CS 591 S2—Formal Language Theory: Integrating Experimentation and Proof—Fall 2018

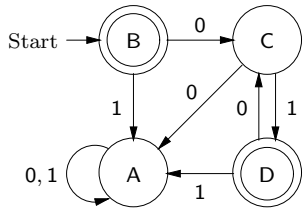
Problem Set 5

Due by 12:30pm on Thursday, November 15

You must submit your problem set solution as a hard copy, either: at the* beginning *of class; or, no later than 12:05pm, via the CS Department drop box labeled "CS 591 S2". In addition, see the instructions in Problem 3 for emailing the Forlan code for Problem 3(b) to me, no later than 12:30pm.

Problem 1 (20 points)

Let M be the DFA



Give a step-by-step explanation of how our DFA minimization algorithm turns M into a DFA N with as few states as possible. Draw N and use Forlan to check that your final answer is correct. Include a transcript of your Forlan session.

Problem 2 (15 points)

Find DFAs M_1 and M_2 such that the DFAs

$$N_1 = \mathbf{minus}(M_1, M_2),$$
$$N_2 = \mathbf{inter}(M_1, \mathbf{complement}(M_2, \emptyset))$$

are *not* equivalent. Use Forlan to check that your answer is correct, and to show how the languages accepted by N_1 and N_2 are related. Include a transcript of your Forlan session.

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Problem 3 (65 points)

Define $\mathbf{IFF} \in \{0,1\}^* \times \{0,1\}^* \to \mathbf{Lan}$ by: for all $x, y \in \{0,1\}^*$,

$$\mathbf{IFF}(x,y) = \{\, w \in \{0,1\}^* \mid x \text{ is a substring of } w \text{ iff } y \text{ is a substring of } w \,\}.$$

For example, 00, 0110, 1001 and 010 are example elements of $\mathbf{IFF}(01,10)$, but 001 and 100 are not elements of this language.

(a) Explain how some of the functions/algorithms that we have studied can be used to define a function/algorithm $\mathbf{iffDFA} \in \{0,1\}^* \times \{0,1\}^* \to \mathbf{DFA}$ such that, for all $x, y \in \{0,1\}^*$, $\mathbf{iffDFA}(x,y)$ is a DFA, with as few states as possible, such that $L(\mathbf{iffDFA}(x,y)) = \mathbf{IFF}(x,y)$. Prove that your answer is correct. [40 points]

(b) In a file `ps5-p3.sml`, define an SML/Forlan function

```
val iffDFA : str * str -> dfa
```

corresponding to your definition of **iffDFA**. You should assume that `iffDFA` will only be called with elements of $\{0,1\}^*$. Include a printout of `ps5-p3.sml` in your hard copy submission, as well as a transcript of the Forlan session in which you evaluate the declaration

```
val dfa = iffDFA(Str.fromString "0011", Str.fromString "1100");
```

and display `dfa` using `DFA.output`. Draw `dfa`, doing your best to make its structure clear. Finally, email `ps5-p3.sml` as a plain text attachment to me (`stough@bu.edu`), with a subject line including "`[591S2:PS5]`". [25 points]