CPSC 313 — Tutorial Exercise #3

Design and Verification of Deterministic Finite Automata

About This Exercise

The following lecture concerns material found in Section 1.1 of *Introduction to the Theory of Computation* and presented in the following lectures.

- Lecture #3: Design of Deterministic Finite Automata
- Lecture #4: Verification of Deterministic Finite Automata

This exercise will be discussed in the tutorials on Monday, January 24, Tuesday, January 25 and Wednesday, January 26. Please try to solve the problems in this exercise ***before*** attending this tutorial, so that you can participate in discussions about how these problems are to be solved and compare your (partial or complete) solutions to the solutions of other students in the class.

Problems To Be Solved

1. Let $\Sigma = \{\mathrm{a}, \mathrm{b}, \mathrm{c}\}$ once again. Use the ***design process*** from Lecture #3 to produce deterministic finite automata for each of the following languages.

   (a) $L = \{\lambda\}$

   (b) $L = \{\omega \in \Sigma^\star \mid \omega \text{ includes at most one } \mathrm{c}\}$

   (c) $L = \{\omega \in \Sigma^\star \mid \omega \text{ includes exactly one } \mathrm{c}\}$

   (d) $L = \{\omega \in \Sigma^\star \mid \mathrm{cc} \text{ is a substring of } \omega\}$
   Recall that a string φ is a ***substring*** of another string ω if and only if

   $$\omega = \mu \cdot \varphi \cdot \nu$$

   for strings $\mu, \nu \in \Sigma^\star$ — so that the symbols in φ must appear, one immediately after the other, in ω. Thus the above language is ***not*** the same as the set of strings that include two or more c's.

(e) The set L of strings in $\Sigma^\star$ that include an a, with a b appearing eventually after that (but, possibly, with other symbols in between), and with another a appearing eventually after the b (possibly with other symbols in between, once again).

(f) $L = \{\omega \in \Sigma^\star \mid \texttt{aba} \text{ is a substring of } \omega\}$

(g) $L = \{\omega \in \Sigma^\star \mid \text{the length of } \omega \text{ is divisible by } 4\}$

Note: The trickiest part of this kind of "design" process probably consists of the initial steps — deciding what information the automaton needs to remember to recognize the given language, and mapping this to a set of subsets of $\Sigma^\star$ that will corresponds to states of the automaton.

Hints about this will be provided in a separate file. However, students are encouraged to try to figure this out without looking that this file — you will be better prepared for later design exercises if you can do that!

2. Apply the ***verification process*** described in Lecture #4 to one (or, ideally, all) of the automata that you produced, when answering the previous question, in order to confirm that your answer is correct.