CS323 Compilation Principle

Assignment 2

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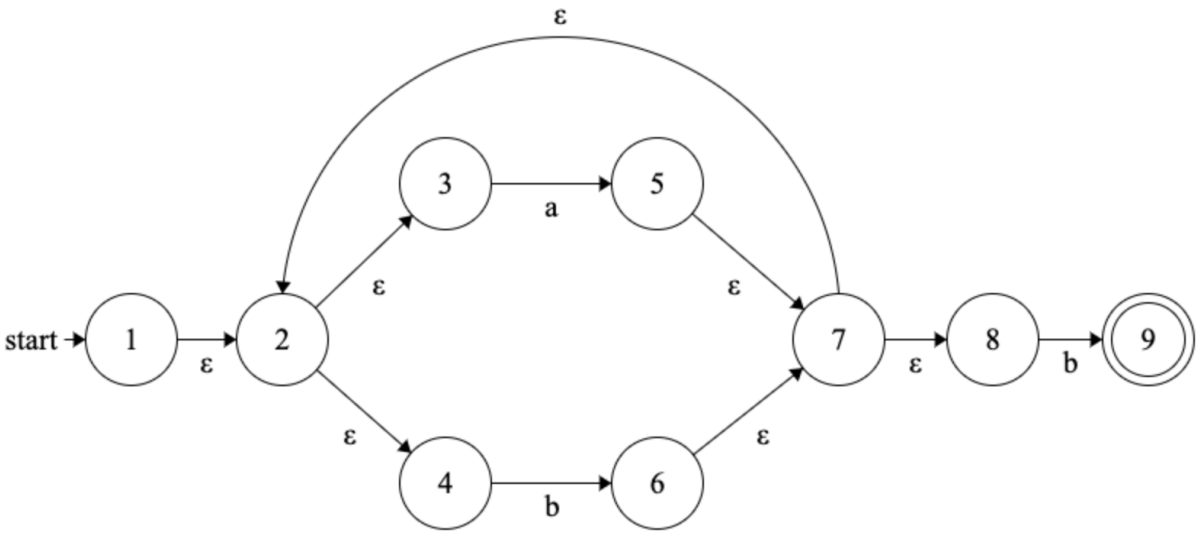
Date | 2020.10.06

Required Exercises

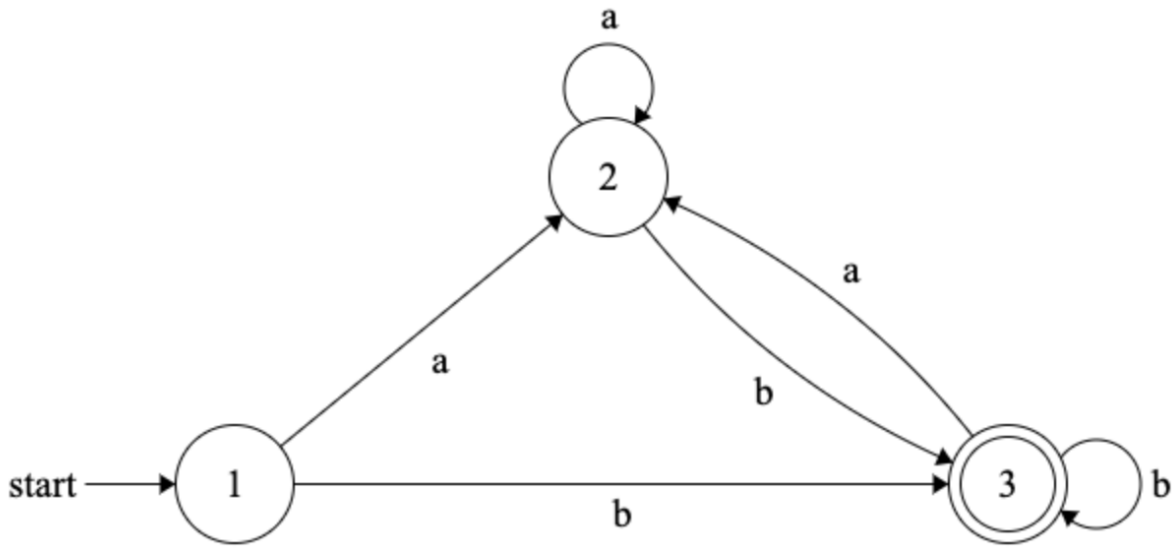
Exercise 1

> Design NFAs and DFAs to recognize each of the following regular languages:
>
> 1. $L((a|b)^*b)$ [10 points]
> 2. $L(((\epsilon|a)^*b)^*)$ [10 points]
> 3. $L((a|b)^*a(a|b)(a|b))$ [10 points]
> 4. $L(a^*ba^*ba^*ba^*)$ [10 points]

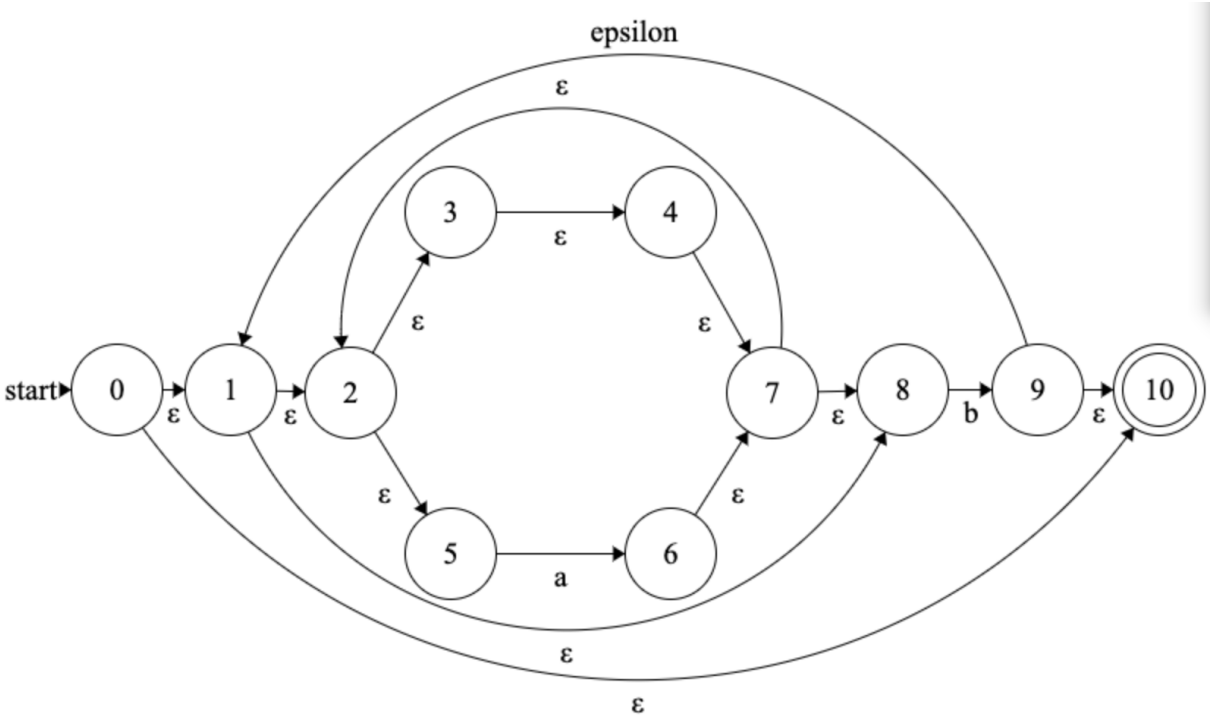
1. NFA:



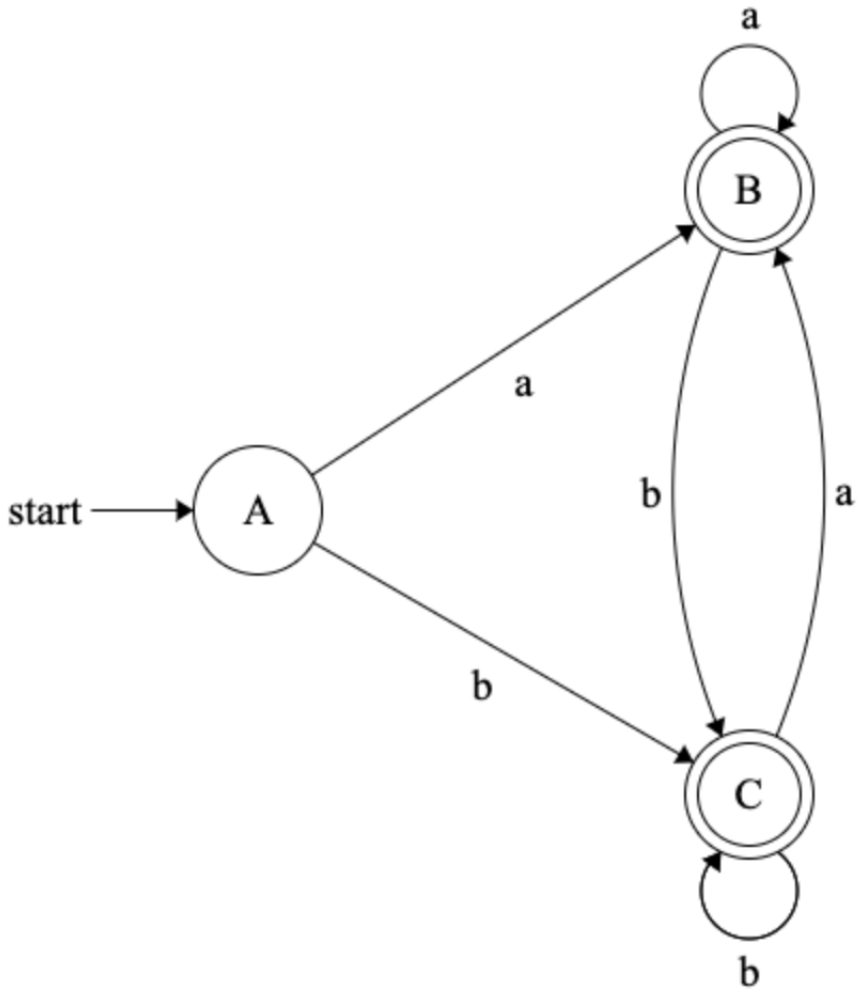
DFA:


a
2
a
a
b
start
1
3
b
b

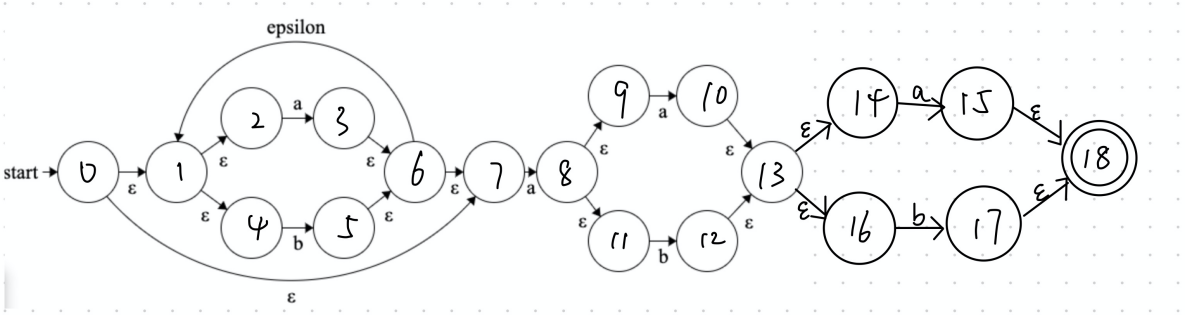
2. NFA:


epsilon
ε
3
4
ε
ε
ε
start
0
1
2
7
8
9
10
ε
ε
ε
ε
b
ε
ε
5
6
a
ε
ε

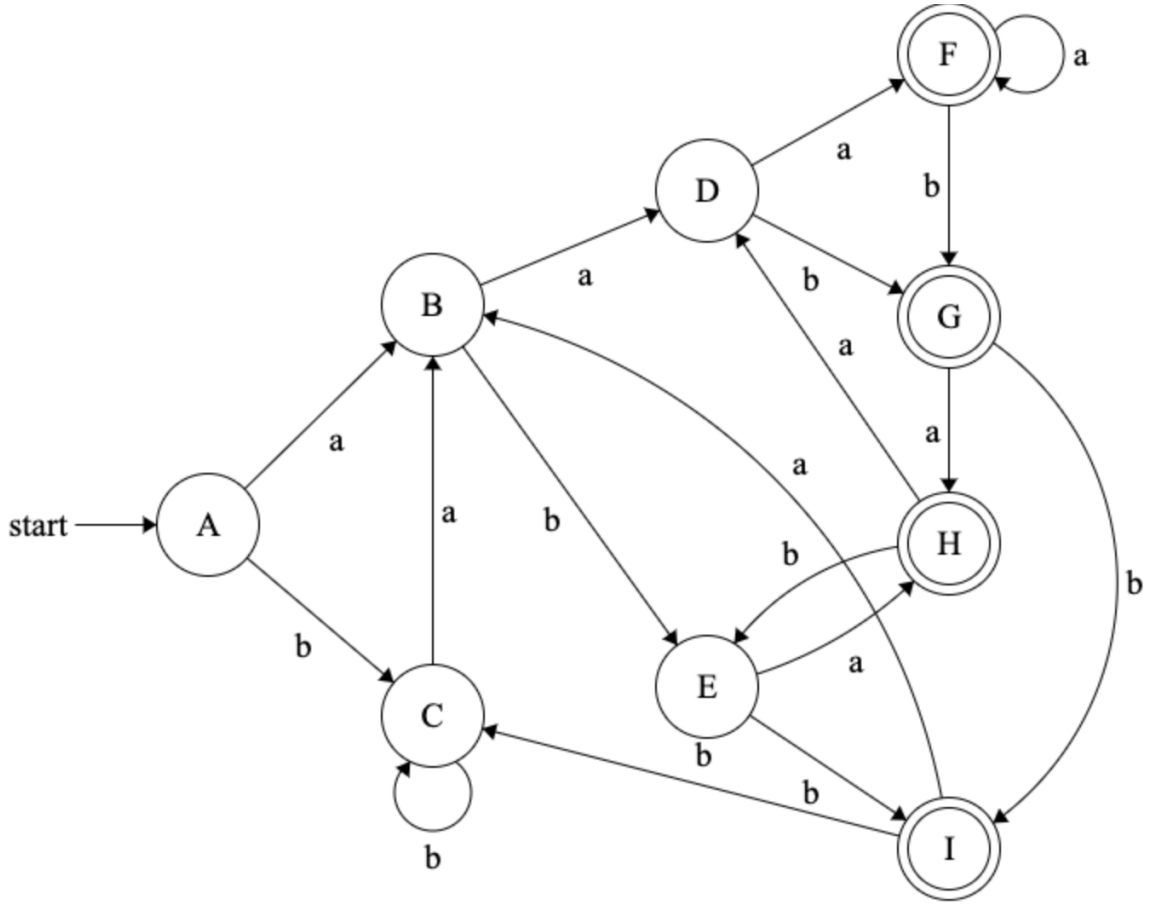
DFA:


a
B
a
b
a
start
A
b
C
b

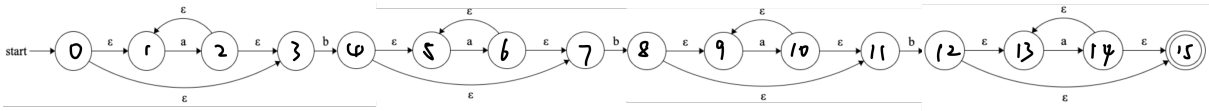
3. NFA:


epsilon
start
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
a
b
ε

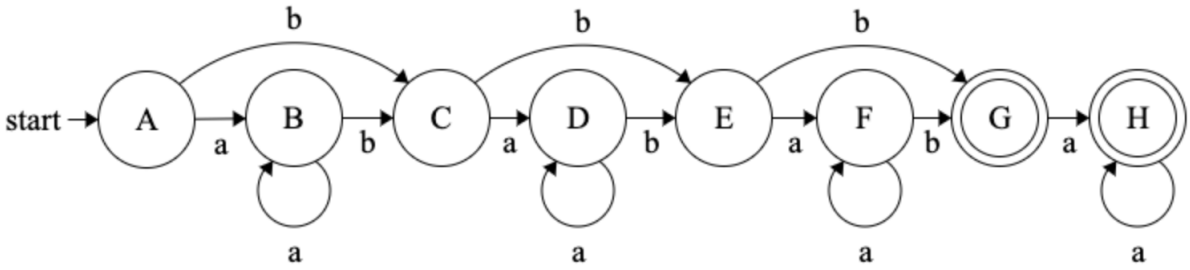
DFA:



4. NFA:



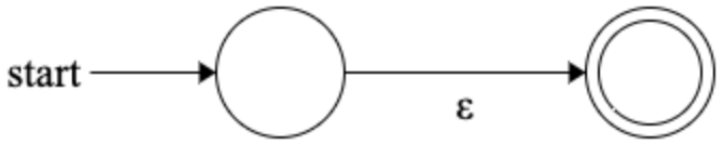
DFA:



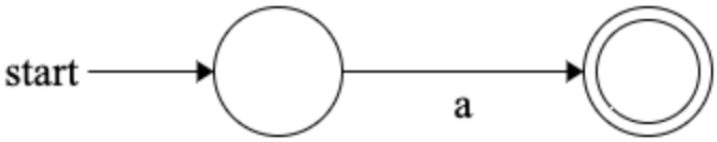
Exercise 2

> Convert the following regular expressions to NFAs using the Thompson's Construction Algorithm (Algorithm 3.23 in the dragon book). Please put down the detailed steps.
>
> 1. $((\epsilon|a)^*b)^*$ [10 points]
> 2. $(a|b)^*a(a|b)(a|b)$[10 points]
> 3. $a^*ba^*ba^*ba^*$ [10 points]

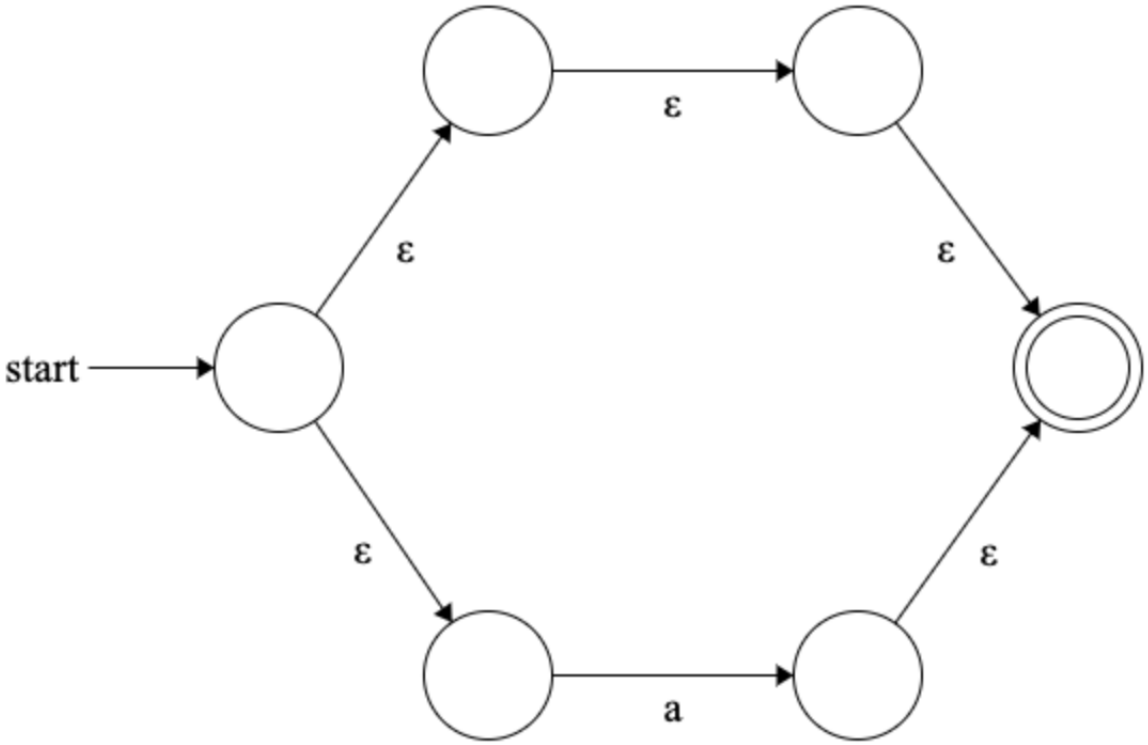
1. $((\epsilon|a)^*b)^*$
    1. NFA for the first ϵ:



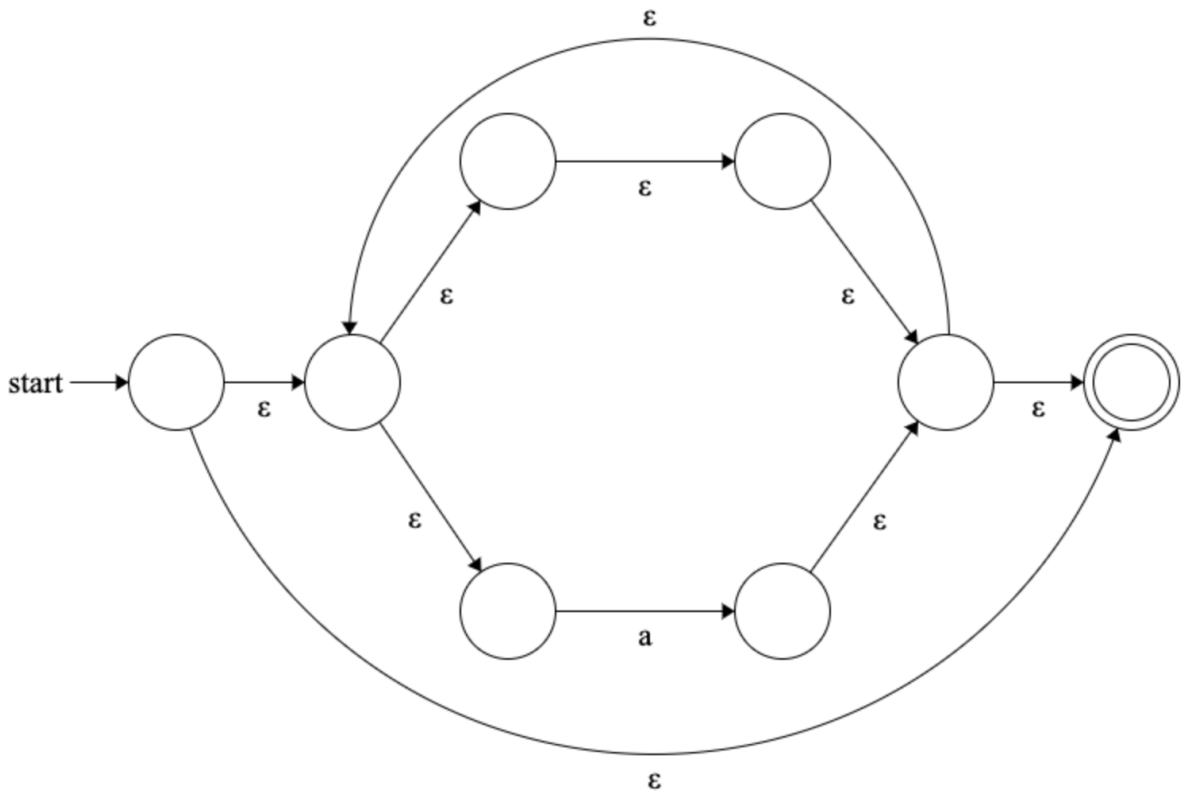
    2. NFA for the first a:



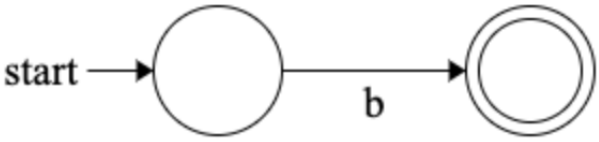
    3. NFA for $(\epsilon|a)$:



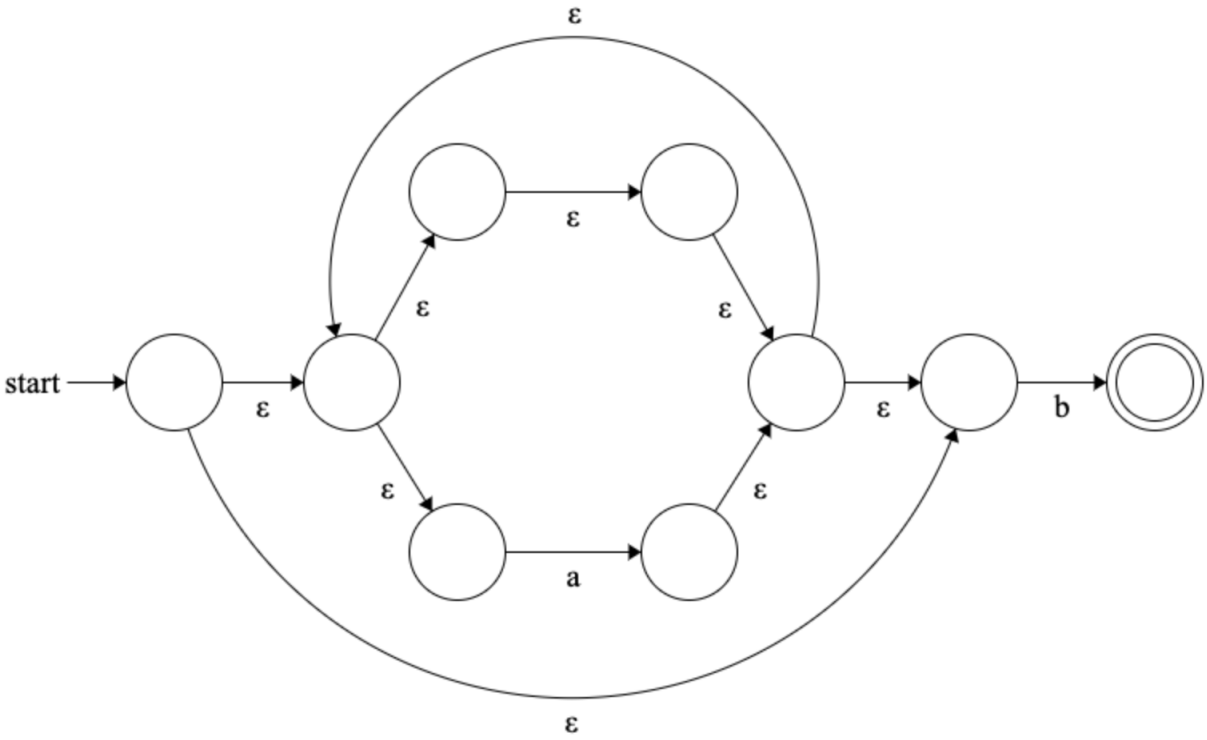
    4. NFA for $(\epsilon|a)^*$:



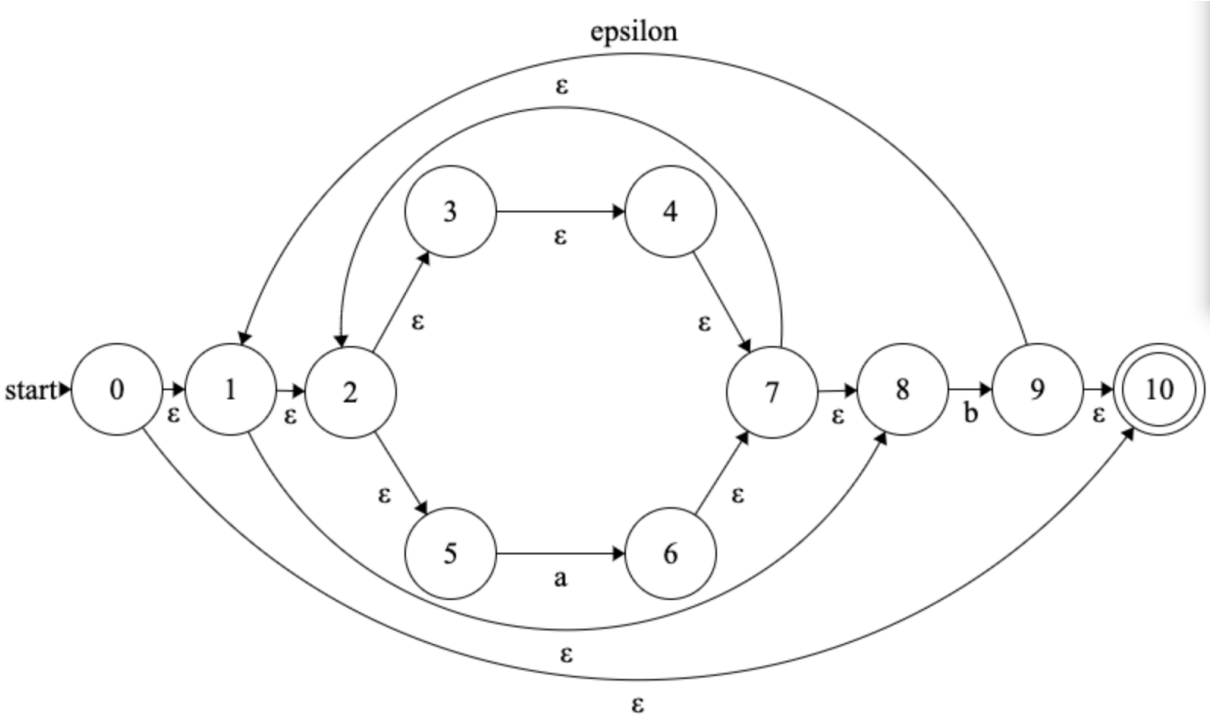
NFA for b:



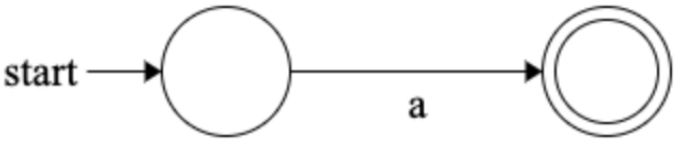
5. NFA for $(\epsilon|a)^*b$:



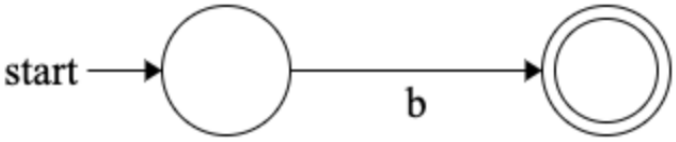
6. NFA for $((\epsilon|a)^*b)^*$:



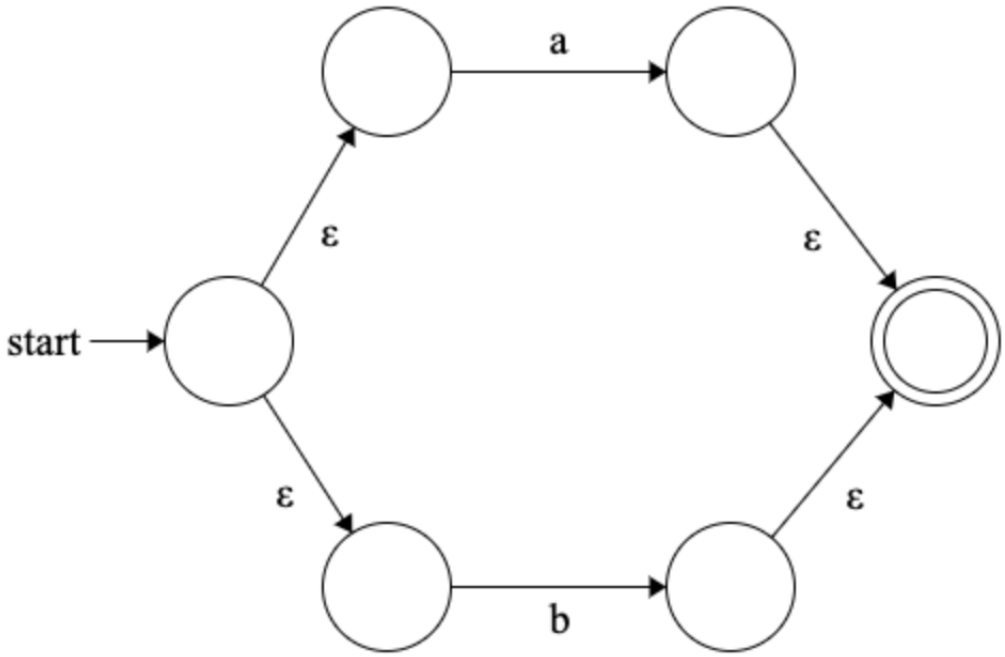
2. $(a|b)^*a(a|b)(a|b)$
    1. NFA for a



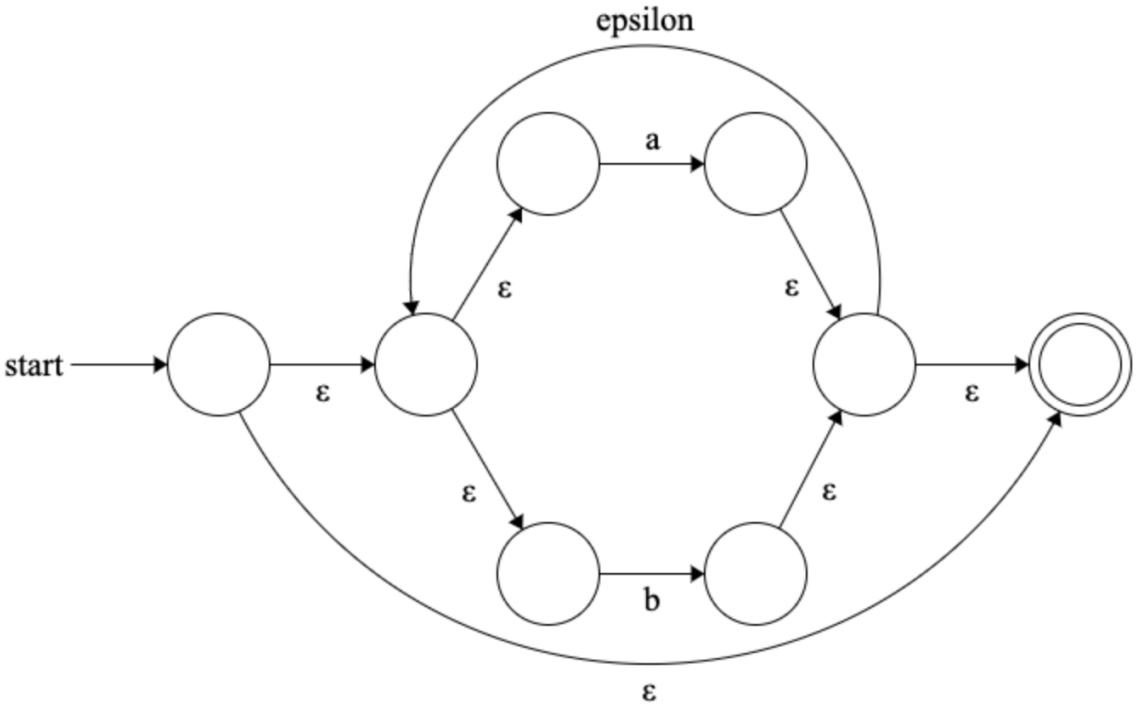
    2. NFA for b



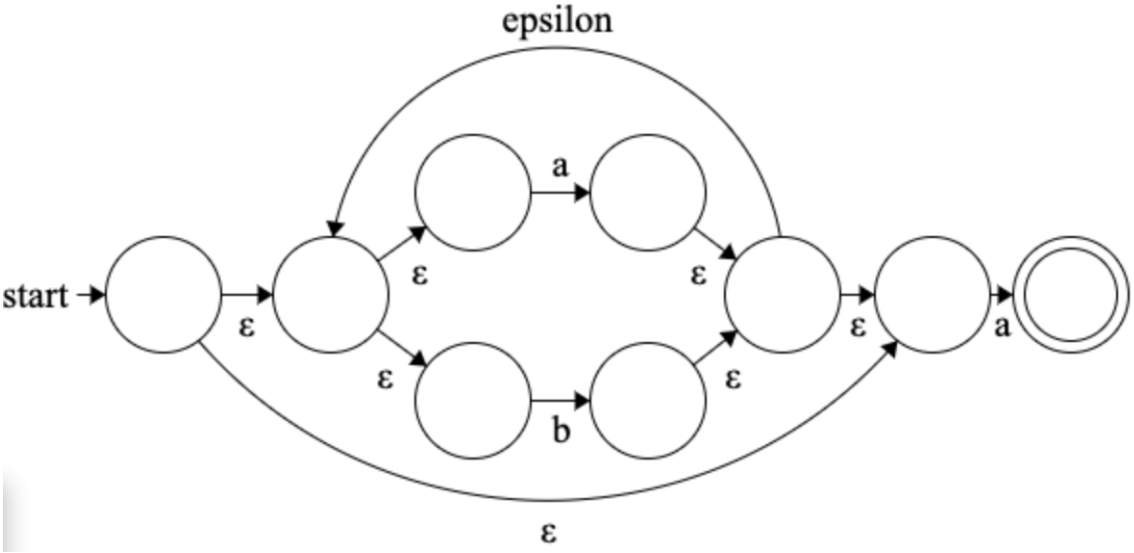
    3. NFA for $(a|b)$



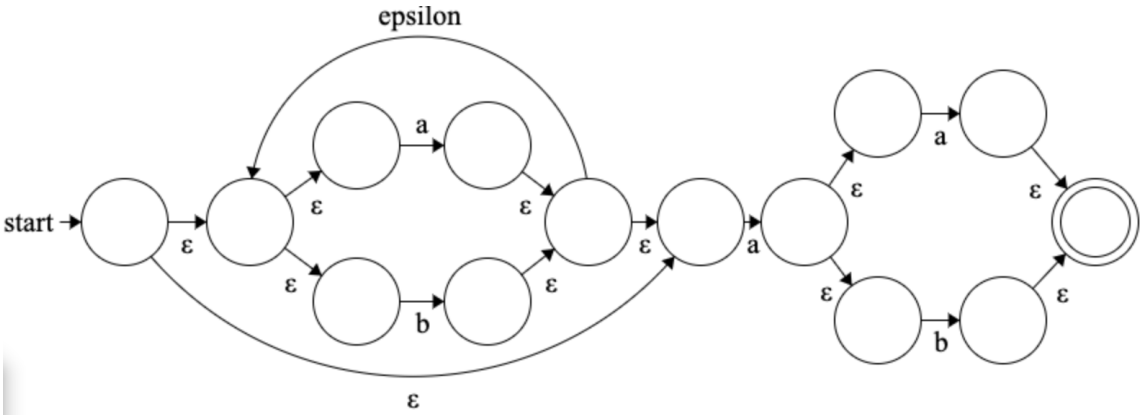
4. NFA for $(a|b)^*$



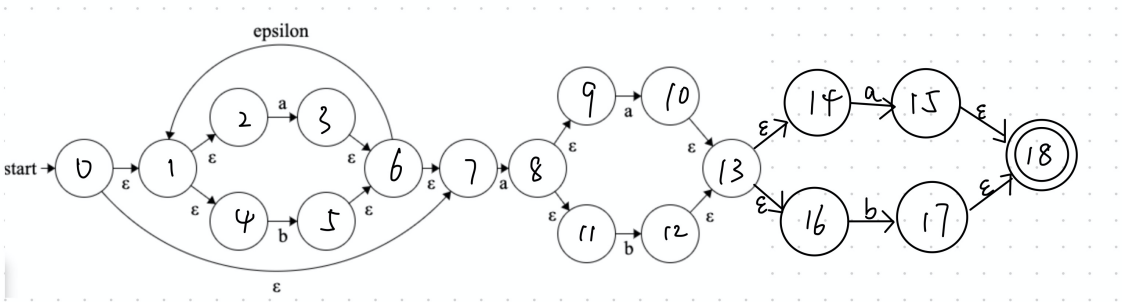
5. NFA for $(a|b)^*a$



6. NFA for $(a|b)^*a(a|b)$

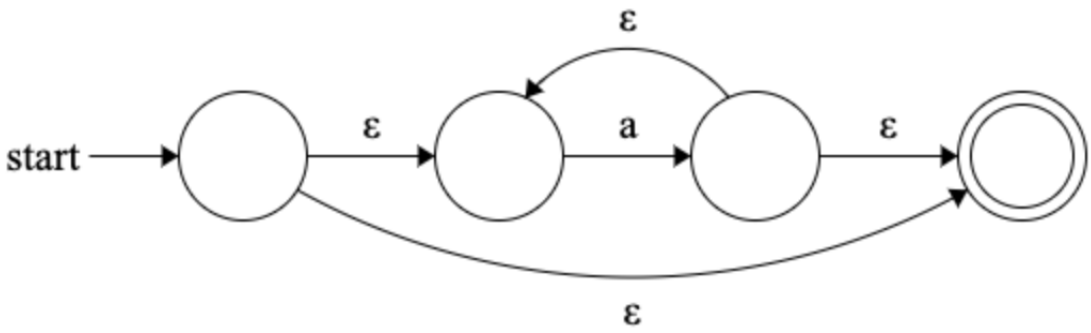


7. NFA for $(a|b)^*a(a|b)(a|b)$



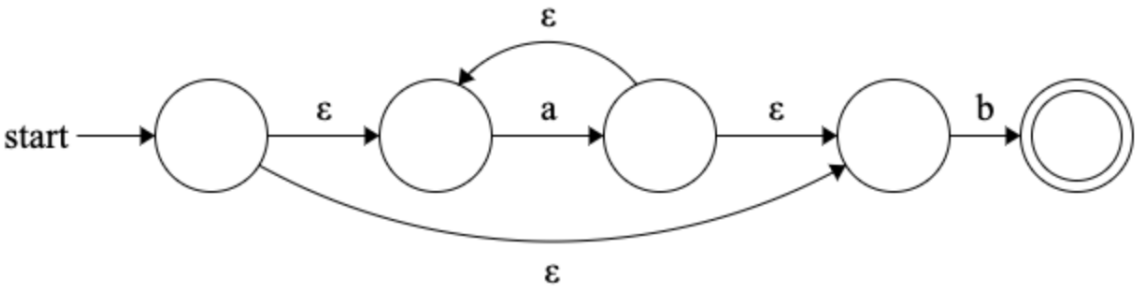
3. $a^*ba^*ba^*ba^*$
    1. NFA for a

    2. NFA for a^*

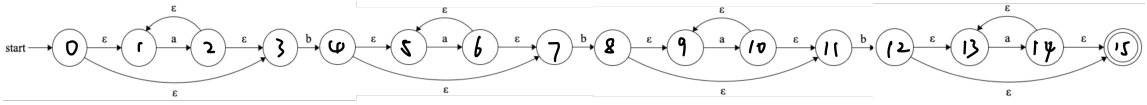


3. NFA for b

4. NFA for a^*b



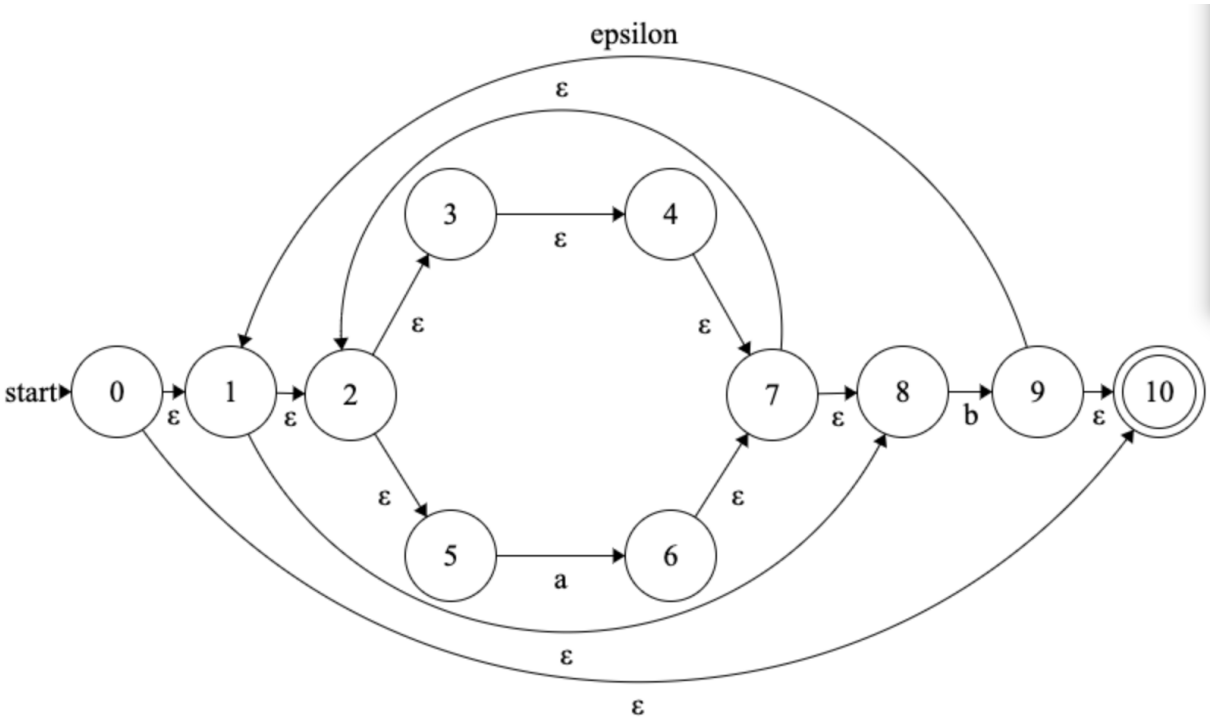
5. NFA for $a^*ba^*ba^*ba^*$



Exercise 3

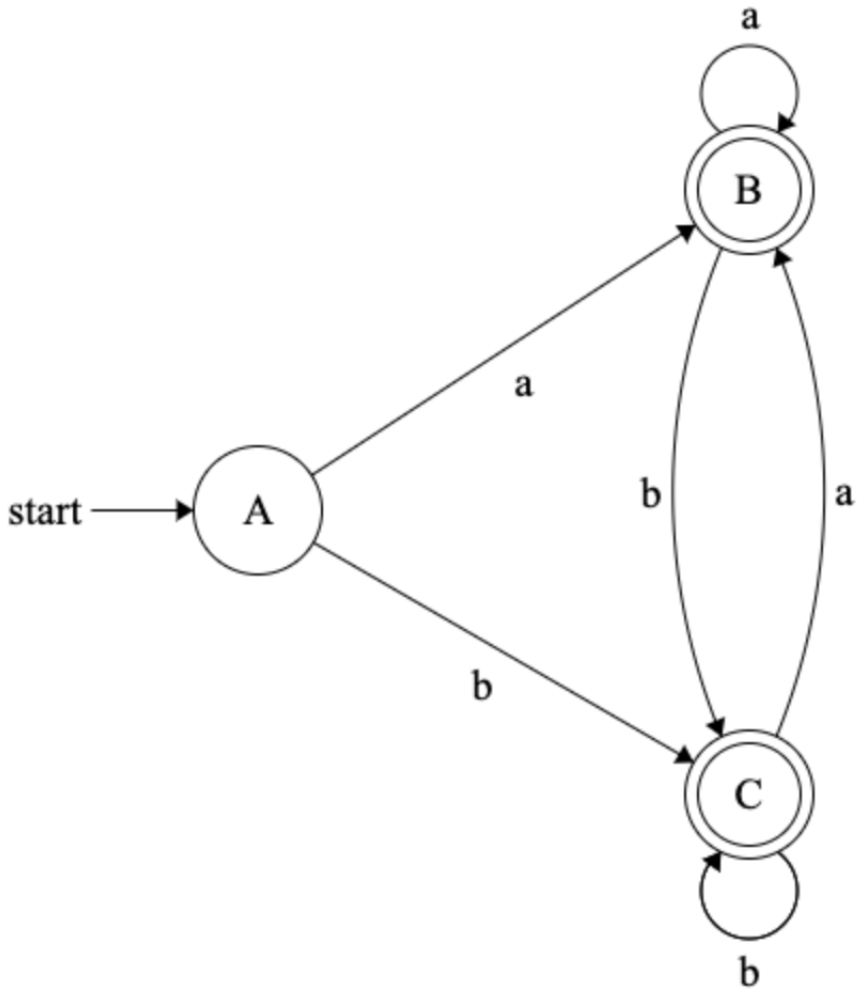
> Convert the NFAs in Exercise 2 to DFAs using the Subset Construction Algorithm (Algorithm 3.20 in the dragon book). Please put down the detailed steps. [30 points in total; 10 points for each correct conversion]

1. NFA: z

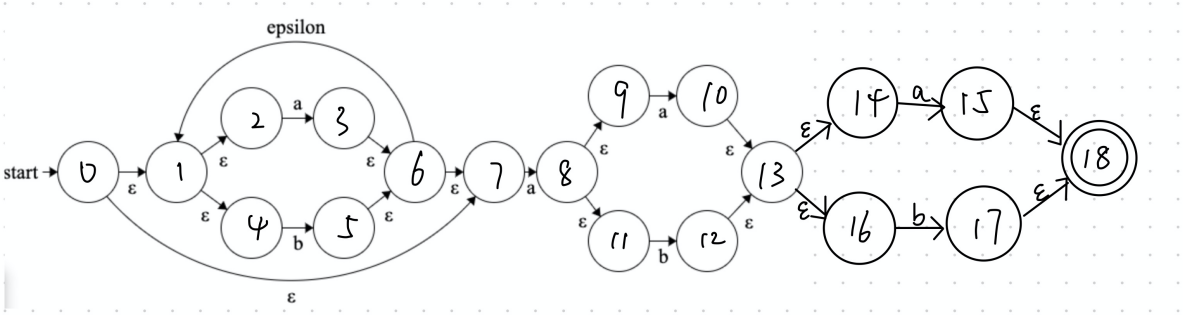


state	I	I_a	I_b
A	{0,1,2,3,4,5,7,8,10}	B	C
B	{2,3,4,5,6,7,8}	B	C
C	{1,2,3,4,5,6,8,9,10}	B	C

DFA:

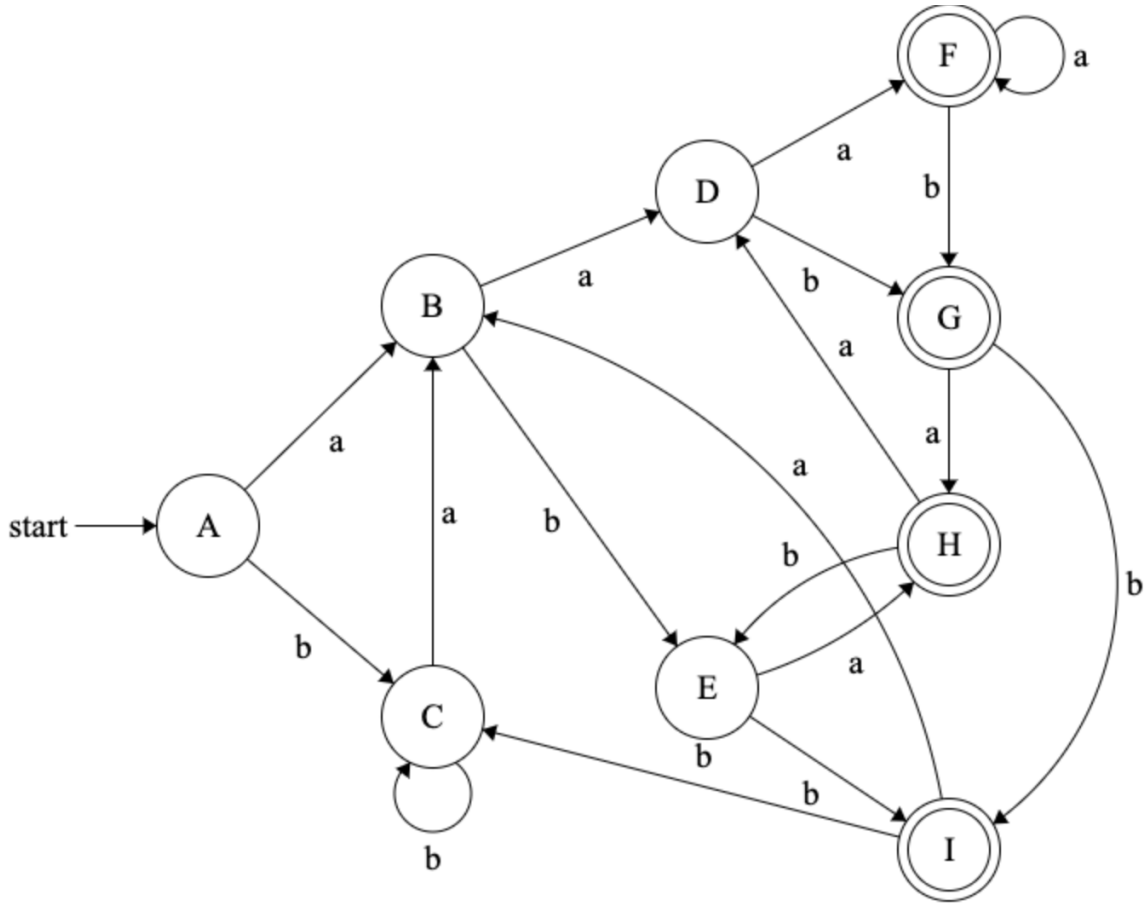

a
B
a
b
a
start
A
b
C
b

2. NFA:

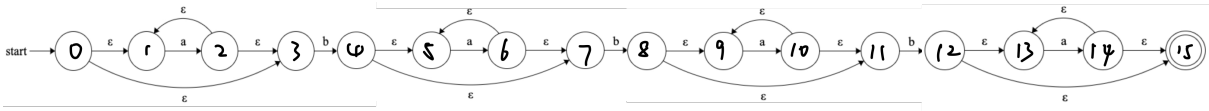

epsilon
start
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
a
b
ε

state	I	I_a	I_b
A	{0,1,2,4,7}	B	C
B	{1,2,3,4,6,7,8,9,11}	D	E
C	{1,2,4,5,6,7}	B	C
D	{1,2,3,4,6,7,8,9,10,11,13,14,16}	F	G
E	{1,2,4,5,6,7,12,13,14,16}	H	I
F	{1,2,3,4,6,7,8,9,10,11,13,14,15,16,18}	F	G
G	{1,2,4,5,6,7,12,13,14,16,17,18}	H	I
H	{1,2,3,4,6,7,8,9,11,15,18}	D	E
I	{1,2,4,5,6,7,17,18}	B	C

DFA:

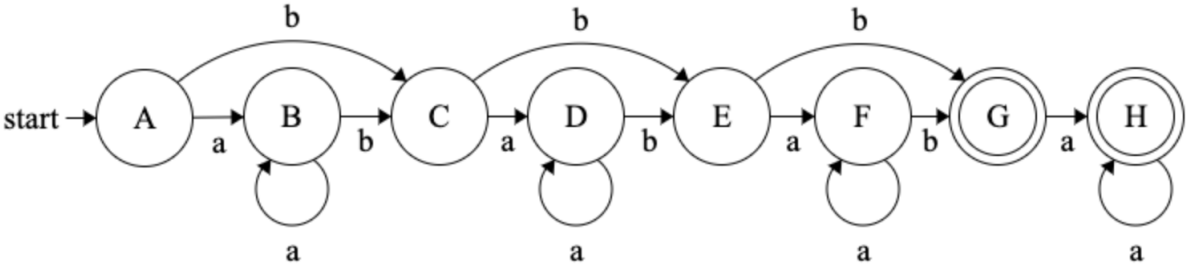


3. NFA:



state	I	I_a	I_b
A	{0,1,3}	B	C
B	{1,2,3}	B	C
C	{4,5,7}	D	E
D	{5,6,7}	D	E
E	{8,9,11}	F	G
F	{9,10,11}	F	G
G	{12,13,15}	H	
H	{13,14,15}	H	

DFA:



Optional Exercises

Exercise 1

> Minimize the number of states of the DFAs you have built for regular expressions 2 and 3 in Exercise 2 using the State-Minimization Algorithm (Algorithm 3.39 in the dragon book). Please put down the detailed steps. [10 points for each correct minimization process]