Exercise 1

Outline the NFA generated by the construction of Thompson relevant to the following regular expression:

$$((a \mid b)^* c)^*$$

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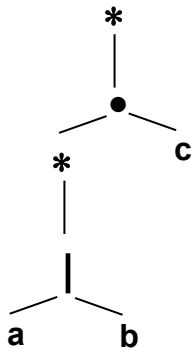

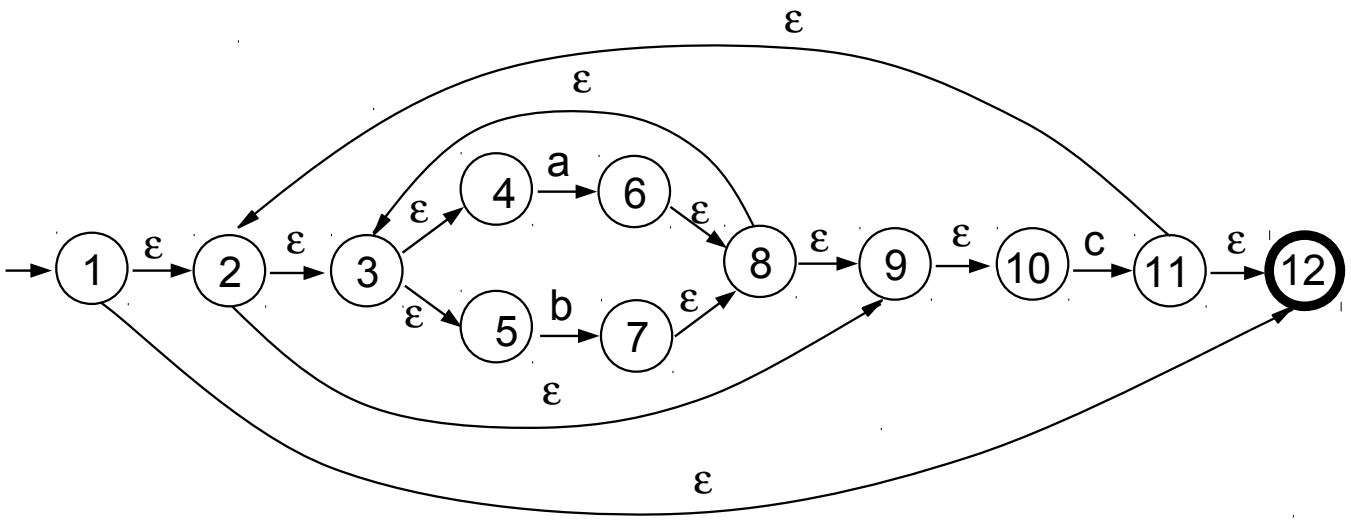

Exercise 2

By means of the construction of Thompson, outline the NFA relevant to the following regular expression:

a (b | c)*d

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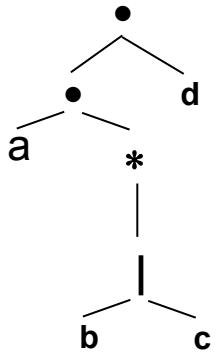
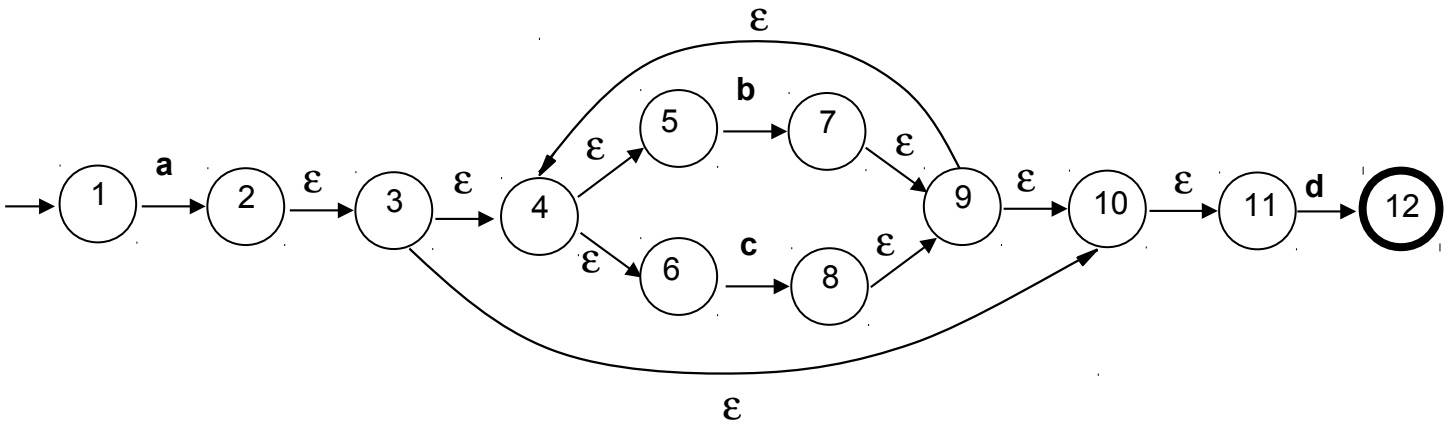
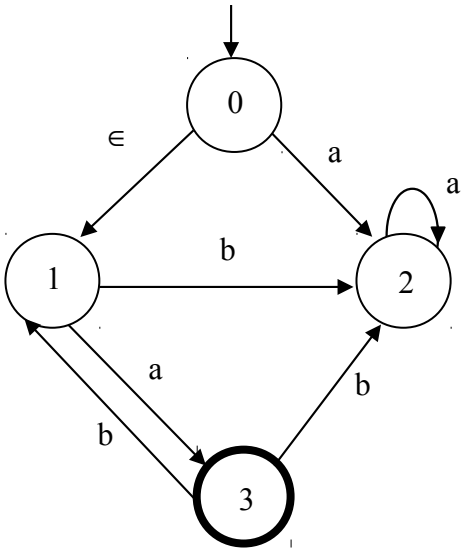




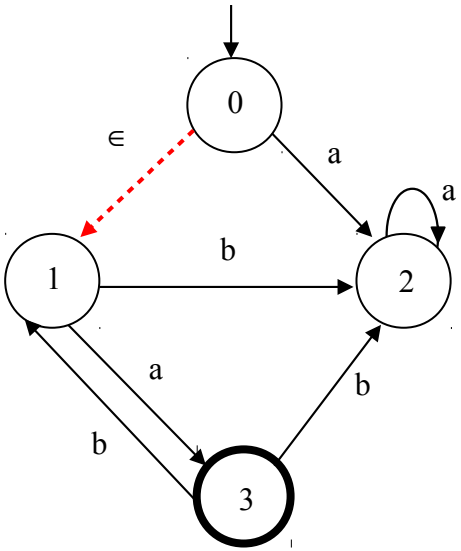
Exercise 3

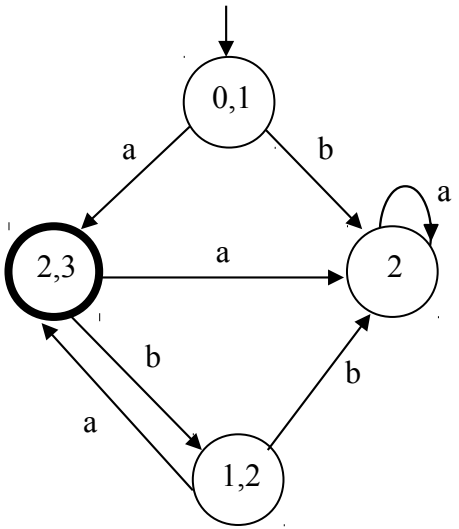
Generate the DFA equivalent to the following NFA:



Exercise 3

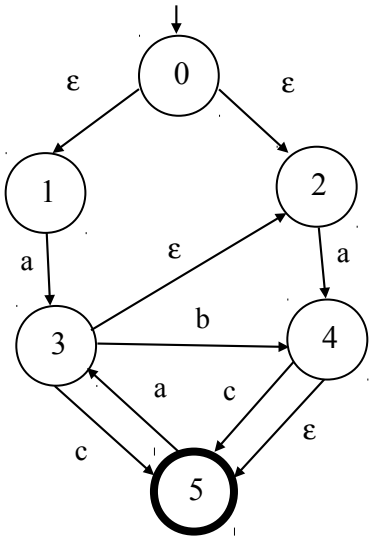
Generate the DFA equivalent to the following NFA:





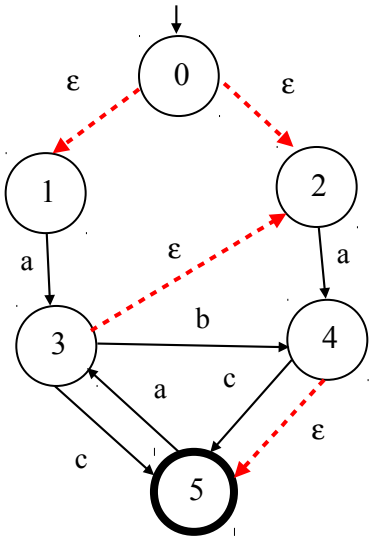
Exercise 4

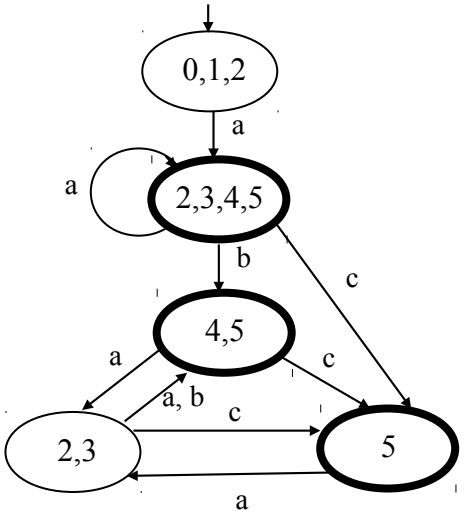
Generate the DFA equivalent to the following NFA:



Exercise 4

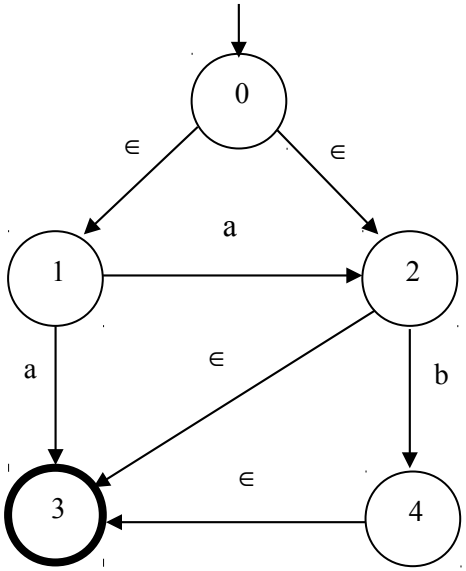
Generate the DFA equivalent to the following NFA:





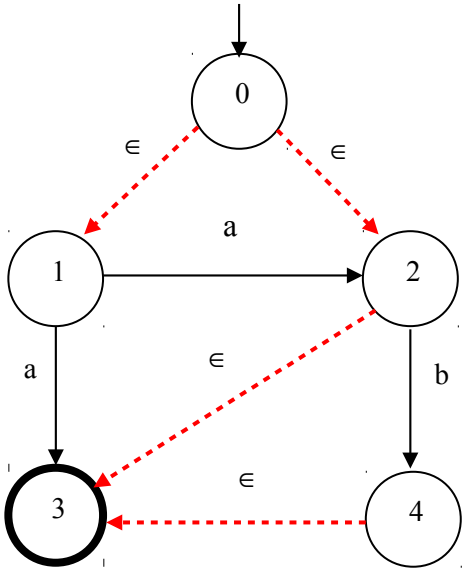
Exercise 5

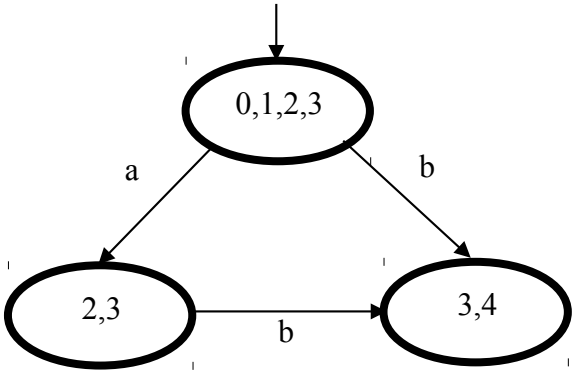
Generate the DFA equivalent to the following NFA:



Exercise 5

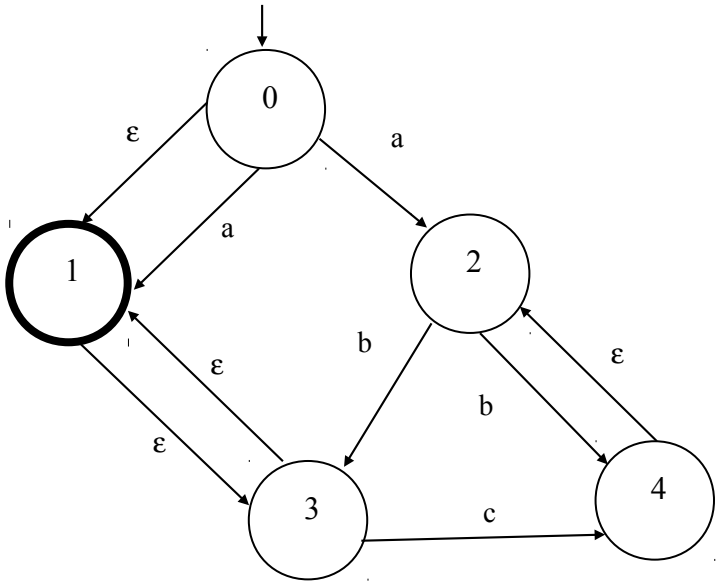
Generate the DFA equivalent to the following NFA:





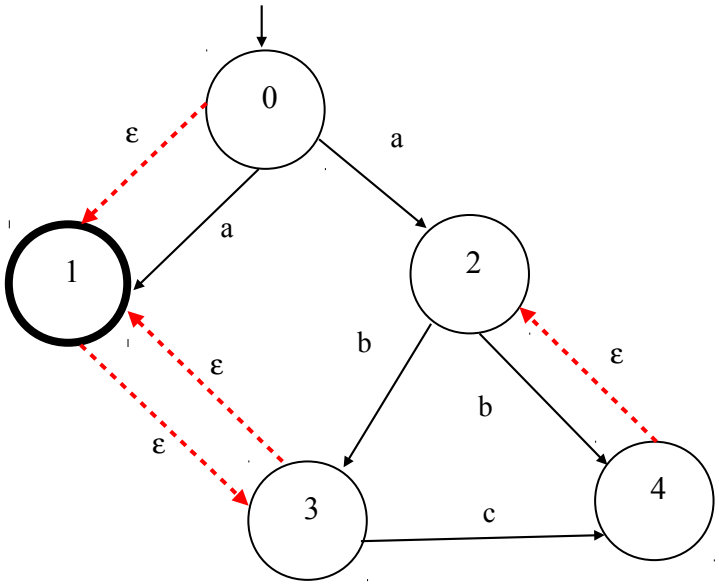
Exercise 6

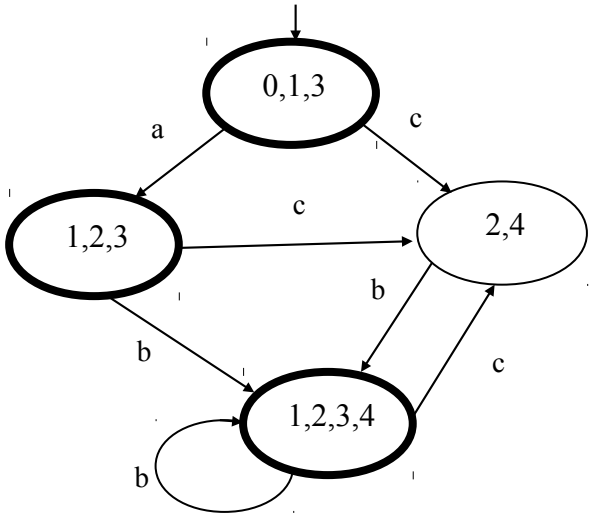
Generate the DFA equivalent to the following NFA:



Exercise 6

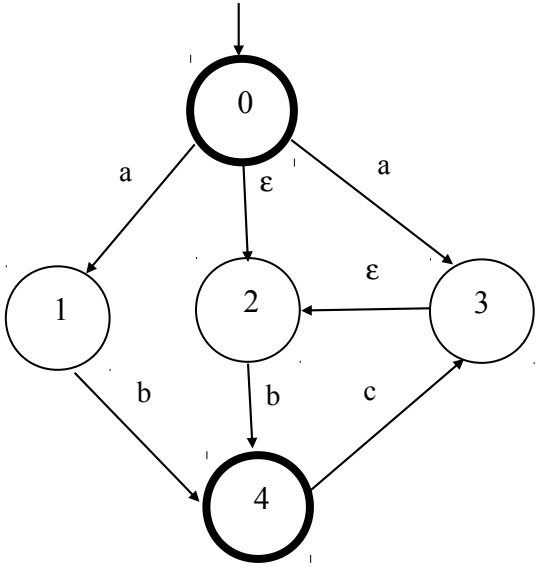
Generate the DFA equivalent to the following NFA:





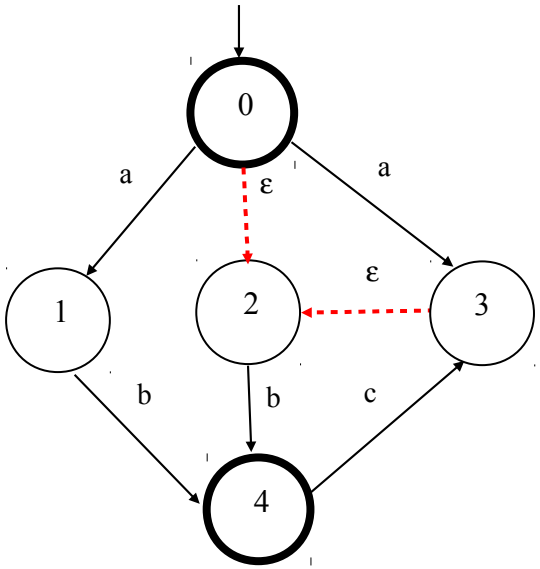
Exercise 7

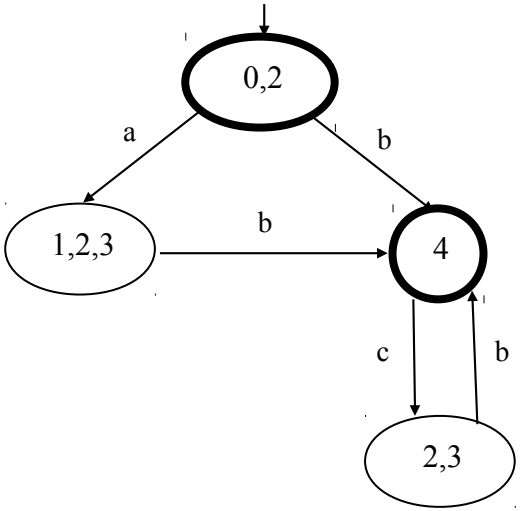
Generate the DFA equivalent to the following NFA:



Exercise 7

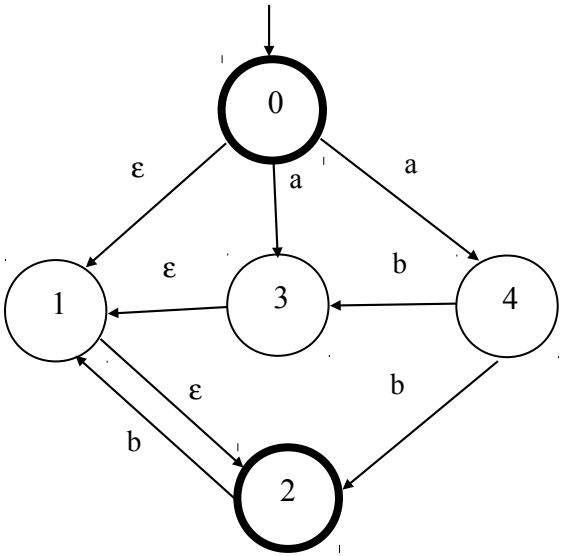
Generate the DFA equivalent to the following NFA:





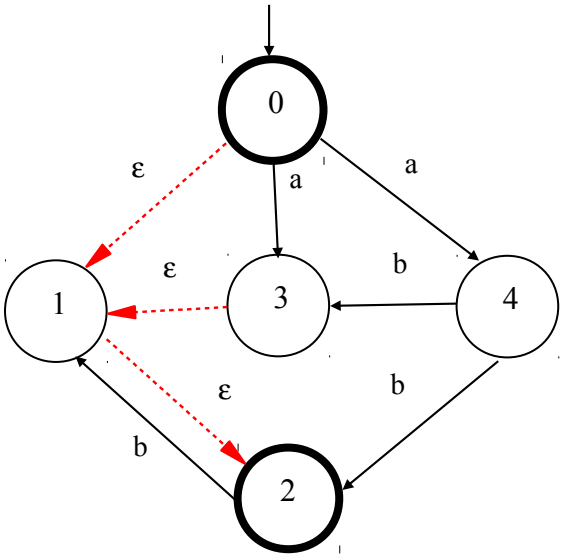
Exercise 8

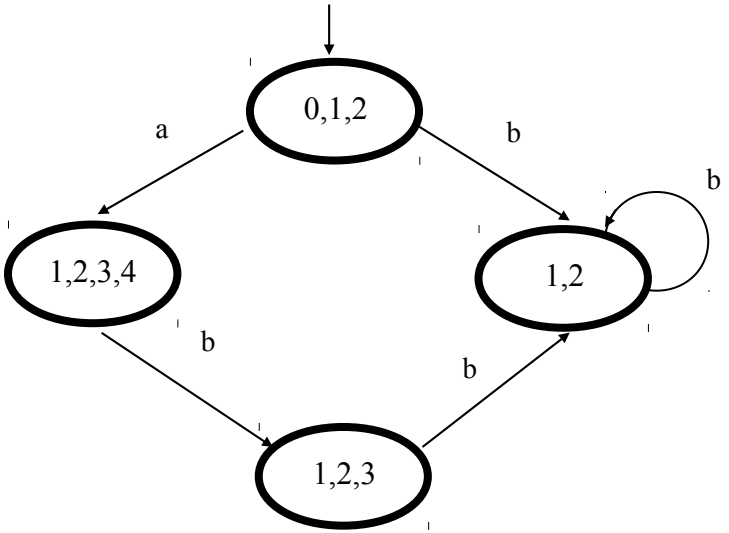
Generate the DFA equivalent to the following NFA:



Exercise 8

Generate the DFA equivalent to the following NFA:





Exercise 9

Given the regular expression **r**: **((a | b) | ε)* c**, we ask to:

a) Outline the tree of expression **r**;

b) Based on the tree of **r**, outline, by means of the construction of Thompson, the NFA recognizing the regular language of **r**.

Exercise 9

Given the regular expression **r**: **((a | b) | ε)* c**, we ask to:

a) Outline the tree of expression **r**;

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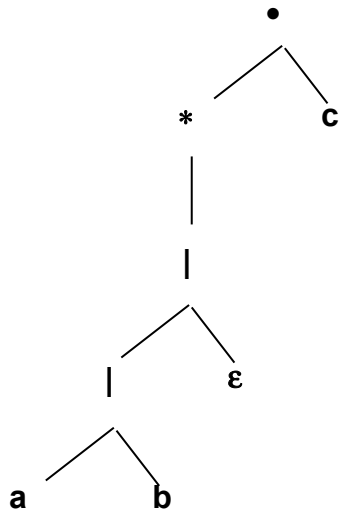
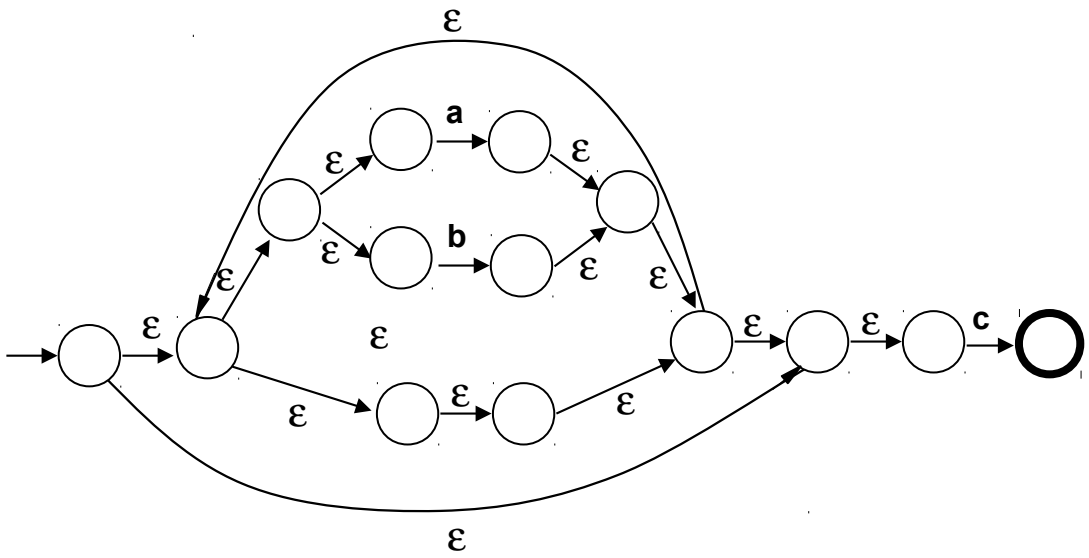
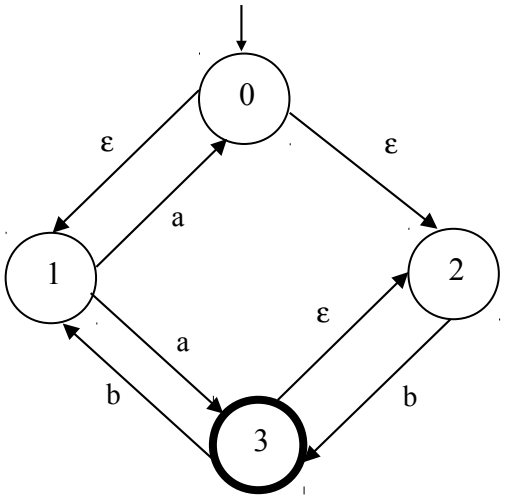




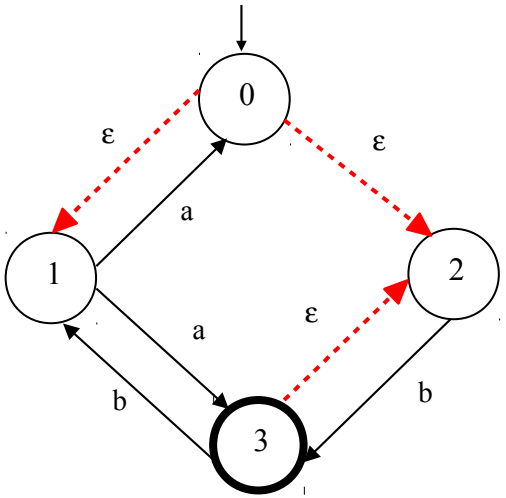
Exercise 10

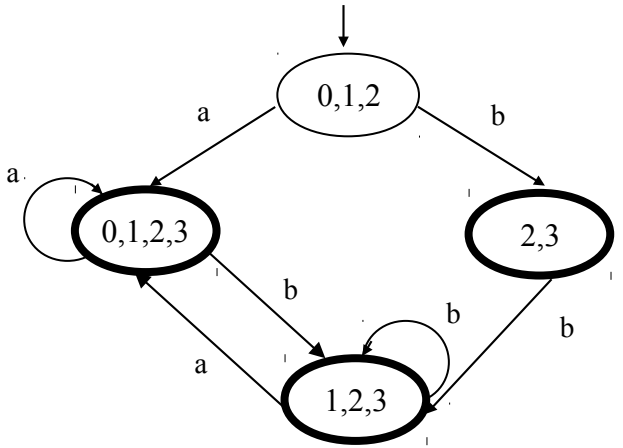
Generate the DFA equivalent to the following NFA:



Exercise 10

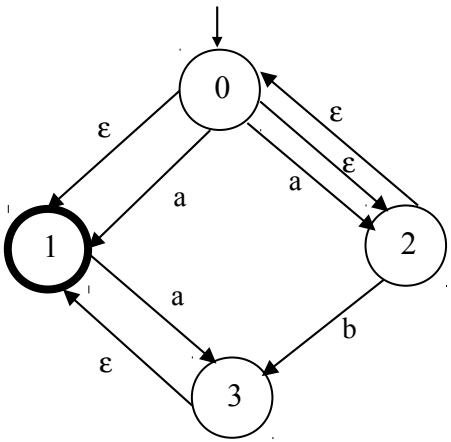
Generate the DFA equivalent to the following NFA:





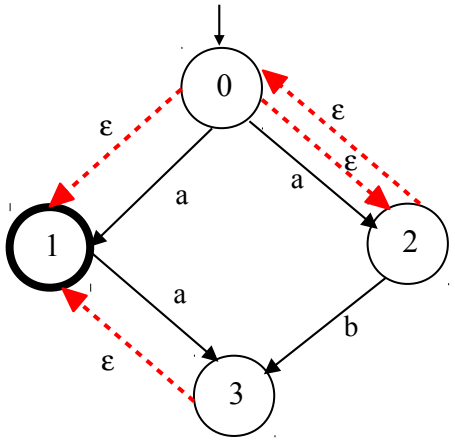
Exercise 11

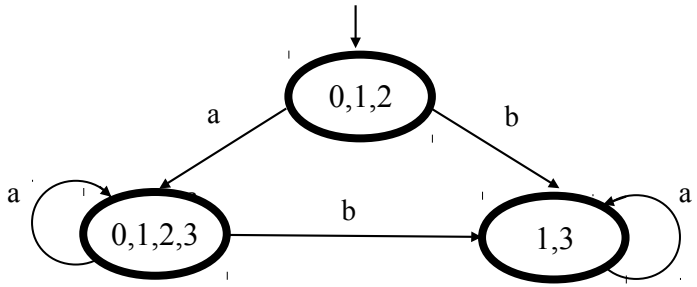
Generate the DFA equivalent to the following NFA:



Exercise 11

Generate the DFA equivalent to the following NFA:





Exercise 12

Given the regular expression **r**: **((a | b)* | c)*** , we ask to:

a) Outline the tree of expression **r**;

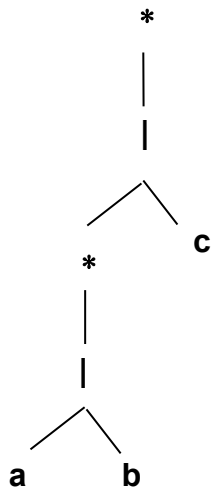
b) Based on the tree of **r**, outline, by means of the canonical construction of Thompson, the DFA recognizing the regular language of **r**.

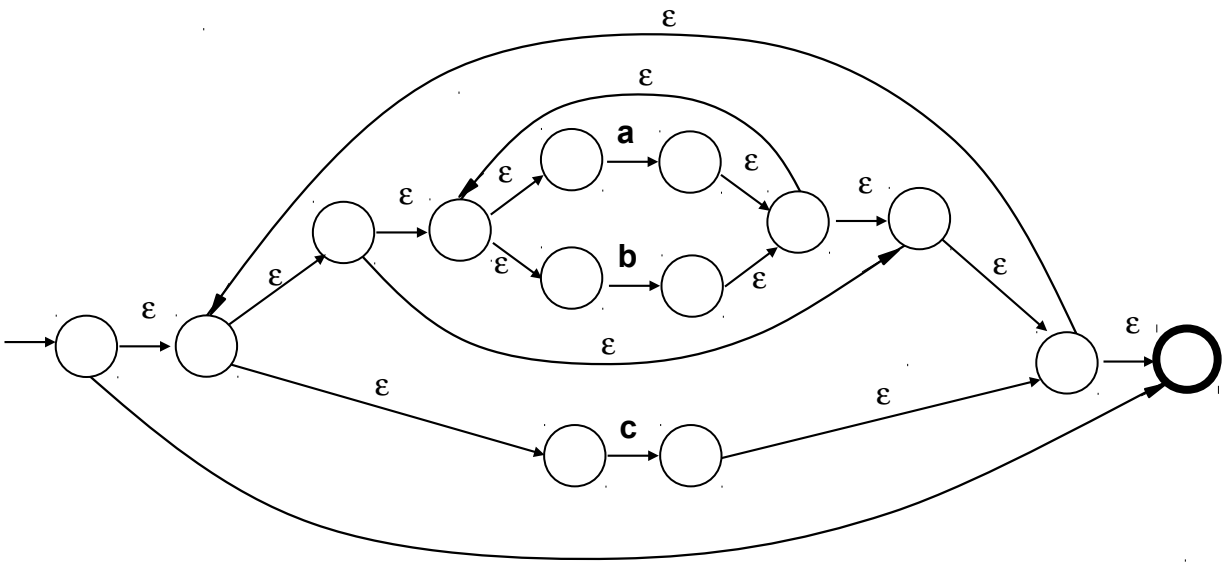
Exercise 12

Given the regular expression **r**: **((a | b)* | c)***, we ask to:

a) Outline the tree of expression **r**;

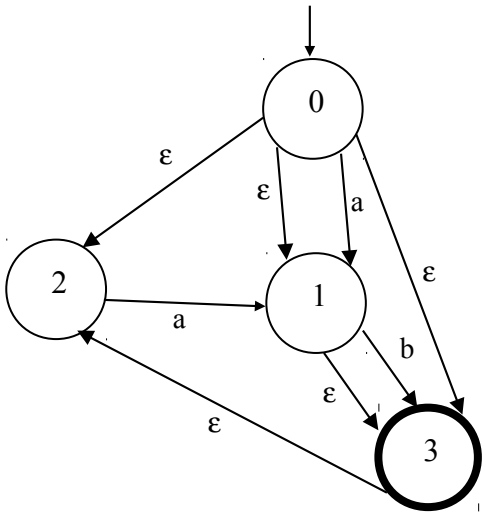
b) Based on the tree of **r**, outline, by means of the canonical construction of Thompson, the DFA recognizing the regular language of **r**.





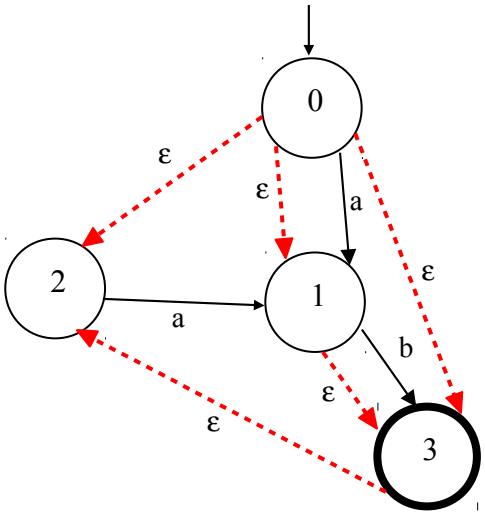
Exercise 13

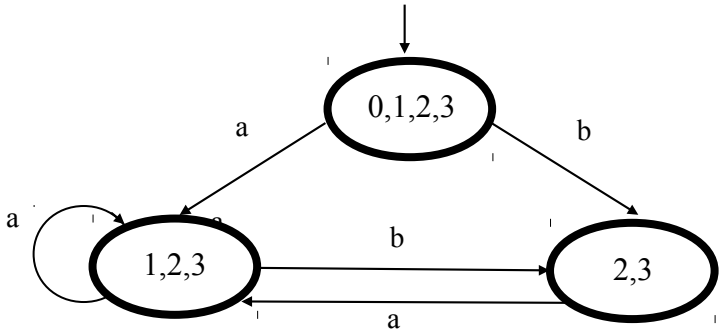
Generate the DFA equivalent to the following NFA:



Exercise 13

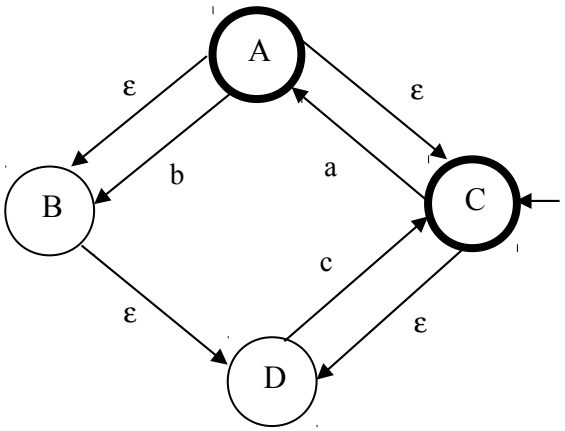
Generate the DFA equivalent to the following NFA:





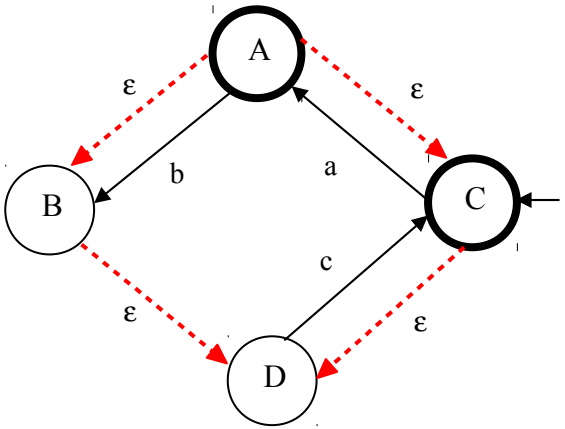
Exercise 14

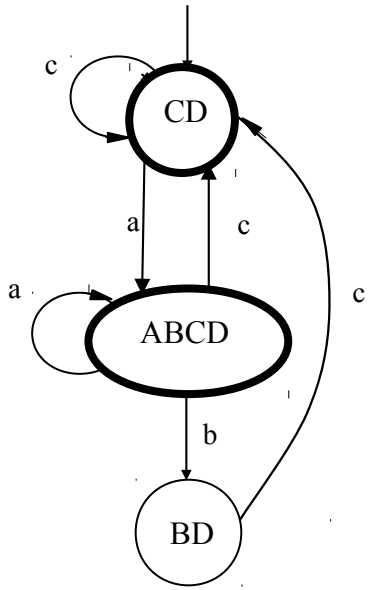
Generate the DFA equivalent to the following NFA:



Exercise 14

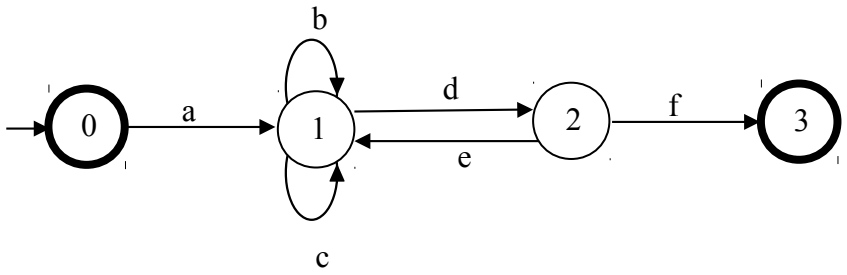
Generate the DFA equivalent to the following NFA:





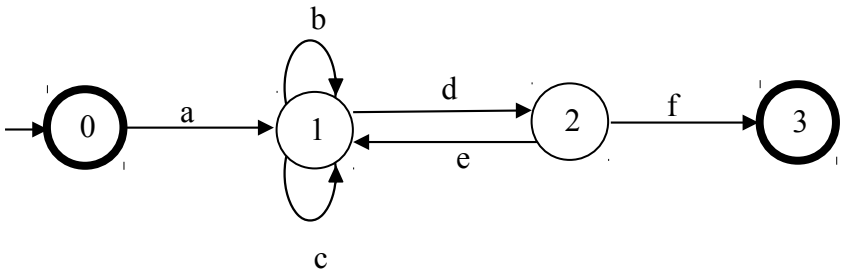
Exercise 15

Specify the BNF of the regular language defined by the following DFA:



Exercise 15

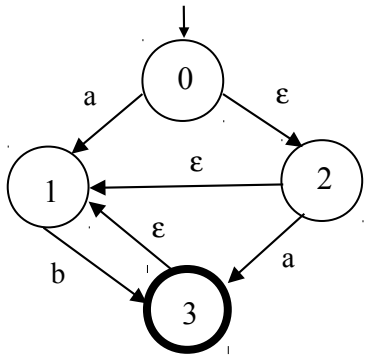
Specify the BNF of the regular language defined by the following DFA:



$$A_0 \rightarrow \mathbf{a}A_1 \mid \varepsilon$$
$$A_1 \rightarrow \mathbf{b}A_1 \mid \mathbf{c}A_1 \mid \mathbf{d}A_2$$
$$A_2 \rightarrow \mathbf{e}A_1 \mid \mathbf{f}A_3$$
$$A_3 \rightarrow \varepsilon$$

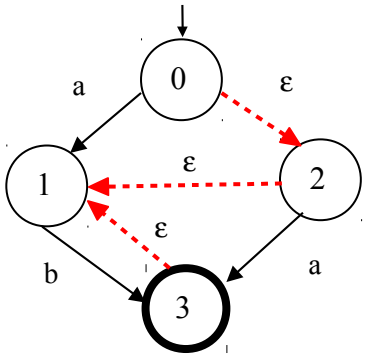
Exercise 16

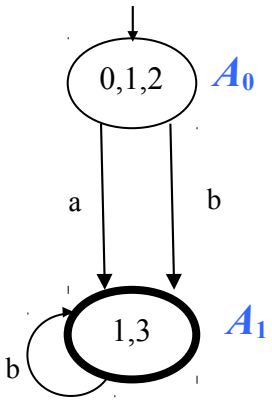
After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.



Exercise 16

After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.

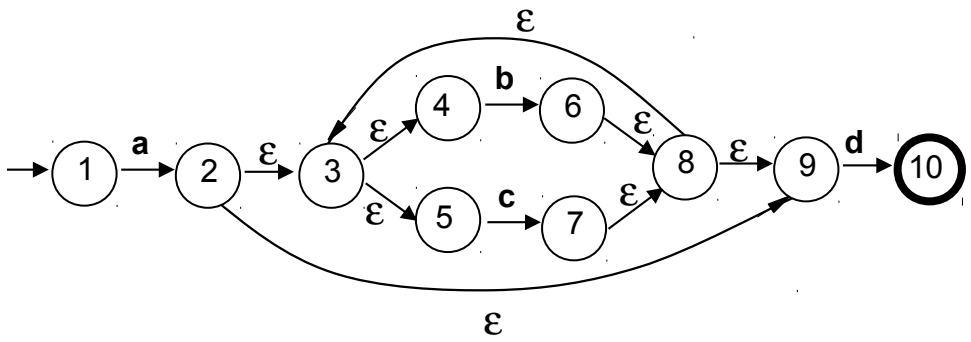




$$A_0 \rightarrow \mathbf{a}A_1 \,|\, \mathbf{b}A_1$$
$$A_1 \rightarrow \mathbf{b}A_1 \,|\, \varepsilon$$

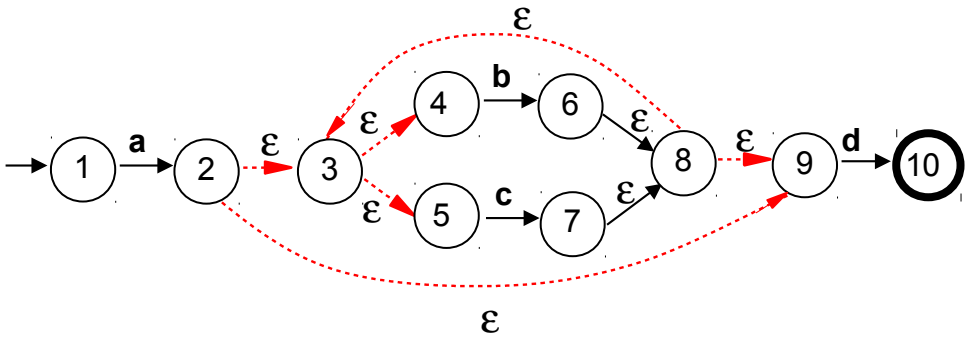
Exercise 17

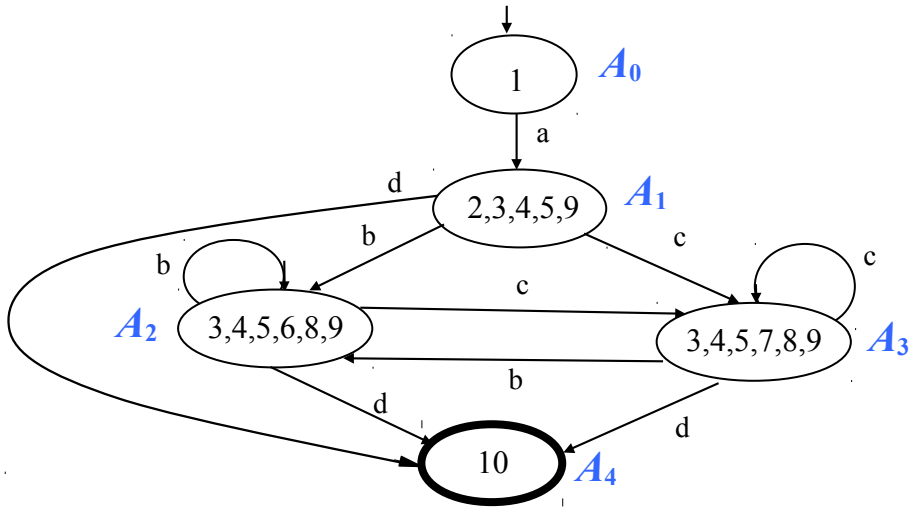
After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.



Exercise 17

After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.

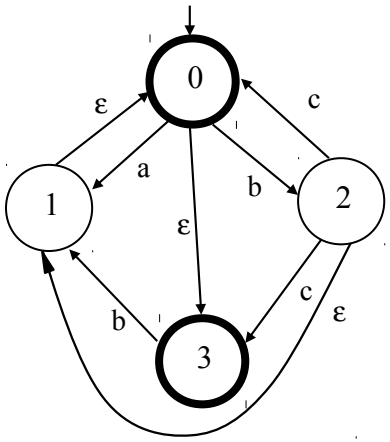




$A_0 \rightarrow \mathbf{a}\ A_1$
$A_1 \rightarrow \mathbf{b}\ A_2 \mid \mathbf{c}\ A_3 \mid \mathbf{d}\ A_4$
$A_2 \rightarrow \mathbf{b}\ A_2 \mid \mathbf{c}\ A_3 \mid \mathbf{d}\ A_4$
$A_3 \rightarrow \mathbf{c}\ A_3 \mid \mathbf{b}\ A_2 \mid \mathbf{d}\ A_4$
$A_4 \rightarrow \boldsymbol{\varepsilon}$

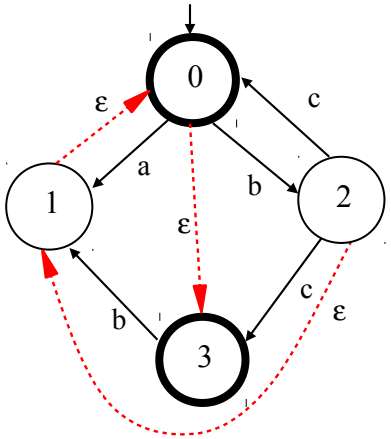
Exercise 18

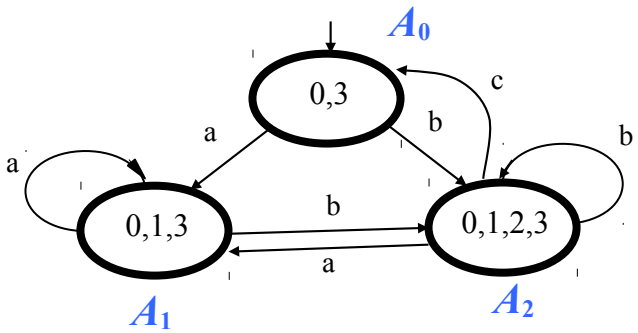
After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.



Exercise 18

After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.

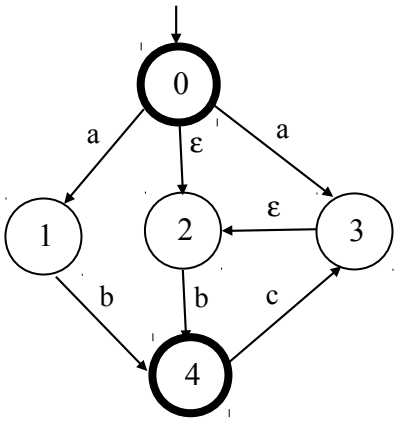




$$A_0 \rightarrow \mathbf{a}\ A_1 \,|\, \mathbf{b}\ A_2 \,|\, \boldsymbol{\varepsilon}$$
$$A_1 \rightarrow \mathbf{a}\ A_1 \,|\, \mathbf{b}\ A_2 \,|\, \boldsymbol{\varepsilon}$$
$$A_2 \rightarrow \mathbf{a}\ A_1 \,|\, \mathbf{b}\ A_2 \,|\, \mathbf{c}\ A_0 \,|\, \boldsymbol{\varepsilon}$$

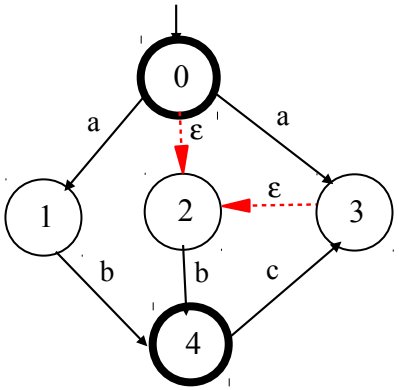
Exercise 19

Specify the BNF of the regular language relevant to the following NFA:



Exercise 19

Specify the BNF of the regular language relevant to the following NFA:



$A_0 \rightarrow \mathbf{a}\ A_1 \mid A_2 \mid \mathbf{a}\ A_3 \mid \varepsilon$

$A_1 \rightarrow \mathbf{b} A_4$

$A_2 \rightarrow \mathbf{b} A_4$

$A_3 \rightarrow A_2$

$A_4 \rightarrow \mathbf{c}\ A_3 \mid \varepsilon$

Exercise 20

Given the following regular expression *r*,

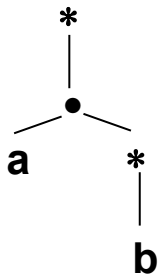
$$r = (\mathbf{a}\ \mathbf{b}^*)^*$$

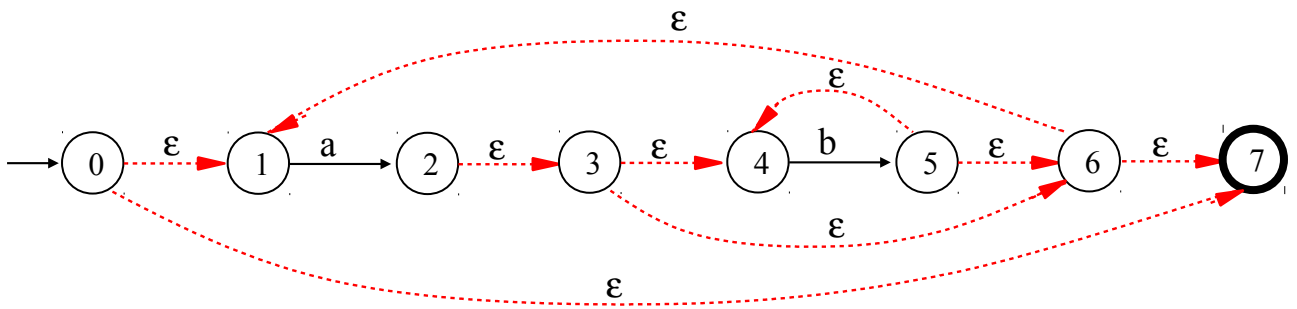
we ask to:

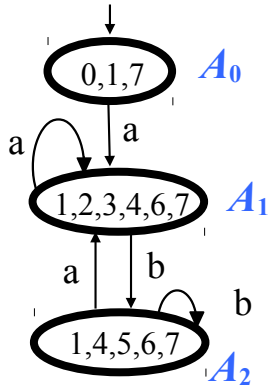
a) Outline NFA(*r*) generated by the canonical construction of Thompson;
b) Transform NFA(*r*) into the equivalent DFA(*r*);
c) Based on DFA(*r*), specify the BNF of the regular language relevant to *r*.

Exercise 20

$r = (\mathbf{a}\ \mathbf{b}^*)^*$







$A_0 \rightarrow \mathrm{a}\ A_1 \mid \varepsilon$

$A_1 \rightarrow \mathrm{a}\ A_1 \mid \mathrm{b}\ A_2 \mid \varepsilon$

$A_2 \rightarrow \mathrm{a}\ A_1 \mid \mathrm{b}\ A_2 \mid \varepsilon$

Exercise 21

Given the following regular expression:

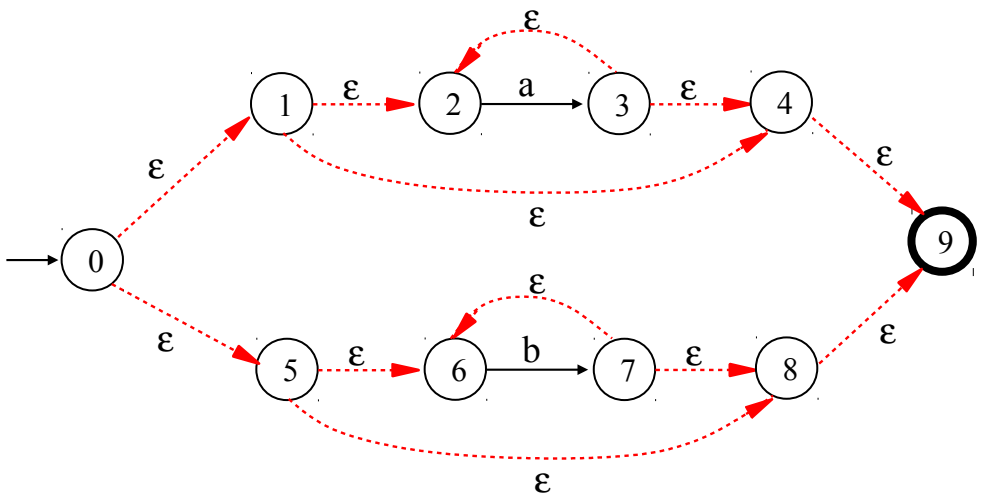
$$r = (\mathbf{a}^* \mid \mathbf{b}^*)$$

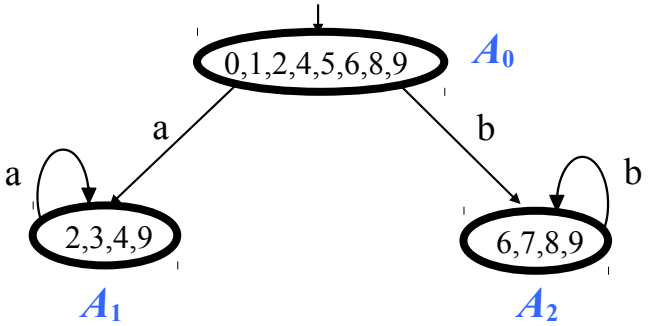
we ask to:

a) Outline the NFA(*r*) generated by means of the (canonical) construction of Thompson;
b) Transform NFA(*r*) into the equivalent DFA(*r*);
c) Based on DFA(*r*), specifiy the BNF of the regular language relevant to *r*.

Exercise 21

$r = (\mathbf{a}^* \mid \mathbf{b}^*)$





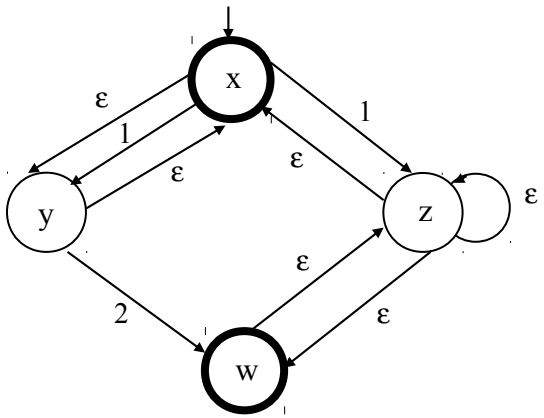
$A_0 \rightarrow \mathrm{a}\ A_1 \mid \mathrm{b}\ A_2 \mid \varepsilon$

$A_1 \rightarrow \mathrm{a}\ A_1 \mid \varepsilon$

$A_2 \rightarrow \mathrm{b}\ A_2 \mid \varepsilon$

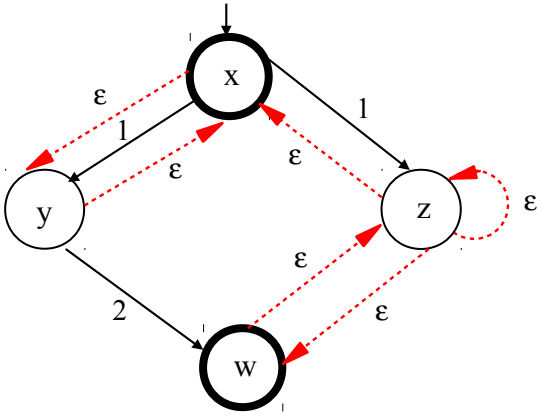
Exercise 22

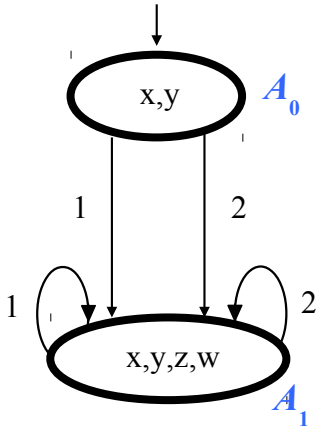
Given the following NFA:



a) Generate the equivalent DFA;
b) Specify the BNF of the regular language of the DFA.

Exercise 22





$$A_0 \rightarrow 1\ A_1 \mid 2\ A_1 \mid \varepsilon$$
$$A_1 \rightarrow 1\ A_1 \mid 2\ A_1 \mid \varepsilon$$

Exercise 23

Given the following regular expression,

$$((\mathbf{a}\ \mathbf{b})^* \mid (\mathbf{c}\ \mathbf{d})^*)^*$$

we ask to:

- Outline the tree of the regular expression;
- Outline the DFA generated by the (canonical) construction of Thompson.

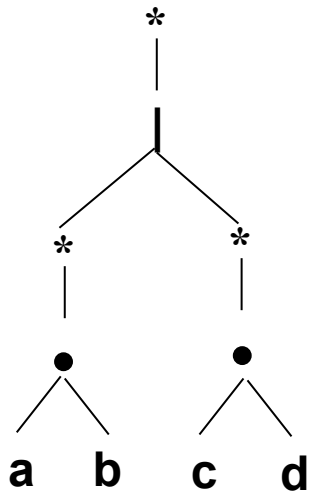
Exercise 23

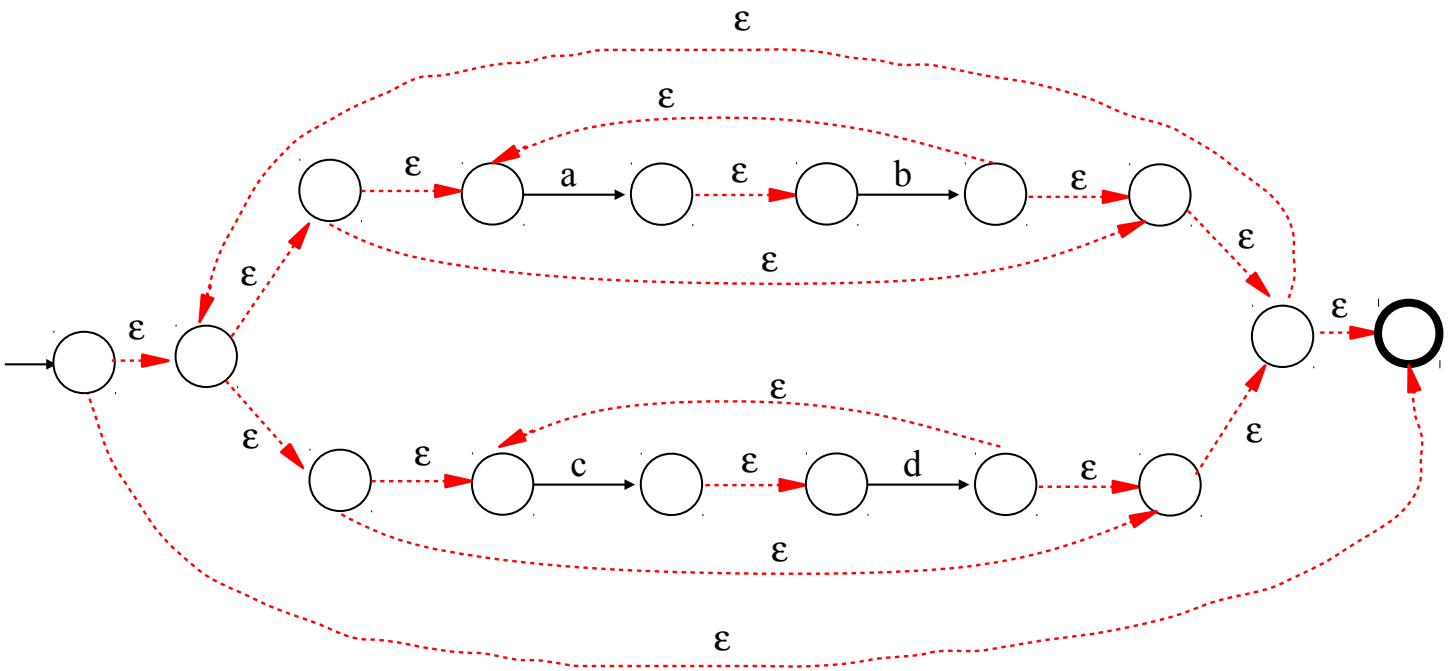
Given the following regular expression,

$$((\mathbf{a}\ \mathbf{b})^* \mid (\mathbf{c}\ \mathbf{d})^*)^*$$

we ask to:

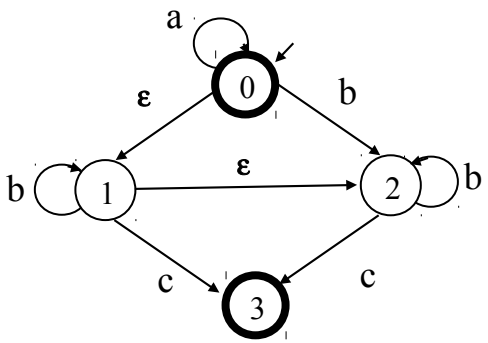
- Outline the tree of the regular expression;
- Outline the DFA generated by the (canonical) construction of Thompson.





Exercise 24

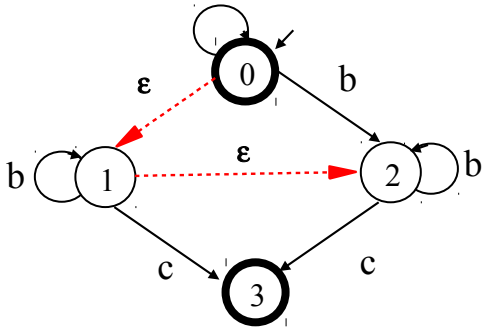
Given the following NFA:



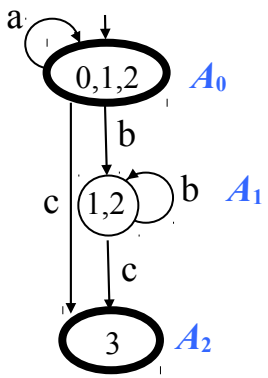
- Generate the equivalent DFA;
- Specify the BNF of the regular language of the DFA.

Exercise 24

Given the following NFA:



- Generate the equivalent DFA;
- Specify the BNF of the regular language of the DFA.



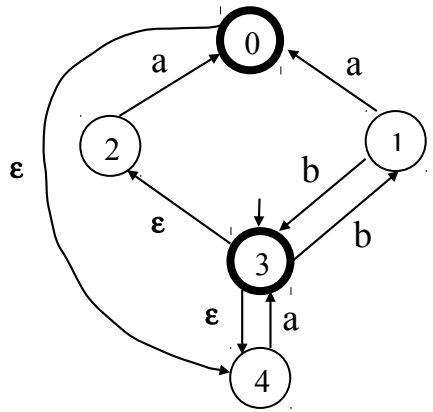
$A_0 \rightarrow \mathbf{a}\ A_0 \mid \mathbf{b}\ A_1 \mid \mathbf{c}\ A_2 \mid \boldsymbol{\varepsilon}$

$A_1 \rightarrow \mathbf{b}\ A_1 \mid \mathbf{c}\ A_2$

$A_2 \rightarrow \boldsymbol{\varepsilon}$

Exercise 25

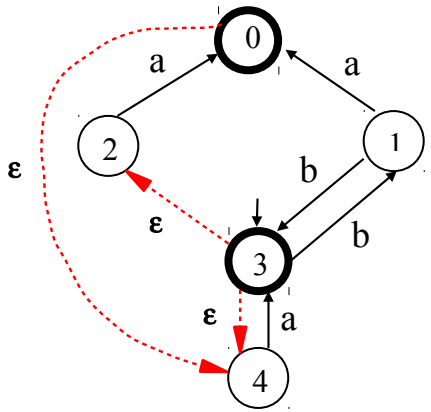
Given the following NFA:



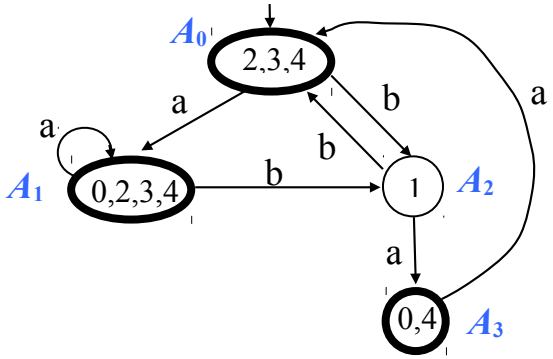
- Generate the equivalent DFA;
- Specify the BNF of the regular language of the DFA.

Exercise 25

Given the following NFA:



- Generate the equivalent DFA;
- Specify the BNF of the regular language of the DFA.



$$A_0 \rightarrow \mathbf{a}\, A_1 \mid \mathbf{b}\, A_2 \mid \boldsymbol{\varepsilon}$$
$$A_1 \rightarrow \mathbf{a}\, A_1 \mid \mathbf{b}\, A_2 \mid \boldsymbol{\varepsilon}$$
$$A_2 \rightarrow \mathbf{a}\, A_3 \mid \mathbf{b}\, A_0$$
$$A_3 \rightarrow \mathbf{a}\, A_0 \mid \boldsymbol{\varepsilon}$$

Exercise 26

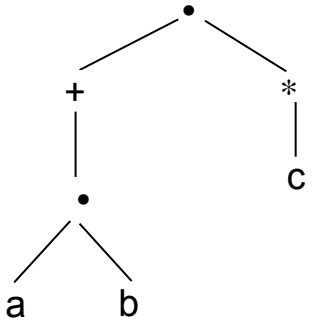
Given the regular expression **r = (a b)$^+$ c***, we ask to:

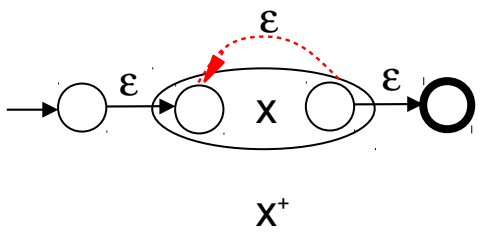
- Outline the tree of **r**;
- Define the (extended) construction rule of Thompson for the operator **+** (repetition one or more times);
- Based on the previous points, outline, by means of the construction of Thompson, the NFA which recognizes the regular language of **r**;
- Specify the BNF of the regular language of the NFA.

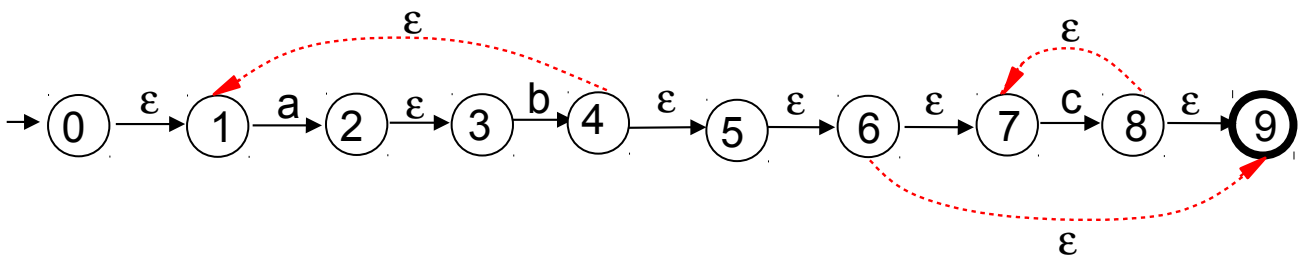
Exercise 26

Given the regular expression **r = (a b)⁺ c***, we ask to:

- Outline the tree of **r**;
- Define the (extended) construction rule of Thompson for the operator **+** (repetition one or more times);
- Based on the previous points, outline, by means of the construction of Thompson, the NFA which recognizes the regular language of **r**;
- Specify the BNF of the regular language of the NFA.







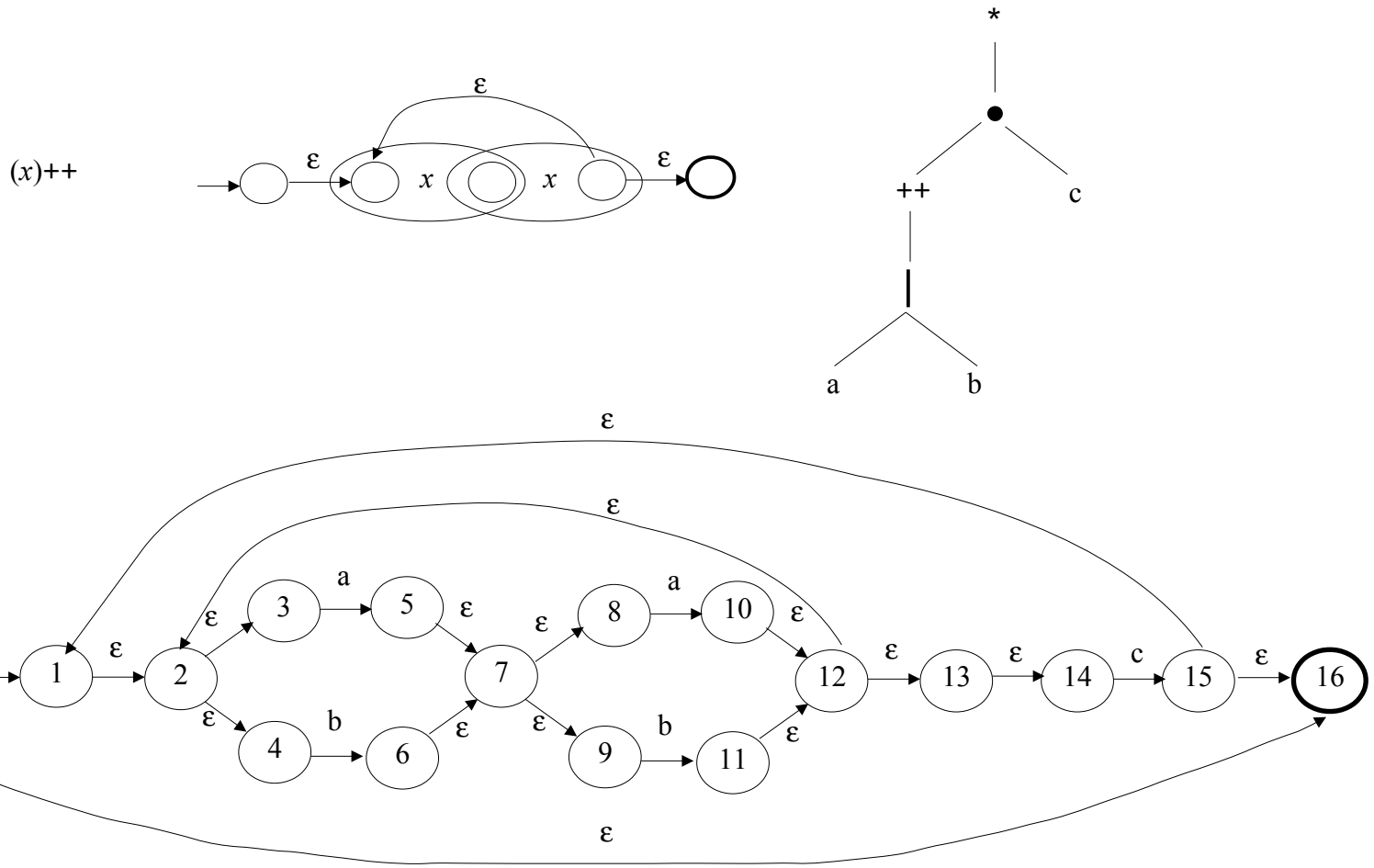
$$A_0 \rightarrow A_1$$
$$A_1 \rightarrow \mathbf{a}\ A_2$$
$$A_2 \rightarrow A_3$$
$$A_3 \rightarrow \mathbf{b}\ A_4$$
$$A_4 \rightarrow A_1 \mid A_5$$
$$A_5 \rightarrow A_6$$
$$A_6 \rightarrow A_7 \mid A_9$$
$$A_7 \rightarrow \mathbf{c}\ A_8$$
$$A_8 \rightarrow A_7 \mid A_9$$
$$A_9 \rightarrow \varepsilon$$

Exercise 27

Specify the extended construction rule of Thompson for the operator ++, defined as repetition $2n$ times, $n \in [1, 2, ...]$. Then, draw the tree of the regular expression **r = ((a | b)$^{++}$ c)***. Finally, based on the construction of Thompson, outline the NFA recognizing the regular language of **r**.

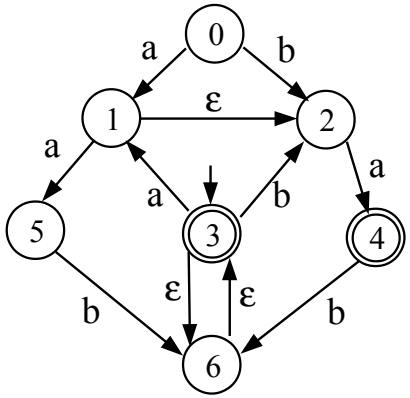
Exercise 27

Specify the extended construction rule of Thompson for the operator ++, defined as repetition 2*n* times, $n \in [1, 2, ...]$. Then, draw the tree of the regular expression **r = ((a | b)++ c)***. Finally, based on the construction of Thompson, outline the NFA recognizing the regular language of **r**.



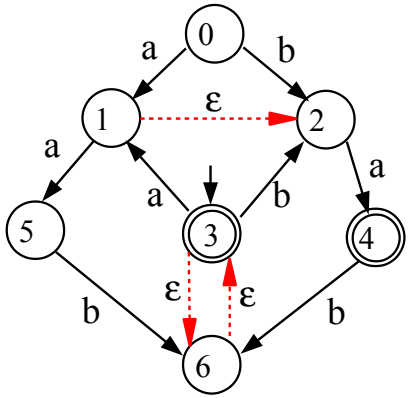
Exercise 28

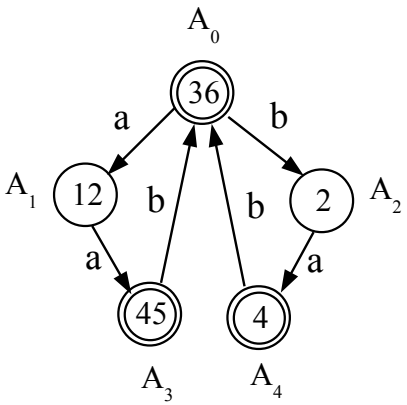
After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.



Exercise 28

After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.





$A_0 \rightarrow \mathbf{a}\, A_1 \mid \mathbf{b}\, A_2 \mid \boldsymbol{\varepsilon}$

$\boldsymbol{A_1 \rightarrow \mathbf{a}\, A_3}$

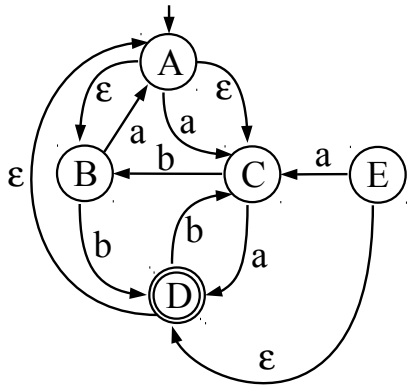
$A_2 \rightarrow \mathbf{a}\, A_4$

$A_3 \rightarrow \mathbf{b}\, A_0 \mid \boldsymbol{\varepsilon}$

$A_4 \rightarrow \mathbf{b}\, A_0 \mid \boldsymbol{\varepsilon}$

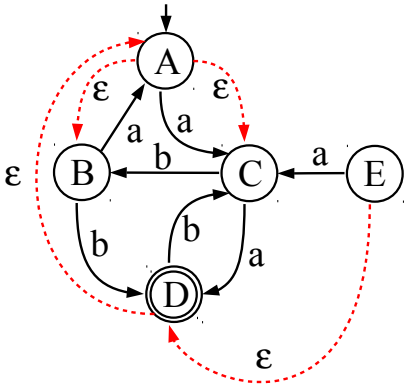
Exercise 29

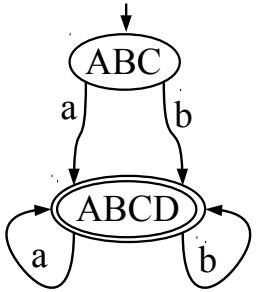
After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.



Exercise 29

After generating the DFA equivalent to the following NFA, specify the BNF expressing the regular language relevant to the DFA.





$A_0 \rightarrow$ **a** A_1 | b A_1

$A_1 \rightarrow$ **a** A_1 | b A_1 | **ε**