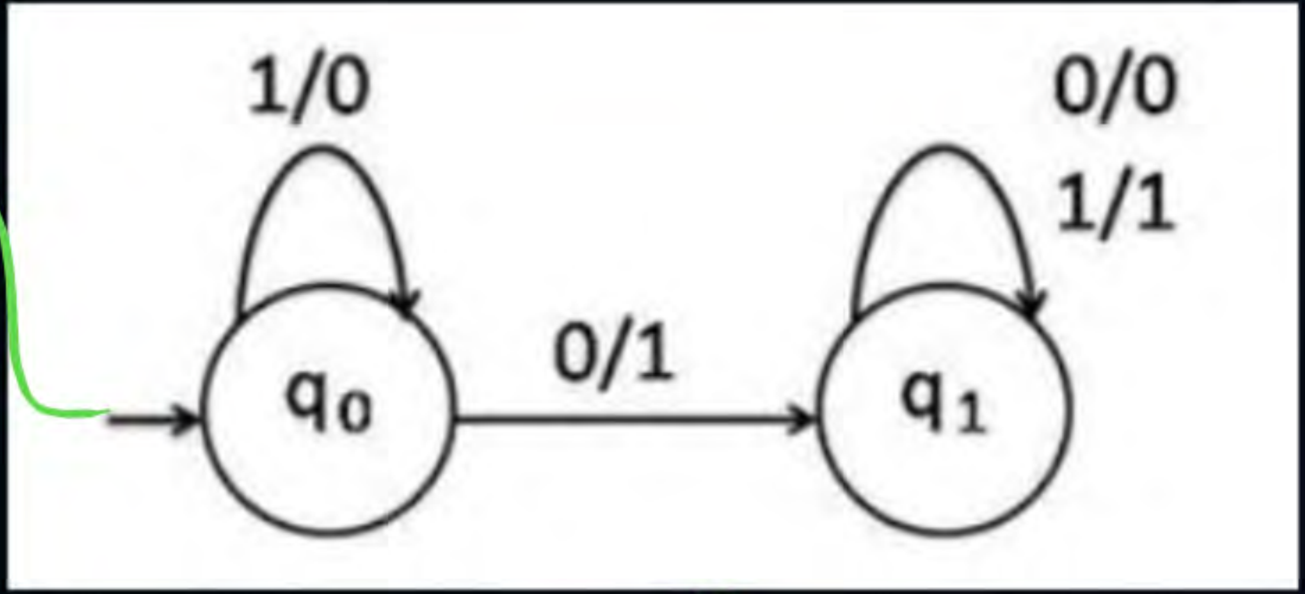
(A) It increments given input

(B) It decrements given input

(C) It left shifts given input

(D) It right shifts given input

001 − 1 = 000



010 → 010

Regulars and CFGs : MSQ

Q61. Consider the following grammar:

$S \to Aa \mid Ab$ $\quad S = A(a+b) = (a+b)(a+b)^*(a+b)$

$A \to aB \mid bB$ $\quad A = (a+b)B = (a+b)(a+b)^*$

$B \to Ba \mid Bb \mid \text{epsilon}$ $\quad B = (a+b)^*$

What is the language generated by above CFG?

A. $(a + b)(a + b)^*$

B. $b(a + b)^*$

C. $(a + b)(a + b)(a + b)^*$

D. None of these

Regulars and CFGs : MSQ

Q62. Consider the following grammar G:

G :

$$S \rightarrow A \mid B$$
$$A \rightarrow aCb \qquad A = a(a+b)^*b$$
$$C \rightarrow aC \mid bC \mid \epsilon \qquad C = (a+b)^*$$
$$B \rightarrow b\boxed{D}a \qquad B = b(a+b)^*a$$
$$D \rightarrow bD \mid aD \mid \varepsilon \qquad D = (b+a)^*$$

$S = A + B$

S is start symbol, A, B, C and D are non-terminals and a, b are terminals. The language generated by above grammar G is

A. $a(a + b)^* b$

B. $a(a + b)^* a + b(a + b)^* b$

C. $a(a + b)^* b + b(a + b)^* a$

D. None of these

Regulars and CFGs : MSQ

Q63. Consider the following context-free grammars:

$G_1: S \rightarrow aS \mid A,\ \boxed{A \rightarrow \varepsilon \mid bA}$ $A = b^*$ $S \rightarrow aS \mid b^*$ $L = a^*b^*$

$G_2: S \rightarrow aA \mid B,\ A \rightarrow aA \mid \varepsilon,\ B \rightarrow bB \mid \varepsilon$

Which one of the following pairs of languages is generated by G_1 and G_2, respectively? $A = a^*$ $B = b^*$ $S \rightarrow aa^* \mid b^*$ $\Rightarrow a^+ + b^*$

A. $\{a^m b^n \mid m > 0 \text{ or } n > 0\}$ and $\{a^m b^n \mid m > 0 \text{ and } n > 0\}$.

B. $\{a^m b^n \mid m \geq 0 \text{ and } n \geq 0\}$ and $\{a^m b^n \mid m > 0 \ \cancel{\text{and}}\ \text{or}\ n \geq 0\}$.

C. $\{a^m b^n \mid m \geq 0 \text{ or } n > 0\}$ and $\{a^m b^n \mid m > 0 \text{ and } n > 0\}$.

D. $\{a^m b^n \mid m \geq 0 \text{ and } n > 0\}$ and $\{a^m b^n \mid m > 0 \text{ or } n > 0\}$.

Regulars and CFGs : NAT

Q64. Consider the following context-free grammar G over the alphabet $\Sigma = \{a, b, c\}$ with S as the start symbol

$$S \rightarrow abScT \mid abc$$
$$T \rightarrow b$$

$\Rightarrow S \rightarrow abScb \mid abc$

Let L = { w | w is in L(G), length of w is less than 9}. Then size of L is ___

= {abc, ababccb}

abc ✓

abScb = ababccb ✓

abScb = ababScbcb = abababccbcb (>9 length)

= 2

Regulars and CFGs : NAT

Q65. Consider the context-free grammars over the alphabet {a, b, c} given below. S and T are non-terminals.

$G_1: S \rightarrow abS \mid T,\ T \rightarrow \underbrace{cT \mid \in}_{c^*}$ $L = (ab)^* c^*$

$G_2: S \rightarrow aSc \mid T,\ T \rightarrow \underbrace{bT \mid \in}_{b^*}$

$a^n b^* c^n$

Number of strings in $L(G_1) \cap L(G_2)$ is ___ $= 2$

$(ab)^* c^* \cap a^n b^* c^n$

$\{\varepsilon, \ldots, abc, \ldots\} \cap \{\varepsilon, abc, \ldots\}$

Regulars and CFGs : MSQ

Q66. Identify the language generated by the following grammar, where S is the start variable.

$$S \rightarrow XY$$
$$\boxed{X \rightarrow aX \mid a} \Rightarrow X = a^+$$
$$Y \rightarrow YX \mid \epsilon$$
$$Y \rightarrow Ya^+ \mid \epsilon \Rightarrow (a^+)^* = a^*$$

$$L = XY = a^+a^* = a^+$$

A) a^*

B) $aa^* = a^+$

C) $(aa)^*$

D) None of these

Regulars and CFGs : MCQ

Q67. Consider L1 = ab*

L2 = ba*

L3 = L1/ L2

Which of the following expression is equivalent to L3?

$L_1/L_2 = ab^*/ba^*$

$= \{ ab^*/b, ab^*/ba, ab^*/baa, ab^*/baaa \ldots \}$

A. L1

B. L2

C. a

D. ab

a/b ×

$ab/b = a$

$abb/b = ab$

$abbb/b = abb$

$= ab^* = L_1$

Slide

$$ab^*/ba^* = \{ab^*/b,\ ab^*/ba,\ ab^*/baa,\ ab^*/baaa, \dots\}$$

$$\times \quad \times \quad \times$$

$$= \{a/b,\ ab/b,\ abb/b,\ ab^3/b, \dots\}$$

$$\times \quad a \quad ab \quad ab^2$$

$$= ab^* = L_1$$

$$a\boxed{bb}/\boxed{bb} = a$$

$$u\boxed{v}/\boxed{v} = u$$

$$ab/b = a$$

$$ab/a = \phi$$

Regulars and CFGs : MSQ

Q68. Consider L1 = ab*

L2 = ba*

L3 = L1 U L2 $= ab^* + ba^*$

Which of the following expression is equivalent to $\boxed{L3^*?}$

$L_3^* = (ab^* + ba^*)^*$

$= (a+b)^*$

A (ab)*

B (ab+ba)*

C (a+b)*

D None of these

Slide

Regulars and CFGs : MCQ

Q69. Consider the following CFG G.

$$G: \boxed{S} \rightarrow ab\,S \mid \in, \quad \boxed{T \rightarrow abT \mid \in}$$

useless

Which of the following is L(G) ?

$L = (ab)^*$

Note :

$S \rightarrow abT \mid \varepsilon$, $T \rightarrow abT \mid \varepsilon$

$S = ab(ab)^* + \varepsilon$

$= (ab)^+ + \varepsilon = (ab)^*$

$T = (ab)^*$

A (ab)*

B $(ab)^+$

C (a+b)*

D None of these

Slide

$= 1$

Q70. If $L = \{b^n a^n \mid n \geq 0\}$, then how many following statements are TRUE?

$L = b^n a^n$

I. L^* is a regular language
II. Reversal of L is a regular language
III. Complement of L is a regular language
IV. Finite Subset of L is always regular language

I. $L^* = \{b^n a^n\}^*$ is not reg

II. $L^{Rev} = \{b^n a^n\}^{Rev} = a^n b^n$ is not reg

III. $\overline{L} = \overline{\{b^n a^n\}}$ is not reg

Regulars and CFGs : MCQ

Q71. How many of the following statements are correct?.

I. Every regular language is finite language FALSE
II. Every finite language is regular language TRUE
III. Every CFL is regular language FALSE
IV. Every regular language is CFL TRUE

A 4

B 3

C 2

D 1

Slide

Regular Languages : NAT

Q72. How many of the following languages are regular?

$L_1 = \{wxw^R \mid w, x \in \{a, b\}^+, w^R \text{ is the reverse of string } w\}$
$L_2 = \{w \mid w, x \in \{a, b\}^*, \text{number of 01's in } w \text{ is even}\}$
$L_3 = \{w \mid w, x \in \{0, 1\}^*, \text{Dec}(w) \text{ is divisible by } 100\}$
$L_4 = \{w \mid w, x \in \{a, b\}^*, w \text{ has more 0's than 1's}\}$

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Regulars and CFGs : MSQ

Q73. Choose FALSE statement.

A Substitution is closed for regular languages

B Substring is closed for regular languages

C Subset is closed for regular languages

D Finite subset is closed for regular languages

Regulars and CFGs : MCQ

Q74. Let $L = \{ w1w2w3 \mid w1, w2, w3 \in \{ a, b \}^*, |w1| = |w2| = |w3| \}$. Choose L from the following.

A $(a+b)^*$

B $(a+b)\,(a+b)^*\,(a+b)$

C $(\,(a+b)\,(a+b)\,(a+b)\,)^*$

D $(a+b)\,(a+b)^*$

Regulars and CFGs : MSQ

Q75. Which of the following operation is closed for finite languages but not closed for infinite languages?

A. Kleene star

B. Union

C. Subset

D. Substitution

THANK - YOU