CS & IT ENGINEERING

Theory of Computation

Regular Languages

Lecture No.- 06

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Recap of Previous Lecture

Topic Regular Expressions

- 4 operators
  - OR
  - Concatenation
  - R^*
  - R^+

Topics to be Covered

Topic Regular Expressions

↳ Simplification

TOPIC:

1) $(a+b).c = ac+bc$

2) $x.(y+z) = xy+xz$

} . over +
. can be distributed over +

3) $p+(q.r) \neq (p+q).(p+r)$

4) $(t.u)+v \neq (t+v).(u+v)$

} + can't be distributed over .

TOPIC:

$$P+(q.r) \neq (P+q).(P+r)$$

$$\Downarrow \qquad \Downarrow$$

$$\{P, qr\} \qquad \{PP, Pr, qP, qr\}$$

TOPIC: Distribution :

□ over ○ :

$$X \square (Y \circ Z) = (X \square Y) \circ (X \square Z)$$

TOPIC:

5) $a + \phi = \phi + a = a$

What is ϕ ?

Identity expression for +

$R + \phi = \phi + R = R$

6) $R \cdot \varepsilon = \varepsilon \cdot R = R$

ε is Identity exp for ·

I is Identity for $\square$

$$X \square I = I \square X = X$$

Right Identity

Left Identity

TOPIC:

7) $a + b = b + a$

$R_1 + R_2 = R_2 + R_1$

+ (OR) satisfies commutative

*** 8) $a \cdot b \neq b \cdot a$

$R_1 R_2 \neq R_2 R_1$

not holds

• not satisfy commutative

$ab \neq ba$

TOPIC:

Note: Is it possible $R_1 R_2 = R_2 R_1$? YES

Case 1: If $R_1 = R_2$

$\hookrightarrow R_1 R_1 = R_1 R_1$

Case 2: If $R_1 = \phi$

$\hookrightarrow \phi \cdot R_2 = R_2 \cdot \phi$

$\phi = \phi$

Case 3: If $R_1 = \varepsilon$

TOPIC:

+ satisfies Associative

9) $\underbrace{(a + b)}_{\text{Left}} + c = a + \underbrace{(b + c)}_{\text{Right}}$

Left Associative

Right Associative

• Satisfies Associative

10) $(a \cdot b) \cdot c = a \cdot (b \cdot c)$

$\underrightarrow{abc}$ $\underrightarrow{abc}$

TOPIC:

Identity

Commutative

Associative

Distributive

} Applicable for Binary operators

TOPIC:

11) $R \cdot \phi = \phi \cdot R = \phi$

ϕ is Dominator (Annihilator) for $\cdot$.

12) $R + \Sigma^* = \Sigma^* + R = \Sigma^*$

Σ^* is Dominator for $+$

TOPIC:

$$\Sigma = \{a\} \Rightarrow \Sigma^* = a^*$$

$$= \{\varepsilon, a, aa, aaa, \ldots\}$$

$$\Sigma = \{a, b\} \Rightarrow \Sigma^* = (a+b)^*$$

$$= \{\varepsilon, a, b, aa, ab, ba, bb, aaa, aab, \ldots\}$$

[MSQ]

#Q1. Find minimum String in $a.a^*.a$

✓ ✓ ✓

$a \; \varepsilon \; a \rightarrow aa$

A ε

B a

C ~~aa~~ ✓

D aaa

[MSQ]

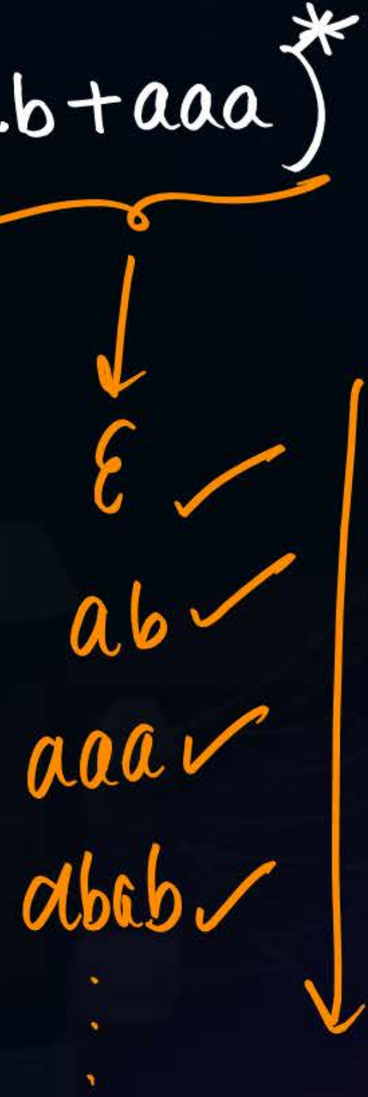
#Q2. Find 2nd minimum String (Second Shortest) generated by $(ab+aaa)^*$

A a

B ab

C aaa

D abab



[MSQ]

#Q3. Find Smallest String generated by $(a^* + b^*)a$

$\varepsilon \quad a \rightarrow a$

A ε

B a

C aa

D ba

[MSQ]

#Q4. $a.a^* =$

A a^*

B a^+

C $a^*.a$

D $a^*.a^* = a^*$

[MSQ]

#Q5. $a^* \cdot a^* =$

A a^*

B $(a^*)^2 = a^* \cdot a^* = a^*$

C $(a^2)^* = (aa)^*$

D $(a^*)^* = a^*$

2 mins Summary

Topic Operators ✓ 4 operators

Topic Properties ✓ 12 properties

Topic Simplification } Next

THANK - YOU