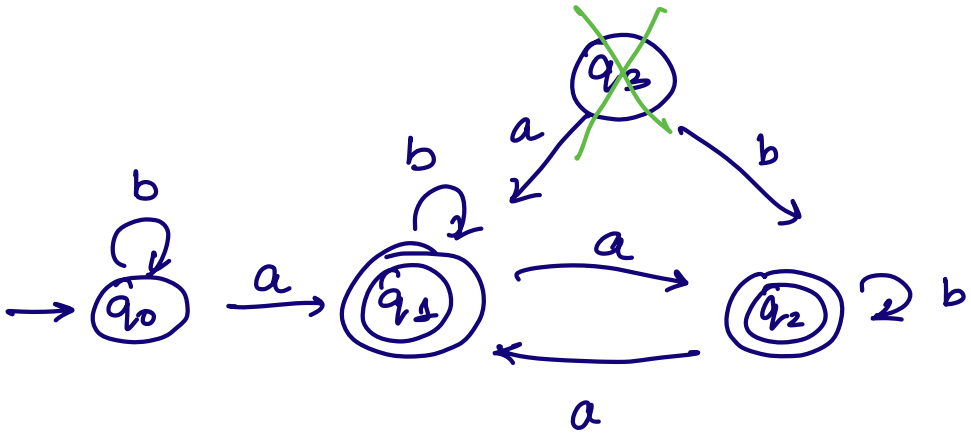
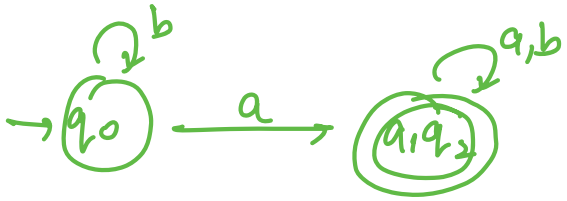
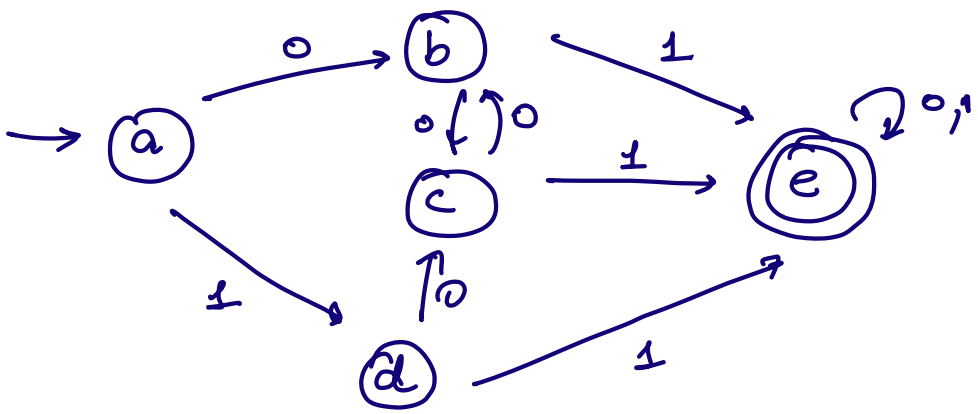
Q:



	a	b
→ q_0	q_1	q_0
* q_1	q_2	q_1
* q_2	q_1	q_2



Q:

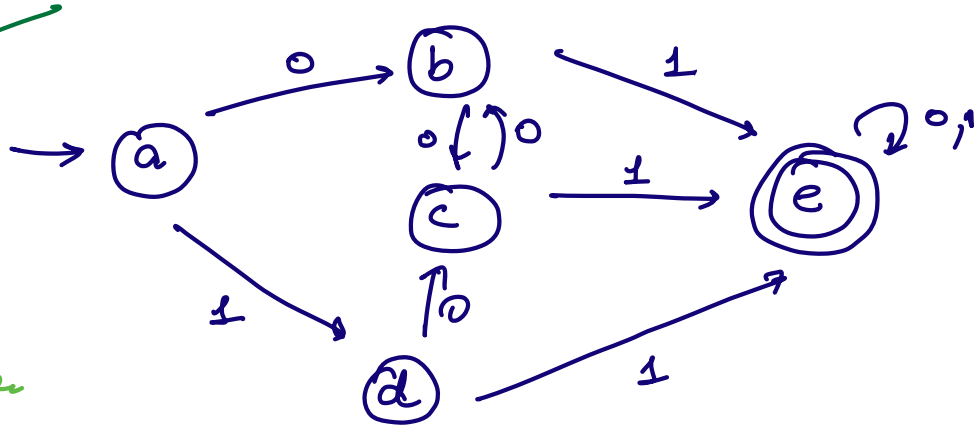


	0	1
→ a	b	d
b	c	e
c	b	e
d	c	e
* e	e	e

	0	1
→ a	bd	bd
bd	c	e
c	bd	e
* e	e	e

	0	1
→ a	bdc	bdc
bdc	bdc	e
* e	e	e

Proper method



	0	1
→ a	b	d
b	c	e
c	b	e
d	c	e
* e	e	e

1. Unreachable State

2. 0 Equivalent States:

[a b c d] [e]

non final — final

1 Equivalent States

ab

	0	1
a	b	d
b	c	e

same set — diff set

[a] [b] [e] ed?

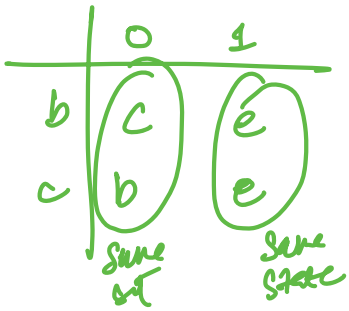
ac

	0	1
a	b	d
c	b	e

same set — diff set

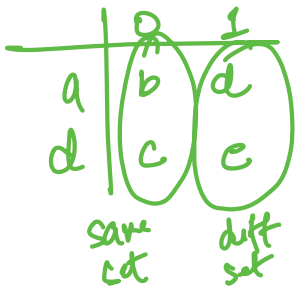
c is not going to stay with a X

bc



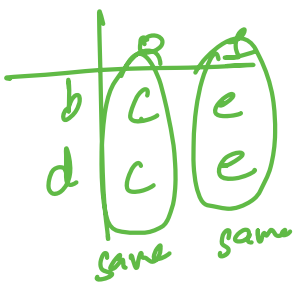
[a] [bc] [e] d?

ad



d not going to stay with c X

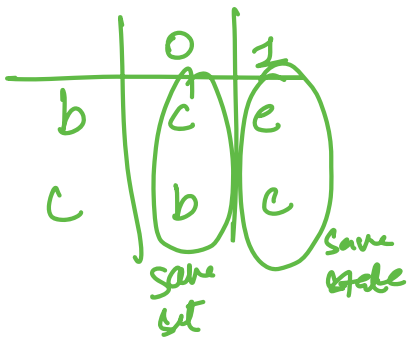
bd
or
cd



[a] [bcd] [e]

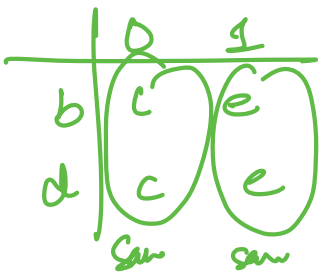
2 equivalence

bc



[a] [bc] [e]
d?

bd
or
cd



[a] [bcd] [e]

Epsilon NFA

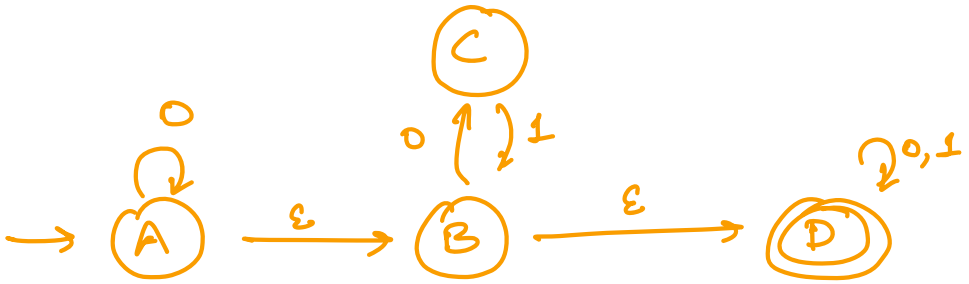
→ Empty string ε

NFA: $Q, \Sigma, \delta, q_0, f$

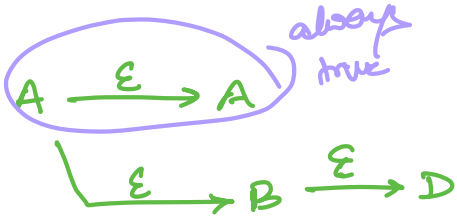
$\delta: Q \times \Sigma \to 2^Q$

ε-NFA: $\delta: Q \times (\Sigma \cup \varepsilon) \to 2^Q$

→ without seeing any alphabet you can have a transition.



ε-closure → what all states you can reach by seeing ε.



ε-closure (A) = {A, B, D}

DFA ≅ NFA ≅ ENFA

Equally powerful

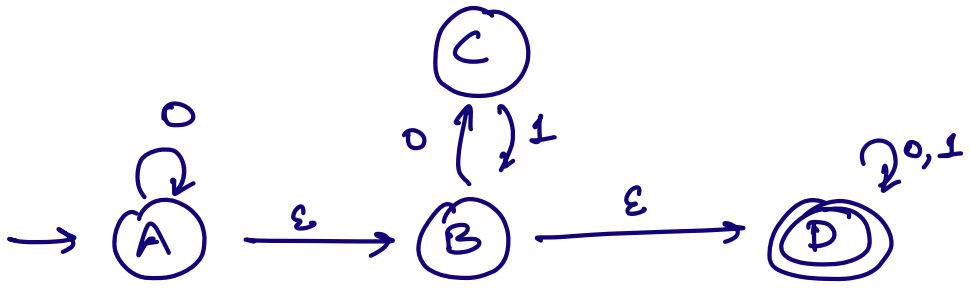
Every DFA is NFA

Every NFA is ENFA

ε-NFA → NFA ?

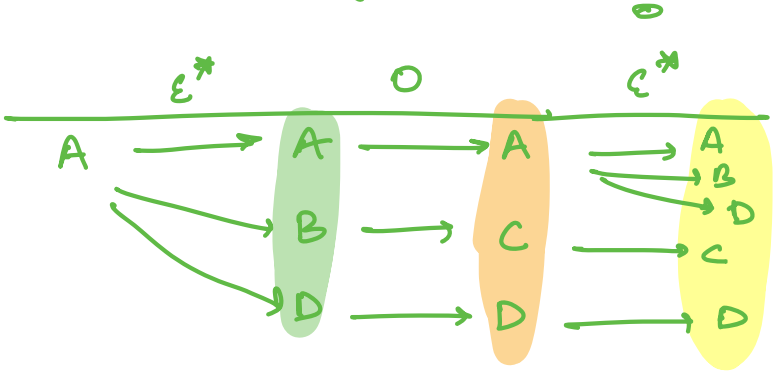
Convert ENFA to ~~NFA~~ DFA

Q:



Where does A goes on 0?

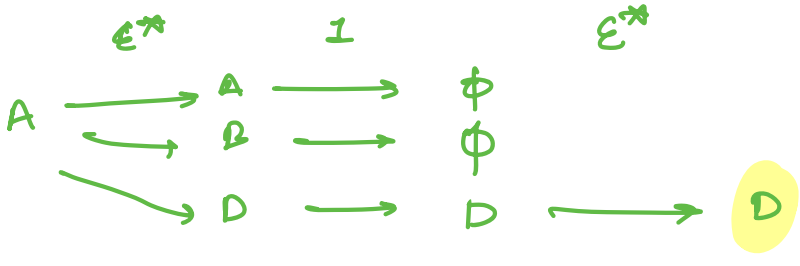
ε-closure (A) = ABD
" (B) = BD
" (D) = D
" (C) = C



$\delta(A,0) = \{ABCD\}$

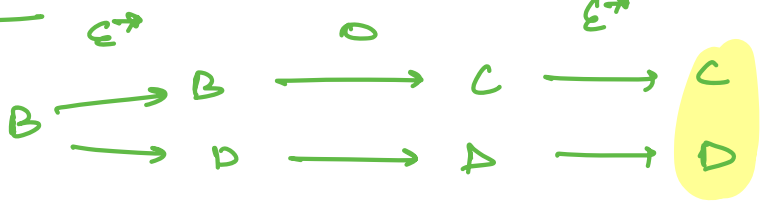
ε-closure (δ (ε-closure (A), 0))

State A, 1

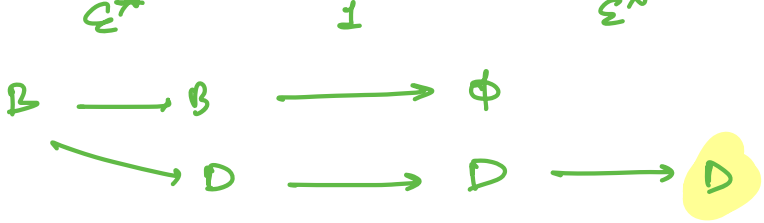


$\delta(A,1) = \{D\}$

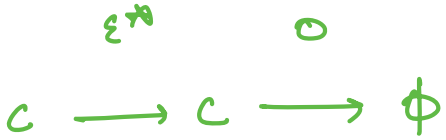
State B, 0



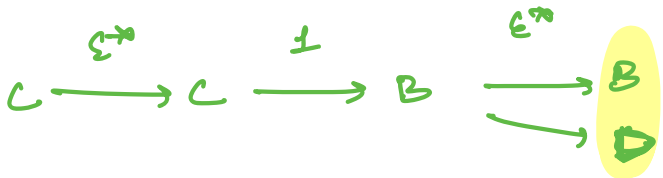
State B, 1



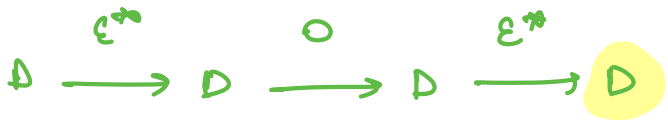
State C, 0



State C, 1



State D, 0

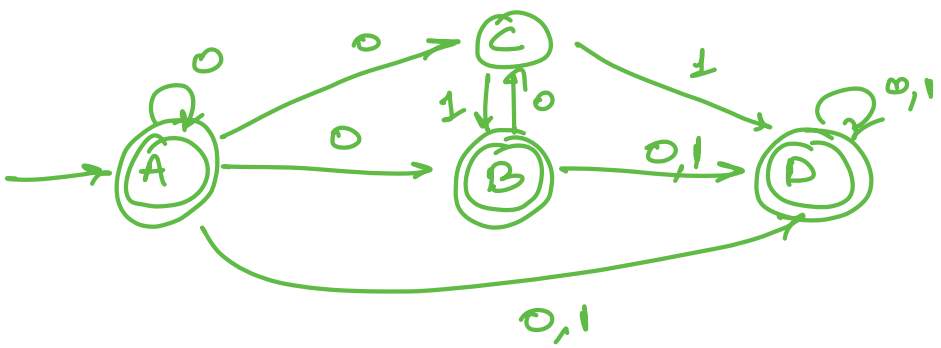


State D, 1

	0	1
→ A	ABCD	D
B	CD	D
C	ϕ	BD
* D	D	D

ε-closure (A) = ABD
" (B) = BD
" (D) = D
" (C) = C

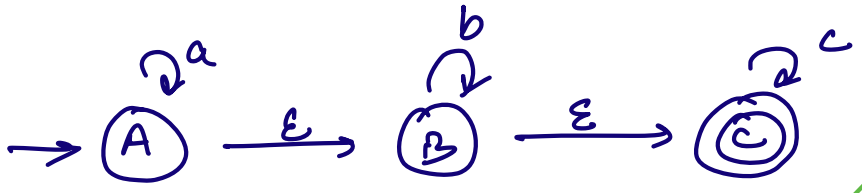
A, B, D final



NFA → DFA no of states increase

ENFA → NFA no of states same (final states increase)

Eg:



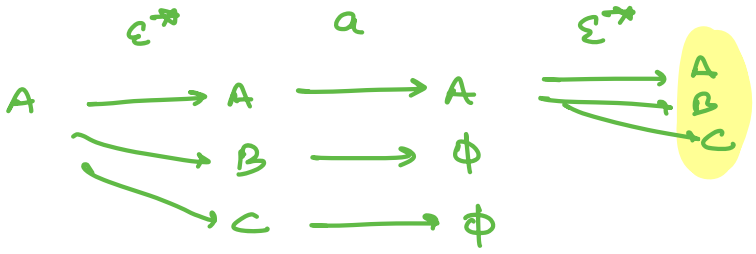
$\Sigma = \{a, b, c\}$

ε-closure(A) = A B C

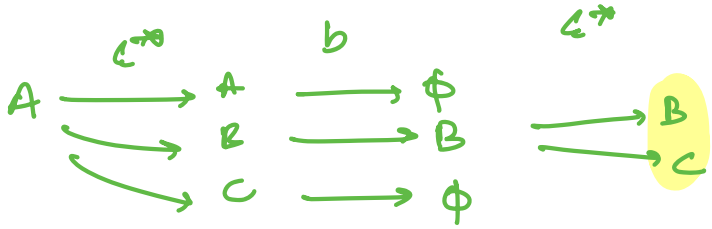
(B) = B C

(C) = C

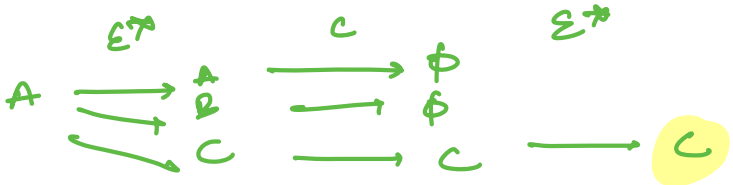
A, a



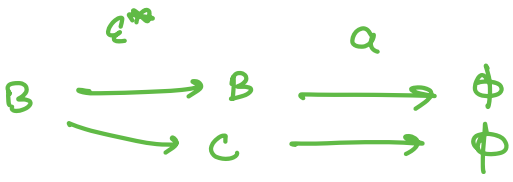
A, b



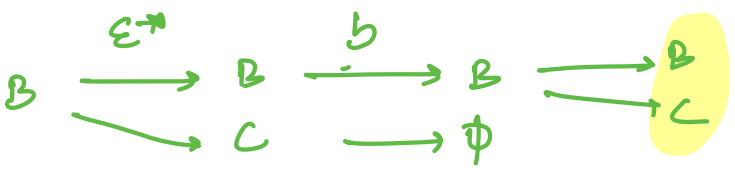
A, C



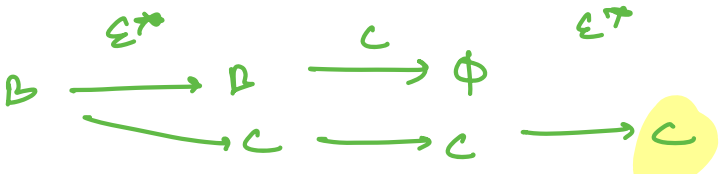
B, a



B, b



B, C



C, a

$C \xrightarrow{\varepsilon^*} C \xrightarrow{a} \phi$

C, b

$C \xrightarrow{\varepsilon^*} C \xrightarrow{b} \phi$

C, c

$C \xrightarrow{\varepsilon^*} C \xrightarrow{c} C$

	a	b	c
→ A*	ABC	BC	C
B*	ϕ	BC	C
C*	ϕ	ϕ	C

ε-closure(A) = A B C
(B) = B C
(C) = C

ENFA
↕
NFA
↕
DFA
↕
min DFA

ENFA NFA DFA

Equally powerful