

# Language and Automata, Assignment 1

Krzysztof Rudnicki  
Student number: 307585

November 17, 2021

## 1.1 Regular expression

We are given following regular expression:

$$a^* + ba^*b + bba^*$$

## 1.2 Examples of accepted strings

1.  $\varepsilon$
2. a
3. bab
4. bba
5. bb

## 1.3 Building NFA using Thompson construction algorithm

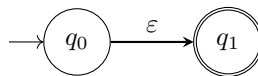


Figure 1.1: Operator 'a'

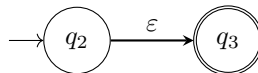


Figure 1.2: Operator 'b'

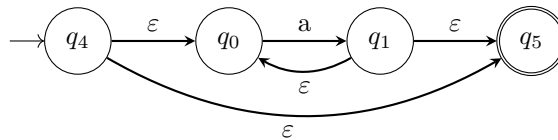


Figure 1.3: Operator 'a\*'

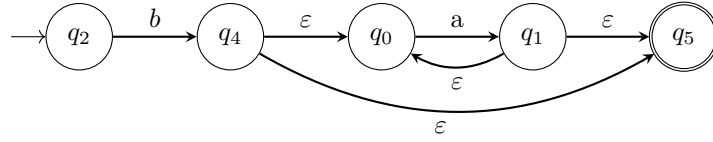


Figure 1.4: Operator ' $ba^*$ '

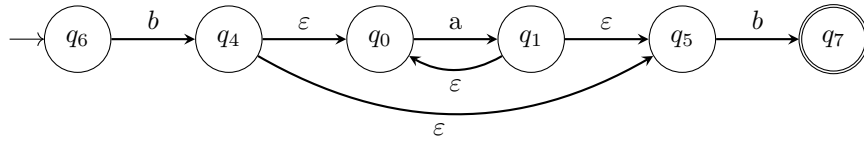


Figure 1.5: Operator ' $ba^*b$ '

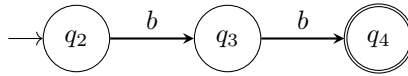


Figure 1.6: Operator ' $bb$ '

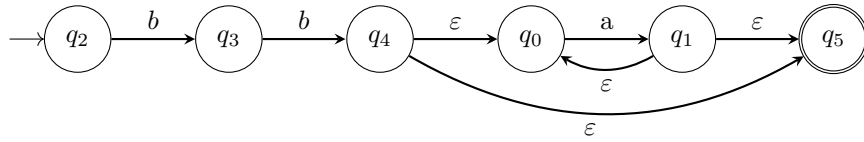


Figure 1.7: Operator ' $bba^*$ '

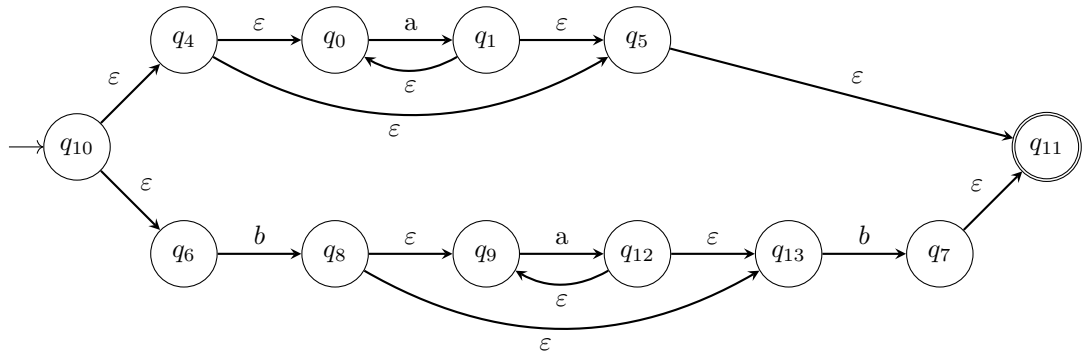


Figure 1.8: Operator ' $a^* + ba^*b$ '

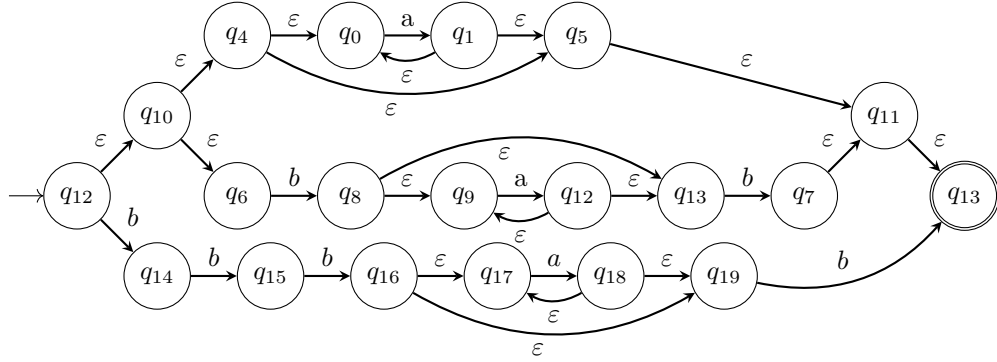


Figure 1.9: Operator ' $a^* + ba^*b + bba^*$ '

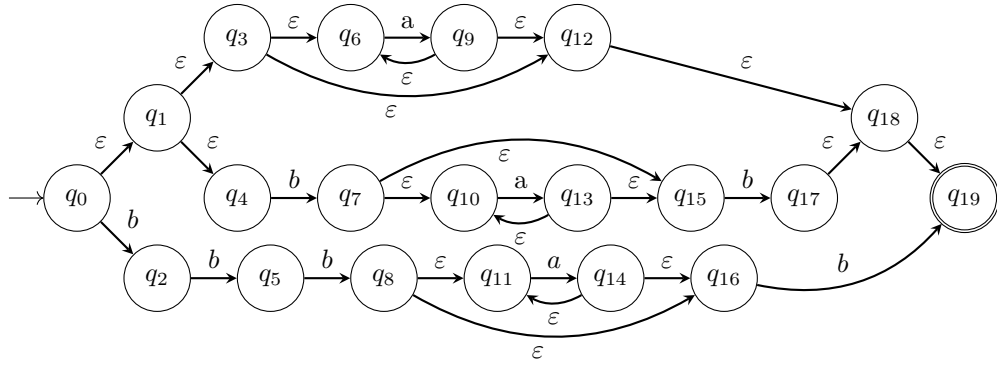


Figure 1.10: Operator ' $a^* + ba^*b + bba^*$ ' - changed names of states

## 1.4 Transforming NFA into DFA using subset algorithm

I will use  $\epsilon_{cl}$  instead of  $\epsilon$ -closure for brevity sake. Final state -  $\underline{q_{19}}$  was marked with an underline and so did all the states of DFA that contain it.

$$\begin{aligned}
A &= \epsilon_{cl}(q_0) = (q_0, q_1, q_3, q_4, q_6, q_{12}, q_{18}, \underline{q_{19}}) = \underline{A} \\
\epsilon_{cl}(\text{move}(\underline{A}, a)) &= (\epsilon_{cl}(\text{move}(q_0, q_1, q_3, q_4, q_6, q_{12}, q_{18}, \underline{q_{19}}, a))) = \epsilon_{cl}(q_9) = (q_9, q_{12}, q_{18}, \underline{q_{19}}) = \underline{B} \\
A &= \epsilon_{cl}(\text{move}(\underline{A}, b)) = \epsilon_{cl}(\text{move}(q_0, q_1, q_3, q_4, q_6, q_{12}, q_{18}, \underline{q_{19}}, b))) = \epsilon_{cl}(q_2, q_7) = (q_{10}, q_{15}) = C \\
\epsilon_{cl}(\text{move}(\underline{B}, a)) &= \epsilon_{cl}(\text{move}(q_9, q_{12}, q_{18}, \underline{q_{19}}, a)) = \emptyset \\
\epsilon_{cl}(\text{move}(\underline{B}, b)) &= \epsilon_{cl}(\text{move}(q_9, q_{12}, q_{18}, \underline{q_{19}}, b)) = \emptyset \\
\epsilon_{cl}(\text{move}(C, a)) &= \epsilon_{cl}(\text{move}(q_{10}, q_{15}), a) = \epsilon_{cl}(q_{13}) = (q_{15}) = D \\
\epsilon_{cl}(\text{move}(C, b)) &= \epsilon_{cl}(\text{move}(q_{10}, q_{15}), b) = \epsilon_{cl}(q_{17}) = (q_{18}, \underline{q_{19}}) = \underline{E} \\
\epsilon_{cl}(\text{move}(D, a)) &= \epsilon_{cl}(\text{move}((q_{15}), a) = \epsilon_{cl}(\emptyset) = \emptyset \\
\epsilon_{cl}(\text{move}(D, b)) &= \epsilon_{cl}(\text{move}((q_{15}), b) = \epsilon_{cl}(q_{17}) = (q_{18}, \underline{q_{19}}) = \underline{E} \\
\epsilon_{cl}(\text{move}(\underline{E}, a)) &= \epsilon_{cl}(\text{move}((q_{18}, \underline{q_{19}}), a) = \epsilon_{cl}(\emptyset) = \emptyset \\
\epsilon_{cl}(\text{move}(\underline{E}, b)) &= \epsilon_{cl}(\text{move}((q_{18}, \underline{q_{19}}), b) = \epsilon_{cl}(\emptyset) = \emptyset
\end{aligned}$$

### 1.4.1 State table

State	a	b
<u>A</u>	<u>B</u>	C
<u>B</u>	$\emptyset$	$\emptyset$
C	D	<u>E</u>
D	$\emptyset$	<u>E</u>
<u>E</u>	$\emptyset$	$\emptyset$
$\emptyset$	$\emptyset$	$\emptyset$

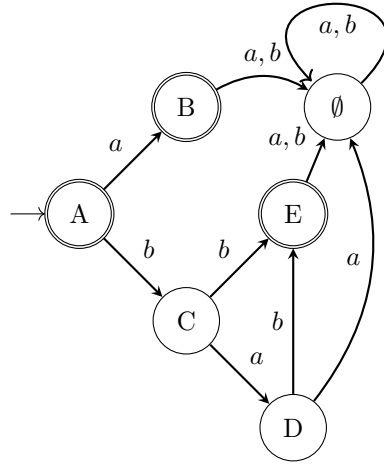


Figure 1.11: DFA graph before minimization

## 1.5 Constructing minimal state DFA