Theoretical Computer Science

Winter semester 21/22

Prof. Dr. Georg Schied

Assignment 5

Deadline: Wednesday, 10 November 2021

8 out of 16 points have to be achieved in order to pass.

Exercise 5.1

Of which *Chomsky type* are the following productions?

(1) $B \rightarrow cA$

(2) $cA \rightarrow B$

(3) $cA \rightarrow BaB$

(4) $C \rightarrow aBc$

Exercise 5.2 - obligatory (4 points)

The following DTD (*document type definition*) for XML documents is given:

```
<!DOCTYPE a [
   <!ELEMENT a (b | c)>
   <!ELEMENT b (c, d?)*>
   <!ELEMENT c (#PCDATA)>
   <!ELEMENT d (#PCDATA)>
]>
```

Which of the following XML documents are *valid* with respect to this DTD? Indicate all errors which are contained in the documents.

```
(1)  <a>
          <c>
               xyz
          </c>
     </a>
```

```
(2)  <a>
          <b>
               <c> 12 </c>
               <d> 34 </d>
               <d> 56 </d>
          </b>
     </a>
```

```
(3)  <a>
          <b>
               <d> 555 </d>
               <c> 444 </c>
               <d> 333 </d>
          </b>
          <c> 666 </c>

     </a>
```

```
(4)  <a>
          <b>
               <c> rrr </c>
               <c> sss </c>
               <d> ttt </d>
               <c> uuu </c>
          </b>
     </a>
```

Exercise 5.3 - obligatory (6 points)

Let A = (~~Q~~ Z, Σ, δ, z_0, E) be a deterministic finite automaton (DFA), where

$Z = \{z_0, z_1, z_2, z_3, z_4, z_5\}$

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

$\delta(z_0,a) = z_1 \quad \delta(z_0, b) = z_2$

$\delta(z_1,a) = z_1 \quad \delta(z_1, b) = z_3$

$\delta(z_2,a) = z_5 \quad \delta(z_2, b) = z_2$

$\delta(z_3,a) = z_3 \quad \delta(z_3, b) = z_4$

$\delta(z_4,a) = z_3 \quad \delta(z_4, b) = z_4$

$\delta(z_5,a) = z_5 \quad \delta(z_5, b) = z_2$

$E = \{z_3, z_4\}$

a) Draw A as a transition diagram.

b) Which of the following strings are accepted by A.

(1) ba

(2) bbb

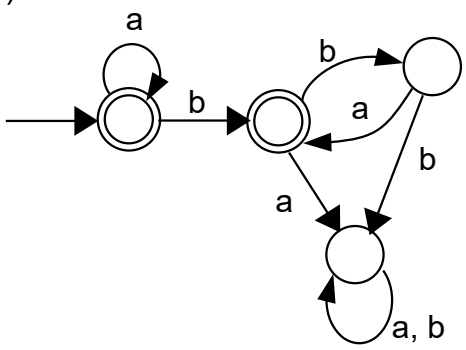
(3) baabab

(4) abababbaaababbba

c) Which language L(A) is accepted by A?

Exercise 5.4

What language does the following DEA accept? (can be specified as a regular expression)



Exercise 5.5

a) Let $\Sigma = \{0,1\}$. Define a deterministic finite automaton (DFA) that accepts the language

$$L_1 = \{w \in \Sigma^* \mid |w| \text{ is odd } \}$$

b) Let $\Sigma = \{0,1\}$. Define a DFA that accepts the language

$$L_2 = \{ 11w00 \mid w \in \Sigma^* \} \cup \{ 00w11 \mid w \in \Sigma^* \}.$$

c) Let $\Sigma = \{\mathtt{a}, \mathtt{b}\}$. Define a DFA accepting all strings $w \in \Sigma^*$ that start with character `b` and contain an odd number of `a` characters.

Exercise 5.6 - obligatory (6 points)

Let $\Sigma = \{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$.

a) Define a DFA that accepts all strings ending with **`bb`**.

b) Define a DFA that accepts the language of the regular expression

`(c`$^+$**`a|b)a*`**.

Exercise 5.7

Define a DFA that accepts all floating-point numbers that are build as following:

- The integer part preceding the decimal point and the fractional part after the decimal point can consist of an arbitrary number of digits (one or more).
- If there is an exponent, it begins with 'e' or 'E', has an optional sign '+' or '-' and an arbitrary number of digits (one or more).

Here are some examples:

```
123.4500
12.345e6
0.20E+678
1004.5e-6789
```

You can omit error states.