LECTURE 9

FINITE STATE AUTOMATA

SUBJECTS

Algorithm to create NFAs from regular expressions

Algorithm to convert from NFA to DFA

Algorithm to minimize DFA

Many examples….

CREATING DETERMINISTIC FINITE AUTOMATA (DFA)

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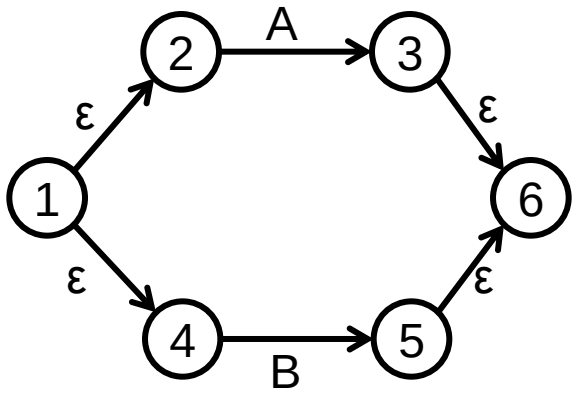
In order to create a DFA, we have to perform the following:

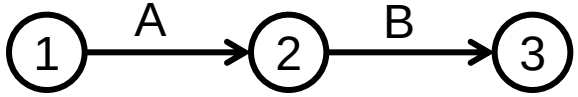
- Create a Non-deterministic Finite Automata (NFA) out of the regular expression
- Convert the NFA into a DFA

NFA CREATION RULES

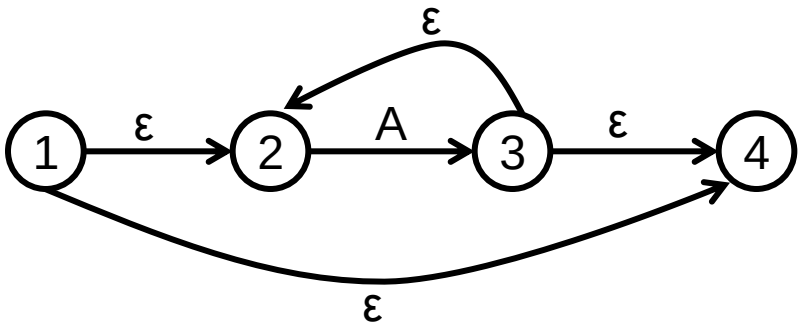
A | B



AB



A*



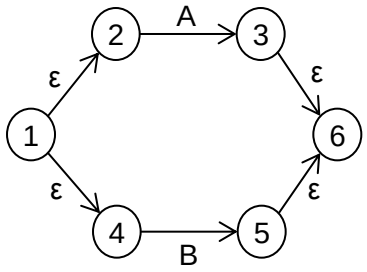
NFA CREATION EXAMPLES

x | yz

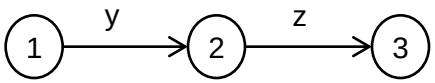
According to precedence rules, this is equivalent to:

x | (yz)

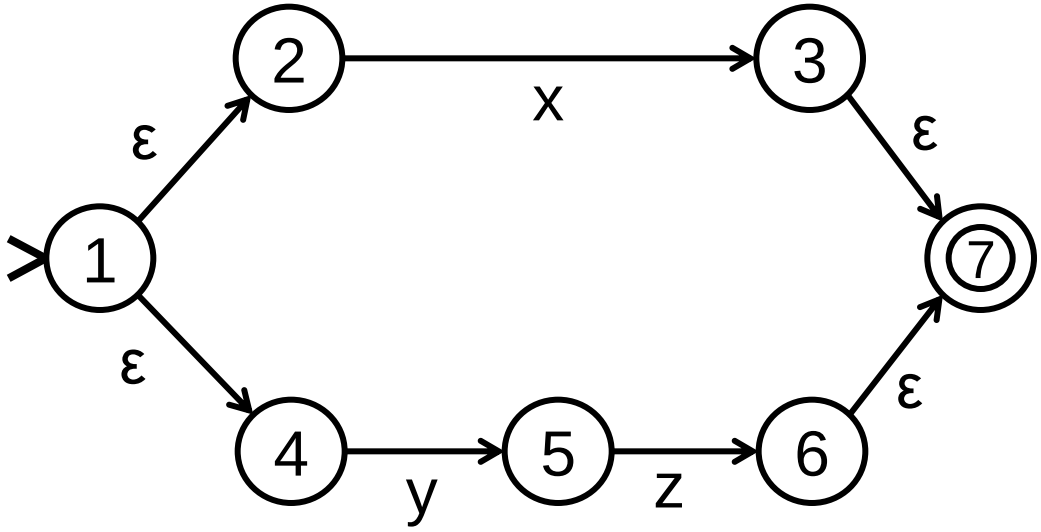
This has the same form as A | B:



And B can be represented as:



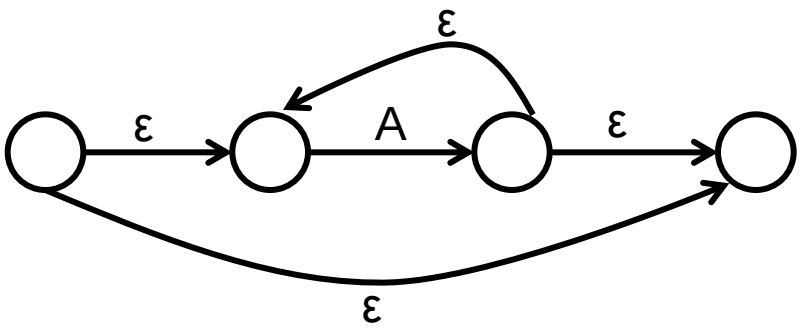
Putting all together:



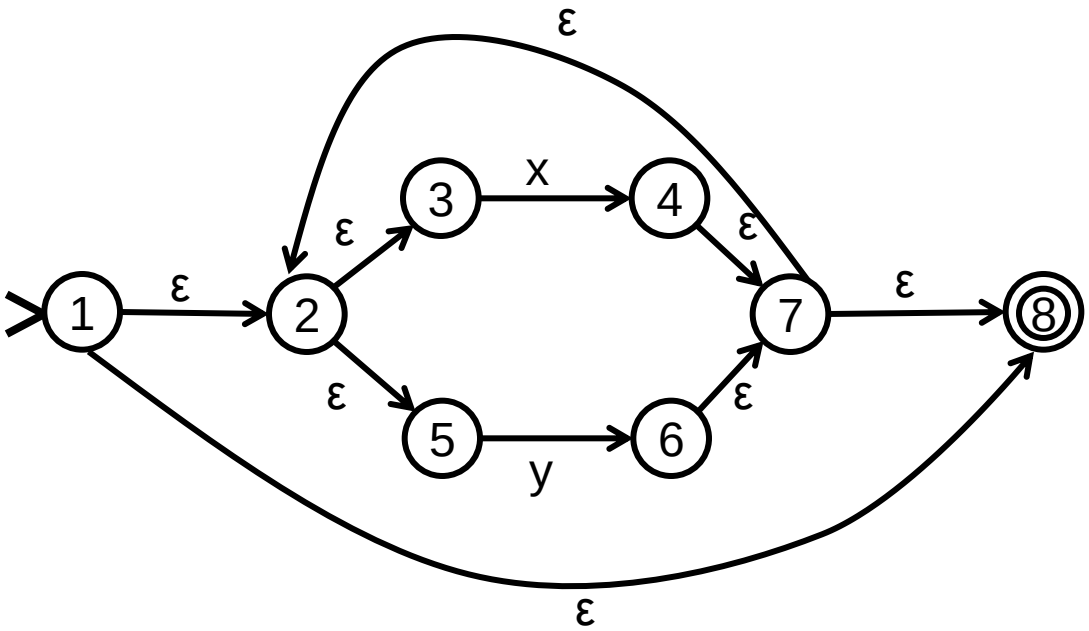
NFA CREATION EXAMPLES

(x | y)*

We have seen A*:

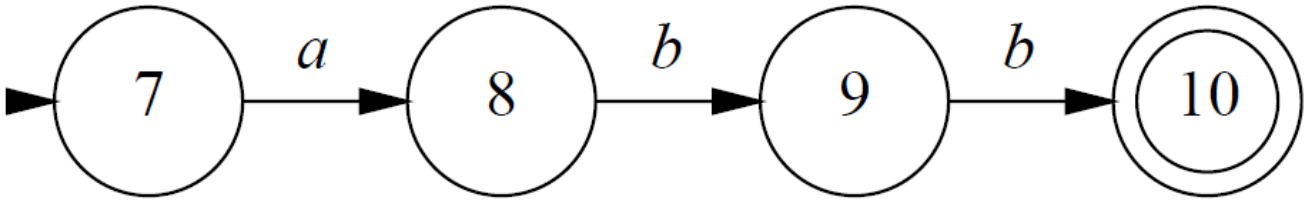


Therefore, (x | y)*:



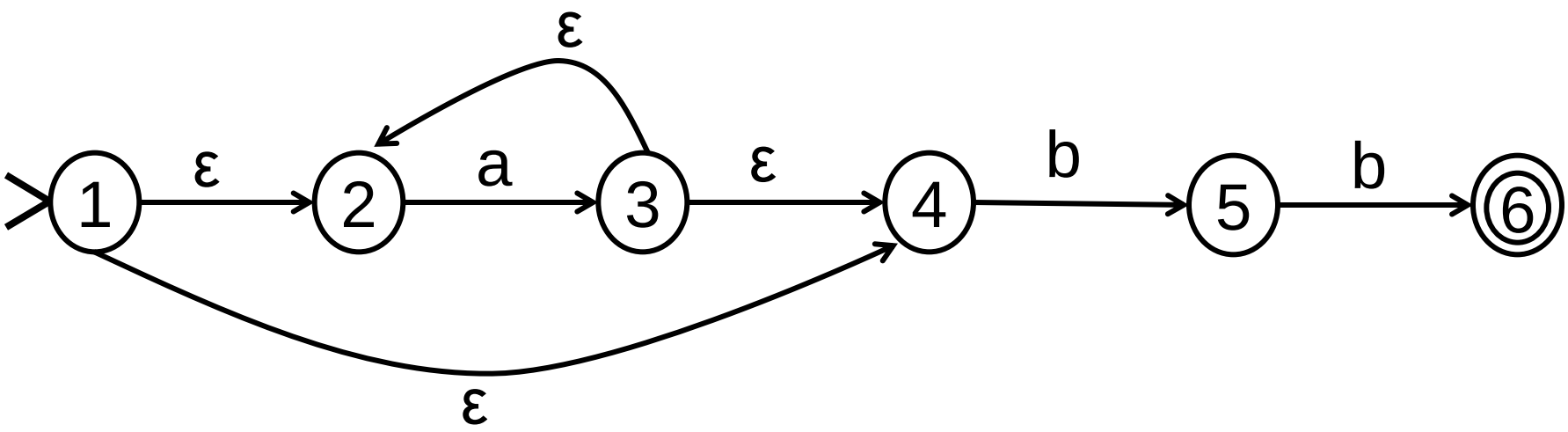
NFA CREATION EXAMPLES

abb



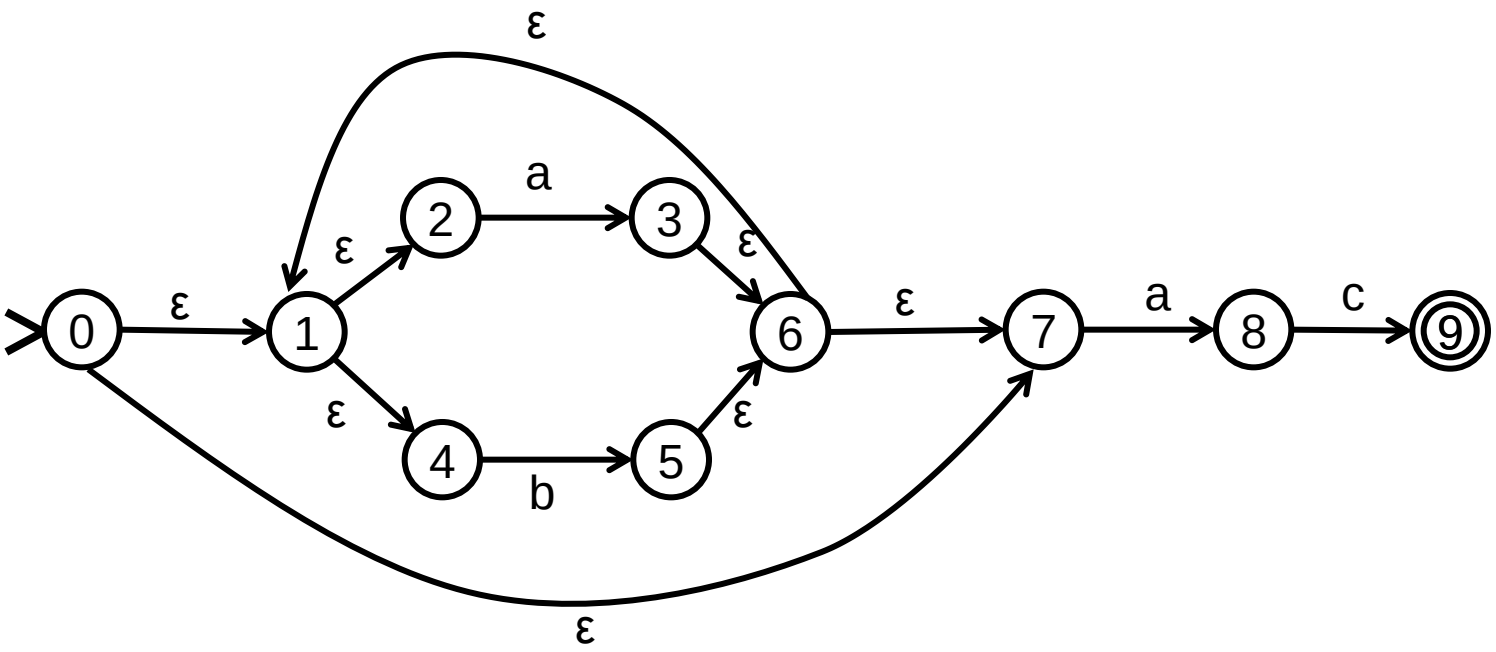
NFA CREATION EXAMPLES

a*bb



NFA CREATION EXAMPLES

(a|b)*ac



CONVERSION OF AN NFA INTO DFA

NFA is very easy to build but hard to interpret by a computer

- We need to convert NFA to a DFA
- ***Subset construction*** is the algorithm that achieves this conversion

In the transition table of an NFA, each entry is a set of states

In the transition table of a DFA, each entry is at most one state

General idea behind the NFA-to-DFA conversion: each DFA state corresponds to a set of NFA states

SUBSET CONSTRUCTION ALGORITHM

Algorithm: **Subset Construction - Used to construct a DFA from an NFA**

Input: **An NFA "*N*"**

Output: **A DFA "*D*" accepting the same language**

SUBSET CONSTRUCTION ALGORITHM

Method:

- Let s be a state in ***"N"*** and ***"T"*** be a set of states, and using the following operations:

Operation	Definition
ε-*closure*(s)	set of NFA states reachable from NFA state s on ε-transitions alone
ε-*closure*(T)	set of NFA states reachable from some NFA state s in T on ε-transitions alone
move(T, a)	set of NFA states to which there is a transition on input symbol a from some NFA state s in T

SUBSET CONSTRUCTION

(MAIN ALGORITHM)

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add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

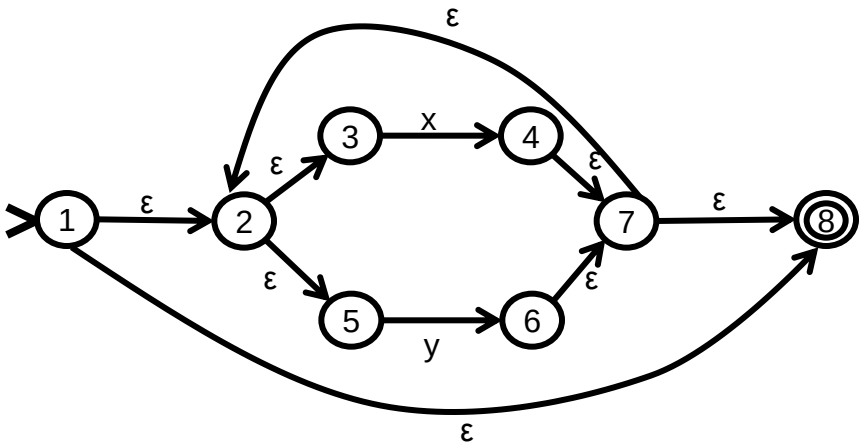
SUBSET CONSTRUCTION

(E-CLOSURE COMPUTATION)

push all states in *T* onto stack
initialize *ε-closure(T)* to *T*
while *stack* is not empty
    pop t, the top element off the stack
    for each state *u* with an edge from *t* to *u* labeled ε
        if *u* is not in *ε-closure(T)*
            add *u* to *ε-closure(T)*
            push *u* onto stack
        endif
    endfor
endwhile

CONVERSION EXAMPLE

Regular Expression:
(x | y)*



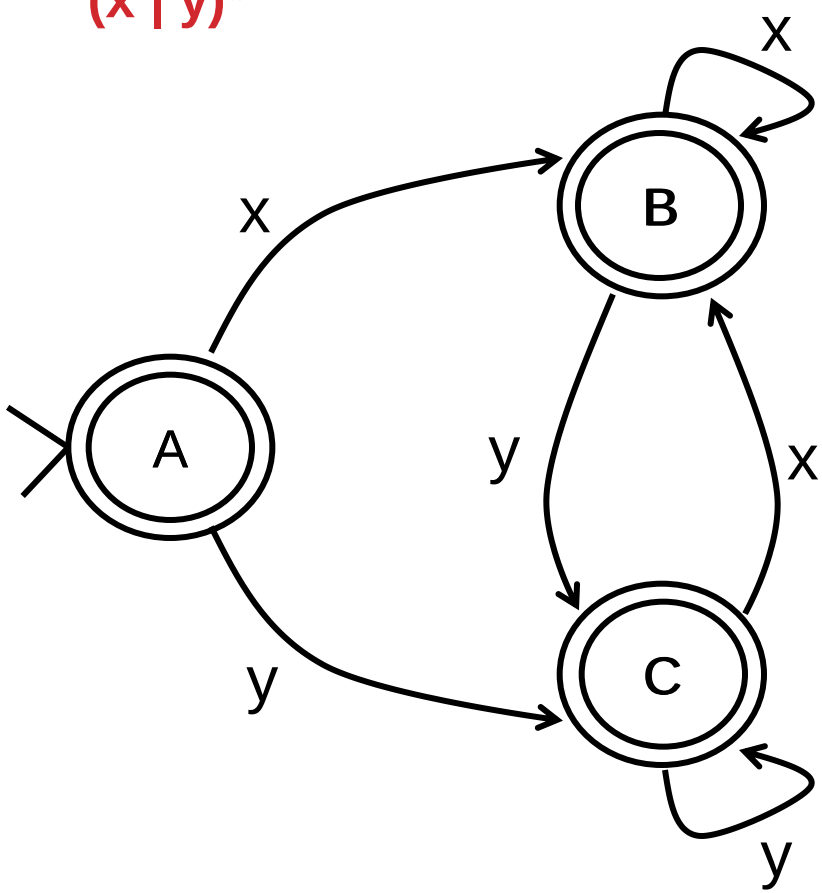
Dstates={A,B,C}, where

- A = (1,2,3,5,8)
- B = (2,3,4,5,7,8)
- C = (2,3,5,6,7,8)

	x	y
A	B	C
B	B	C
C	B	C

CONVERSION EXAMPLE

Regular Expression:
(x | y)*

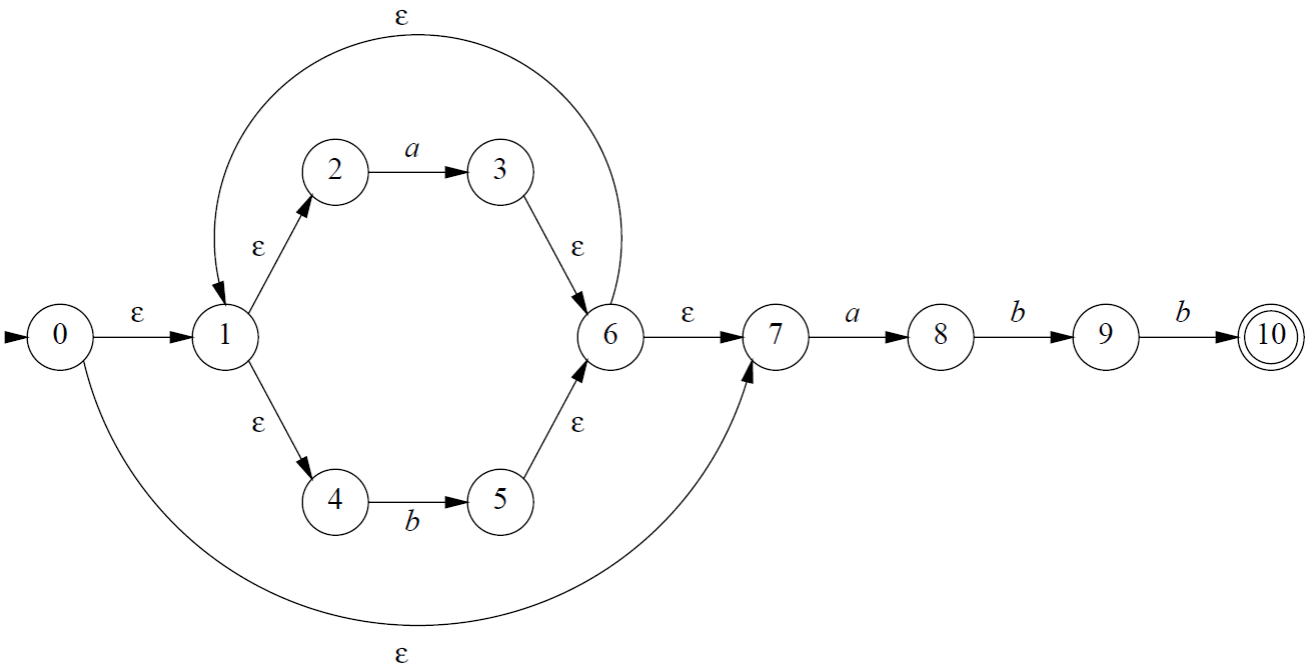


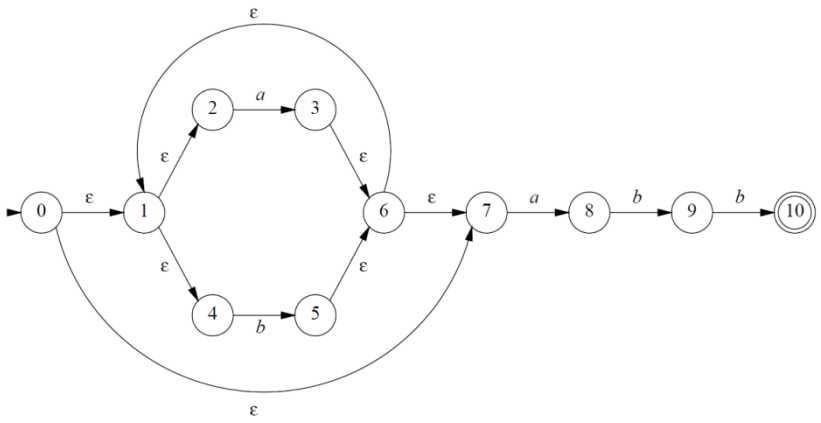
	x	y
A	B	C
B	B	C
C	B	C

ANOTHER CONVERSION EXAMPLE

Regular Expression:

(a | b)*abb





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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
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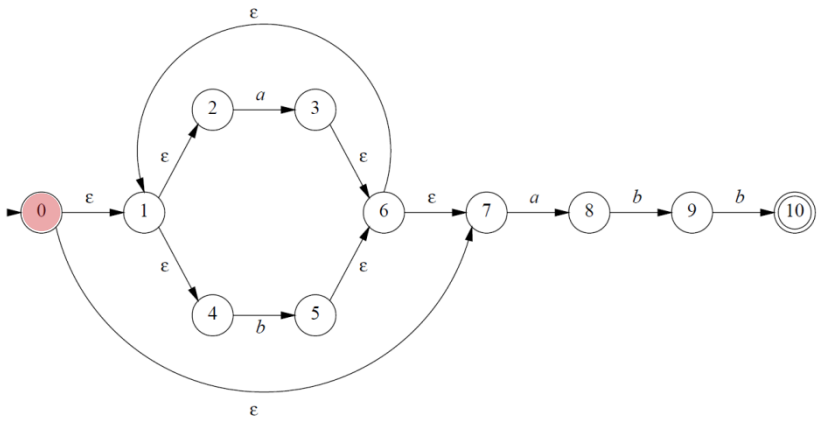
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = ε-closure(0)



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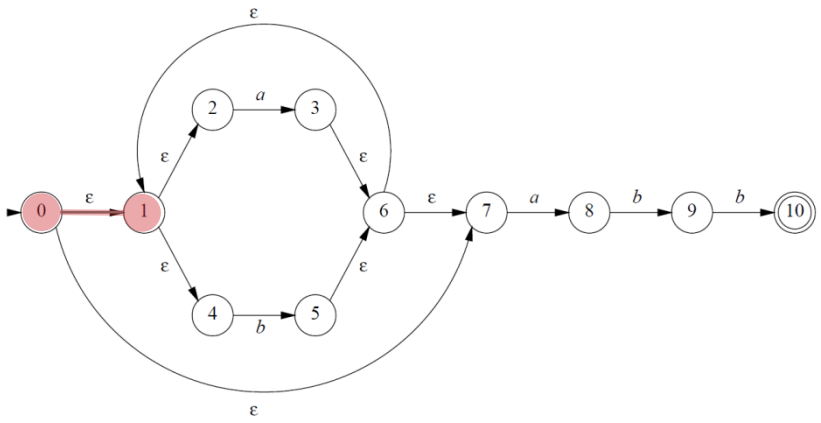
T = ε-closure(0)
  = {0,



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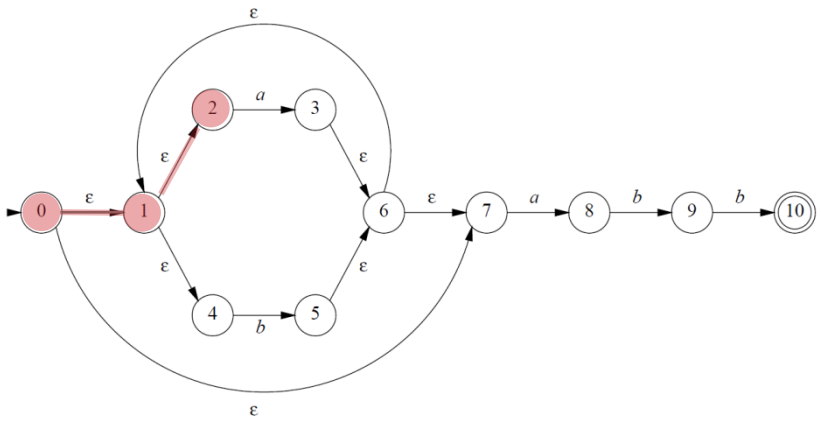
A state of D is accepting if it contains at least one accepting state in N

T = ε-closure(0)
  = {0,1,



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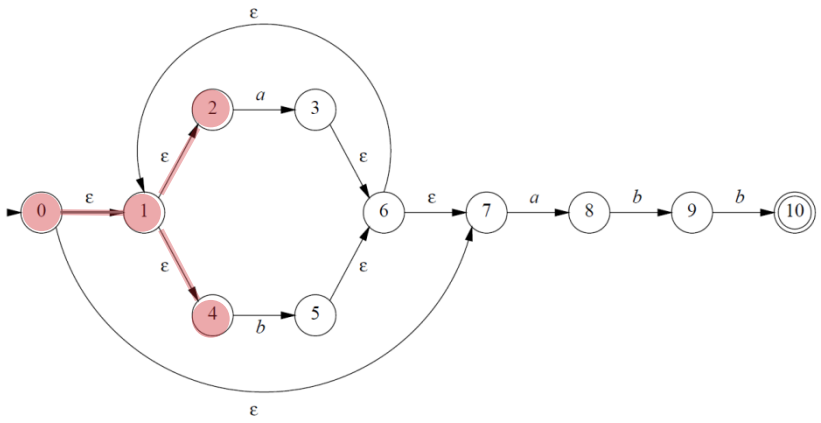
T = ε-closure(0)
  = {0,1,2,



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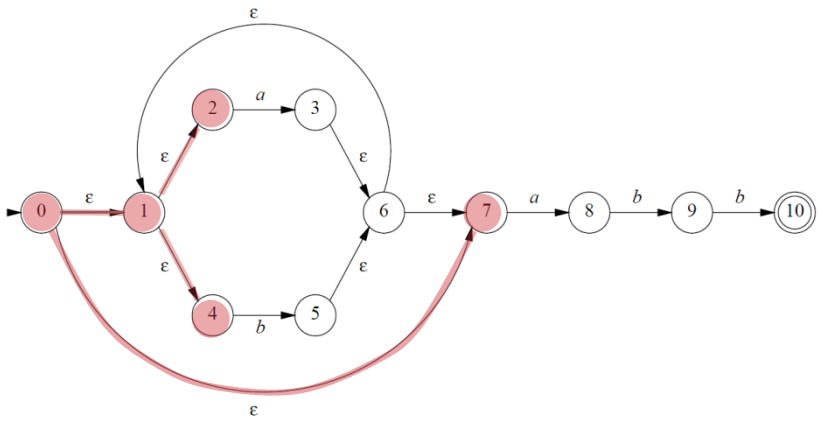
T = ε-closure(0)
  = {0,1,2,4,



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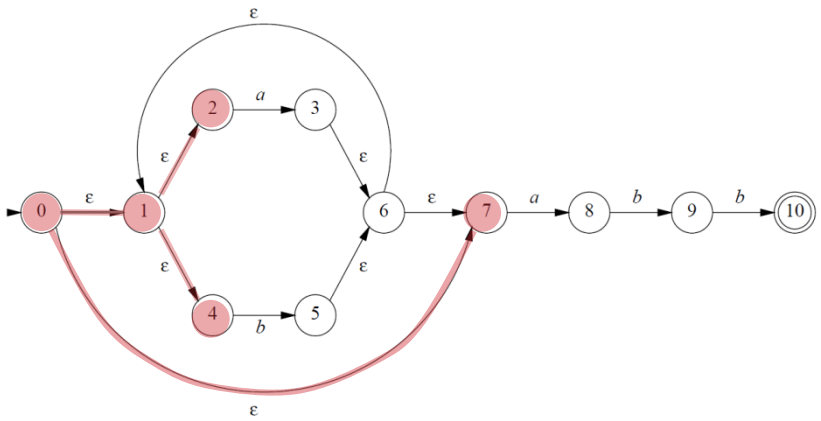
  = {0,1,2,4,7}



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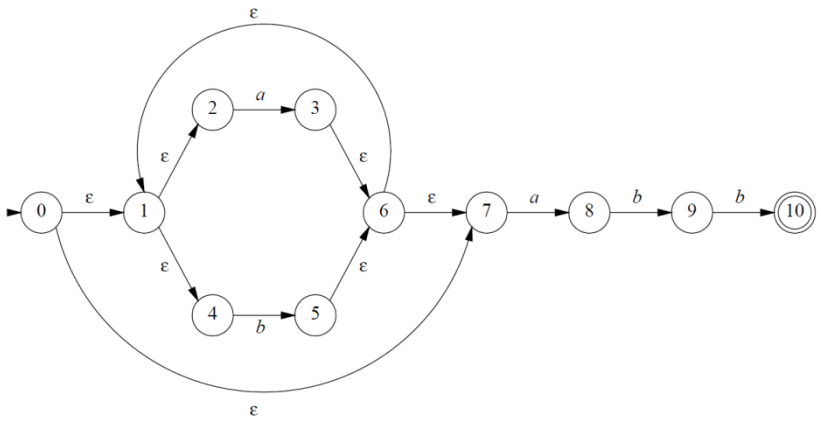
T = ε-closure(0)
= {0,1,2,4,7} = A

Dstates:

A □

Cheat Sheet

A = {0,1,2,4,7}



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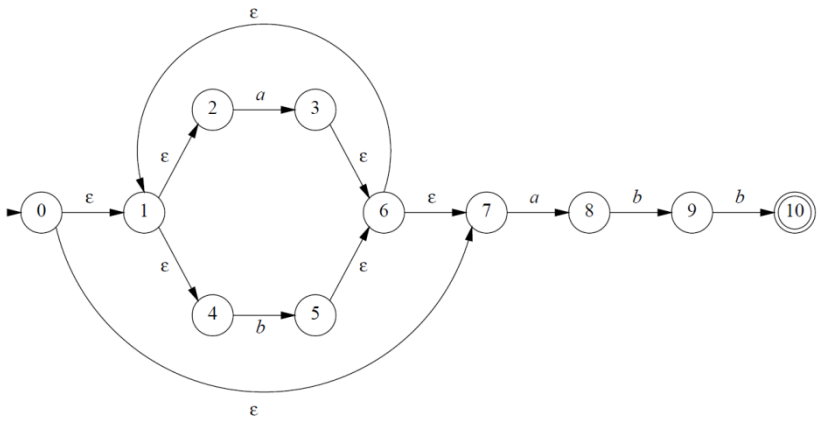

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Dstates:
A ☑

Cheat Sheet

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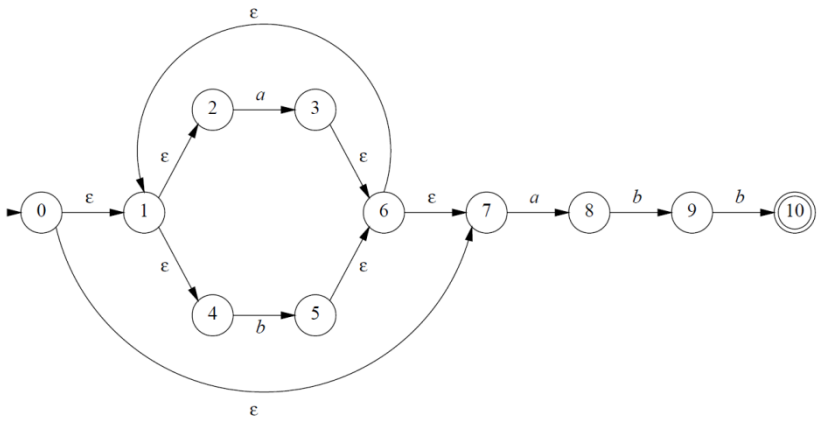

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Dstates:
A ☑

Cheat Sheet

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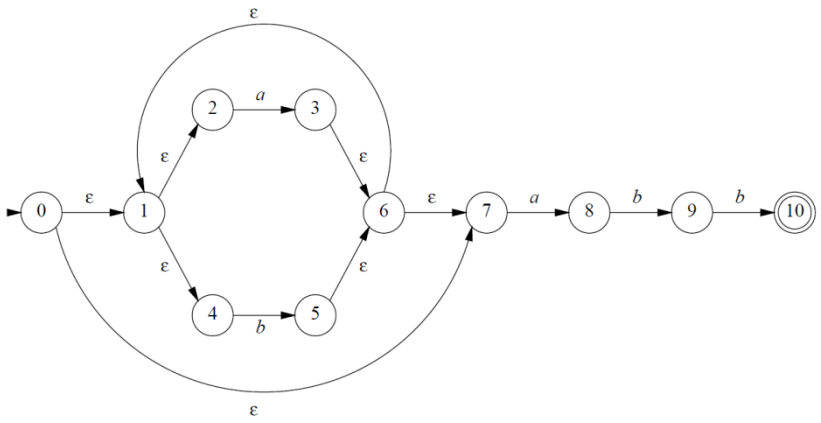

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T = ε-closure(0)
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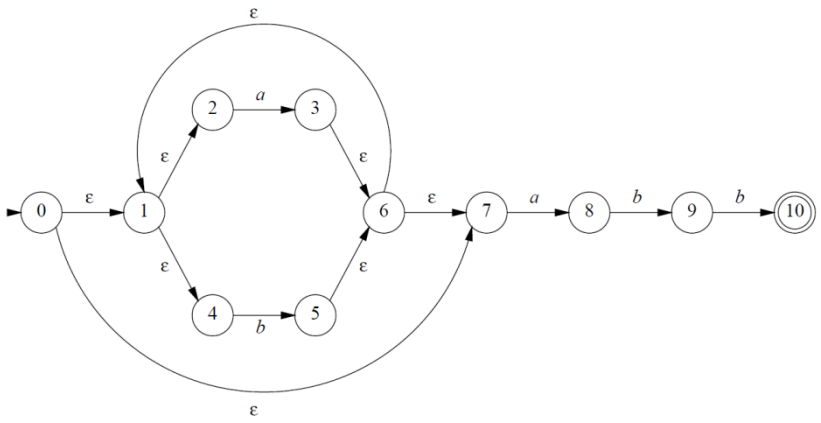
Dstates:
A ☑

U = ε-closure(move(T,a))

Cheat Sheet

A = {0,1,2,4,7}



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Dstates:
A ☑

U = ε-closure(move(T,a))
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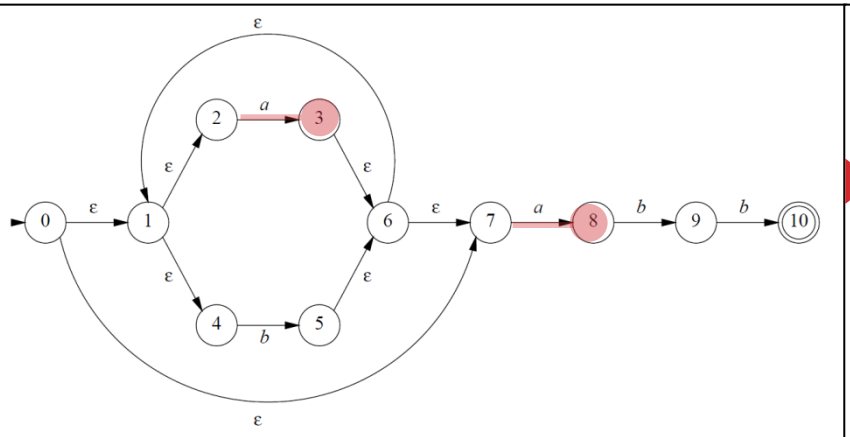
Cheat Sheet

A = {0,1,2,4,7}



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Dstates:
A ☑

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Cheat Sheet

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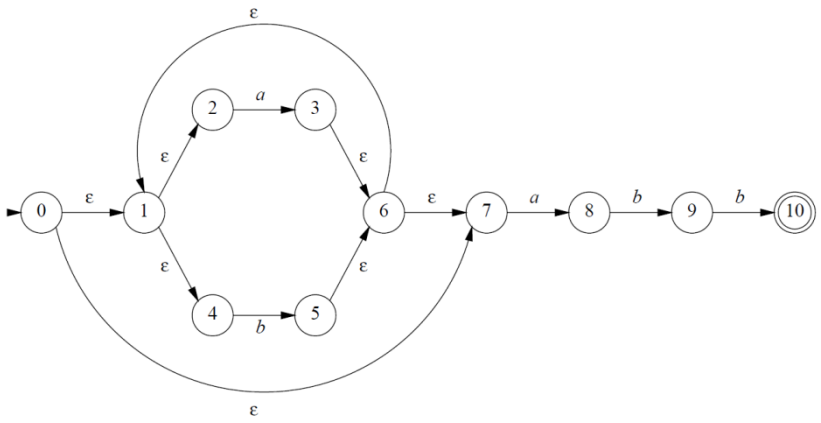

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A state of D is accepting if it contains at least one accepting state in N

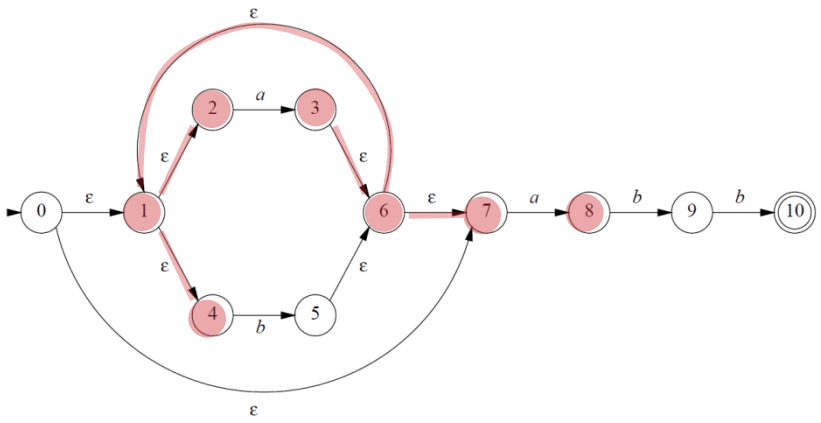
T = ε-closure(0)
  = {0,1,2,4,7} = A

Dstates:
A ☑

U = ε-closure(move(T,a))
  = ε-closure(move({0,1,2,4,7},a))
  = ε-closure({3,8})

Cheat Sheet

A = {0,1,2,4,7}



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T = ε-closure(0)
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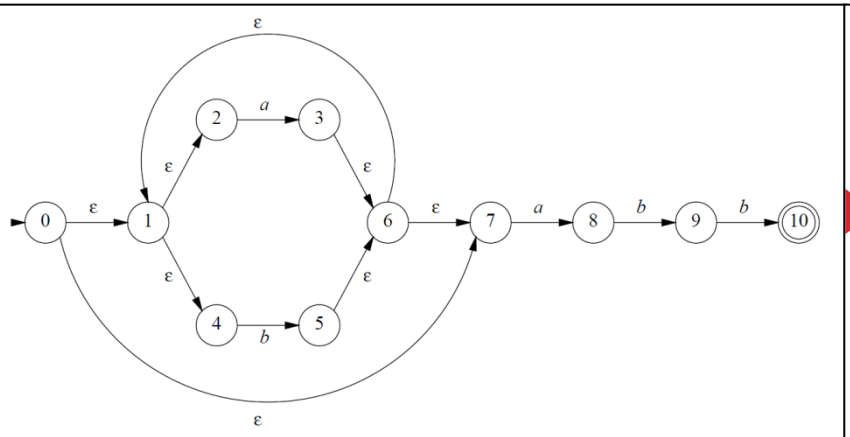
Dstates:

A ☑

U = ε-closure(move(T,a))
  = ε-closure(move({0,1,2,4,7},a))
  = ε-closure({3,8})
  = {1,2,3,4,6,7,8}

Cheat Sheet

A = {0,1,2,4,7}



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    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = ε-closure(0)
  = {0,1,2,4,7} = A

U = ε-closure(move(T,a))
  = ε-closure(move({0,1,2,4,7},a))
  = ε-closure({3,8})
  = {1,2,3,4,6,7,8} = B

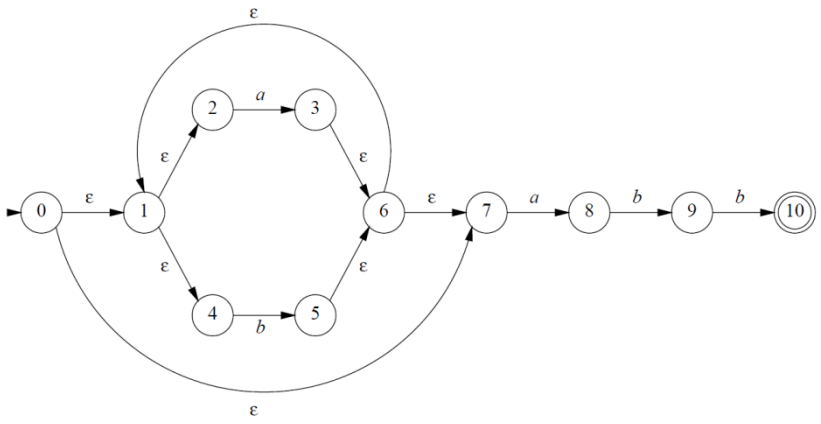
Dstates:

A	☑
B	☐

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}

ε-closure({3,8}) = B



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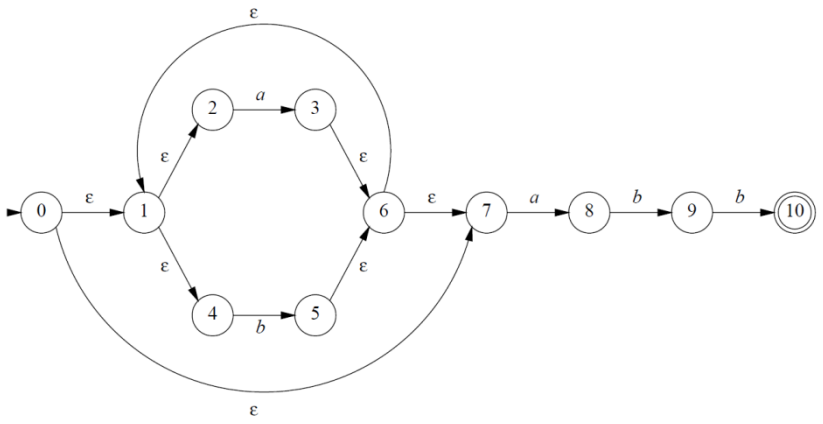

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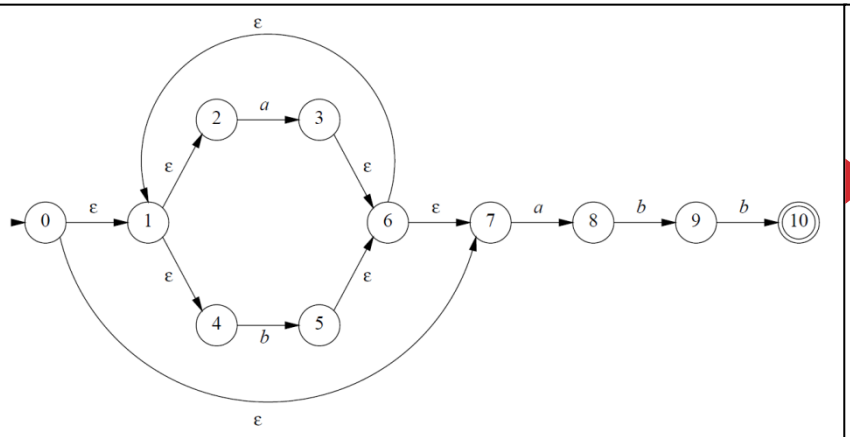

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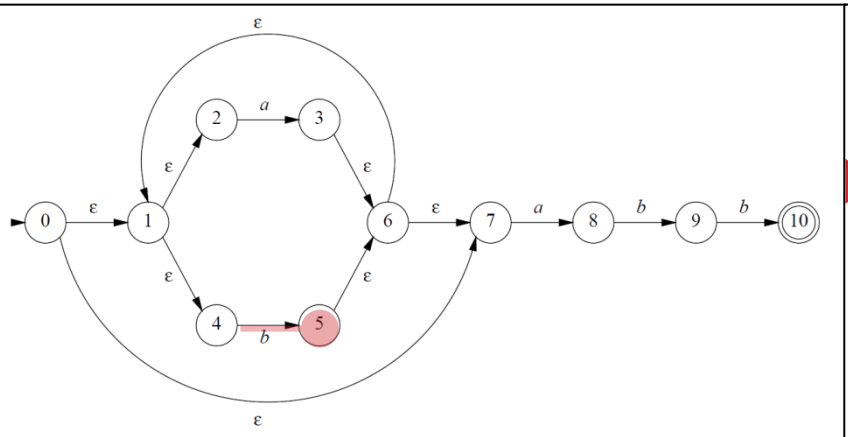

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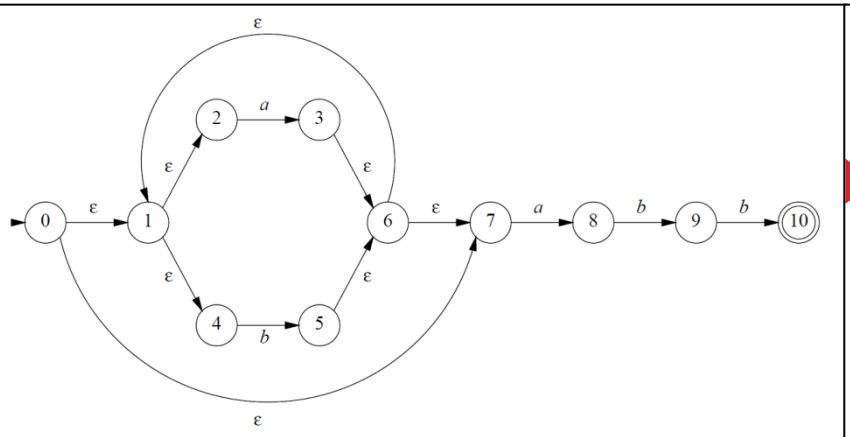

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Dstates:

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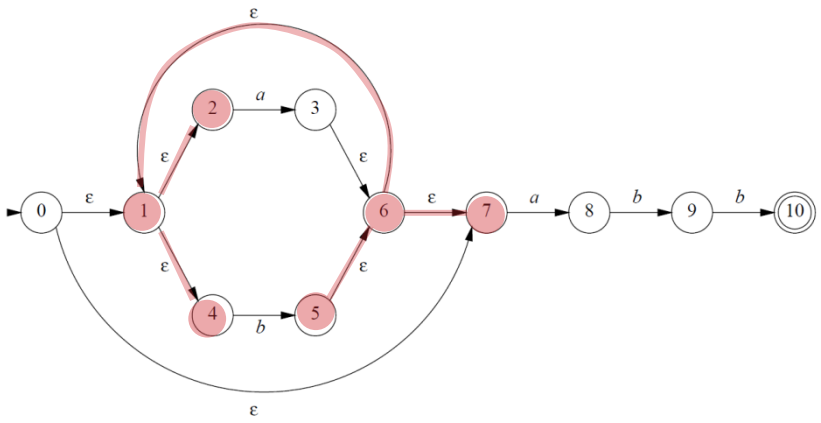

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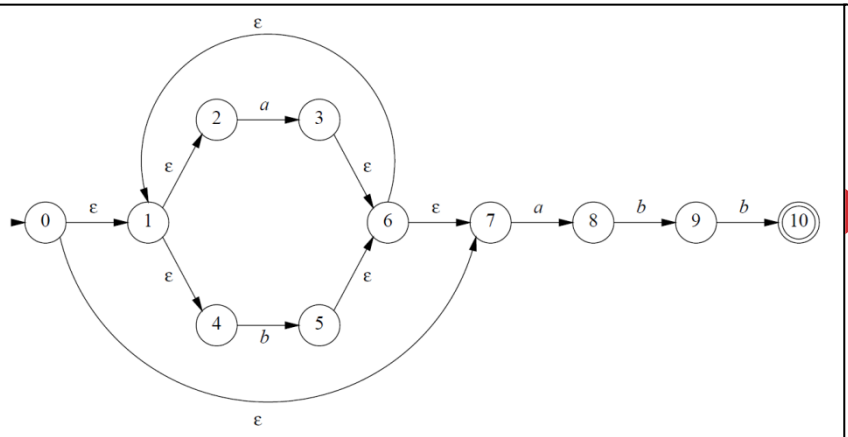

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Dstates:

A	☑
B	☐
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	a	b
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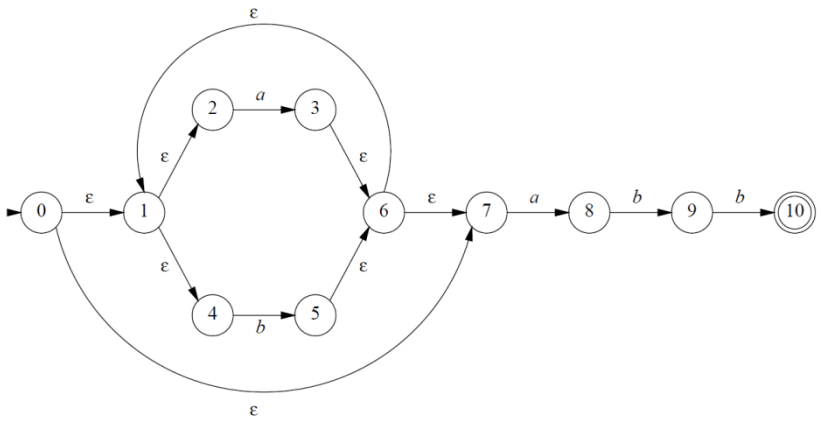

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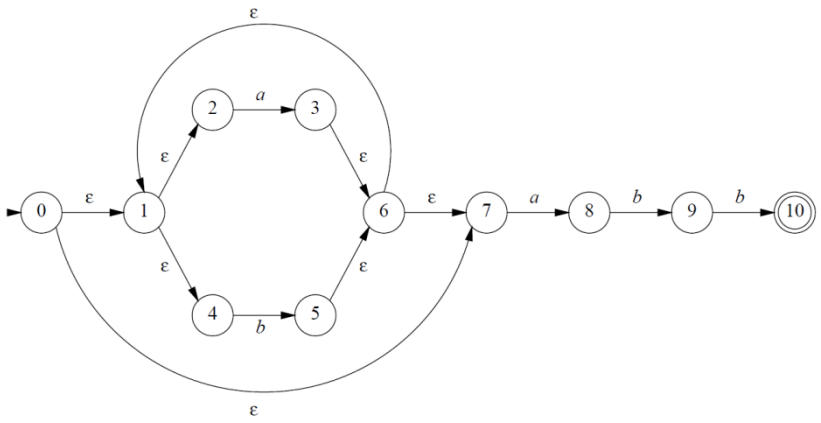

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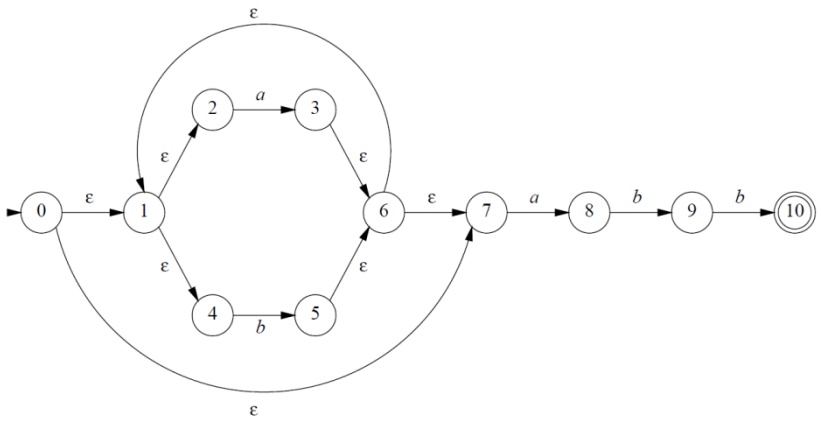

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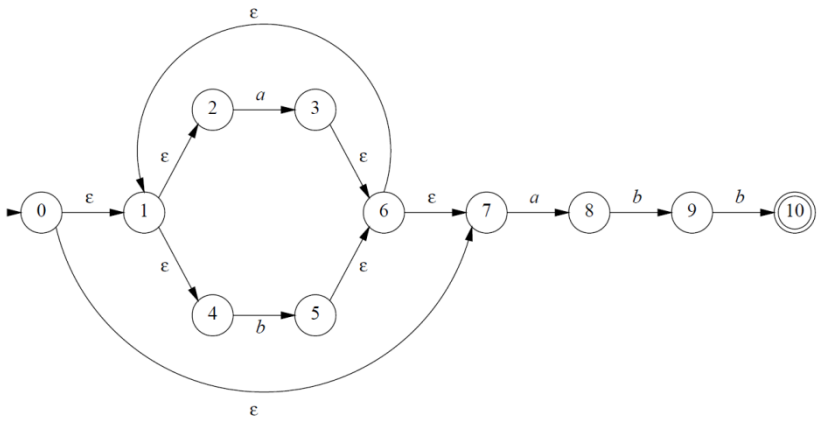

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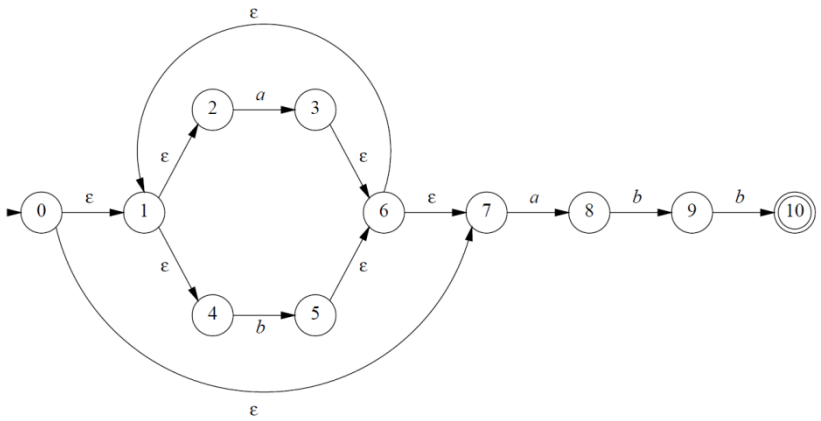

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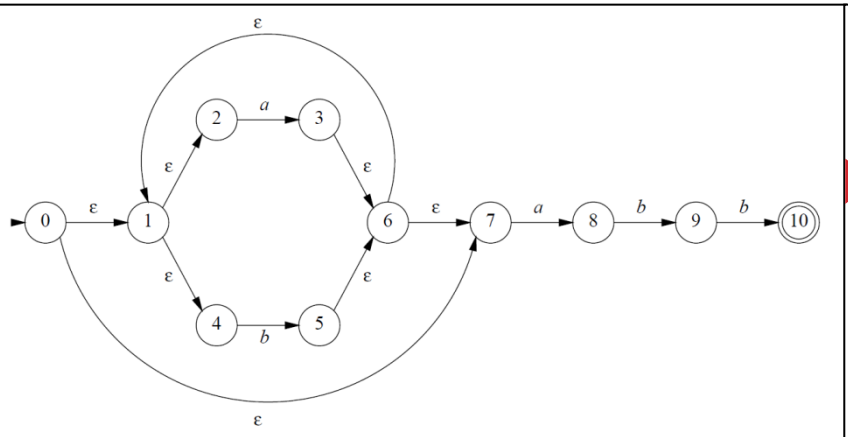

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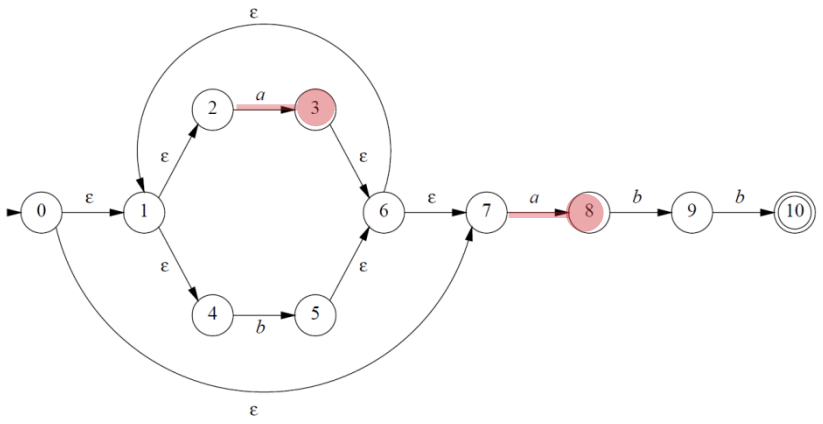

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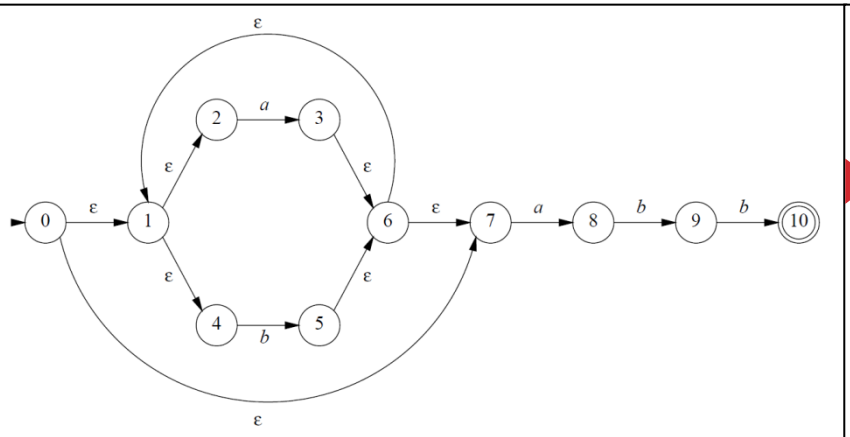

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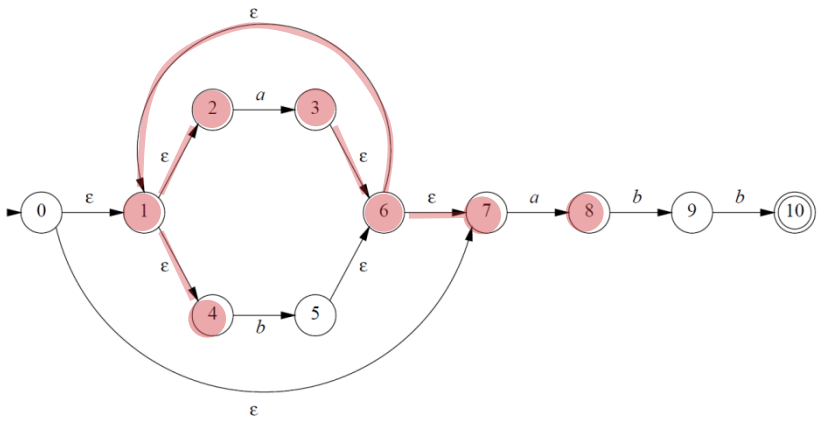

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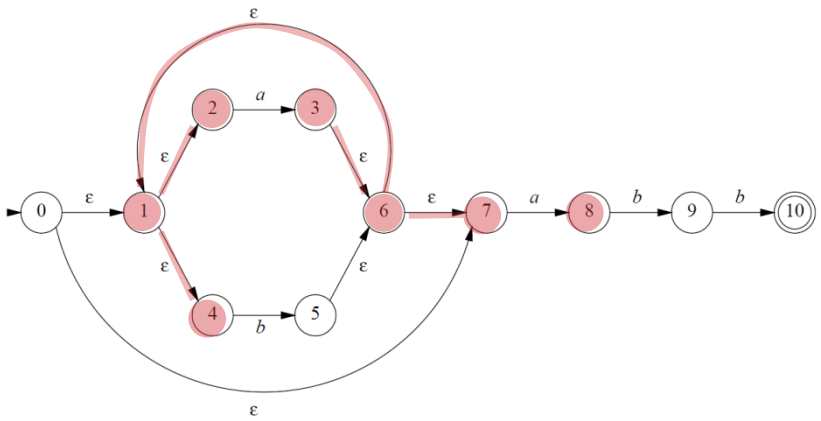

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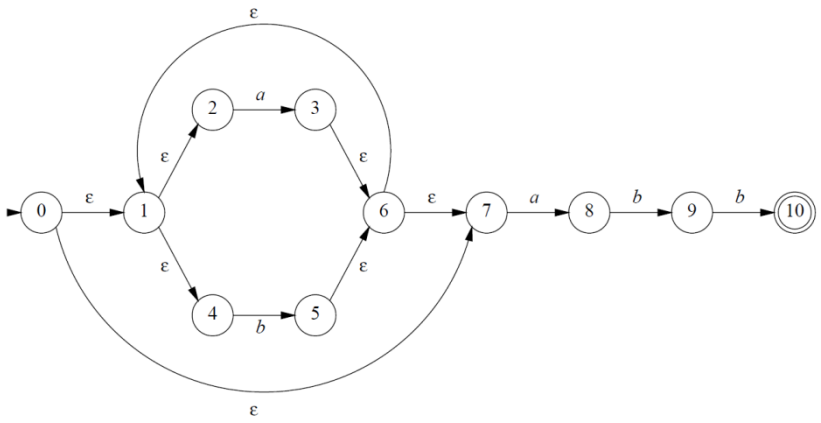


add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,a))
= ε-closure(move({1,2,3,4,6,7,8},a))
= ε-closure({3,8})
= {1,2,3,4,6,7,8} = B

Dstates:

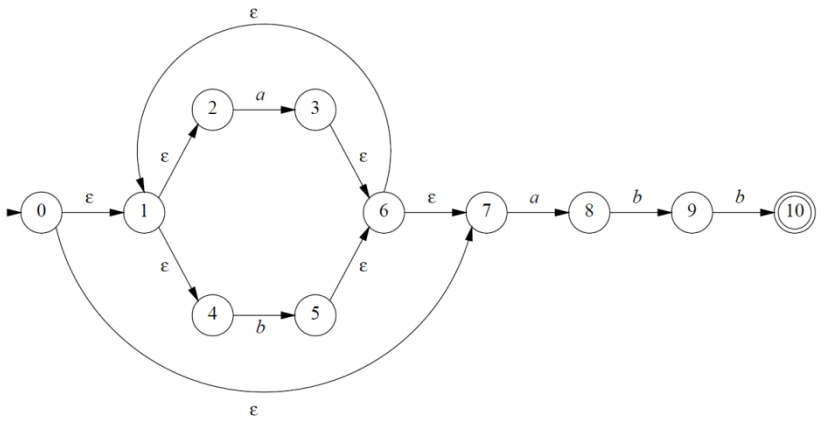
A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}

ε-closure({3,8}) = B
ε-closure({5}) = C



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while $\exists$ unmarked state T in *Dstates*
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        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

Dstates:

A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
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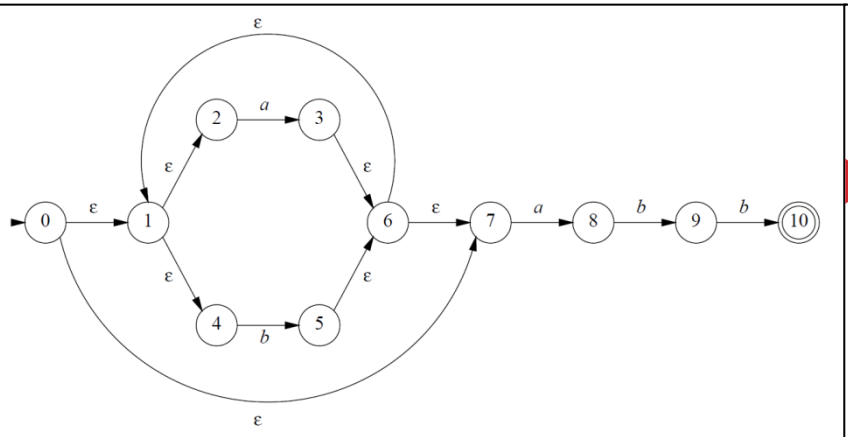


add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))

Dstates:

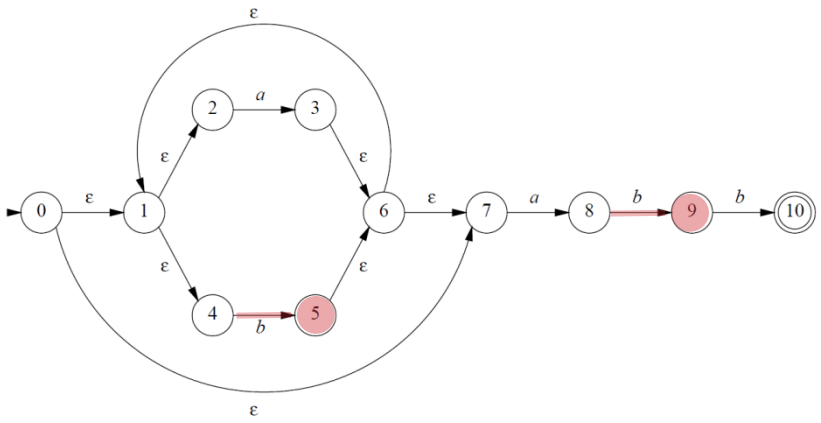
A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}

ε-closure({3,8}) = B
ε-closure({5}) = C



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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))

Dstates:

A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
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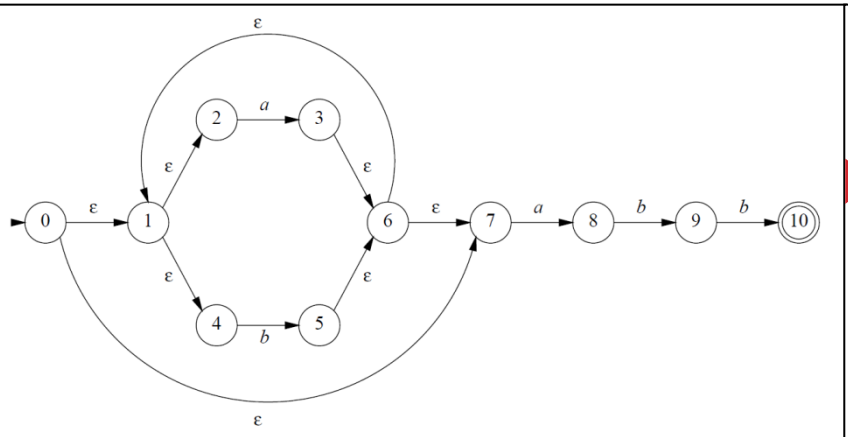

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        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))
= ε-closure({5, 9})

Dstates:

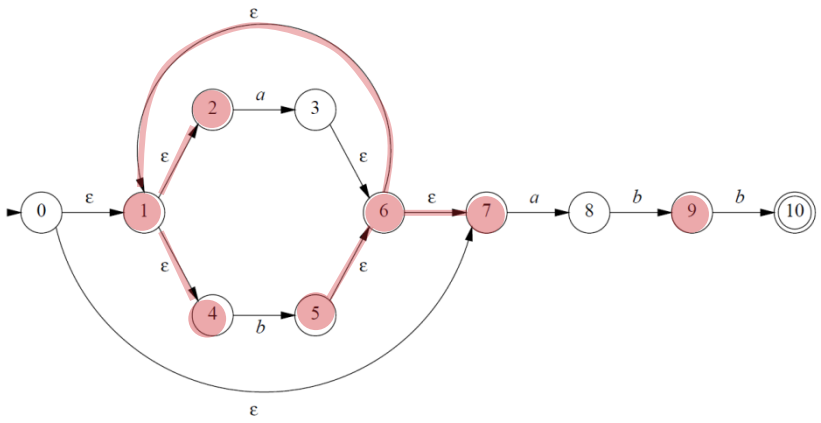
A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}

ε-closure({3,8}) = B
ε-closure({5}) = C



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    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))
= ε-closure({5, 9})

Dstates:

A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
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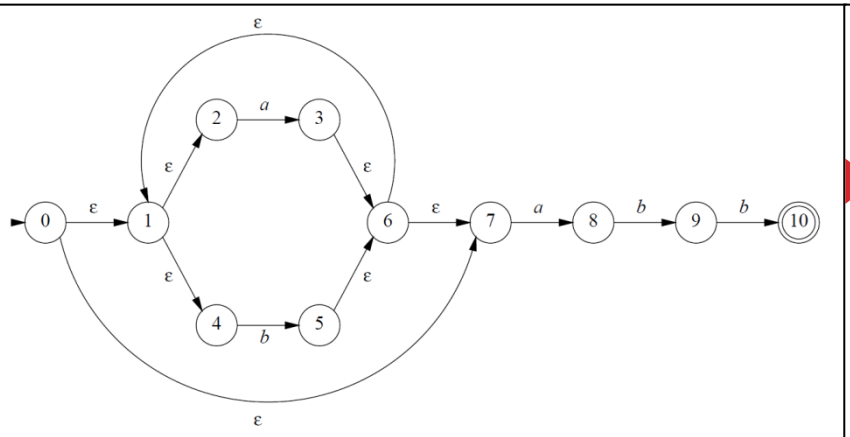

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        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))
= ε-closure({5, 9})
= {1,2,4,5,6,7,9}

Dstates:

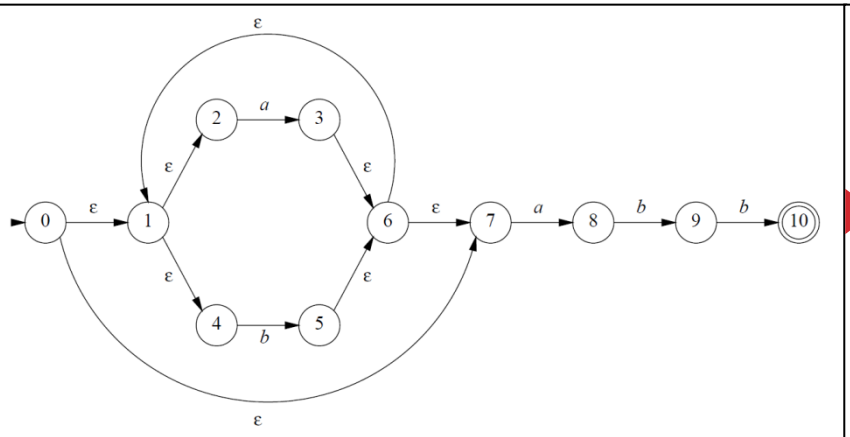
A	☑
B	☑
C	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}

ε-closure({3,8}) = B
ε-closure({5}) = C



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))
= ε-closure({5, 9})
= {1,2,4,5,6,7,9} = D

Dstates:

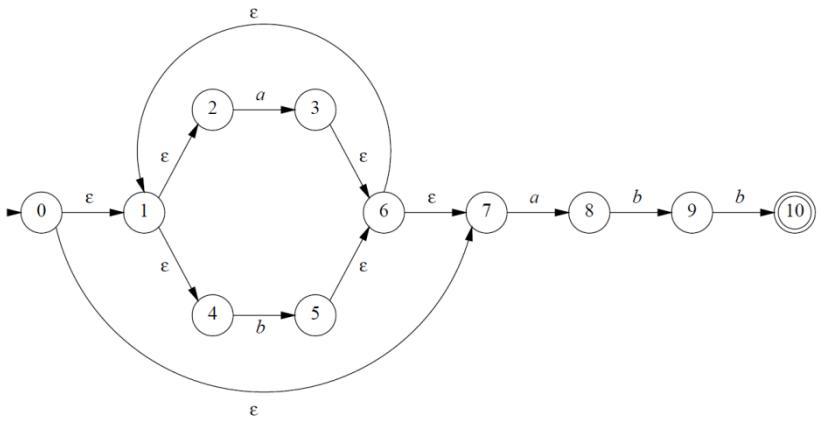
A	☑
B	☑
C	☐
D	☐

	a	b
A	B	C
B	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

U = ε-closure(move(T,b))
= ε-closure(move({1,2,3,4,6,7,8},b))
= ε-closure({5, 9})
= {1,2,4,5,6,7,9} = D

Dstates:

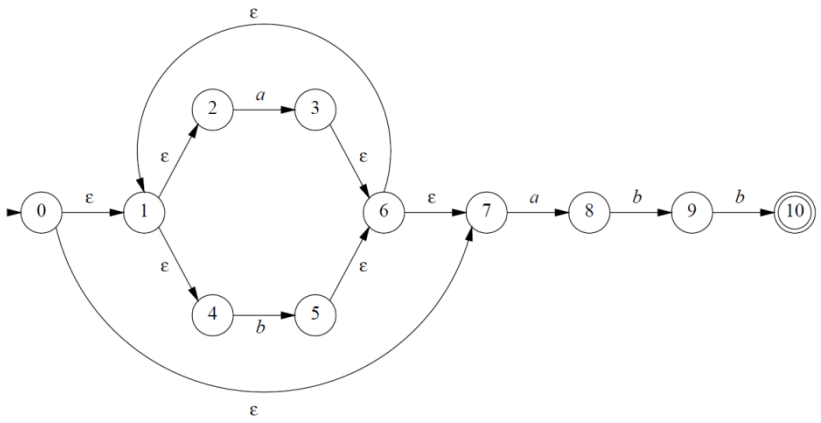
A	☑
B	☑
C	☐
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = B

Dstates:

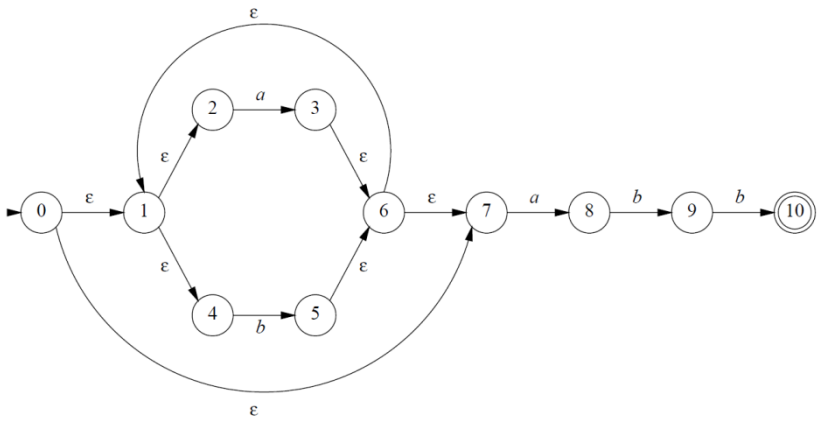
A	☑
B	☑
C	☐
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

Dstates:

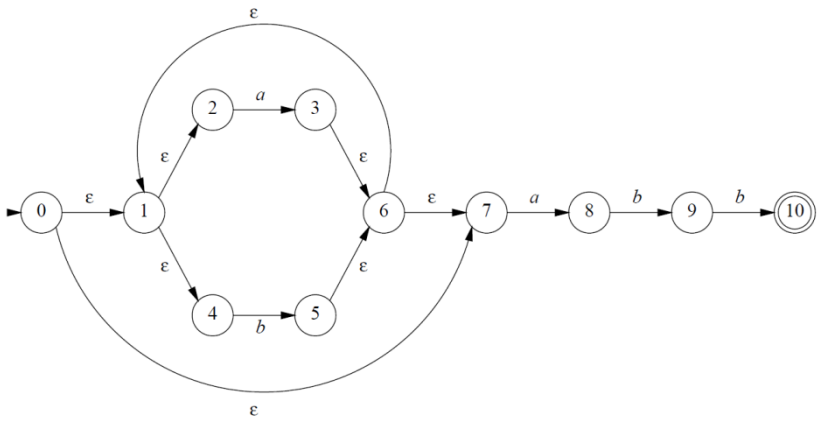
A	☑
B	☑
C	☐
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



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    for each input symbol a
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        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
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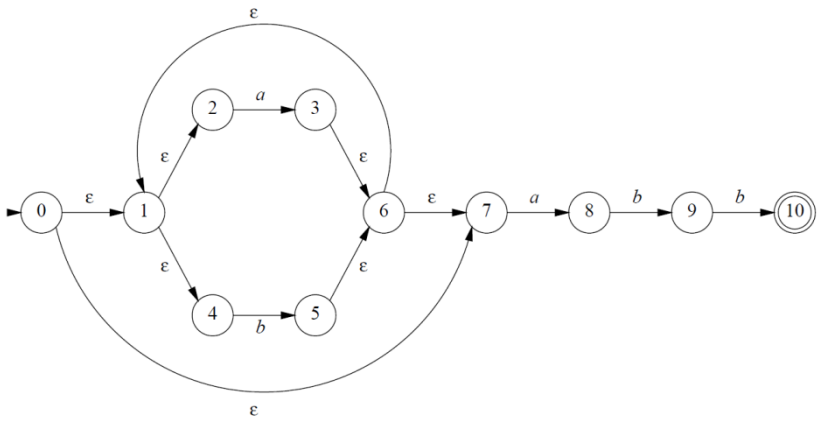
ε-closure({5,9}) = D



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    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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ε-closure({3,8}) = B
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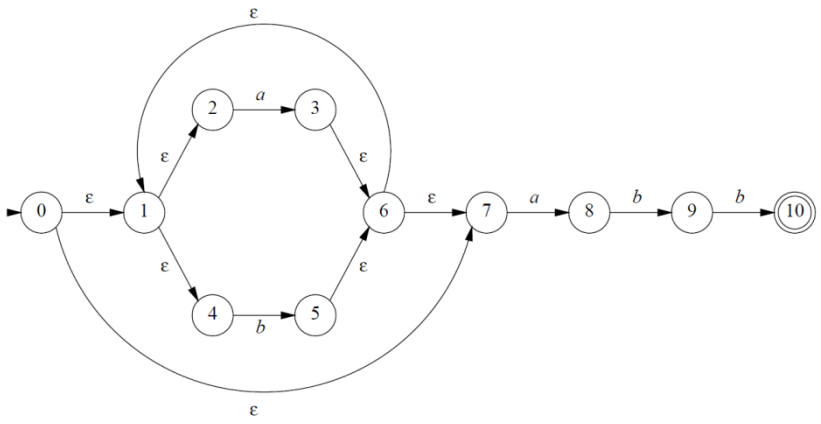

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        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7},a))

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
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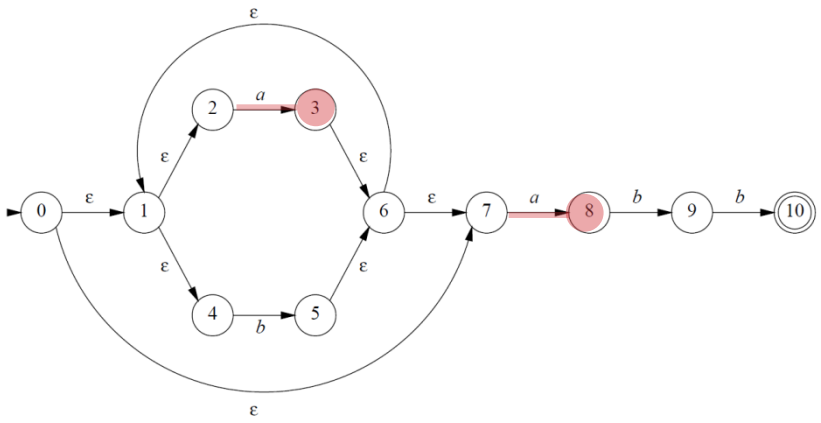

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    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7},a))
= ε-closure({3,8})

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
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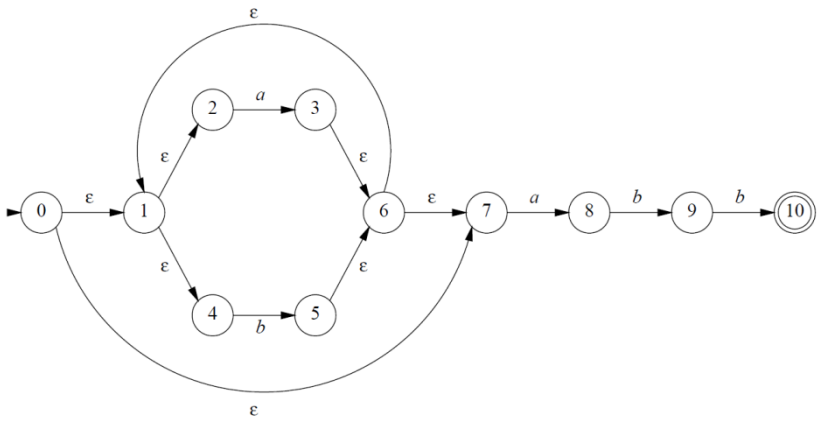

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        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7},a))
= ε-closure({3,8}) = B

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
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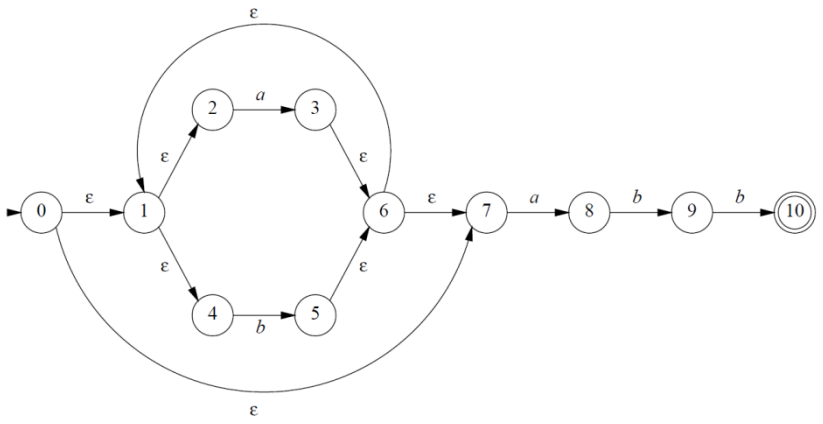

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        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7},a))
= ε-closure({3,8}) = B

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D

Cheat Sheet

A = {0,1,2,4,7}
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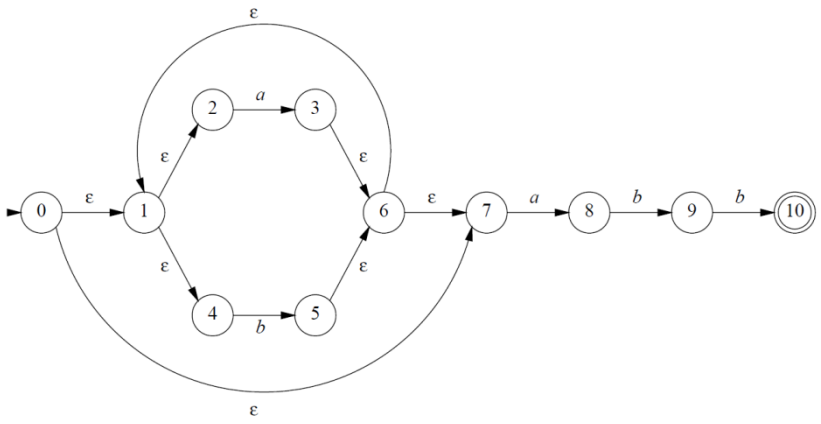
ε-closure({5}) = C
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7},a))
= ε-closure({3,8}) = B

Dstates:

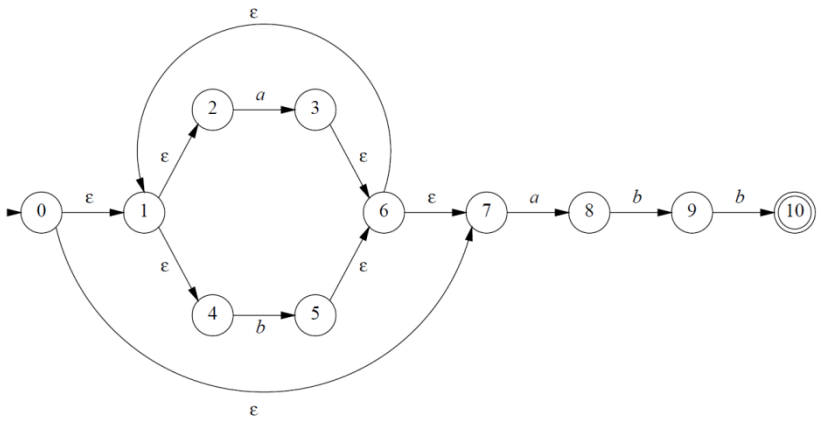
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

Dstates:

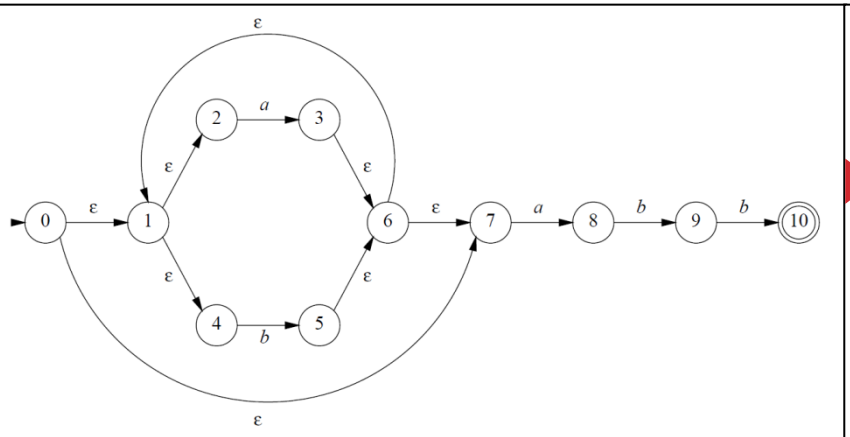
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7},b))

Dstates:

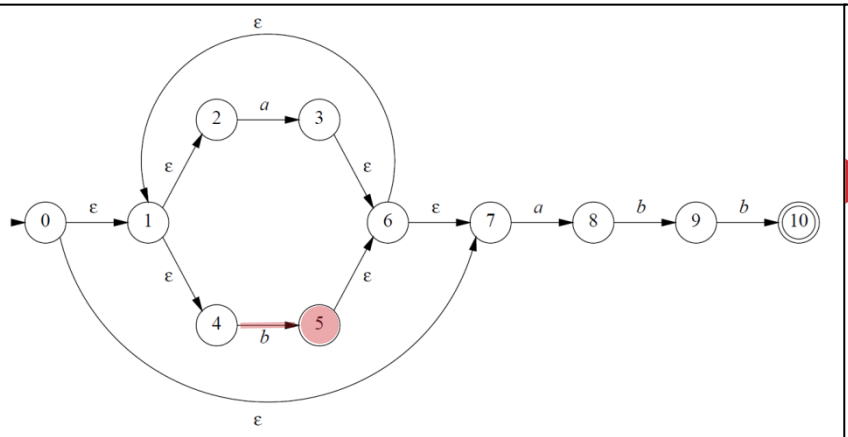
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T,a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T,a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7},b))
= ε-closure(5)

Dstates:

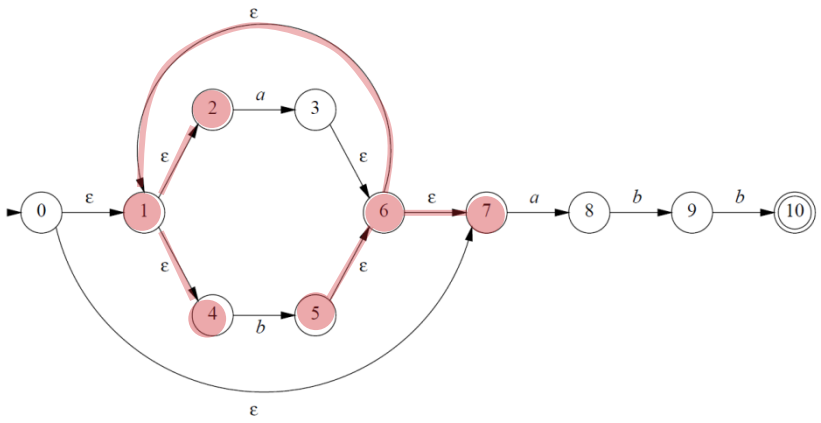
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7},b))
= ε-closure(5) = C

Dstates:

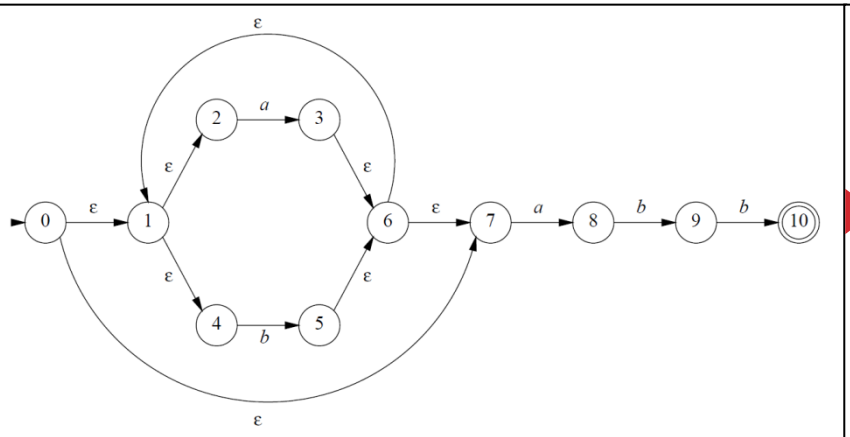
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7},b))
= ε-closure(5) = C

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
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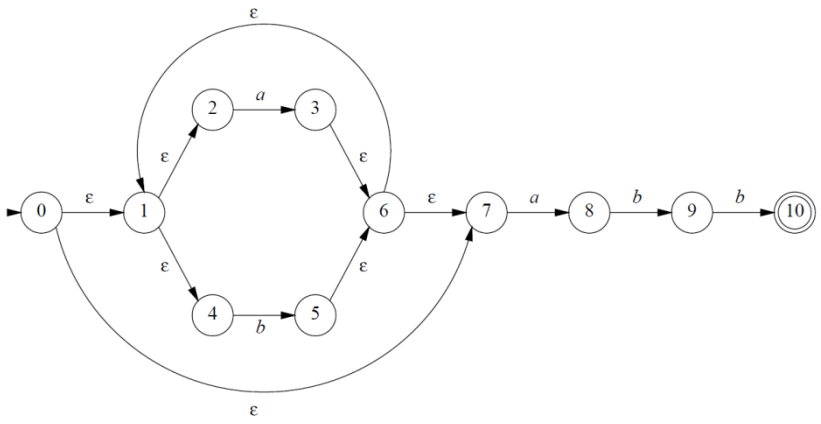
ε-closure({5,9}) = D



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7},b))
= ε-closure(5) = C

Dstates:

A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

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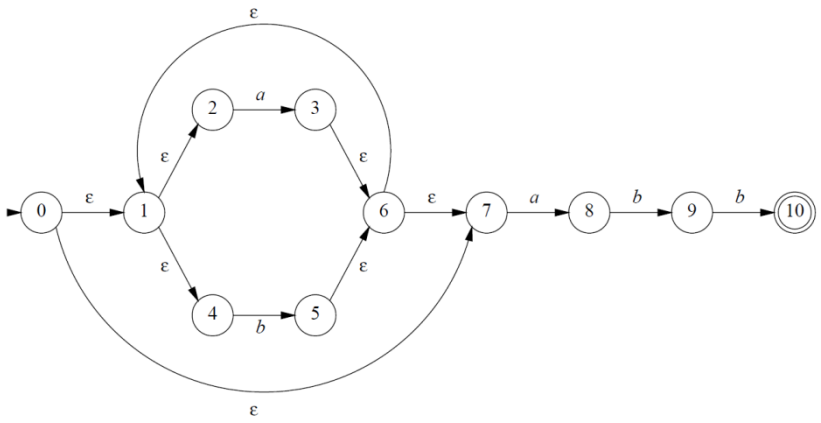
ε-closure({5}) = C
ε-closure({5,9}) = D



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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = C

Dstates:

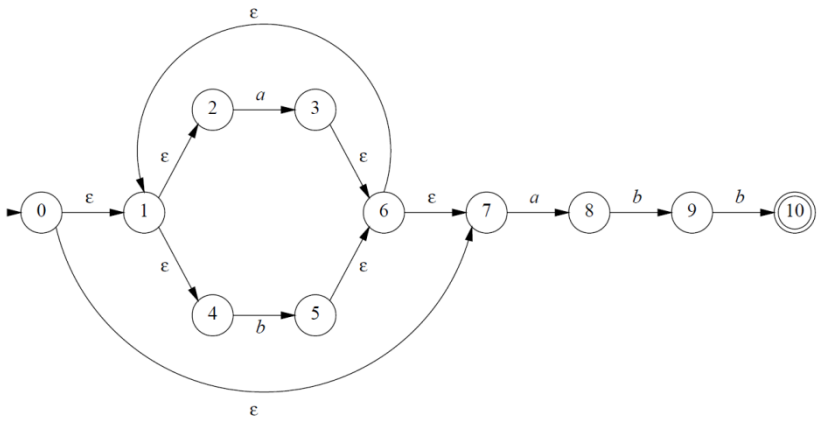
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

Dstates:

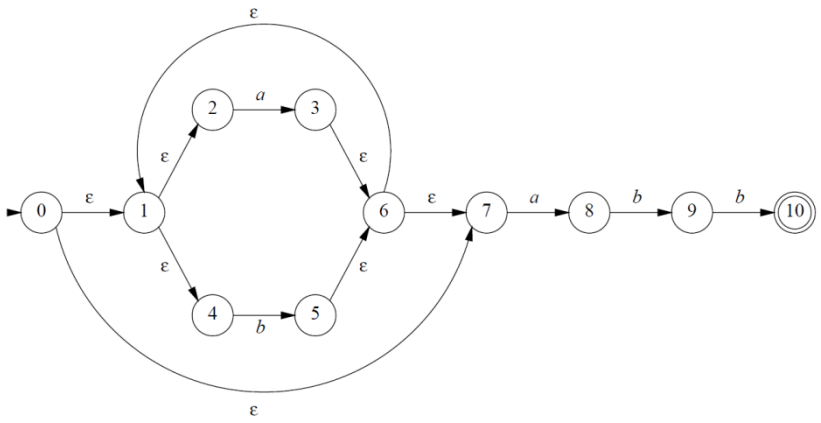
A	☑
B	☑
C	☑
D	☐

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D



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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

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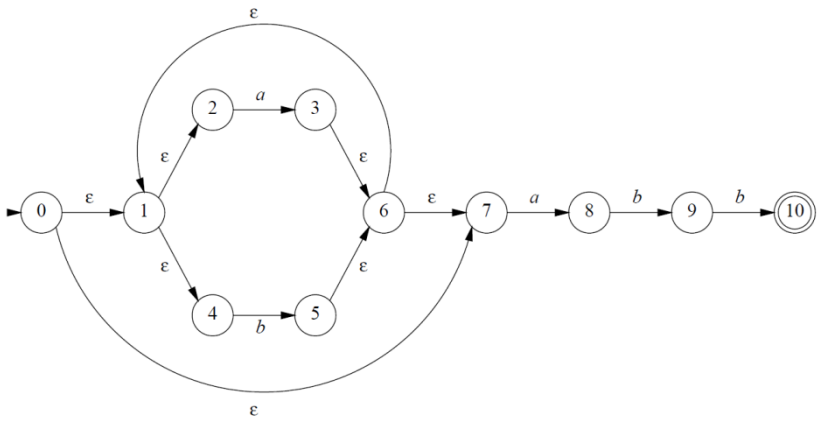

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        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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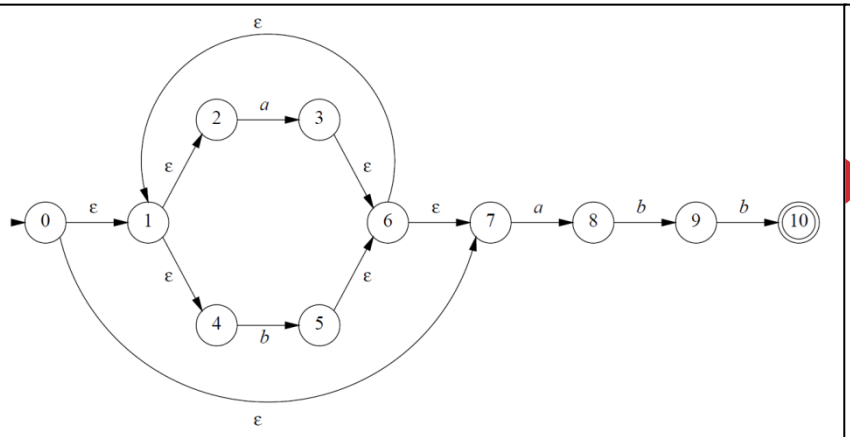

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        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,9},a))

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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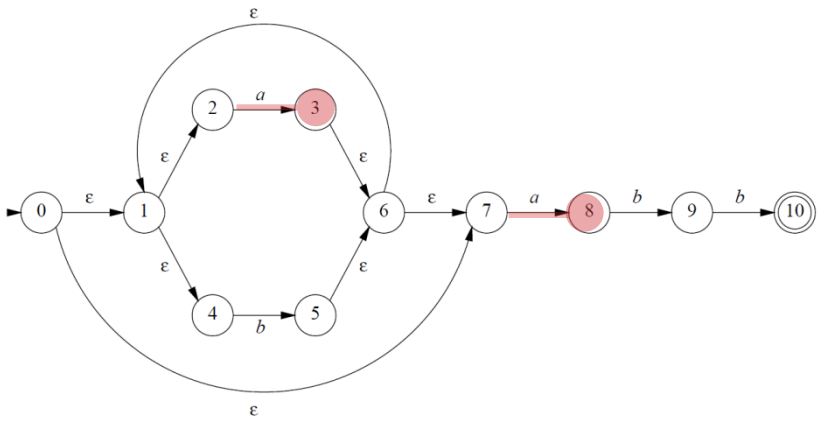

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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,9},a))

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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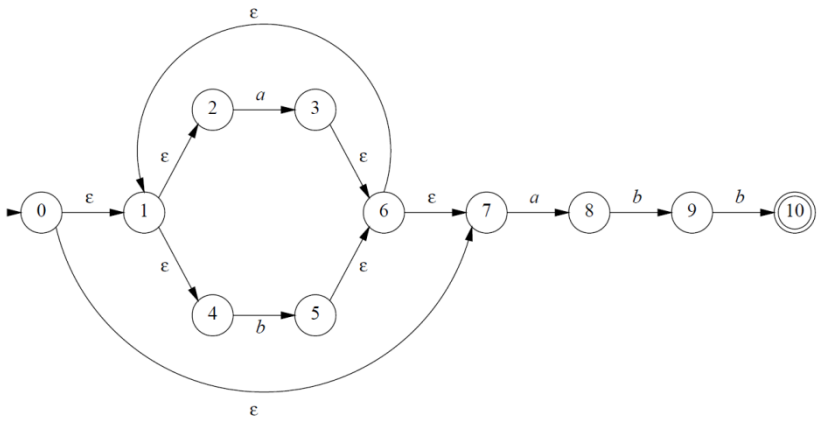

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    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,9},a))
= ε-closure({3,8})

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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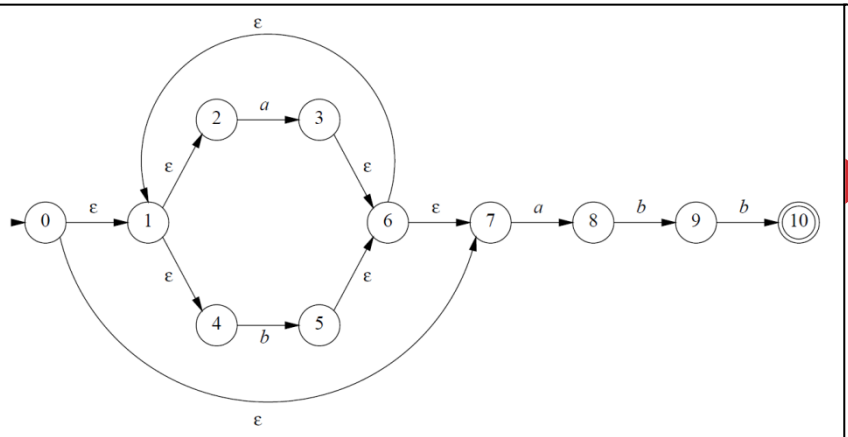

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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,9},a))
= ε-closure({3,8}) = B

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
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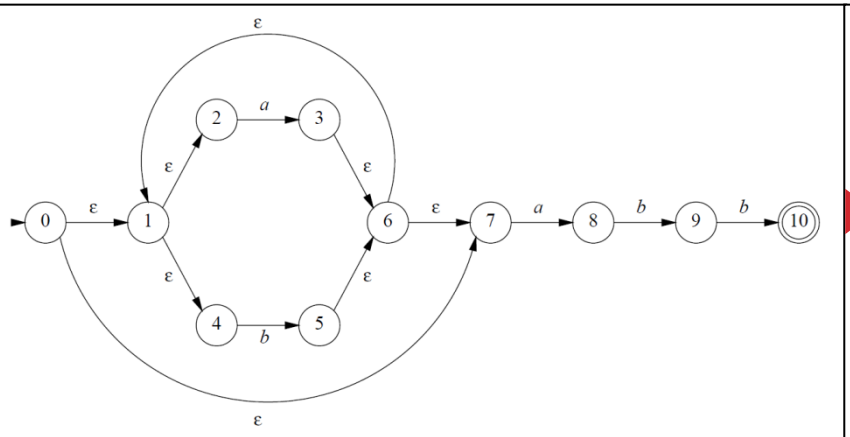
ε-closure({5,9}) = D



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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,9},a))
= ε-closure({3,8}) = B

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

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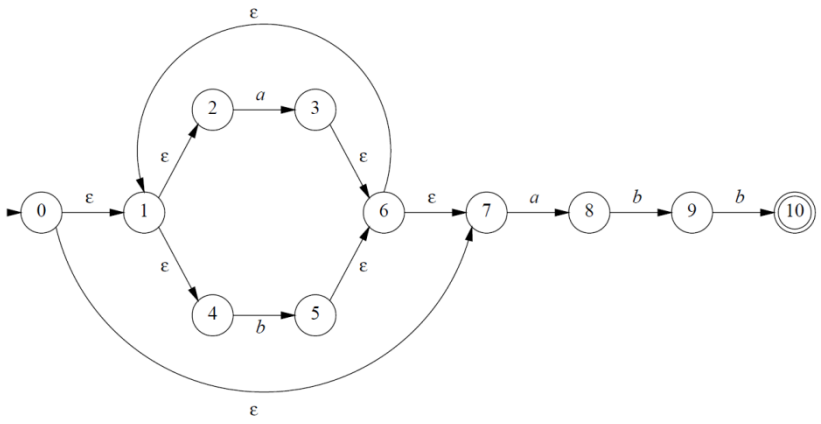

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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,9},a))
= ε-closure({3,8}) = B

Dstates:

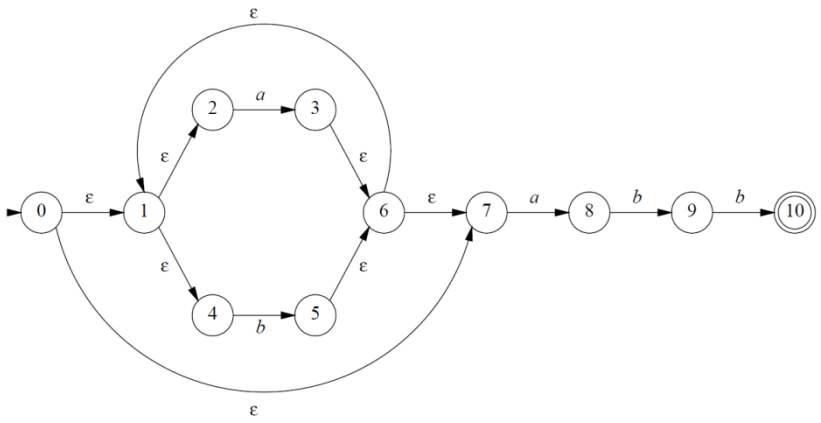
A	☑
B	☑
C	☑
D	☑

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D

	a	b
A	B	C
B	B	D
C	B	C
D	B	



add state $T = \varepsilon\text{-}closure(s_0)$ unmarked to *Dstates*
while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
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D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
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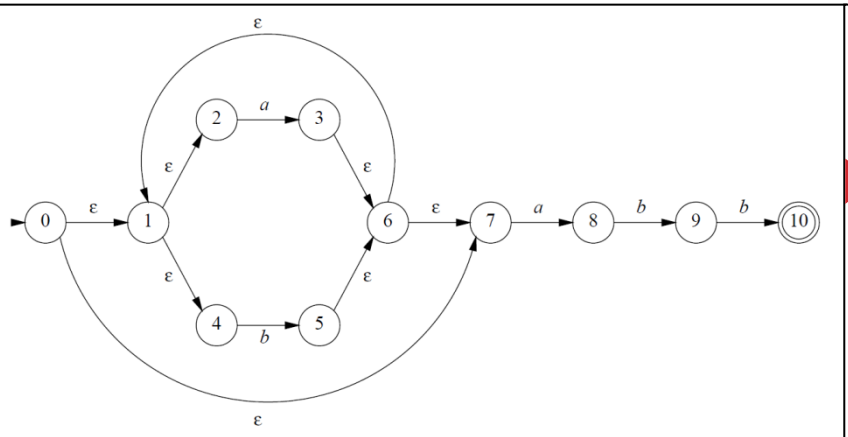
ε-closure({5,9}) = D



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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,9},b))

Dstates:

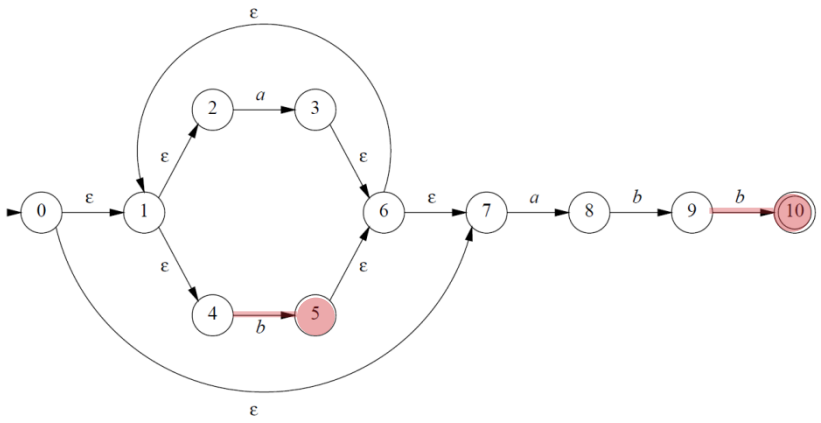
A	☑
B	☑
C	☑
D	☑

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D

	a	b
A	B	C
B	B	D
C	B	C
D	B	



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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T,a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T,a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,9},b))

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
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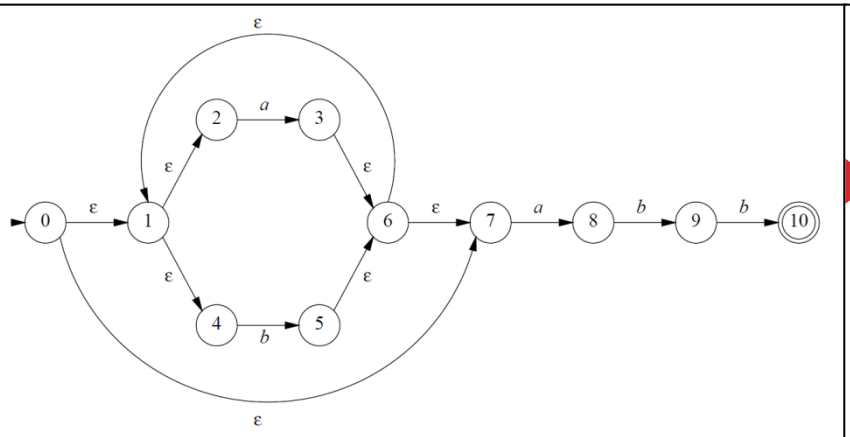
ε-closure({5,9}) = D



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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,9},b))
= ε-closure({5,10})

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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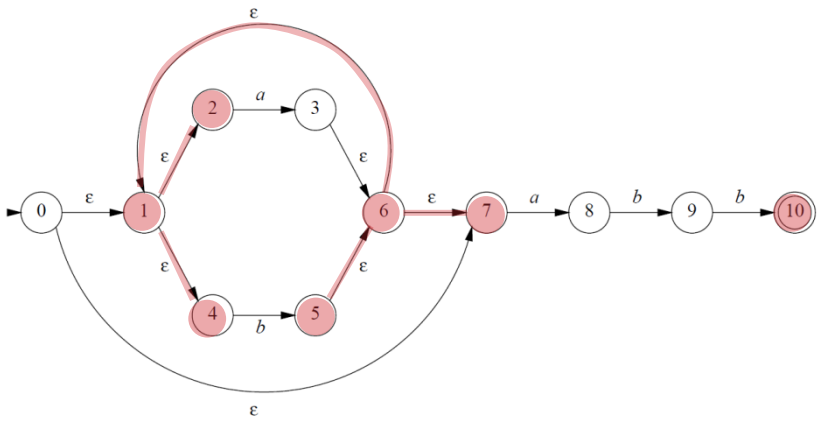

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while $\exists$ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,9},b))
= ε-closure({5,10})
= {1,2,4,5,6,7,10}

Dstates:

A	☑
B	☑
C	☑
D	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
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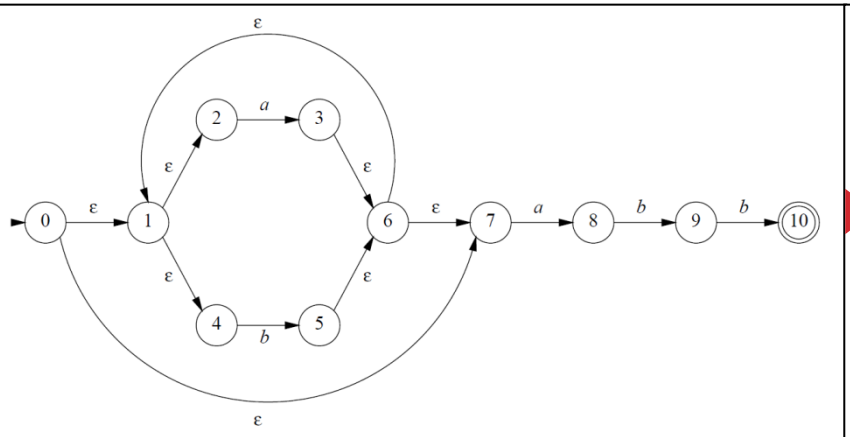

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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,9},b))
= ε-closure({5,10})
= {1,2,4,5,6,7,10} = E

Dstates:

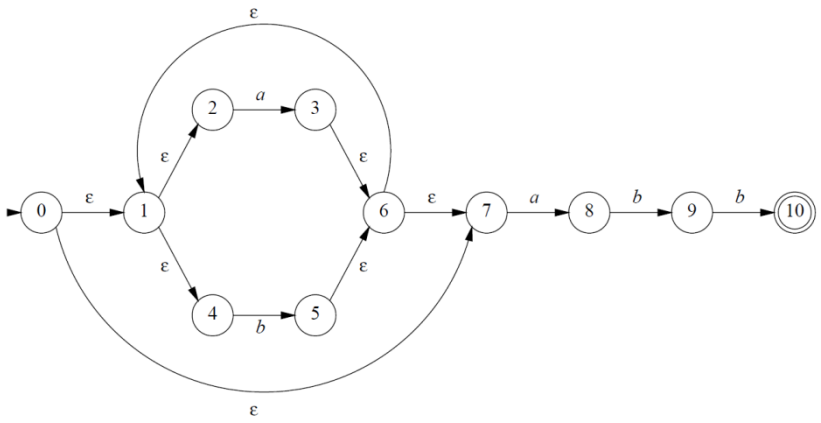
A	☑
B	☑
C	☑
D	☑
E	☐

	a	b
A	B	C
B	B	D
C	B	C
D	B	

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}
E = {1,2,4,5,6,7,10}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D
ε-closure({5,10}) = E



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while ∃ unmarked state T in *Dstates*
    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,9},b))
= ε-closure({5,10})
= {1,2,4,5,6,7,10} = E

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☐

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

Cheat Sheet

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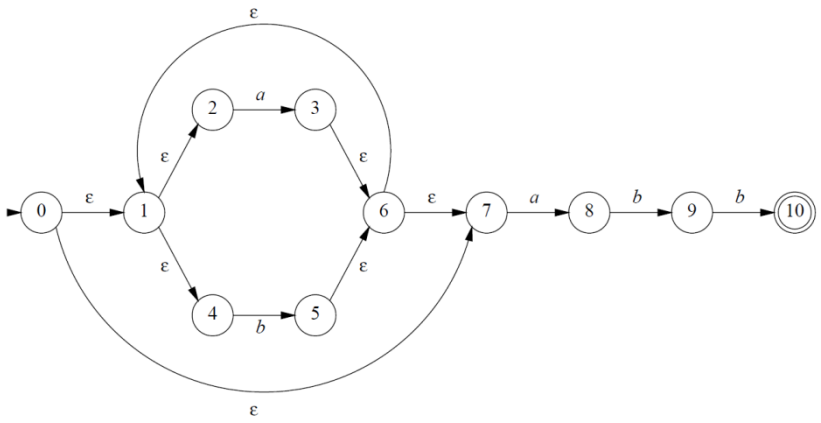

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        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = D

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☐

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
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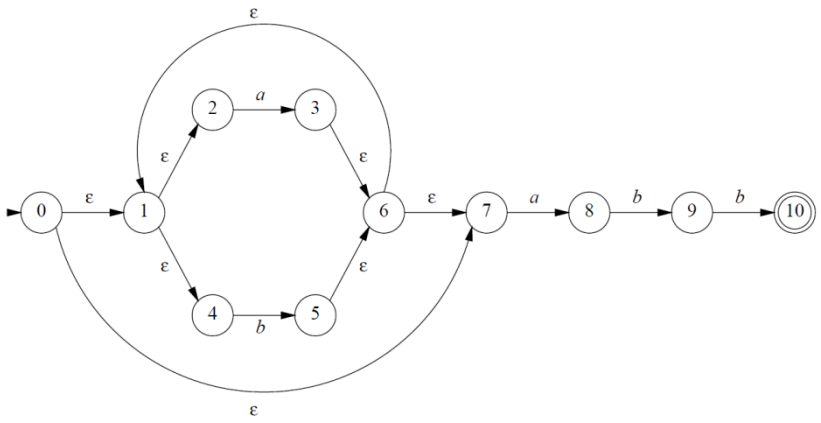

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    for each input symbol a
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        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☐

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

Cheat Sheet

A = {0,1,2,4,7}
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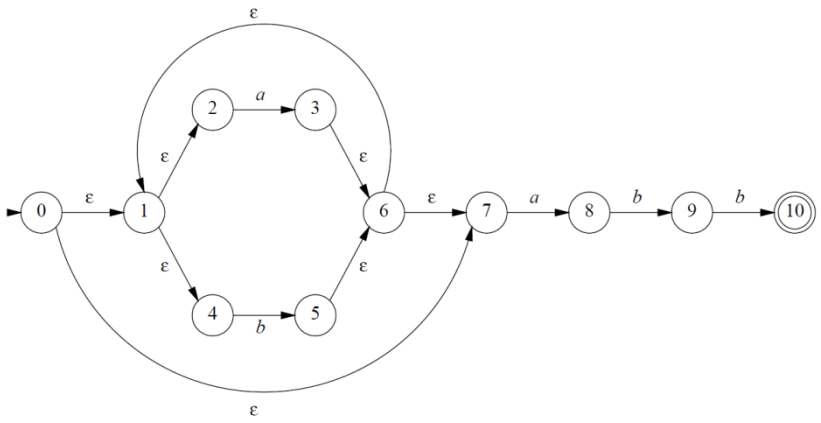

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        Dtrans$[T, a] = U$
    endfor
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$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

Cheat Sheet

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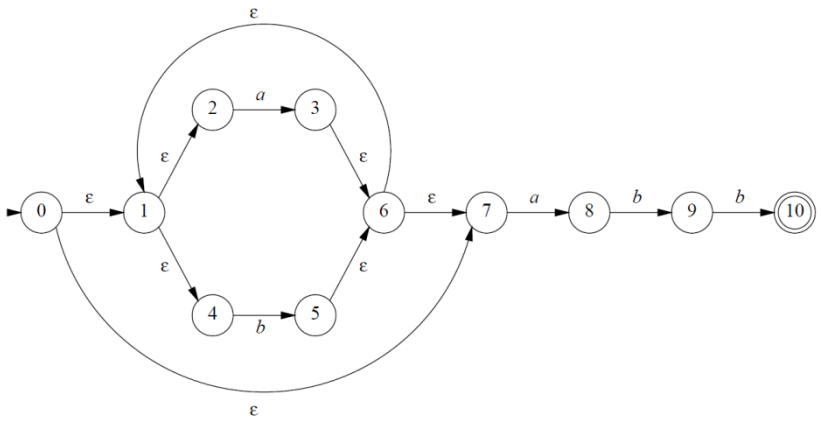

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    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

Cheat Sheet

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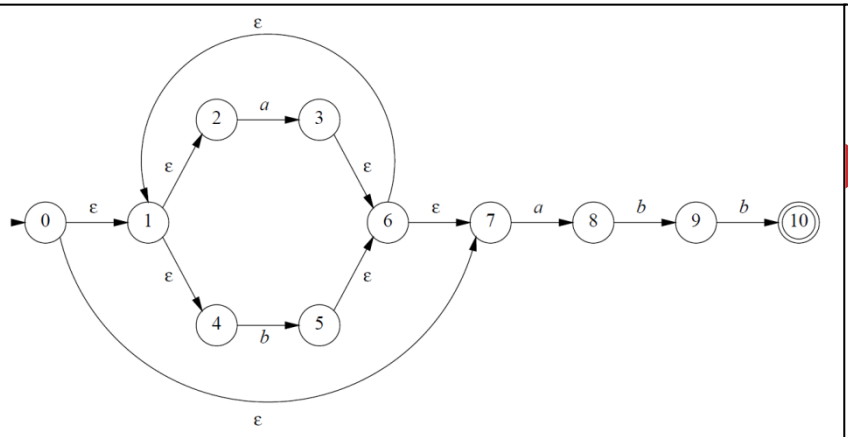

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    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,10} ,a))

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
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Cheat Sheet

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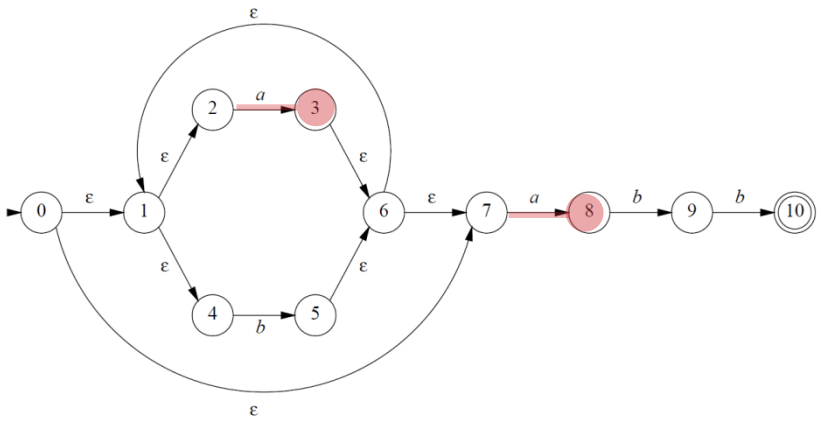

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    mark T
    for each input symbol a
        $U = \varepsilon\text{-}closure(move(T, a))$
        if $U \notin$ *Dstates* **then** add U to *Dstates* unmarked
        $Dtrans[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,10} ,a))

Dstates:

A	☑
B	☑
C	☑
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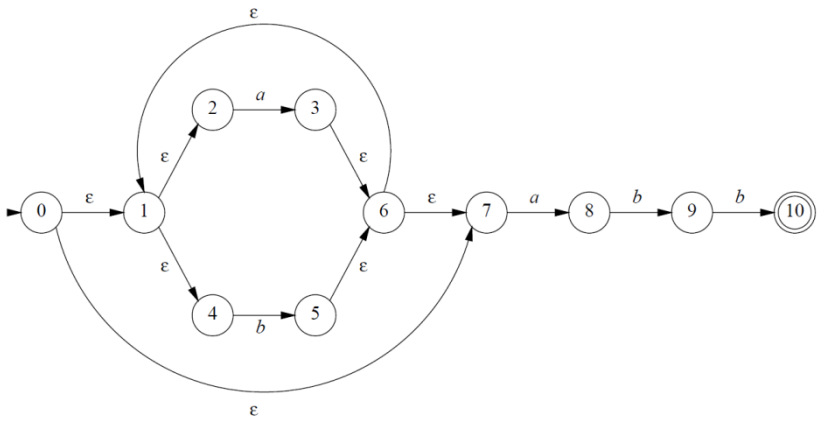

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        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

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= ε-closure(move({1,2,4,5,6,7,10} ,a))
= ε-closure({3,8})

Dstates:

A	☑
B	☑
C	☑
D	☑
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	a	b
A	B	C
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Cheat Sheet

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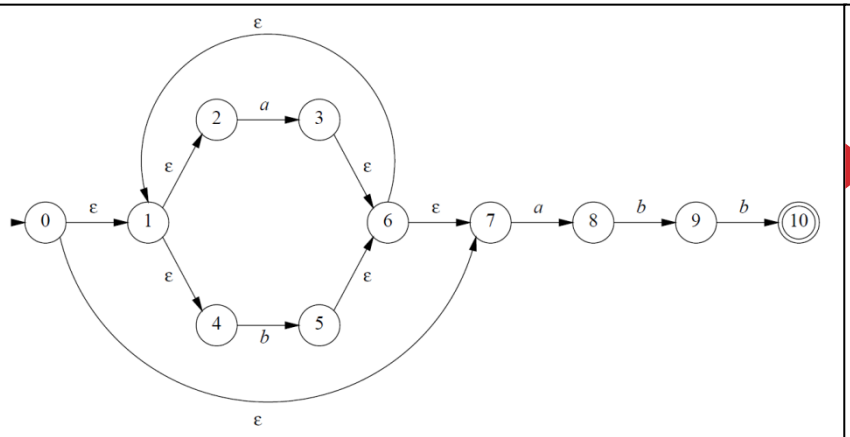

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    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
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T = E

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Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

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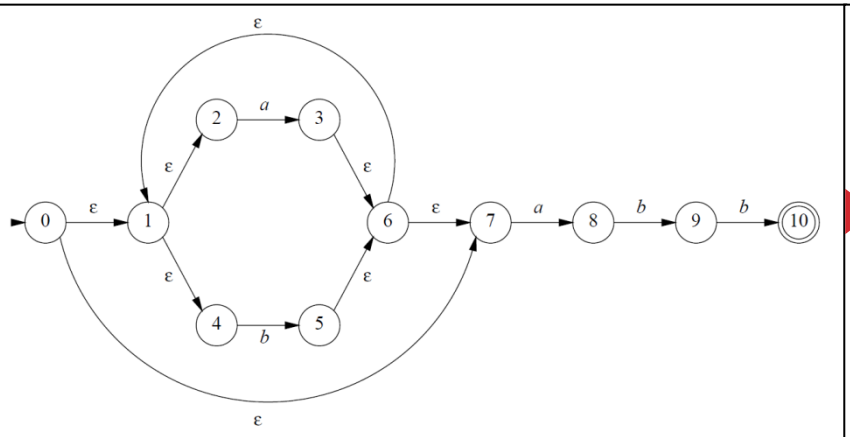
ε-closure({5,9}) = D
ε-closure({5,10}) = E



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        Dtrans$[T, a] = U$
    endfor
endwhile

$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

U = ε-closure(move(T,a))
= ε-closure(move({1,2,4,5,6,7,10} ,a))
= ε-closure({3,8}) = B

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	E

Cheat Sheet

A = {0,1,2,4,7}
B = {1,2,3,4,6,7,8}
C = {1,2,4,5,6,7}
D = {1,2,4,5,6,7,9}
E = {1,2,4,5,6,7,10}

ε-closure({3,8}) = B
ε-closure({5}) = C
ε-closure({5,9}) = D
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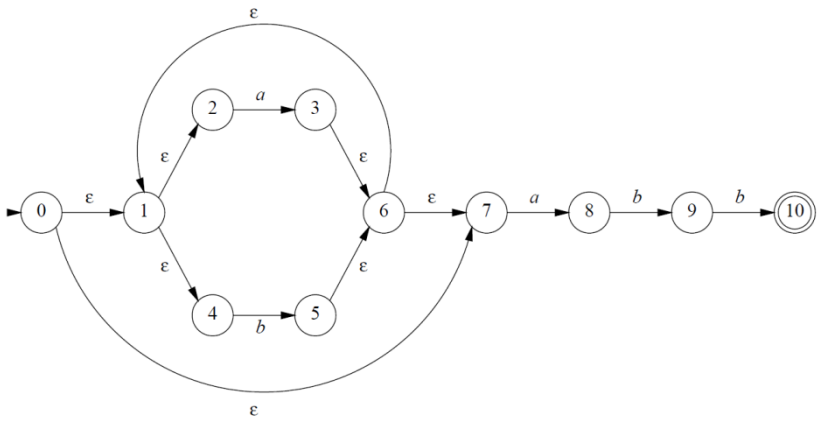

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B	☑
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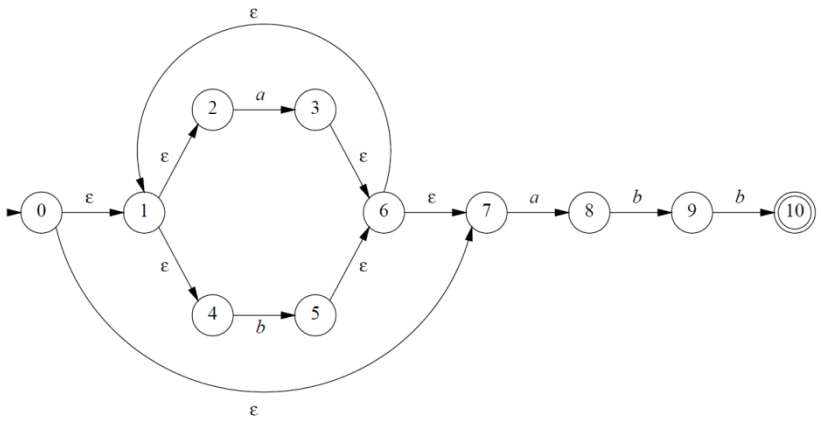
	a	b
A	B	C
B	B	D
C	B	C
D	B	E
E	B	



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A state of D is accepting if it contains at least one accepting state in N

T = E

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
B	B	D
C	B	C
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E	B	

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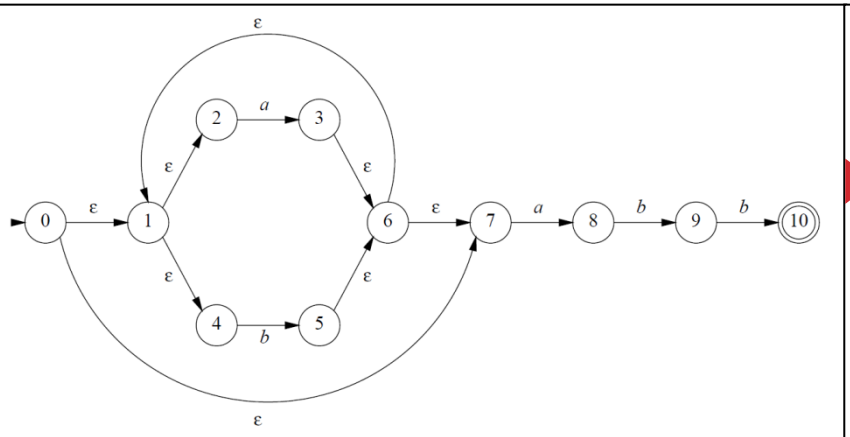

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A state of D is accepting if it contains at least one accepting state in N

T = E

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Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

	a	b
A	B	C
B	B	D
C	B	C
D	B	E
E	B	

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A = {0,1,2,4,7}
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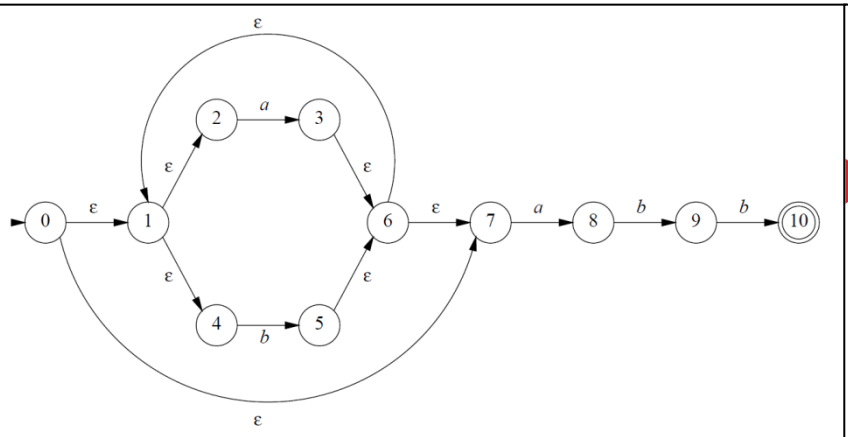

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$\varepsilon\text{-}closure(s_0)$ is the start state of D
A state of D is accepting if it contains at least one accepting state in N

T = E

U = ε-closure(move(T,b))
= ε-closure(move({1,2,4,5,6,7,10} ,b))
= ε-closure(5) = C

Dstates:

A	☑
B	☑
C	☑
D	☑
E	☑

Cheat Sheet

A = {0,1,2,4,7}
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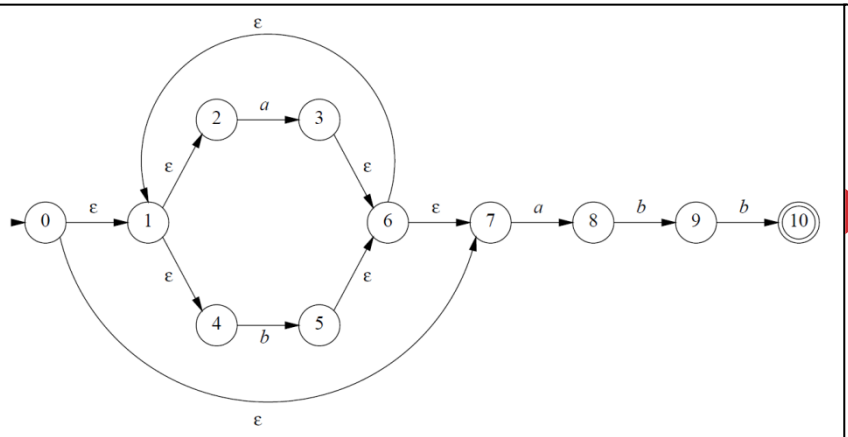
A	B	C
B	B	D
C	B	C
D	B	E
E	B	



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Dstates:

A	☑
B	☑
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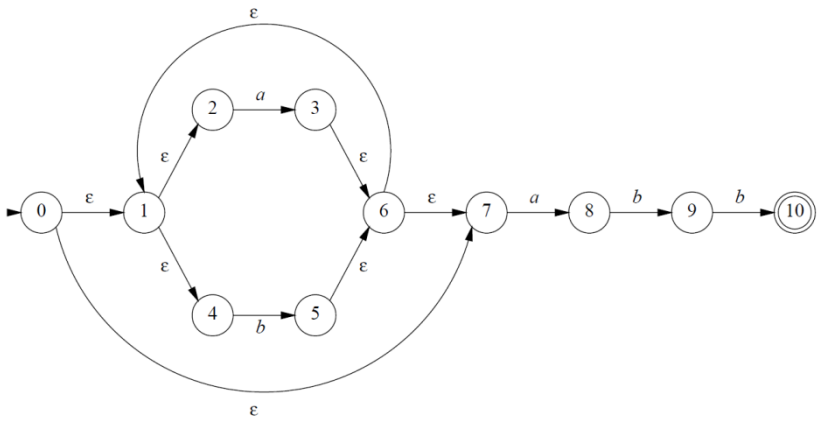
C	B	C
D	B	E
E	B	



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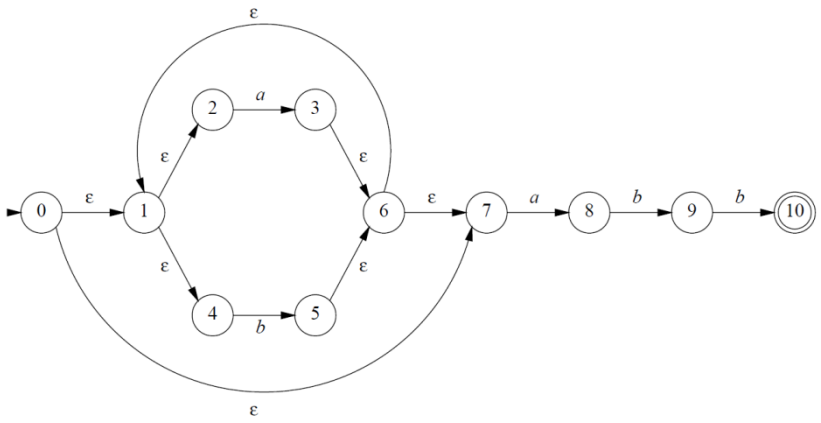

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Dstates:

A	☑
B	☑
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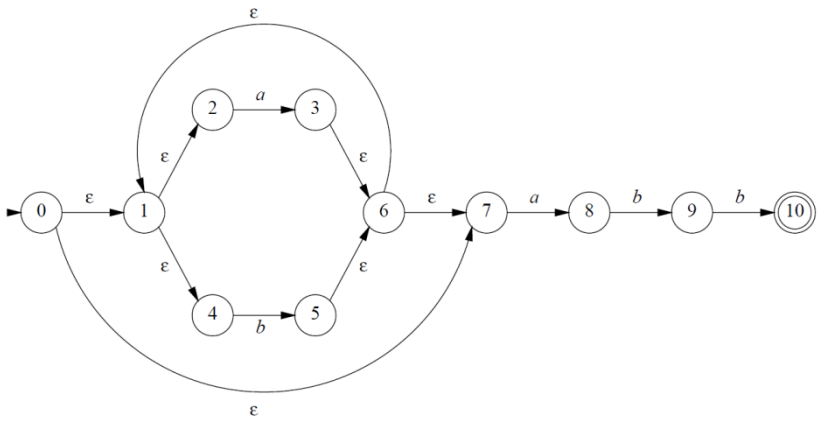
C	B	C
D	B	E
E	B	C



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Dstates:

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Cheat Sheet

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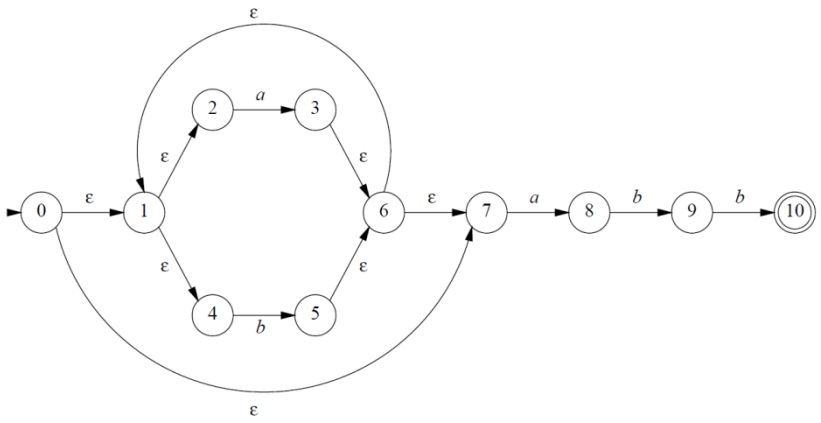
E	B	C



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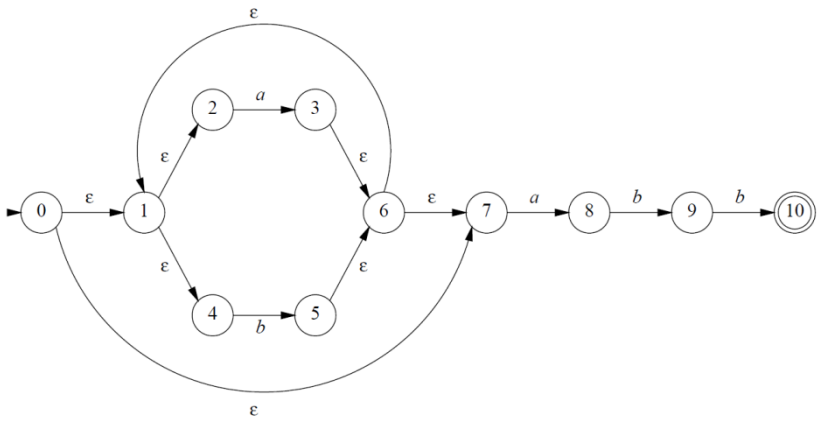

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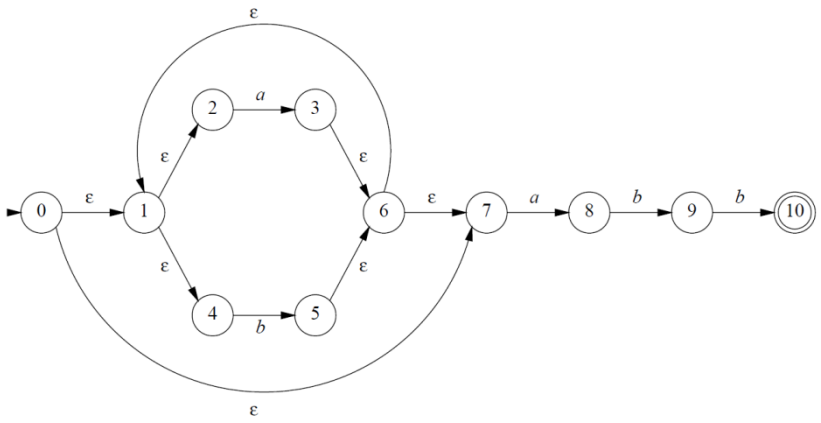
	a	b
> A	B	C
B	B	D
C	B	C
D	B	E
E	B	C



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Dstates:

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	a	b
> A	B	C
B	B	D
C	B	C
D	B	E
E	B	C

SUMMARY

Regular Expression:

(a | b)*abb

$$A = \{0, 1, 2, 4, 7\}$$
$$B = \{1, 2, 3, 4, 6, 7, 8\}$$
$$C = \{1, 2, 4, 5, 6, 7\}$$
$$D = \{1, 2, 4, 5, 6, 7, 9\}$$
$$E = \{1, 2, 4, 5, 6, 7, 10\}$$

	a	b
A	B	C
B	B	D
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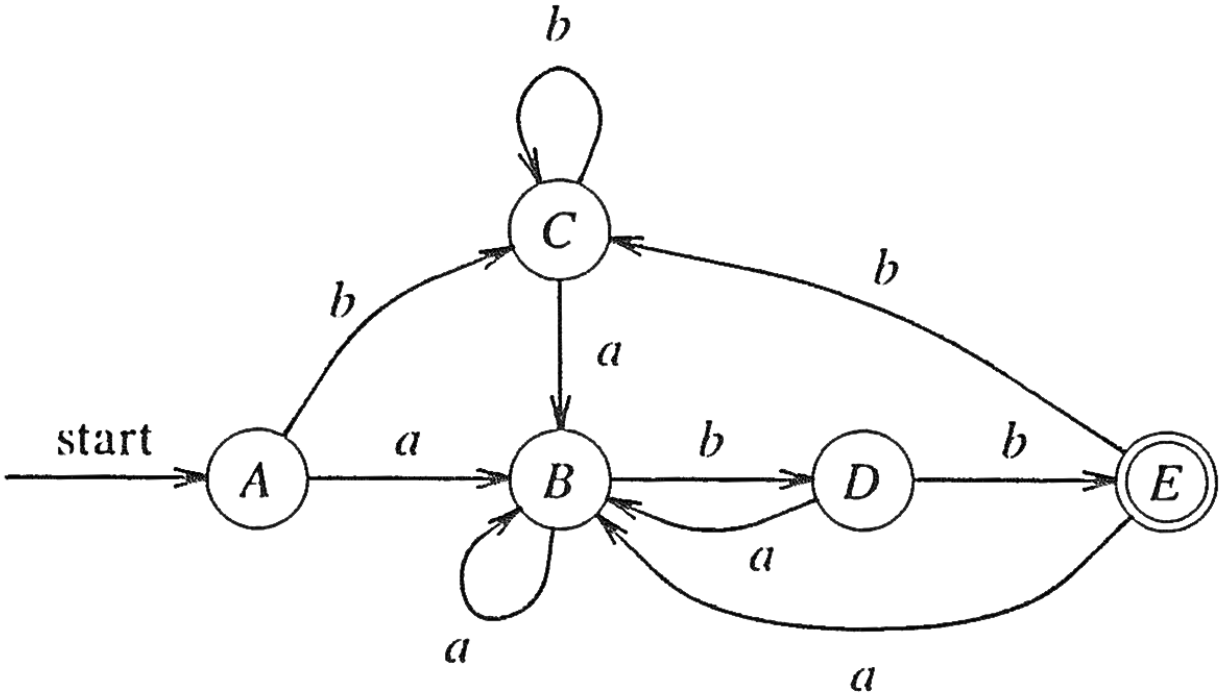
E	B	C

RESULTING DFA

Regular Expression:

(a | b)*abb



MINIMIZING THE NUMBER OF STATES IN DFA

Minimize the number of states of a DFA by finding all groups of states that can be distinguished by some input string

Each group of states that cannot be distinguished is then merged into a single state

MINIMIZING THE NUMBER OF STATES IN DFA

Algorithm: **Minimizing the number of states of a DFA**

Input: **A DFA *"D"* with a set of states S**

Output: **A DFA *"M"* accepting the same language as *"D"* yet having as few states as possible**

MINIMIZING THE NUMBER OF STATES IN DFA

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Method:

1. Construct an initial partition Π of the set of states with two groups:
   - The accepting states group
   - All other states group
2. Partition Π to Π_{new} (using the procedure shown on the next slide)
3. If Π_{new} != Π, **then Π= Π_{new}** and repeat step (2). Otherwise, repeat go to step (4)
4. Create a single *DFA M* state from every group in Π
5. Specify the accepting states of *DFA M*. An accepting state in *DFA M* corresponds to a group in Π that contains an accepting state in *DFA D*
6. Specify the initial state of *DFA M*. An initial state in *DFA M* corresponds to a group in Π that contains an initial state in *DFA D.*

CONSTRUCT NEW PARTITION PROCEDURE

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for each group G of Π do begin

Partition G into subgroups such that two states S and T of G are in the same subgroup if and only if

for each symbol "a" ∈ ∑ do begin

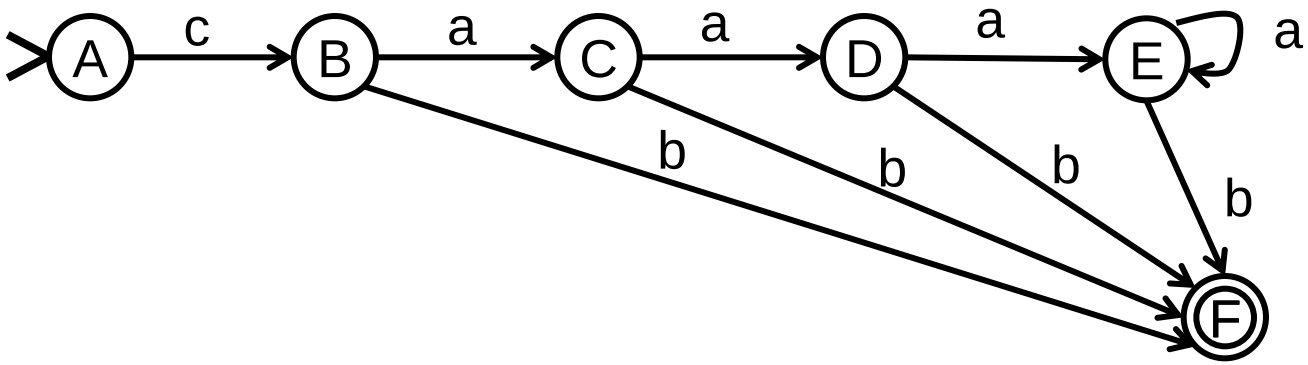
1. both S and T do not have transitions on "a", **or**
2. both S and T **have** transitions on "a" to states in the same group

endfor

Replace G in Π_{new} by the set of all subgroups formed

endfor

EXAMPLE OF DFA MINIMIZATION



$\Pi =$ { **A, B, C, D, E** ; **F** }

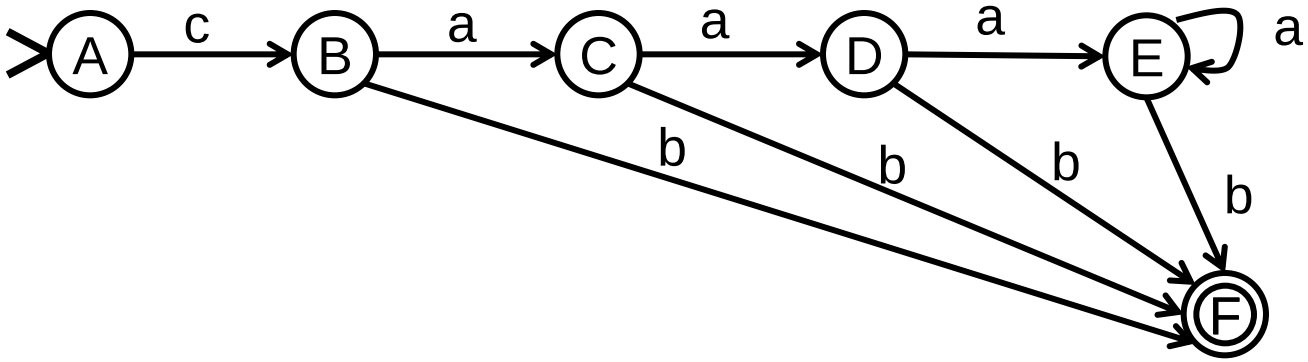
For **A** and **B**

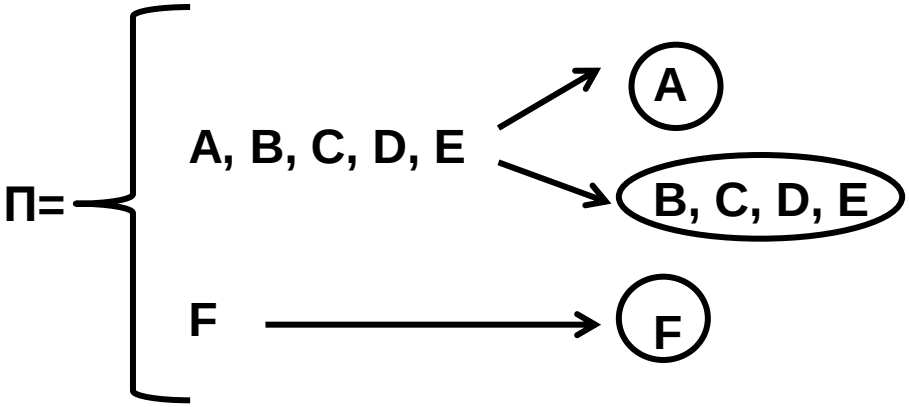
- Transition on “a” from **A** are not possible
- Transition on “a” from **B** lead to group {A,B, C D, E}

Therefore, **A** and **B** cannot belong to the same group in Π_{new}

This should be done for every pair of states on every possible symbol of $\sum$

EXAMPLE OF DFA MINIMIZATION





EXAMPLE OF DFA MINIMIZATION

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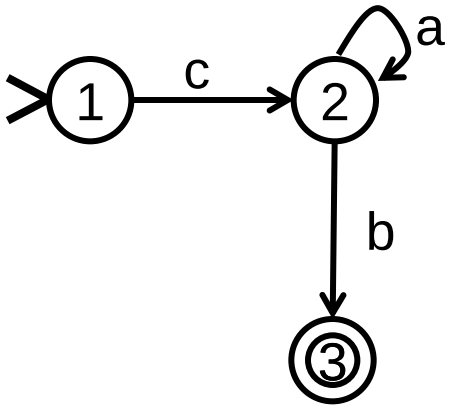
Minimized DFA, where:

- 1: A
- 2: B, C, D, E
- 3: F



THANK YOU!

QUESTIONS?