CS 516—Software Foundations via Formal Languages—Spring 2025

Problem Set 3

Due by 11:59pm on Thursday, March 6

Problem 1 (25 Points)

Define a function **diff** $\in \{0,1\}^* \to \mathbb{Z}$ by: for all $w \in \{0,1\}^*$,

$$\textbf{diff}\, w = \text{the number of } 1\text{'s in } w - \text{the number of } 0\text{'s in } w.$$

Let $X = \{\, w \in \{0,1\}^* \mid |w| \leq 6 \text{ and } \textbf{diff}\, w = 0 \,\}$.

Use Forlan to find and show the correctness of a regular expression α such that $L(\alpha) = X$. Try to make α as simple as possible (see `Reg.compareComplexity`), and use Forlan to display the size, number of concatenations, and number of symbols of α, as well as whether α is standardized. Try to do as much as possible of the work of finding and showing the correctness of α using Forlan. See the book or the Forlan manual for some useful functions for creating regular expressions that were not covered in the slides. (Include a listing of your Forlan session.)

Problem 2 (5 Points)

Solve Exercise 3.3.7, finding regular expressions α and β such that $\textbf{cc}\, \alpha = \textbf{cc}\, \beta$ but $\textbf{size}\ \alpha \neq \textbf{size}\ \beta$. Use Forlan to check your solution. (Provide a transcript of your Forlan session.)

Problem 3 (10 Points)

Use `Reg.locallySimplifyTrace` to illustrate how reduction rule (20) works as part of local simplification. (Include a listing of your Forlan session.)

Problem 4 (60 points)

Let **diff** be as in Problem 1, and define $Y = \{\, w \in \{0,1\}^* \mid \text{for all prefixes } v \text{ of } w, -2 \leq \textbf{diff}\, v \leq 2 \,\}$.

(a) Find a regular expression α such that $L(\alpha) = Y$. [15 points]

(b) Prove that your answer to part (a) is correct. [45 points]