"CS 374" Spring 2015 — Homework 2

Due Tuesday, February 10, 2015 at 10am

••• Some important course policies •••

- **You may work in groups of up to three people.** However, each problem should be submitted by exactly one person, and the beginning of the homework should clearly state the names and NetIDs of each person contributing.
- **You may use any source at your disposal**—paper, electronic, or human—but you ***must*** cite ***every*** source that you use. See the academic integrity policies on the course web site for more details.
- **Submit your pdf solutions in Moodle.** See instructions on the course website and submit a separate pdf for each problem. Ideally, your solutions should be typeset in LaTex. If you hand write your homework make sure that the pdf scan is easy to read. Illegible scans will receive no points.
- **Avoid the Three Deadly Sins!** There are a few dangerous writing (and thinking) habits that will trigger an automatic zero on any homework or exam problem. Yes, we are completely serious.
  - Give complete solutions, not just examples.
  - Declare all your variables.
  - Never use weak induction.
- Unlike previous editions of this and other theory courses we are not using the "I don't know" policy.

See the course web site for more information.

If you have any questions about these policies,
please don't hesitate to ask in class, in office hours, or on Piazza.

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1. (a) Draw an NFA that accepts the language $\{w \mid$ there is exactly one block of 0s of even length$\}$. (A "block of 0s" is a substring of 0s that is not contained in any longer substring of 0s.)

   (b) i. Draw an NFA for the regular expression $(010)^* + (01)^* + 0^*$.

   ii. Now using the powerset construction (also called the subset construcion), design a DFA for the same language. Label the states of your DFA with names that are sets of states of your NFA.

2. Let L be regular and accepted by DFA $M = (Q, \Sigma, \delta, q_0, F)$. Show that the language $\text{SELF-REFLECT}(L) = \{w \mid ww^R \in L\}$ is also regular by constructing an NFA $N = (Q^N, \Sigma, \delta^N, q_0^N, F^N)$ that accepts it. You should completely/precisely/formally specify the components of N in terms of those of M. Make sure to describe in English how your NFA works.

3. Let $M = (Q, \Sigma, \delta, q_0, F)$ be a DFA. Define $\overline{M}$ to be the DFA obtained by swapping final and nonfinal states of M. That is, $\overline{M} = (Q, \Sigma, \delta, q_0, Q - F)$.

   (a) What is the relationship between $L(M)$ and $L(\overline{M})$? Explain your answer.

   (b) Now let $M = (Q, \Sigma, \delta, q_0, F)$ be an NFA, and define the NFA $\overline{M} = (Q, \Sigma, \delta, q_0, Q - F)$. Describe $L(\overline{M})$. For any language L, let $\overline{L} = \Sigma^* - L$ be the complement of L. In particular, for any NFA M, $\overline{L(M)}$ is the set of strings that are not in $L(M)$. What is the relationship between $L(\overline{M})$ and $\overline{L(M)}$? Explain your answer.

   (c) Define an NFA that accepts $\overline{L(M)} - L(\overline{M})$, and explain how it works.

   (d) Define an NFA that accepts $L(\overline{M}) - \overline{L(M)}$, and explain how it works.