Rajshahi University of Engineering & Technology
Department of Computer Science and Engineering

Compiler
Lexical Analysis

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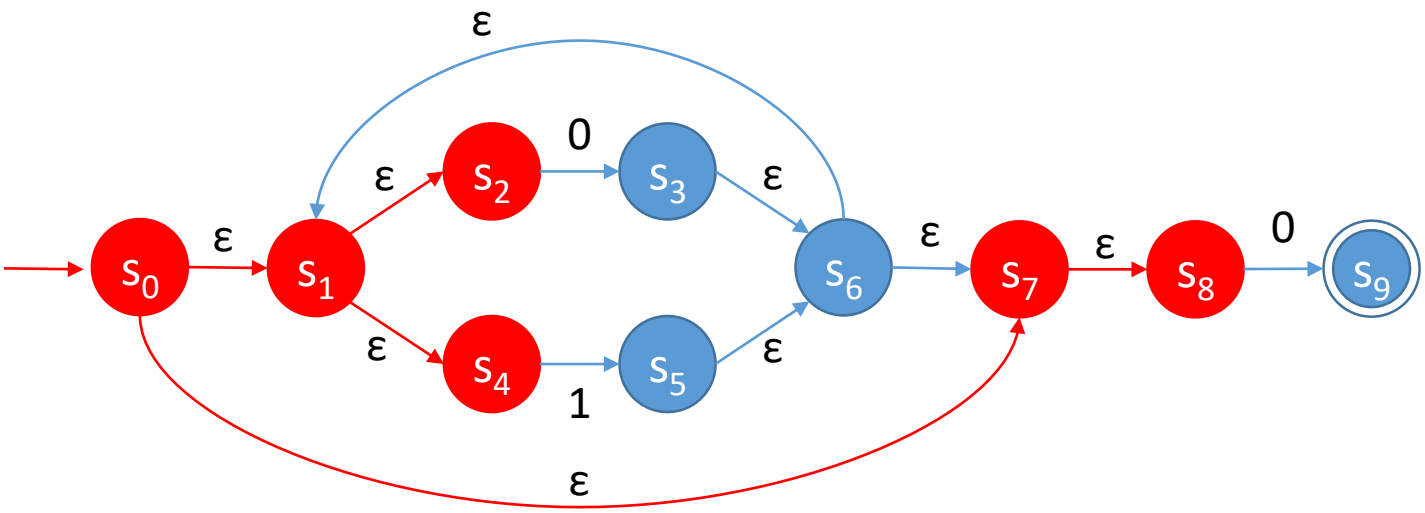
❖ Epsilon closure: E( )

- Epsilon closure of a state S_0 is set of state that can be reached from the state S_0 with epsilon(ε).
- Epsilon closure of a state contain itself also.



Epsilon closure of s_0 $E(s_0)$: {s_0, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_1 $E(s_1)$: {s_1, s_2, s_4}
Epsilon closure of s_2 $E(s_2)$: {s_2}
Epsilon closure of s_3 $E(s_3)$: {s_3, s_6, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_4 $E(s_4)$: {s_4}
Epsilon closure of s_5 $E(s_5)$: {s_5, s_6, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_6 $E(s_6)$: {s_6, s_1, s_2, s_4, s_7, s_8}

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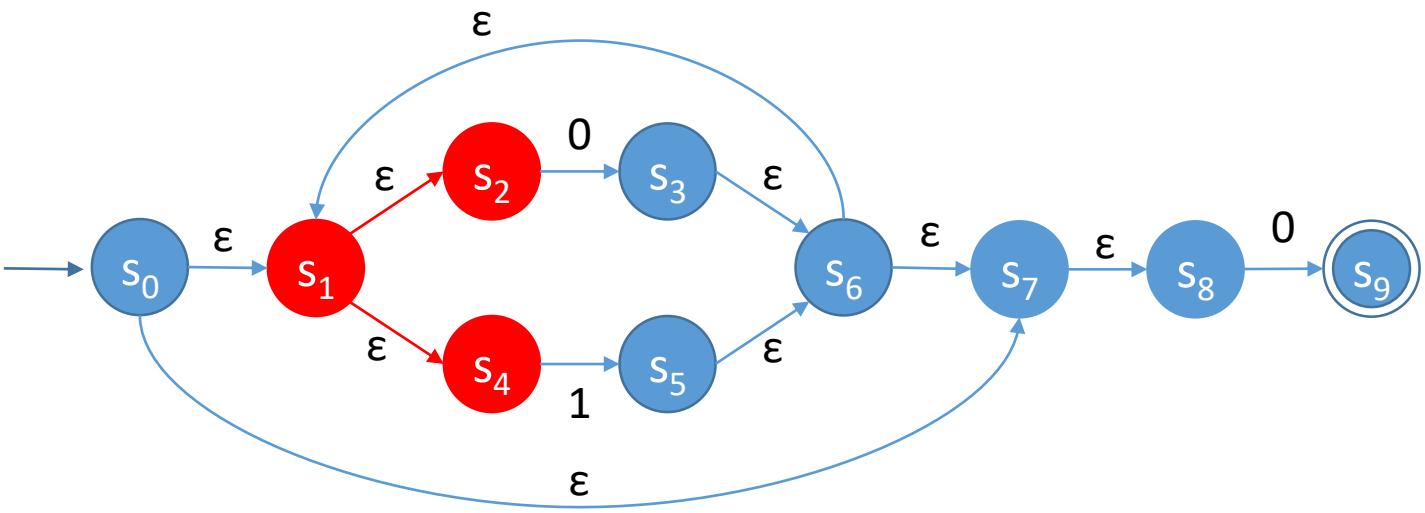

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Epsilon closure of s_3 $E(s_3)$: {s_3, s_6, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_4 $E(s_4)$: {s_4}
Epsilon closure of s_5 $E(s_5)$: {s_5, s_6, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_6 $E(s_6)$: {s_6, s_1, s_2, s_4, s_7, s_8}

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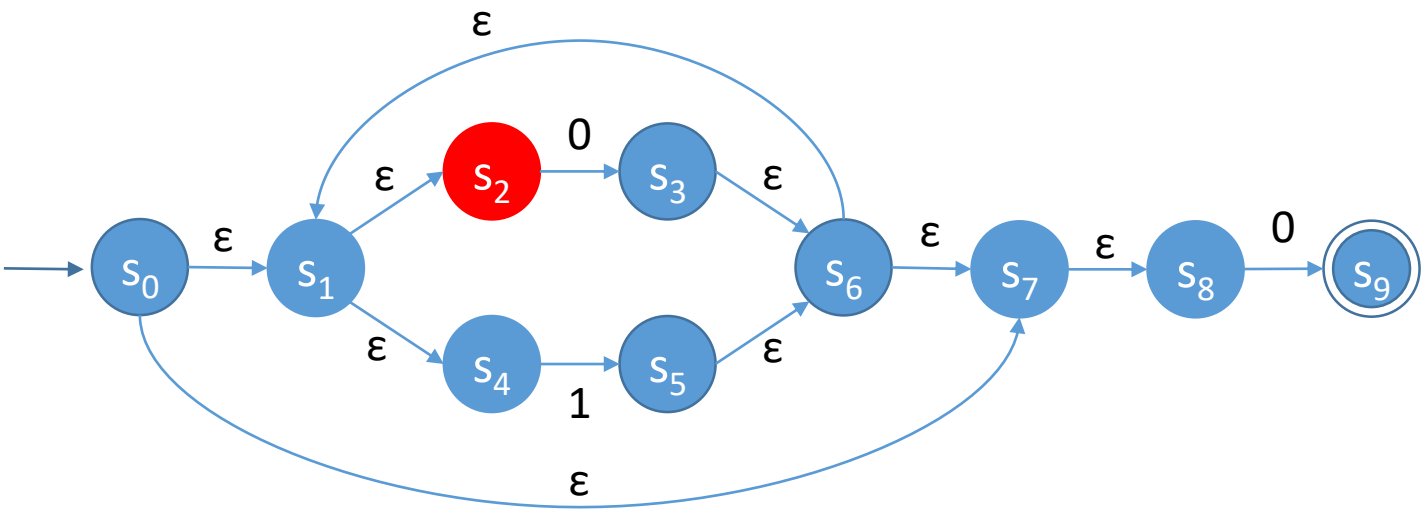

Epsilon closure of s_0 $E(s_0)$: {s_0, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_1 $E(s_1)$: {s_1, s_2, s_4}
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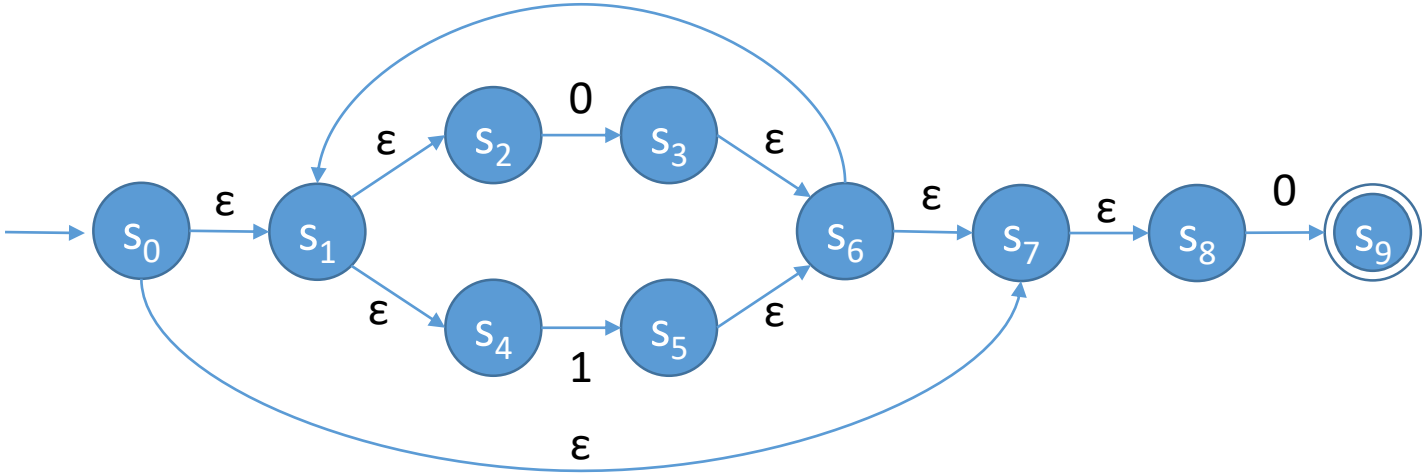
Epsilon closure of s_3 $E(s_3)$: {s_3, s_6, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_4 $E(s_4)$: {s_4}
Epsilon closure of s_5 $E(s_5)$: {s_5, s_6, s_1, s_2, s_4, s_7, s_8}
Epsilon closure of s_6 $E(s_6)$: {s_6, s_1, s_2, s_4, s_7, s_8}

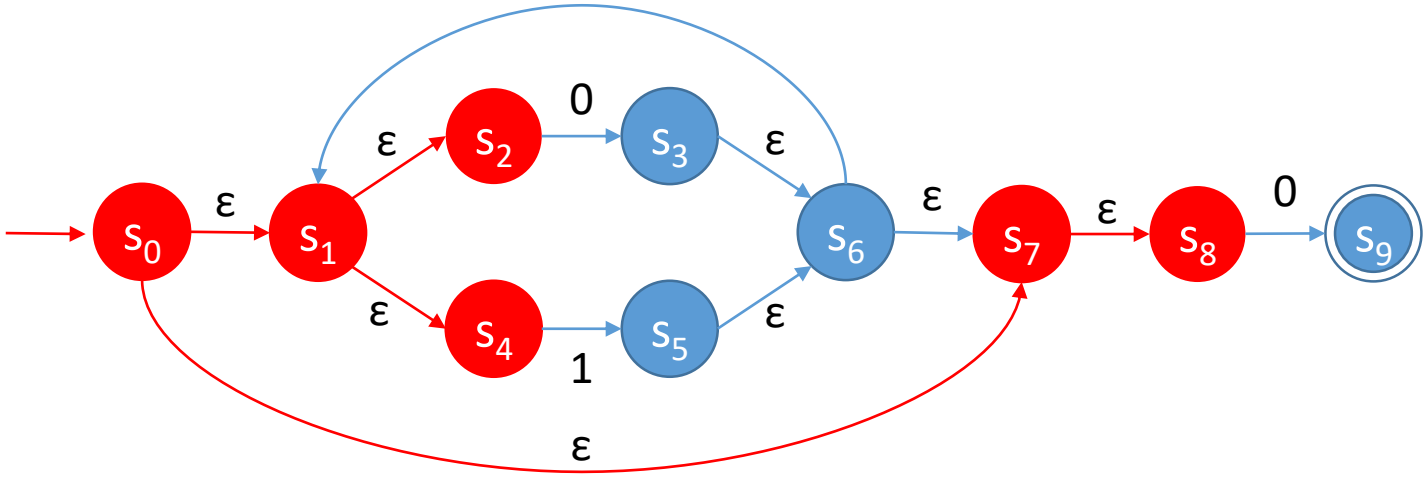
❖ Example

- Language: All binary even number
- Regular Expression: (0|1)*0
- NFA:



❖ Example

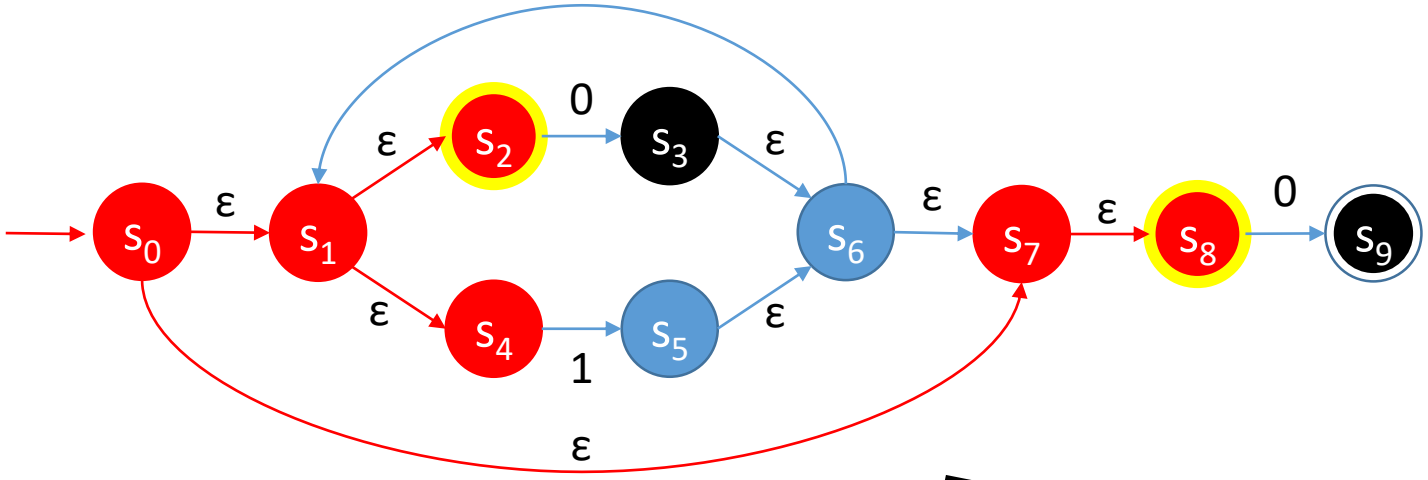
- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ {s0, s1, s2, s4, s7, s8}		

❖ Example

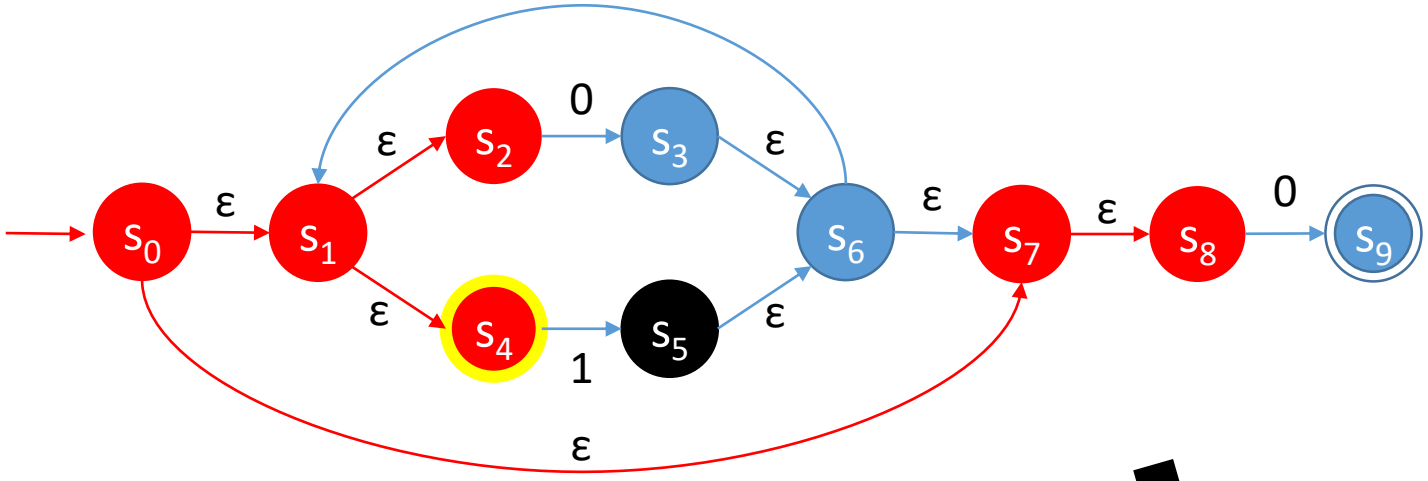
- DFA:



	Epsilon Closure E( )	0	1
$\{s_0\}$	$E(s_0)=$ $\{s0, s1, \mathbf{s2}, s4, s7, \mathbf{s8}\}$	$\{s_3, s_9\}$	

❖ Example

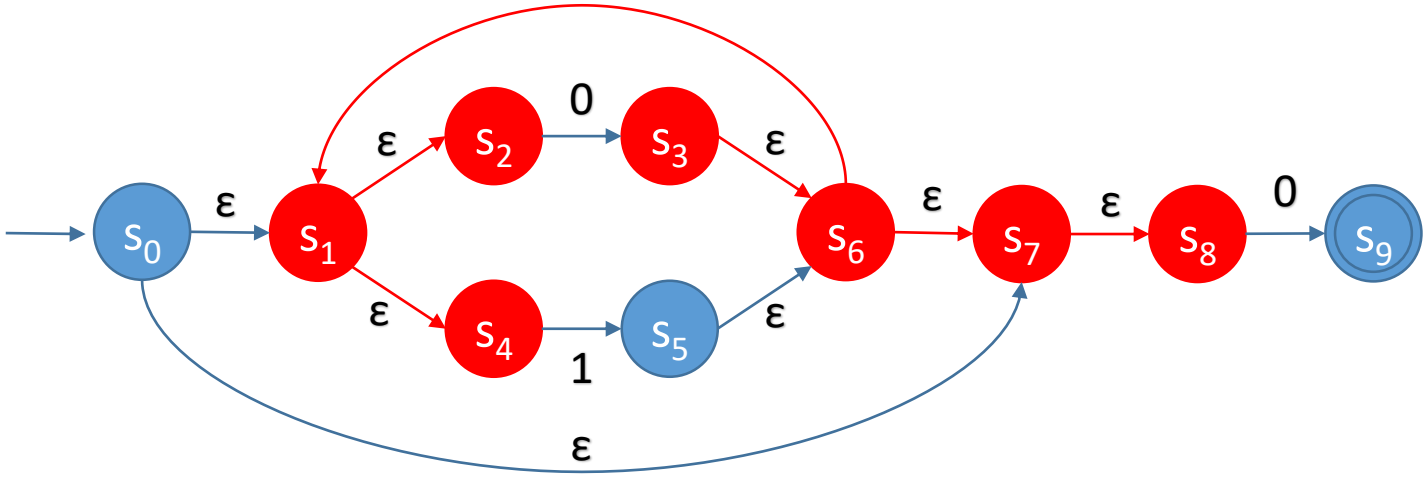
- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ {s0, s1, s2, **s4**, s7, s8}	$\{s_3, s_9\}$	$\{s_5\}$

❖ Example

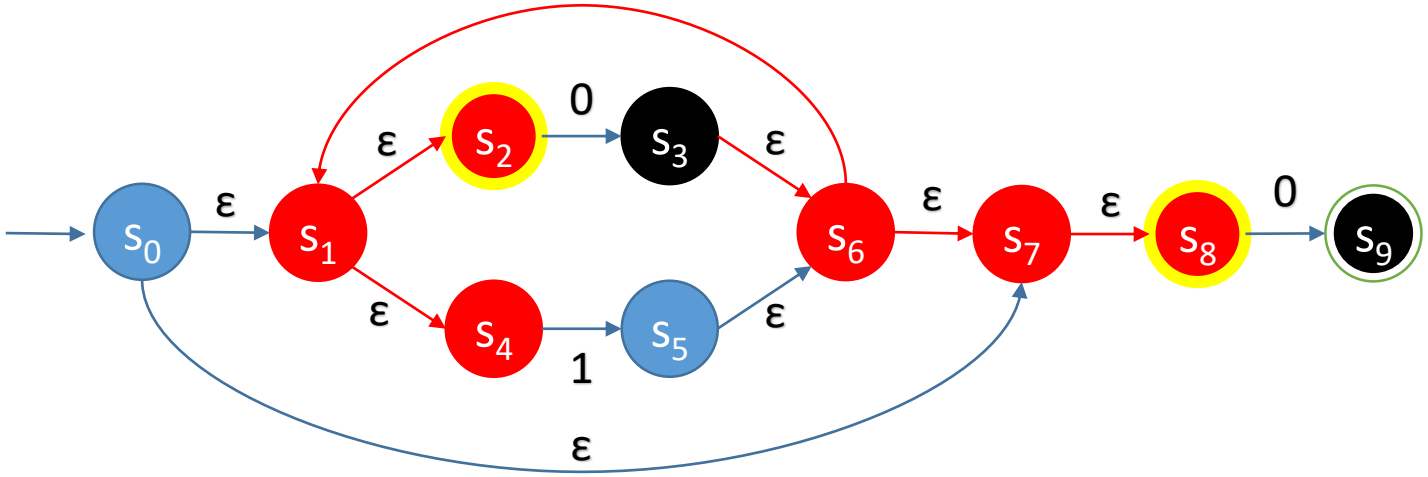
- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ {s0, s1, s2, s4, s7, s8}	$\{s_3, s_9\}$	$\{s_5\}$
$\{s_3, s_9\}$	$E(s_3)$ U $E(s_9)=$ $\{s_3, s_6, s_7, s_8, s_1, s_2, s_4\}$ U $\{s_9\}$ $\{s_3, s_6, s_7, s_8, s_1, s_2, s_4, s_9\}$		

❖ Example

- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ $\{s0, s1, s2, s4, s7, s8\}$	$\{s_3, s_9\}$	$\{s_5\}$
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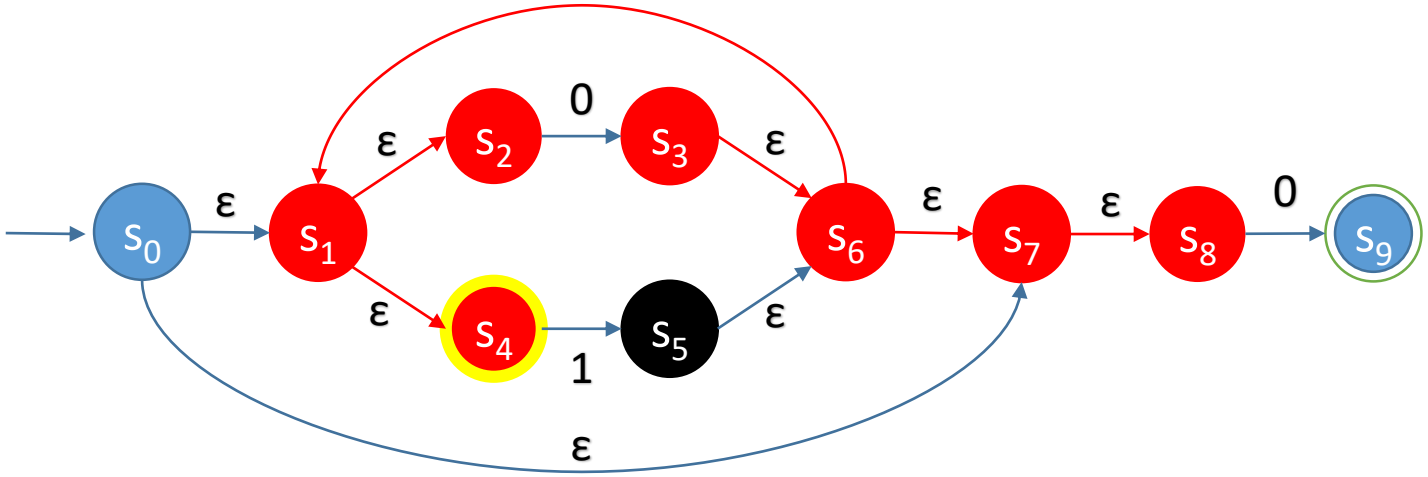
❖ Example

- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ {s0, s1, s2, s4, s7, s8}	$\{s_3, s_9\}$	$\{s_5\}$
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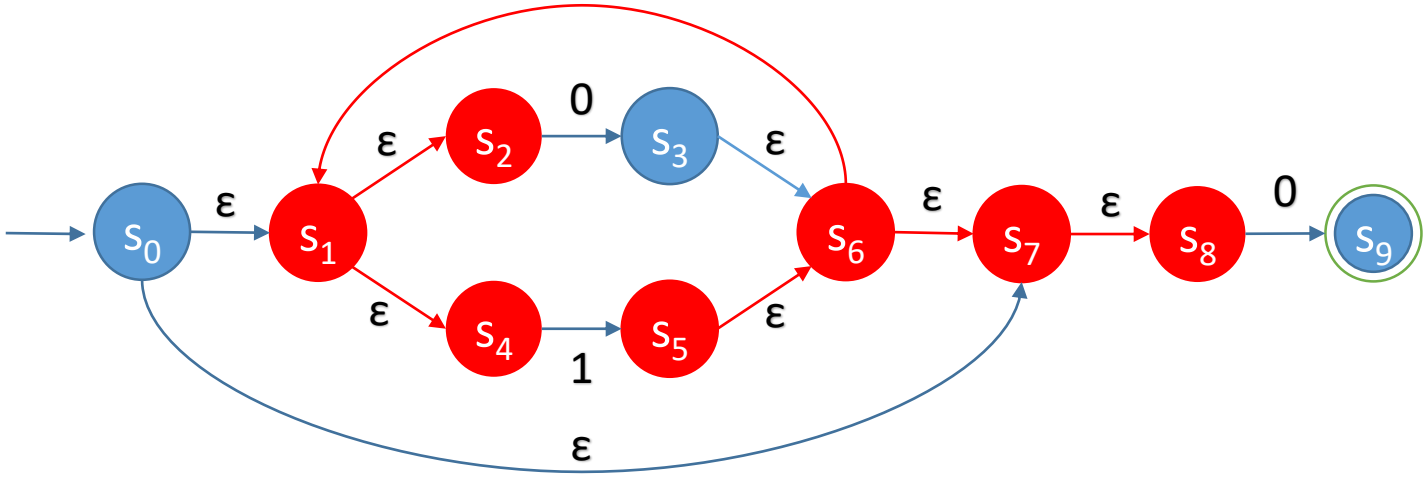
❖ Example

- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ {s0, s1, s2, s4, s7, s8}	$\{s_3, s_9\}$	$\{s_5\}$
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$\{s_5\}$	$E(s_5)=$ $\{s_5, s_6, s_7, s_8, s_1, s_2, s_4\}$		

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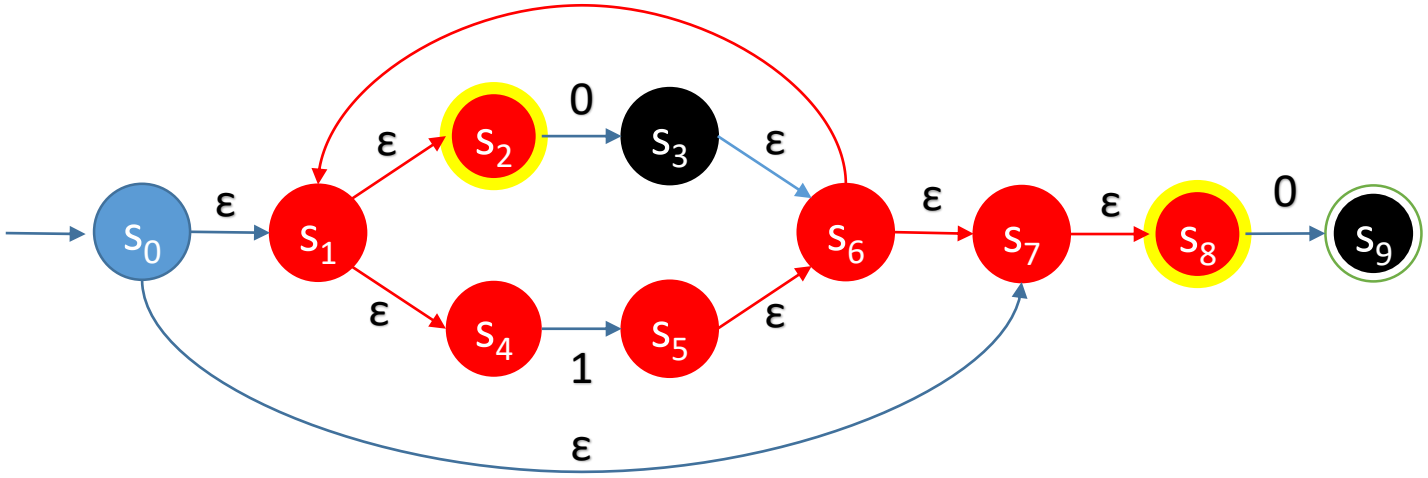
❖ Example

- DFA:



	Epsilon Closure E( )	0	1
s_0	$E(s_0)=$ {s0, s1, s2, s4, s7, s8}	$\{s_3, s_9\}$	$\{s_5\}$
$\{s_3, s_9\}$	$E(s_3)$ U $E(s_9)=$ $\{s_3, s_6, s_7, s_8, s_1, s_2, s_4\}$ U $\{s_9\}$ $\{s_3, s_6, s_7, s_8, s_1, s_2, \mathbf{s_4}, s_9\}$	$\{s_3, s_9\}$	$\{s_5\}$
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❖ Example

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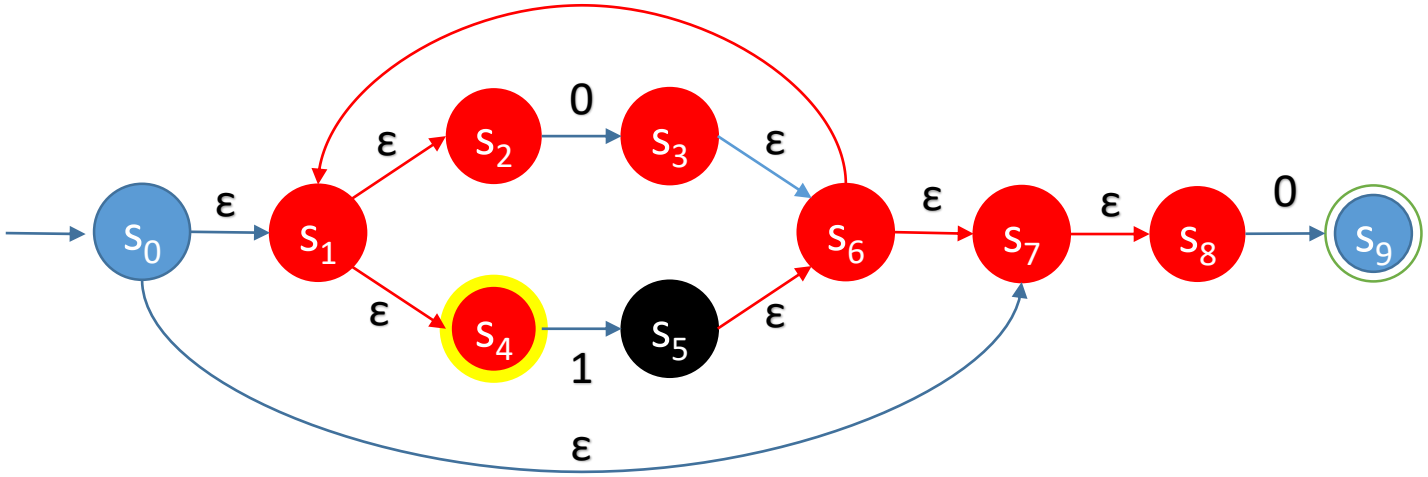

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s_0	$E(s_0)=$ {s0, s1, s2, s4, s7, s8}	$\{s_3, s_9\}$	$\{s_5\}$
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$\{s_5\}$	$E(s_5)=$ $\{s_5, s_6, s_7, s_8, s_1, s_2, \mathbf{s_4}\}$	$\{s_3, s_9\}$	$\{s_5\}$

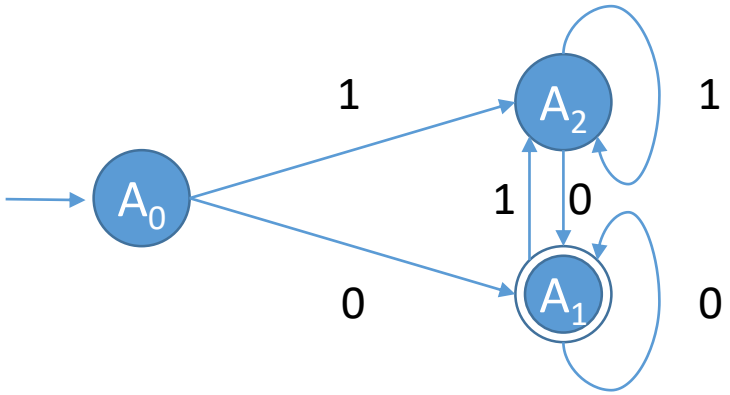
❖ Example

- DFA:

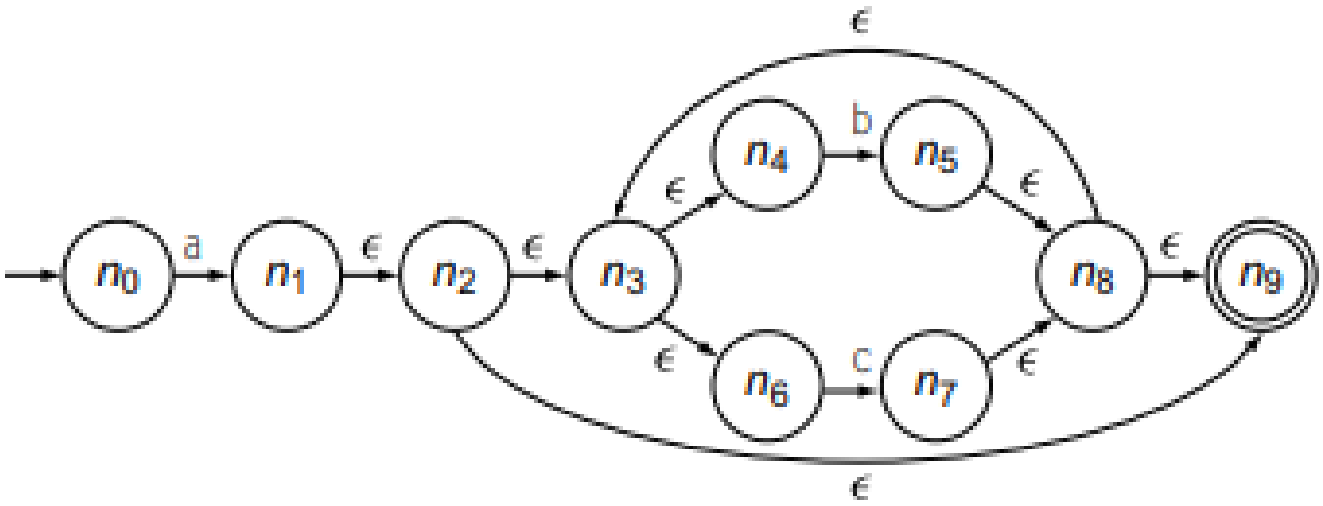
A_0 = {s0, s1, s2, s4, s7, s8}

A_1 = {s3, s6, s1, s2, s4, s7, s8, s9}

A_2 = {s5, s6, s1, s2, s4, s7, s8}



❖ The Subset Construction(NFA to DFA)



(a) NFA for "$a(b \mid c)^*$" (With States Renumbered)

Set Name	DFA States	NFA States	ϵ-closure(Delta(q,*))		
			a	b	c
q_0	d_0	n_0	$\{n_1, n_2, n_3, n_4, n_6, n_9\}$	– none –	– none –
q_1	d_1	$\{n_1, n_2, n_3, n_4, n_6, n_9\}$	– none –	$\{n_5, n_8, n_9, n_3, n_4, n_6\}$	$\{n_7, n_8, n_9, n_3, n_4, n_6\}$
q_2	d_2	$\{n_5, n_8, n_9, n_3, n_4, n_6\}$	– none –	q_2	q_3
q_3	d_3	$\{n_7, n_8, n_9, n_3, n_4, n_6\}$	– none –	q_2	q_3

(b) Iterations of the Subset Construction