

## Homework 4

Please submit your solutions via email. Please submit only ASCII text or PDFs. Every solution should be preceded by the corresponding question, like:

**Q<sub>n</sub>:**     ...a difficult question from me...  
**A:**        ...an answer from you ...  
**Q<sub>n</sub> + 1**   ...another difficult question...  
**A:**        ...another brilliant answer from you...

Solutions will only be accepted until 30th December! Please send only one homework per email.

1. If a regular expression  $r$  does not contain any occurrence of  $\emptyset$ , is it possible for  $L(r)$  to be empty?
2. Define the tokens and regular expressions for a language consisting of numbers, left-parenthesis (, right-parenthesis ), identifiers and the operations +, - and \*. Can the following strings in this language be lexed?
  - $(a + 3) * b$
  - $)() + + - 33$
  - $(a/3) * 3$

In case they can, can you give the corresponding token sequences.

3. Assume that  $s^{-1}$  stands for the operation of reversing a string  $s$ . Given the following *reversing* function on regular expressions

$$\begin{aligned} rev(\emptyset) &\stackrel{\text{def}}{=} \emptyset \\ rev(\epsilon) &\stackrel{\text{def}}{=} \epsilon \\ rev(c) &\stackrel{\text{def}}{=} c \\ rev(r_1 + r_2) &\stackrel{\text{def}}{=} rev(r_1) + rev(r_2) \\ rev(r_1 \cdot r_2) &\stackrel{\text{def}}{=} rev(r_2) \cdot rev(r_1) \\ rev(r^*) &\stackrel{\text{def}}{=} rev(r)^* \end{aligned}$$

and the set

$$Rev A \stackrel{\text{def}}{=} \{s^{-1} \mid s \in A\}$$

prove whether

$$L(rev(r)) = Rev(L(r))$$

holds.

4. Assume the delimiters for comments are `/*` and `*/`. Give a regular expression that can recognise comments of the form

$$/* \dots */$$

where the three dots stand for arbitrary characters, but not comment delimiters. (Hint: You can assume you are already given a regular expression written `ALL`, that can recognise any character, and a regular expression `NOT` that recognises the complement of a regular expression.)

5. Simplify the regular expression

$$(\emptyset \cdot (b \cdot c)) + ((\emptyset \cdot c) + \epsilon)$$

Does simplification always preserve the meaning of a regular expression?

6. The Sulzmann & Lu algorithm contains the function `mkeps` which answers how a regular expression can match the empty string. What is the answer of `mkeps` for the regular expressions:

$$\begin{aligned} &(\emptyset \cdot (b \cdot c)) + ((\emptyset \cdot c) + \epsilon) \\ &(a + \epsilon) \cdot (\epsilon + \epsilon) \end{aligned}$$

7. What is the purpose of the record regular expression in the Sulzmann & Lu algorithm?