CPSC 351 — Tutorial Exercise #7

Regular Operations and Regular Expressions

1 About This Exercise

This exercise is intended to help you to understand and use regular operations and regular expressions.

Getting Started

The first two problems should be straightforward, Discussion of these will probably be limited, in the tutorial, so that there is time to discuss and work on the (somewhat) more challenging problems that follow them.

1. Each of the following is a regular expression over the alphabet $\Sigma = \{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$. Give a brief description of the ***language*** of these regular expressions in simple English (or set-theoretic notation, if that is easier for you to do).

   (a) $(((\mathtt{a})^\star \cup (\mathtt{b})^\star) \cup (\mathtt{c})^\star)$

   (b) $(((\mathtt{a})^\star \circ (\mathtt{b})^\star) \circ (\mathtt{c})^\star)$

   (c) $((\Sigma \cup \lambda) \circ (\Sigma \cup \lambda))$

2. Describe the languages of each of the following regular expressions over the alphabet $\Sigma = \{\mathtt{a}, \mathtt{b}, \mathtt{c}, \mathtt{d}\}$. These are all regular expressions that can arise when regular expressions are used in computer software.

   (a) $(\Sigma \cup \emptyset)$

   (b) $(\Sigma \circ \emptyset)$

   (c) $(\Sigma \cup \lambda)$

   (d) $(\lambda \cup \emptyset)$

Problems Discussed in the Tutorial

3. Describe the language of each of the following regular expressions over the alphabet $\Sigma = \{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$. These are regular expressions that can arise when regular expressions are used in computer software — and ***they might be trickier than they appear***.

   (a) $(\emptyset)^\star$

   (b) $(\lambda)^\star$

4. Let $\Sigma = \{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$. Give a regular expression over Σ whose language is the set of strings in $\Sigma^\star$ that have at most four copies of the symbol "a" (but which can have any number of copies of "b" or "c") — and show that your answer is correct.