## Education Notice: Mawlana Bhashani Science and Technology University - MBSTU

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## Presentation Topic: Convert DFA to Regular Expression

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## ****DFA to Regular Expression-****

## The two popular methods for converting a given DFA to its regular expression are-

Convert DFA to Regular Expression (Method)

Arden’s Method State Elimination Method

**Arden’s Theorem –**

 Let P and Q be two regular expressions. If P does not contain null string, then following equation in R = Q + RP, Has a unique solution by R = QP\*

**Assumptions –**

* The transition diagram should not have €-moves.
* It must have only one initial state.

## Solution ****Steps-****

 To convert a given DFA to its regular expression using Arden’s Theorem, following steps are followed-

**Step-01:**

* Form an equation for each state considering the transitions which comes towards that state.
* Add ‘∈’ in the equation of initial state.

**Step-02:**  Bring final state in the form R = Q + RP to get the required RE

**Important Notes-**

**Note-01:**

 Arden’s Theorem can be used to find a regular expression for both DFA and NFA.

**Note-02:**

 If there exists multiple final states, then-

* Write a regular expression for each final state separately.
* Add all the regular expressions to get the final regular expression.

## ****Problem-01:****

 Find regular expression for the following DFA using Arden’s Theorem-

a

Q1qq1 b

a a

## ****Solution-****

### **Step-01:**

 Form an equation for each state-

q1 = ∈ …… (1)

q2 = q1.a …… (2)

q3 = q1.b + q2.a + q3.a ……. (3)

### **Step-02:**

Bring final state in the form R = Q + RP.

Using (1) in (2), we get-

q2 = ∈.a

q2 = a ……. (4) [∈.a = a]

Using (1) and (4) in (3), we get-

q3 = q1.b + q2.a + q3.a

q3 = ∈.b + a.a + q3.a [∈.b = b]

q3 = (b + a.a) + q3.a ……. (5) [R = Q + RP, then R = QP\*]

R Q + RP

Using Arden’s Theorem in (5), we get-

q3 = (b + a.a) a\* (Ans)

Thus, Regular Expression for the given DFA = (b + aa) a\*

**Problem -02:** Find regular expression for the following DFA

a

b a b a

b

a,b

**Solution:**

q1 = ∈+ q2.b + q3.a …… (1)

q2 = q1.a …… (2)

q3 = q1.b…… (3)

q4 = q2.a + q3.b+q4 (a+b) ……. (4)

Putting the value of q1 and q3 into q1.we get,

q1 = ∈+ q1.a.b + q1.b.a

q1 = ∈+ q1 (a.b + b.a)

q1 = ∈+ q1 (a.b + b.a) [R=Q+RP]

q1 = ∈ (a.b + b.a)\* [R=QP\*]

q1 = (a.b + b.a)\* [∈.a=a]

Thus, Regular Expression for the given DFA = (a.b + b.a)\*

**Problem-03:**  Find regular expression for the following DFA using Arden’s Theorem-

**0** 1 1

## 1 0

## 

## 

## 0

## Solution:

q1 = ∈+ q1.0 + q3.0 …… (1)

q2 = q1.1 + q2.1 + q3.1 …… (2)

q3 = q2.0…… (3)

## Putting the value of q3 into q2.We get,

## q2 = q1.1 + q2.1 + q2.01

## q2 = q1.1 + q2 (1 + 01) [R=Q +RP] [R=QP\*]

## q2 = q1.1 (1 + 01)\* …… (4)

## Putting the value of q2 into q3.We get,

## q3 = q1.1 (1 + 01)\*.0 …… (5)

## Putting the value of q3 into q1.We get,

## q1 = ∈+ q1.0 + q1.1 (1 + 01)\*.0.0

## q1 = ∈+ q1 (0 + 1 (1 + 01)\*.00)

## q1 = ∈ (0 + 1 (1 + 01)\*.00)\*

## q1 = (0 + 1 (1 + 01)\*.00)\*

Thus, Regular Expression for the given DFA = (0 + 1 (1 + 01)\*.00)\*

**Problem-04:** Find regular expression for the following DFA using Arden’s Theorem-

**0 1 0,1**

**1 0**

## Solution:

q1 = ∈ + q1.0 …… (1)

q2 = q1.1 + q2.1 …… (2)

q3 = q2.0 + q3 (0+1) ……. (3)

From q1. We get,

q1 = ∈ + q1.0 [R=Q+RP]

R Q + RP

q1 = ∈.0\*

q1 = 0\*

From q2. We get,

q2 = q1.1 + q2.1

q2 = 0\*.1 + q2.1 [q1 = 0\*]

R Q + RP

q2 = 0\*.1.1\*

The required Regular expression is = Sum of two final state

= q1 + q2

= 0\* + 0\*.1.1\*

Thus, Regular Expression for the given DFA = 0\* + 0\*.1.1\*

## Problem-05: Find regular expression for the following DFA using Arden’s Theorem-

## a,b a a,b

## a

## 

## b b

## 

## a, b

## Solution:

q1 = ∈ …… (1)

q2 = q1 (a+b) …… (2)

q3 = q2.a + q4.b ……. (3)

q4 = q3 (a+b) …… (4)

q5 = q2.b + q4.b + q5(a + b) ……. (5)

Putting the value of q1 in q2.We get,

q2 =∈ (a+b)

q2 = (a+b)

Putting the value of q2 and q4 into q3.We get,

q3 = q2.a + q4.b ……. (3)

q3 = (a+b).a + q3 (a+b).b

q3 = ((a+b).a ((a+b).b)\*

Thus, Regular Expression for the given DFA = ((a+b).a ((a+b).b)\*